



PEDRO HENRIQUE MENDES CARVALHO

**TWO NEW SPECIES OF *PHAEOPHILACRIS* WALKER, 1871
(ORTHOPTERA: GRYLLOIDEA: PHALANGOPSIDAE) FROM
CAVES IN KENYA AND PICTORIAL KEY FOR *PH.*
(*TAENACRIS*) GOROCHOV, 2020**

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RESUMO

O gênero *Phaeophilacris* Walker, 1871, pertencente à família Phalangopsidae, é endêmico do continente africano. Abriga atualmente 80 espécies agrupadas em 11 subgêneros. Mais de 50% dessas espécies são encontradas em ambientes subterrâneos. Organismos encontrados nesses locais podem ser classificados de acordo com o grau de adaptação às condições ambientais limitantes do habitat em que vivem. Neste estudo, são apresentadas a descrição de duas novas espécies de grilos troglófilos do gênero *Phaeophilacris* recentemente descobertas nas cavernas Kereita e Baboons, ambas localizadas no Quênia. As duas espécies recém-descritas foram alocadas no subgênero *Ph. (Taenacris)* Gorochoy, 2020, principalmente com base em características específicas observadas na genitália de grilos machos adultos. Adicionalmente, é fornecida a primeira chave pictórica para o subgênero *Ph. (Taenacris)*. A descrição de novas espécies para o gênero *Phaeophilacris* não só amplia nosso conhecimento acerca da diversidade desse grupo, mas também fornece subsídios para o desenvolvimento de muitas outras áreas da Biologia, incluindo conservação e gestão de ecossistemas subterrâneos.

Palavras-chave: taxonomia, complexo fálico, grilos de caverna

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1. INTRODUÇÃO

A família Phalangopsidae Blanchard, 1845 (Orthoptera, Grylloidea) é caracterizada por seus grandes escapos antenais, pernas notavelmente alongadas em comparação com o comprimento total do corpo, e, devido à semelhança de sua aparência com aranhas, são conhecidos como "spider-cricket" ou grilos-aranha (Souza-Dias, 2015). Os falangopsídeos apresentam ampla distribuição, sendo encontrados em ambientes tropicais e subtropicais de todo o mundo (Cigliano *et al.*, 2023), especialmente na região Neotropical, seu centro de diversificação (Desutter-Grandcolas, 1995; Souza-Dias, 2015). Esses grilos podem ter hábito diurno ou noturno e são encontrados na serapilheira, arbustos, sob galhos de árvores, em fendas de troncos ou rochas e em ambientes subterrâneos (Desutter-Grandcolas, 1995).

Os habitats subterrâneos englobam uma enorme diversidade de ecossistemas, tais como cavernas, águas subterrâneas, vazios resultantes de escavações artificiais, e redes de fissuras e poros na rocha, cujas dimensões desafiam a exploração direta por seres humanos (Culver & Pipan, 2019). Esses ambientes subterrâneos são caracterizados pela escassez de recursos alimentares, ausência de luz e estabilidade climática, especialmente no que se refere a temperatura e umidade (Ginet & Decou, 1977; Camacho, 1992).

Os organismos que habitam ambientes subterrâneos frequentemente manifestam adaptações morfológicas e fisiológicas, denominadas troglomorfismos, que conferem a eles a capacidade de enfrentar as condições limitantes associadas a esses habitats (Christiansen, 1962). Neste contexto, pode-se empregar a classificação Schiner-Racovitza para agrupar organismos cavernícolas com base no grau de adaptação às condições do ambiente subterrâneo. As espécies denominadas estigóxenas e troglóxenas habitam temporariamente ambientes subterrâneos, porém obrigatoriamente completam seus ciclos de vida na superfície; as espécies estigófilas e troglófilas, por sua vez, apresentam populações consolidadas tanto em ambientes epígeos quanto hipógeos; por fim, os organismos estigóbios e troglóbios são estritamente cavernícolas, completando integralmente seus ciclos de vida em ambientes subterrâneos (Holsinger & Culver, 1988; Gibert & Deharveng, 2002; Sket, 2008).

Durante expedição a cavernas no Quênia, pesquisadores do Centro de Estudos em Biologia Subterrânea da Universidade Federal de Lavras encontraram grilos falangopsídeos troglófilos do gênero *Phaeophilacris* Walker, 1871. Esse gênero apresenta uma íntima relação com ambientes cavernícolas, sendo mais da metade das espécies encontradas em ambientes subterrâneos (Cigliano *et al.*, 2023).

O presente estudo, por conseguinte, tem como objetivo ampliar o entendimento acerca da diversidade e distribuição do gênero *Phaeophilacris* mediante a descrição de duas novas espécies, coletadas em cavernas na região sudoeste do Quênia.

A descrição de novas espécies é fundamental para a documentação da biodiversidade, monitoramento de populações, análises precisas de comunidades e ecossistemas e implementação eficaz de medidas de conservação em ambientes ameaçados por atividades antrópicas. Por esse motivo, além da descrição dos caracteres morfológicos observados em cada uma das duas novas espécies, são apresentadas informações relevantes a respeito do habitat e papel ecossistêmico desempenhado por esses organismos.

O artigo elaborado para esta monografia foi redigido em conformidade com as diretrizes do periódico *Zootaxa*. Na Introdução, delineamos sucintamente o histórico taxonômico do gênero *Phaeophilacris*, com especial ênfase no subgênero *Phaeophilacris* (*Taenacris*), no qual as duas novas espécies, objeto deste estudo, foram alocadas e, em Material e Métodos, fornecemos informações essenciais sobre a localidade-tipo das duas novas espécies, assim como o número de indivíduos coletados. Além disso, destacamos a metodologia empregada na descrição e medição de caracteres morfológicos gerais. Ressaltamos, de modo particular, a importância da descrição minuciosa da genitália masculina desse grilo. Essa ênfase é justificada pela relevância dessa estrutura anatômica, que abriga características diagnósticas fundamentais não apenas para a discriminação e identificação de espécies de *Phaeophilacris*, mas também de grande parte dos falangopsídeos.

Na sessão Resultados, apresentamos e descrevemos, com auxílio de fotografias, os caracteres morfológicos gerais e a genitália masculina das novas espécies. Adicionalmente, provemos informações pertinentes sobre o habitat no qual esses organismos estão inseridos, contextualizando-os em seu ambiente natural. Na Discussão, estabelecemos uma comparação criteriosa entre as genitálias masculinas das duas espécies recém-descritas e aquelas pertencentes às outras cinco espécies do subgênero *Ph.* (*Taenacris*). Em seguida, disponibilizamos uma chave pictórica de identificação de espécies para o subgênero, proporcionando uma ferramenta útil para futuras pesquisas e estudos taxonômicos.

Em última análise, enfatizamos que este estudo não apenas contribui para a ampliação do conhecimento acerca da diversidade do gênero *Phaeophilacris*, mas também fornece subsídios essenciais para futuras pesquisas em outros segmentos da Biologia. Dessa forma, o referido artigo tem implicações significativas não apenas no âmbito da taxonomia, mas também no que concerne à conservação e gestão de ecossistemas subterrâneos.

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Two new species of *Phaeophilacris* Walker, 1871 (Orthoptera: Grylloidea: Phalangopsidae) from caves in Kenya and pictorial key for *Ph. (Taenacris)* Gorochov, 2020

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Abstract

The genus *Phaeophilacris* Walker, 1871 (Grylloidea: Phalangopsidae), endemic to Africa, currently encompasses 80 species grouped into 11 subgenera. Over half of these species inhabit subterranean environments. This study introduces the description of two novel species discovered in two distinct caves in Kenya. The two species described herein are assigned to the subgenus *Ph. (Taenacris)* Gorochov, 2020, based on distinct male genitalia characteristics. Additionally, we provide the first pictorial key for the subgenus *Ph. (Taenacris)*.

Key words: taxonomy, phallic complex, cave crickets

Resumo

O gênero *Phaeophilacris* Walker, 1871 (Grylloidea: Phalangopsidae), endêmico da África, atualmente engloba 80 espécies agrupadas em 11 subgêneros. Mais da metade dessas espécies habita ambientes subterrâneos. Este estudo apresenta a descrição de duas novas espécies descobertas em duas cavernas distintas no Quênia. As duas espécies aqui descritas são atribuídas ao subgênero *Ph. (Taenacris)* Gorochov, 2020, principalmente com base em características distintas dos órgãos genitais masculinos. Além disso, fornecemos a primeira chave pictórica para o subgênero *Ph. (Taenacris)*.

Palavras-chave: taxonomia, complexo fálico, grilos de caverna

Introduction

According to the Orthoptera Species File (Cigliano *et al.* 2023), there are currently 23 genera of Phalangopsidae listed for Africa: *Afrophaloria* Desutter-Grandcolas, 2015, *Heterotrypus* Saussure, 1878, *Hirpinus* Stål, 1855, *Homoeogryllus* Guérin-Méneville, 1847, *Kameruloria* Gorochov, 2003, *Larandeicus* Chopard, 1937, *Paragryllodes* Karny, 1909, *Paragryllus* Guérin-Méneville, 1844,

Phaeogryllus Bolívar, 1912, *Phaeophilacris* Walker, 1871, *Phalangacris* Bolívar, 1895, *Phaloria* Stål, 1877, *Phasmagryllus* Desutter-Grandcolas, 2015, *Prosecogryllus* Brancsik, 1893, *Seselia* Hugel & Desutter-Grandcolas, 2021, *Schizotrypus* Chopard, 1954, *Socotracris* Desutter-Grandcolas, 2012, *Stalacris* Desutter-Grandcolas, 2013, *Subtiloria* Gorochov, 1999, *Ugandacla* Gorochov, 2022, *Upupagryllus* Desutter-Grandcolas, 2015, *Xenadenacris* Gorochov, 2020, *Zaora* Walker, 1869.

The genus *Phaeophilacris* is endemic to the African continent and exhibits a wide distribution range across all central sub-Saharan Africa, spanning from the eastern regions (Somalia, Kenya, Tanzania) to the western coast (Angola, Gabon, Cameroon) (Cigliano *et al.* 2023). Additional occurrences have been documented in Ghana, Ivory Coast, Sierra Leone, and Guinea (Cigliano *et al.* 2023), with several new records being shared recently specially through citizen science (see: <https://www.inaturalist.org/observations?taxon_id=371965>).

Despite the extensive distribution range of the genus, *Phaeophilacris* species are predominantly found in regions with high and relatively constant air humidity (Kaltenbach 1983). Previous studies have recorded their presence in hygrophilous forests (Kaltenbach 1983) and unconventional habitats such as termite nests (Sjöstedt 1910; Chopard 1946), wells, rodent burrows, recently excavated wild boar burrows, and caves (Kaltenbach 1983). Some specimens have also been observed in grass huts of villagers in Mozambique (Kaltenbach 1983) and near urban environments (see: <https://www.inaturalist.org/observations?taxon_id=371965 >) Notably, over half of the described species within the genus are troglaxene or troglophile (Kaltenbach 1983; Cigliano *et al.* 2023). Moreover, certain species, namely *Ph. adami* Chopard, 1969, may exhibit troglomorphisms, such as significantly reduced compound eyes, depigmented tegument, and elongated antennae and cerci (Chopard 1969), emphasizing their adaptability to subterranean environments.

Molecular phylogenetic evidence suggests that the genus is part of a monophyletic clade (Chintauan-Marquier *et al.* 2016). Currently, *Phaeophilacris* comprises 80 species grouped in 11 subgenera, distinguished primarily by differences in the male genitalia (Kaltenbach 1983; Gorochov 2020; 2022). The subgenera are as follows: *Ph. (Araneacris)* Gorochov, 2022, *Ph. (Bukobacris)* Gorochov, 2020, *Ph. (Cavernacris)* Sjöstedt, 1910, *Ph. (Djacris)* Gorochov, 2020, *Ph. (Guasacris)* Sjöstedt, 1912, *Ph. (Hymenacris)* Gorochov, 2020, *Ph. (Korupacris)* Gorochov, 2020, *Ph. (Phaeophilacris)* Walker, 1871, *Ph. (Pholeogryllus)* Chopard, 1923, *Ph. (Speluncacris)* Sjöstedt, 1910, e *Ph. (Taenacris)* Gorochov, 2020 (Cigliano *et al.* 2023).

Ph. (Taenacris) is defined by having membranous epiphallic posterolateral lobes resembling a finger in shape, with a narrow sclerotized band throughout their extent (Gorochov 2020). Additionally, the distal end of their ectoparameres is rounded or tapered, and shorter than the epiphallic posterolateral lobes (Gorochov 2020). There are five species within the subgenus *Ph. (Taenacris)*: *Ph. (T.) anikini* Gorochov, 2020, *Ph. (T.) brevipes* Chopard, 1957, *Ph. (T.) chopardiana* Kaltenbach, 1983, *Ph. (T.) cycloptera* Kaltenbach, 1986 and *Ph. (T.) tomentosa* Kaltenbach, 1986 (Cigliano *et al.* 2023). *Ph. (T.) brevipes*, *Ph. (T.) cycloptera*, and *Ph. (T.) tomentosa*, particularly, have caves as their type locality (Cigliano *et al.* 2023). Although *Ph. (T.) anikini* type locality is an epigeal habitat, specimens were found inside of caves (Gorochov 2020).

In light of the substantial diversity observed among crickets within the genus *Phaeophilacris*, the objective of this study is to describe two new species found in caves in Kenya. Furthermore, we provide a pictorial key as well as a distribution map for the subgenus *Ph. (Taenacris)* to assist in future endeavors requiring species-level identification of these organisms.

Material and methods

Collection and depository – Holotype and paratype of *Ph. (T.) kereita* n. sp. (2 ♂♂) were, through active search, found and captured during a visit to Kereita cave (36°39'46.62"E, 0°56'3.03"S), located in Gatamaiyu Forest Natural Reserve, Kenya, in January 24th 2020. Holotype of *Ph. (T.)* n. sp. 2 (1 ♂)

was captured using the same method during a visit to Baboons cave (36°24'17.168"E, 1°7'54.422"S), located in the Mount Suswa, Rift Valley, Kenya, in January 23rd 2020.

Depository – Specimens were subjected to preservation in 70% ethanol. Holotypes of *Ph. (T.) n. sp. 1* and *Ph. (T.) n. sp. 2* were deposited in a collection of a research facility in Kenya. The paratype of *Phaeophilacris (Taenacris) n. sp. 1* was accessioned in the Collection of Subterranean Invertebrates of Lavras (ISLA) at the Center of Studies on Subterranean Biology (CEBS), situated at the Federal University of Lavras (UFLA) in the state of Minas Gerais, Brazil.

Examination – The morphology of the two new herein described species was examined and compared using a Stemi 2000 (ZEISS) stereomicroscope. Detailed measurements and photographs of the overall morphology were conducted utilizing an Axio Zoom V16 (ZEISS) stereomicroscope.

Adult males underwent dissection, and their phallic complexes were immersed, for a minimum period of 24 hours, in eppendorf tubes containing a pancreatin enzymatic solution (Álvarez-Padilla & Hormiga 2007). Following digestion, the phallic complexes underwent thorough examination and comparison using a Stemi 2000 (ZEISS) stereomicroscope. Photographs were acquired using an Axio Zoom V16 (ZEISS) stereomicroscope. All photographs were edited using Adobe Photoshop.

The nomenclature employed in the description of the phallic complex of the two new species was originally introduced by Gorochov (1995) in Russian, subsequently adapted to English (Gorochov 2002), and further refined by the same author in subsequent works (2011; 2014).

Abbreviations – *Male phallic complex*: Epiphallus — **Ep.a.**, anterior portion of the epiphallus; **Ep.p.**, posterior portion of the epiphallus; **Ep.pl.**, epiphallic posterolateral lobes; **Rm.**, rami. Ectoparamere — **Ect.av.**, ectoparameric anteroventral lobe; **Ect.pd.**, ectoparameric posterodorsal lobe. Endoparamere — **A.p.**, apodema principale. **R.**, rachis. **F.**, formula.

Results

Family Phalangopsidae Blanchard, 1845

Tribe Phalangopsini Blanchard, 1845

Subtribe Phaeophilacridina Gorochov, 2020

Genus *Phaeophilacris* Walker, 1871

Subgenus *Phaeophilacris (Taenacris)* Gorochov, 2020

Phaeophilacris (Taenacris) n. sp. 1

(Figures 2–6, 7–14, 15–17, 18–22; Table 1)

Material examined — Holotype, ♂, Kenya, Gatamaiyu Forest Natural Reserve, Kereita cave (36°39'46.62"E, 0°56'3.03"S), 24.I.2020, R.L. Ferreira; condition: body coloration tarnished, male genitalia dissected and stored alongside the holotype, left legs I, II and III, and right leg III detached and also stored alongside the holotype. Paratype, ♂, Kenya, Gatamaiyu Forest Natural Reserve, Kereita cave (36°39'46.62"E, 0°56'3.03"S), 24.I.2020, R.L. Ferreira; condition: body coloration slightly tarnished, male genitalia dissected and stored alongside the holotype, left legs I, II and III detached and also stored alongside the paratype, right leg III missing.

Diagnosis — Combination of the following characteristics: posterior portion of the epiphallus membranous and U-shaped (Figs. 2 and 3, Ep.p.); posterolateral lobes of the epiphallus short and curved backwards, apex subtriangular-shaped and dorsally projected (Figs. 2, 5 and 6, Ep.pl.); ectoparameres

divided into anteroventral lobe and posterodorsal lobes, posterior margin of the anteroventral lobe with a short, centralized and rounded projection pointing towards the posterior region of the genitalia, posterodorsal lobe tapered, slightly curved outwards and roughly V-shaped (Figs. 3, 5 and 6, Ect.av. and Ect.pd.); rachis with an anteromedial constriction, forming a ring around the posterior portion of the formula, posterior margin quadrangular (Fig. 3, R.).

Male genitalia (holotype, Figs. 2–6) — phallic complex short in general view (Figs. 2–6). **Epiphallus**: anterior portion dorsally projected and inclined forward, lateral margins rounded and expanding, to a small extent, backwards (Figs. 2 and 6, Ep.a.); posterior portion membranous and U-shaped (Figs. 2 and 3, Ep.p.); posterolateral lobes short, predominantly membranous, with a slightly sclerotized band extending along their entire length, curved upwards (in lateral view) and inwards (in dorsal and ventral views), apex subtriangular-shaped and dorsally projected, with dorsolateral surface covered with setae, lateral setae elongated (Figs. 2, 3 and 6, Ep.pl.); rami missing (Rm.). **Ectoparameres**: sclerotized and divided into anteroventral lobe and posterodorsal lobe (Figs. 3–6, Ect.av. and Ect.pd.); anteroventral lobe well-developed, expanding both ventrally and laterally, with an almost quadrangular contour in lateral view, inner margin with a medium-sized rounded projection towards the center of the genitalia, posterior margin with a short, centralized, and rounded projection pointing towards the posterior region of the genitalia (Figs. 3–6, Ect.av.); posterodorsal lobe tapered, extending towards the posterior region of the genitalia, reaching in length the posterior margin of the epiphallus, slightly curved outwards, with a shape similar to that of a fin in ventral view, outline roughly V-shaped in lateral and laterofrontal views (Figs. 3–6, Ect.pd.). **Endoparamere**: apodema principale membranous, concave (in lateral view), extremities slightly curved upwards (Fig. 3, A.p.). **Rachis**: almost as long as the central margin of the posterior portion of the epiphallus, sclerotized, with an anteromedial constriction, forming a ring around the posterior portion of the formula, posterior margin with a quadrangular outline (in ventral view) and small acute centered projection in frontal view (Figs. 3 and 4, R.). **Formula**: almost as long as the apodema principale, rectangular-shaped and membranous, region adjacent to the constriction of the rachis smaller in diameter and slightly sclerotized (Fig. 3, F.).

Variations in the male genitalia (paratype) — **Epiphallus**: posterolateral lobes (Ep.pl.) with a sclerotized and wide band extending along their entire length, curved backwards but not inwards; rami (Rm.) slightly sclerotized, elongated, longer than the apodema principale. **Endoparamere**: apodema principale (A.p.) slightly sclerotized, concave in lateral view, extremities slightly curved towards the dorsal region of the genitalia. **Formula** (F.) shorter than the apodema principale, rectangular and sclerotized, with the margin adjacent to the constriction of the rachis being more sclerotized than the rest of the structure.

Body morphology (holotype, Figs. 7–17) — **Body color** (after fixation in ethanol 70%): head, pronotum, tegmina, abdomen, cerci and legs pale whitish yellow, without dark spots (Figs. 7–14); **Body color** (in vivo observations): general coloration pale brown, locomotor appendages yellowish-orange (Figs. 21–22). **Head**: slightly pubescent, dorsoventrally elongated (Figs. 7 and 8), fastigium covered by long setae and approximately as wide as half the length of the antennal scape (Fig. 9); scape well-developed, 1.5 times longer than the compound eyes in lateral view (Fig. 8); maxillary palp divided into five palpomeres, the first two short and of similar length, palpomeres III and IV elongated and of comparable length, the terminal palpomere longer than the others with a club-shaped apex (Fig. 8); labial palp short and divided into three parts, the posterior palpomere as long as the anterior and median palpomeres combined, featuring a rounded and dilated apex (Fig. 8); ocelli absent, and the compound eyes slightly reduced, dorsal region near the antennal cavities depigmented (Figs. 7 to 9). **Thorax**: pronotum pubescent, with its anterior and posterior margins arched and covered by elongated bristles, the median region intersected by an anteroposterior groove, lateral lobes subtriangular, facing downward and slightly towards the head (Figs. 8 and 11); metanotal gland poorly developed, confined to the anterior margin of the metanotum, adorned with numerous setae, concealed by the tegmina, and subdivided into left and right lobes, which are separated by a whitish line that extends anterodorsally until reaching the

supra-anal plate (Fig. 13). **Abdome:** tergites pubescent; supra-anal plate subtriangular-shaped and pubescent, with a rounded posterior margin covered by long bristles, shorter than the subgenital plate and equal in length to the paraprocts (Figs. 12 and 13); subgenital plate approximately two times longer than the supra-anal plate, pubescent, with lateral and posterior margins also covered by long bristles, subtriangular-shaped, apex of the posterior margin straight (Figs. 12 to 14); cerci pubescent and covered by long setae throughout their length, the inner portion of the base covered by globose setae (Figs. 12 to 14). **Tegmina:** slightly sclerotized and moderately translucent, pubescent, reduced, and lanceolate, rounded at the apex and partially covering tergites I and II, as well as the anterior portion of tergite III; inner margins not touching; dorsal field intersected by two or three poorly-marked longitudinal veins, while the lateral field is bordered by an also poorly-marked longitudinal vein curving towards the center of the body, posterior portion of the lateral field whitish and thickened (Figs. 10 and 11). **Legs:** pubescent; leg I (28.01 mm) longer than leg II (25.55 mm), femur bearing small forward-pointing denticles on both ventral margins, tibia devoid of tympanum (Fig. 15); tibia of legs I and II bearing two ventral apical spurs (Fig. 15); tarsomere I of legs I (4.92 mm) and II (3.94 mm) serrated ventrally and longer than tarsomeres II and III combined (Fig. 15); leg III (41 mm) longer than legs I and II, tibia serrated dorsally, bearing four subapical spines on the outer dorsal margin (Fig. 17-w, x, y, z) and three on the inner dorsal margin (Fig. 16-m, n, o), as well as three apical spurs on the outer surface (Fig. 17-a, b, c) and four on the inner surface (Fig. 16-d, e, f, g); spur "a" longer than the others, spur "b" longer than spur "c"; spur "f" longer than the others, spur "e" longer than spurs "d" and "g", tarsomere I (4.61 mm) of leg III also serrated ventrally, longer than tarsomeres II and III together, and bearing two small dorsally positioned subapical spines and two apical spurs, with the inner one longer than the outer one (Figs. 16 and 17).

Variations in body morphology (paratype) — *Legs:* tibia of left leg III bearing five subapical spines instead of four on the outer margin.

Ecological remarks — Kereita cave is located within the limits of the Gatamaiyu Forest Natural Reserve. Gatamaiyu Forest (Fig. 18) is a remaining section of the Kikuyu Escarpment Forest, encompassing a vast area of 37,620 hectares. This expansive forested landscape comprises several distinct forest blocks, including Kereita, Kinale, Kamae, Kieni, Raggia, Kijabe, and Uplands, in addition to Gatamaiyu. Within Gatamaiyu Forest, which spans 4,720 hectares, approximately 75% consists of native forest, while 8% is characterized by exotic tree species. The remaining portion features scrublands, bamboo groves, and herbaceous croplands. Despite extensive logging activities occurring in the 1950s and 1960s, Gatamaiyu Forest has remarkably regenerated over time. This forest serves a vital role as a watershed area for numerous rivers and springs, including the Gatamaiyu, Bathi, Kiruiru, and Nyanduma rivers.

The entrance to Kereita Cave is situated at an altitude of 2,400 meters above sea level, nestled in the heart of the forest, adjacent to a substantial waterfall (Fig. 19). Due to its proximity to the lake created by the waterfall, it is likely that during periods of heavy rainfall, the lower main chamber of the cave may experience flooding. Nevertheless, the cave floor in the main chamber is consistently damp due to the mist generated by the waterfall, which permeates through the cave entrance.

The cave consists of a main chamber, approximately 20 meters in length, and a secondary upper conduit, spanning approximately 10 meters. Notably, individuals of the species *Phaeophilacris* n. sp. 1 were not observed within the primary cave chamber. Instead, they were primarily found in the lateral upper conduit, particularly along the cave's ceiling and walls. These specimens tended to cluster around cracks in the rock formations (Fig. 21). It is worth mentioning that the majority of the specimens observed in these aggregations were immatures, with only a single adult male identified (Fig. 22), despite the presence of several sub-adult male specimens.

The primary organic materials present in the cave included plant debris carried in by water and bat guano. An intriguing aspect of the cave environment is the intense noise level caused by the nearby waterfall. The noise is so pronounced that even holding conversations inside the cave becomes challenging. Consequently, any form of acoustic communication is impeded. The behavior of these

specimens was particularly intriguing. Typically, cave crickets tend to exhibit evasive behavior, scurrying away when approached with headlamps, suggesting a degree of photophobia and a tendency to seek shelter when disturbed. However, what sets *Phaeophilacris* **n. sp. 1** apart is the surprising composure of these specimens. They remained remarkably calm, even in the presence of a human with powerful lights in close proximity. Unlike other species, they did not display any attempts to seek shelter but rather remained still and composed.

Although the waterfall near Kereita Cave is a tourist attraction, the cave itself appears to receive very few visitors. To access the cave, one must cross the river, as its entrance is on the opposite bank from the trail. Additionally, because the cave entrance is in close proximity to the waterfall, many visitors seem hesitant to enter, often choosing to avoid it. As a result, the interior of the cave remains relatively undisturbed, showing minimal signs of human interference. Furthermore, access to the cave is only permitted when visitors are accompanied by park rangers, as the area is known to have elephants and other wildlife that could pose a risk to humans.

Phaeophilacris (*Taenacris*) **n. sp. 2**

(Figures 23–27, 28–32, 33–36; Table 2)

Material examined — Holotype, ♂, Kenya, Rift Valley, Mount Suswa, Baboons cave (36°24'17.168"E, 1°7'54.422"S), 23.I.2020, R.L. Ferreira; condition: body coloration slightly tarnished, male genitalia dissected and stored alongside the holotype, subgenital plate, left legs I and II detached and also stored alongside the holotype, left leg III, and right legs I and III missing.

Diagnosis — Combination of the following characteristics: posterior portion of the epiphallus membranous and slightly U-shaped (Fig. 24, E.p.); posterolateral lobe of the epiphallus short and curved backwards, apex subtriangular-shaped and dorsally projected, tip facing the anterior region of the phallic complex (Figs. 24, 26 and 27, Ep.pl.); ectoparameres divided into anteroventral lobe and posterodorsal lobes, posterior margin of the anteroventral lobe with a short, centralized, rounded and more pronounced projection pointing towards the posterior region of the genitalia, posterodorsal lobe more tapered than that of *Ph. (T.) n. sp. 1*, ventral margin with a small, but pronounced rounded projection adjacent to the posterior margin of the anteroventral lobe (Figs. 24–27, Ect.av. and Ect.pd.); rachis with an anteromedial constriction, forming a ring around the posterior portion of the formula, posterior margin subtriangular-shaped (Figs. 24, 25 and 27, R.).

Male genitalia (holotype, Figs. 23–27) — phallic complex short in general view (Figs. 23–27). **Epiphallus**: anterior portion minimally dorsally projected and highly inclined forward in comparison to *Ph. (T.) n. sp. 1*, lateral margins rounded and expanding, to a small extent, backwards, akin to *Ph. (T.) n. sp. 1* (Figs. 23 and 27, Ep. a.); posterior portion membranous and U-shaped to a lesser extent when compared to that of *Ph. (T.) n. sp. 1* (Figs. 23 and 24, Ep. p.); posterolateral lobes shorter than those of *Ph. (T.) n. sp. 1*, but not curved inwards (in dorsal and ventral views), predominantly membranous, with a slightly sclerotized band extending along their entire length, apex subtriangular-shaped and dorsally projected, similar to *Ph. (T.) n. sp. 1*, but with the tip facing the anterior region of the phallic complex, with the dorsolateral surface covered with setae, lateral setae elongated, similar to *Ph. (T.) n. sp. 1* (Figs. 23, 24, 26 and 27, Ep. pl.); rami present, slightly sclerotized, elongated, longer than the apodema principale (Figs. 23, 24 and 27, Rm.). **Ectoparameres**: sclerotized and divided into anteroventral lobe and posterodorsal lobe (Figs. 24–27, Ect.av. and Ect.pd.); anteroventral lobe developed, expanding both ventrally and laterally, with an almost quadrangular contour that is more defined than that of *Ph. (T.) n. sp. 1*, rounded projections situated in the inner and posterior margins are also more pronounced than those of *Ph. (T.) n. sp. 1* (Figs. 24–27, Ect.av.); posterodorsal lobe more tapered than that of *Ph. (T.) n. sp. 1*, extending towards the posterior region of the genitalia, slightly surpassing the posterior margin of the epiphallus in length, slightly curved outwards, with a shape similar to that of a fin in ventral view,

outline roughly V-shaped in lateral and laterofrontal views, ventral margin with a small, but pronounced rounded projection adjacent to the posterior margin of the anteroventral lobe (Figs. 24–27, Ect. pd.). **Endoparamere:** apodema principale slightly sclerotized, concave in lateral view, extremities slightly curved upwards (Figs. 23 and 27, A.p.). **Rachis:** almost as long as the central margin of the posterior portion of the epiphallus, sclerotized, with an anteromedial constriction, forming a ring around the posterior portion of the formula, resembling *Ph. (T.) n. sp. 1*, posterior margin subtriangular-shaped, with a more tapered outline and small acute centered projection in frontal view (Figs. 24 and 25, R.). **Formula:** shorter than the apodema principale, rectangular-shaped and sclerotized, with the region adjacent to the constriction of the rachis being more sclerotized and smaller in diameter than the rest of the structure (Fig. 24, F.).

Body morphology (holotype, Figs. 28–32) — **Body color** (after fixation in ethanol 70%): head, pronotum and tegmina yellowish-orange brown (Figs. 28–30 and 32), abdomen, cerci and legs (I and II) pale whitish-yellow; **Body color** (in vivo observations): general coloration dark brown, locomotor appendages light yellowish-red. **Head:** slightly pubescent, dorsoventrally elongated (Figs. 28 and 29), fastigium covered by long setae and approximately as wide as half the length of the antennal scape (Fig. 28); scape well-developed, 1.5 times longer than the compound eyes in lateral view (Fig. 29); maxillary palp divided into five palpomeres, the first two short and of similar length, palpomeres III and IV elongated and of comparable length, the terminal palpomere longer than the others with a club-shaped apex (Fig. 29); labial palp short and divided into three parts, the posterior palpomere as long as the anterior and median palpomeres combined, featuring a rounded and dilated apex (Fig. 29); ocelli absent, and the compound eyes slightly reduced, dorsal region near the antennal cavities depigmented (Figs. 28 and 29). **Thorax:** pronotum pubescent, with its anterior and posterior margins arched and covered by elongated bristles, the median region intersected by an anteroposterior groove, lateral lobes subtriangular, facing downward and forward, being slightly shifted towards the anterior region of the pronotum in comparison to *Ph. (T.) n. sp. 1* (Figs. 29 and 32); metanotal gland poorly developed, confined to the anterior margin of the metanotum, adorned with numerous setae, concealed by the tegmina, and subdivided into left and right lobes, which are separated by a whitish line that extends anterodorsally until reaching the supra-anal plate. **Abdome:** tergites pubescent; supra-anal plate subtriangular-shaped and pubescent, with a rounded posterior margin covered by long bristles, slightly shorter than the paraprocts (Fig. 31); subgenital plate pubescent, with lateral and posterior margins also covered by long bristles, subtriangular-shaped, apex of the posterior margin straight; cerci pubescent and covered by long setae throughout their length, the inner portion of the base covered by globose setae (Fig. 31). **Tegmina:** slightly more sclerotized than those of *Ph. (T.) n. sp. 1*, moderately translucent, pubescent, reduced, and lanceolate, partially covering tergites I and II, as well as the anterior portion of tergite III; inner margins not touching; dorsal field intersected by one or two poorly-marked longitudinal veins, while the lateral field is bordered by an also poorly-marked longitudinal vein curving towards the center of the body, posterior portion of the lateral field whitish and thickened (Figs. 30 and 32). **Legs:** pubescent; leg I (31.80 mm) longer than leg II (28.369 mm), femur bearing small forward-pointing denticles on both ventral margins, tibia devoid of tympanum; tibia of legs I and II bearing two ventral apical spurs; tarsomere I of legs I (5.90 mm) and II (4.45 mm) serrated ventrally and longer than tarsomeres II and III combined; right and left legs III missing, but probably presents a distribution of spurs and spines similar to *Ph. (T.) n. sp. 1* described herein.

Ecological remarks — Mount Suswa, situated within the Rift Valley in Kenya, ranks among the largest and most intricate Quaternary volcanoes in the region (Fig. 33). This imposing geological formation ascends from the southward-sloping Rift Valley floor, assuming the form of an asymmetric, shield-shaped cone with an expansive coverage spanning approximately 270 square kilometers (Johnson 1969). Comprising mainly sodalite-bearing, phonolitic lava flows along with lesser amounts of pyroclastic materials, the volcanic cone was established atop a preexisting volcanic plateau consisting of quartz-bearing trachyte flood lavas (Johnson 1969).

Mount Suswa is home to one of the most significant lava tube systems in Kenya. Within an approximately 3 square kilometer area, extensive phonolitic basalt flows have formed a complex network of lava tube caves, making it the largest concentration of such caves in East Africa (Simons 1998a). These caves, numbering around 40 in total, are part of a highly intricate system with multiple levels of passages, spanning an estimated combined length of over 11 kilometers. Most of the cave entrances are the outcome of substantial roof collapses. Notably, there are three distinct levels of passages within this system. The uppermost passages are situated just beneath the lava's surface crust, whereas the lowest passages can be found at depths ranging from 20 to 35 meters below ground level. It is common to observe passages from different levels overlapping one another. In examining cross-sections of completely filled-in tubes visible in the cave walls, it becomes evident that the network was once even more extensive. The size of these passages varies significantly. In the largest cave systems, passages typically measure between 6 to 10 meters in diameter, although they can expand to 20 to 30 meters where breakdowns have occurred. Furthermore, individual passage segments, extending both from the main chambers and between collapse sites, can span anywhere from 10 meters to over half a kilometer in length (Simons 1998a).

The Baboons cave (Fig. 34) represents just a small portion of the intricate network of lava tube caves found in the region. These caves underwent an interesting history of human use, some of which have had significant impacts on them. Several decades ago (from 1966 to 1984), these caves were exploited for bat guano, which was used as a fertilizer (Simons 1998b). The primary producers of this guano were the African Giant Free-Tailed Bats, *Otomops harrisoni* (Fig. 35) (Ralph *et al.* 2015). Remarkably, these bats still inhabit the cave system and continue to generate substantial quantities of guano, which accumulates on the cave floor.

Specimens of *Ph. n. sp. 2* were seldom encountered within the cave system. It is worth noting that Simons (1998b) had previously made mention of the presence of "pale crickets with long antennae," which likely corresponds to the species described herein. Notably, the behavior of *Ph. n. sp. 2* differs markedly from that observed in *Ph. n. sp. 1*. While the latter species displayed relative calmness, *Ph. n. sp. 2* is exceptionally elusive, surpassing the elusiveness of other *Phaeophilacris* species. Individuals were consistently seen in isolation from one another and exhibited a rapid retreat response, even when humans were at a considerable distance (over 3 meters). Given the abundance of rock blocks scattered across the cave floor, capturing these crickets proved to be an extremely challenging task, as they swiftly sought refuge among the rocky terrain. Consequently, despite efforts, only a single adult male specimen was collected. While this hypothesis remains somewhat speculative, it is possible that this elusive behavior has been intensified by historical guano removal activities within the cave. These activities likely caused significant disruption to the cricket population. It is important to note that, in addition to guano, these crickets have been observed consuming unconventional organic resources, such as baboon carcasses (Fig. 36). Specimens of *Ph. n. sp. 2* were observed feeding on such cadavers, although they swiftly retreated before photographic documentation could be obtained.

The cave system is presently utilized for tourism; however, it lacks infrastructure to support visitors adequately. Moreover, owing to the substantial bat colony within, there exists a potential risk of an epidemic outbreak. Several distinct viruses have previously been documented in Kenyan caves, including those within the Mount Suswa area (Conrardy *et al.* 2014; Kamau *et al.* 2022). Therefore, exercising caution is strongly advised when visiting these caves, and monitoring programs should be instituted to prevent potential epidemic or pandemic outbreaks.

Discussion

Male genitalia comparisons

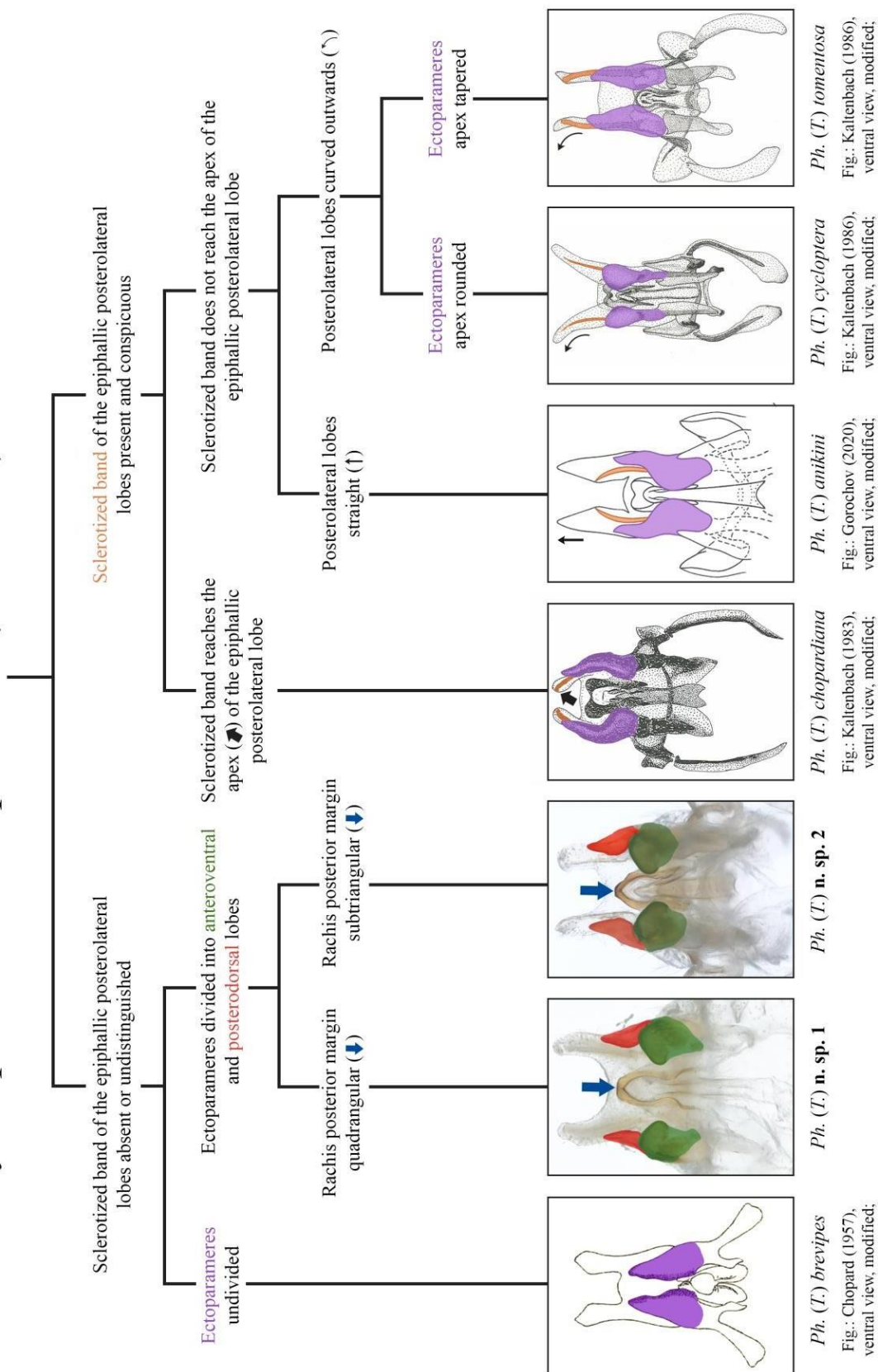
Due to the male phallic complex being a structure of major taxonomic importance, particularly with regard to the morphological attributes of the epiphallus and ectoparamere, as elucidated by Kaltenbach

(1983), we conducted a detailed comparison between the new species herein described and the other five species previously described for the subgenus *Ph. (Taenacris)* Gorochov, 2020.

The anterior portion of the epiphallus in *Ph. (T.) n. sp. 1* resembles that of *Ph. (T.) tomentosa*, *Ph. (T.) chopardiana*, and *Ph. (T.) n. sp. 2* as it dorsally projects and has lateral margins that briefly expand backwards. The posterior portion of the epiphallus is U-shaped and, therefore, differs in contour from other species in the subgenus, except for *Ph. (T.) n. sp. 2*. The posterolateral lobes of *Ph. (T.) n. sp. 1* are curved inward as documented for *Ph. (T.) chopardiana*, albeit to a lesser extent. Their length, however, approaches that of the lobes of *Ph. (T.) anikini*, *Ph. (T.) brevipes*, and *Ph. (T.) tomentosa*, being longer than the lobes of *Ph. (T.) chopardiana* and *Ph. (T.) n. sp. 2*. The apex of the posterolateral lobes of the epiphallus in *Ph. (T.) n. sp. 2* is unique within the subgenus, projecting dorsally and also facing towards the anterior region of the body. The ectoparameres of *Ph. (T.) n. sp. 1* and *Ph. (T.) n. sp. 2* have a general similar outline to those of *Ph. (T.) anikini* and *Ph. (T.) chopardiana*; however, they are segmented into two connected parts: the anteroventral portion and the posterodorsal portion. *Ph. (T.) n. sp. 1* and *Ph. (T.) n. sp. 2* differ from each other in the more tapered shape of the apex of the posterodorsal portion of the ectoparameres in *Ph. (T.) n. sp. 2*, and, additionally, by the more pronounced rounded projection adjacent to the posterior margin of the anteroventral lobe of *Ph. (T.) n. sp. 2*. Another difference lies in the shape of the posterior margin of the rachis, which, in *Ph. (T.) n. sp. 1*, is quadrangular, while in *Ph. (T.) n. sp. 2*, it is subtriangular. Both species lack the pair of rounded lobes present at the apex of the rachis in *Ph. (T.) tomentosa*, *Ph. (T.) chopardiana*, *Ph. (T.) anikini*, and *Ph. (T.) cycloptera*.

Pictorial key to *Phaeophilacris* (*Taenacris*) species (Fig. 37)

Key to species of *Phaeophilacris* (*Taenacris*) Gorochov, 2020



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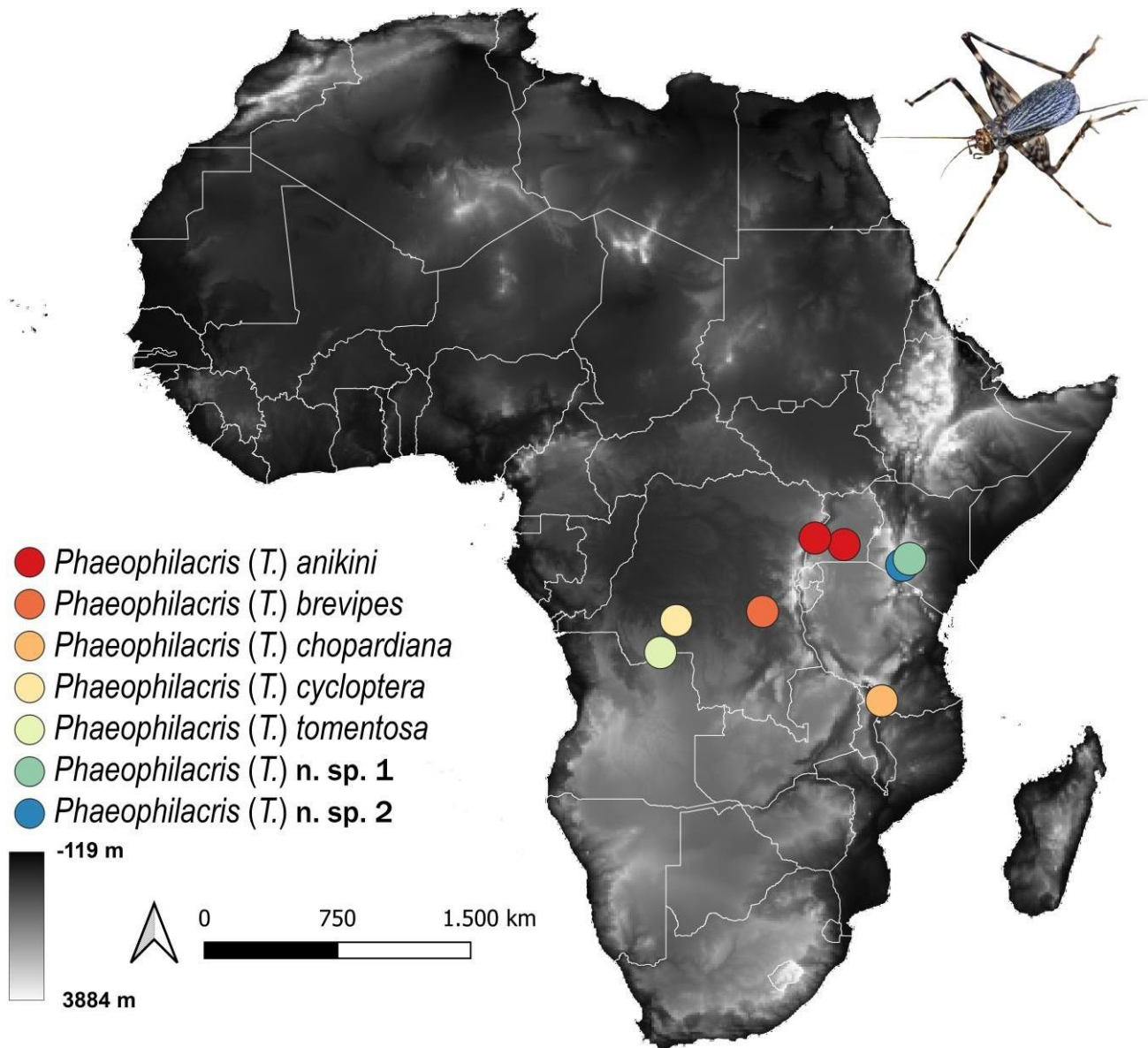
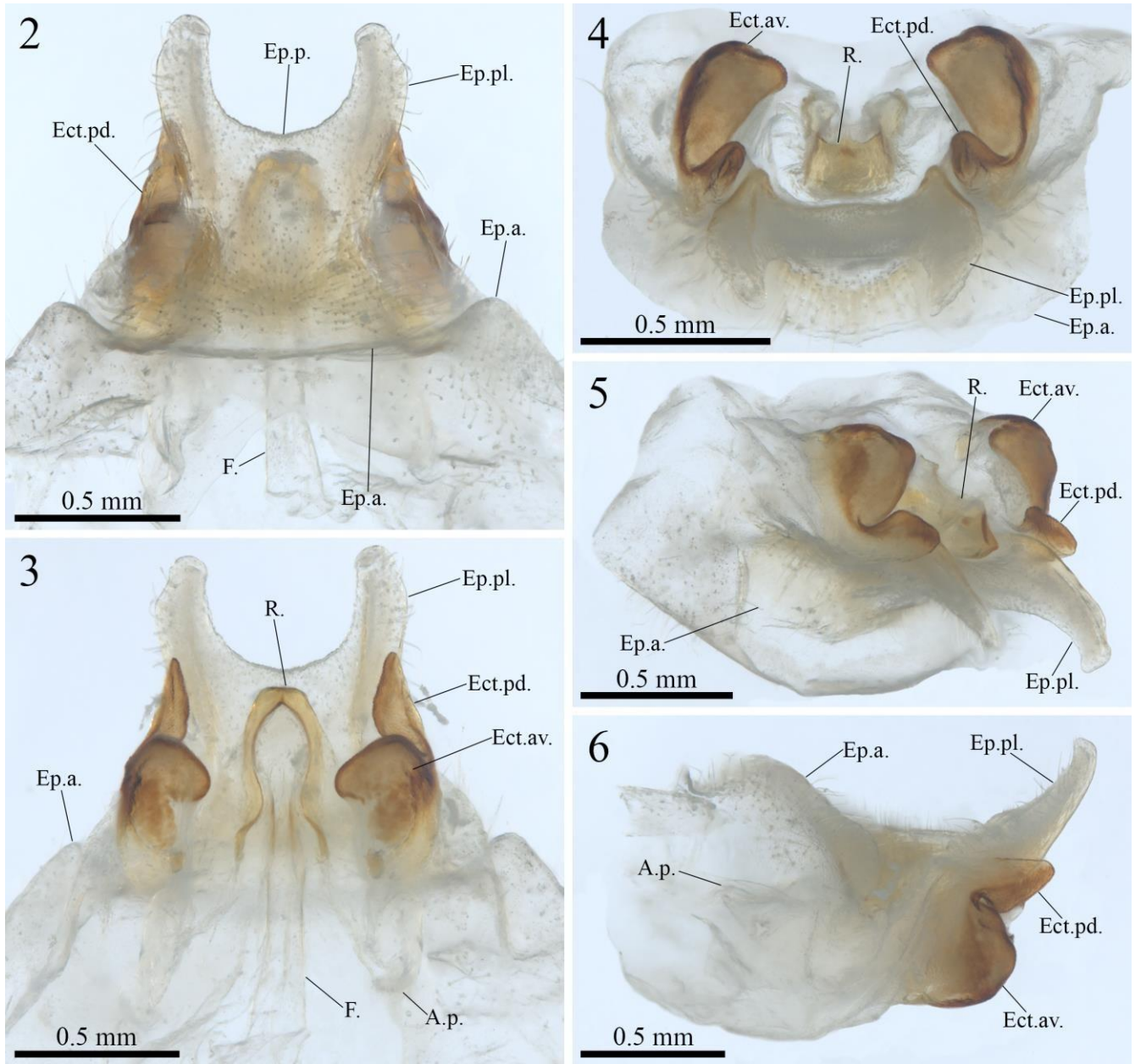
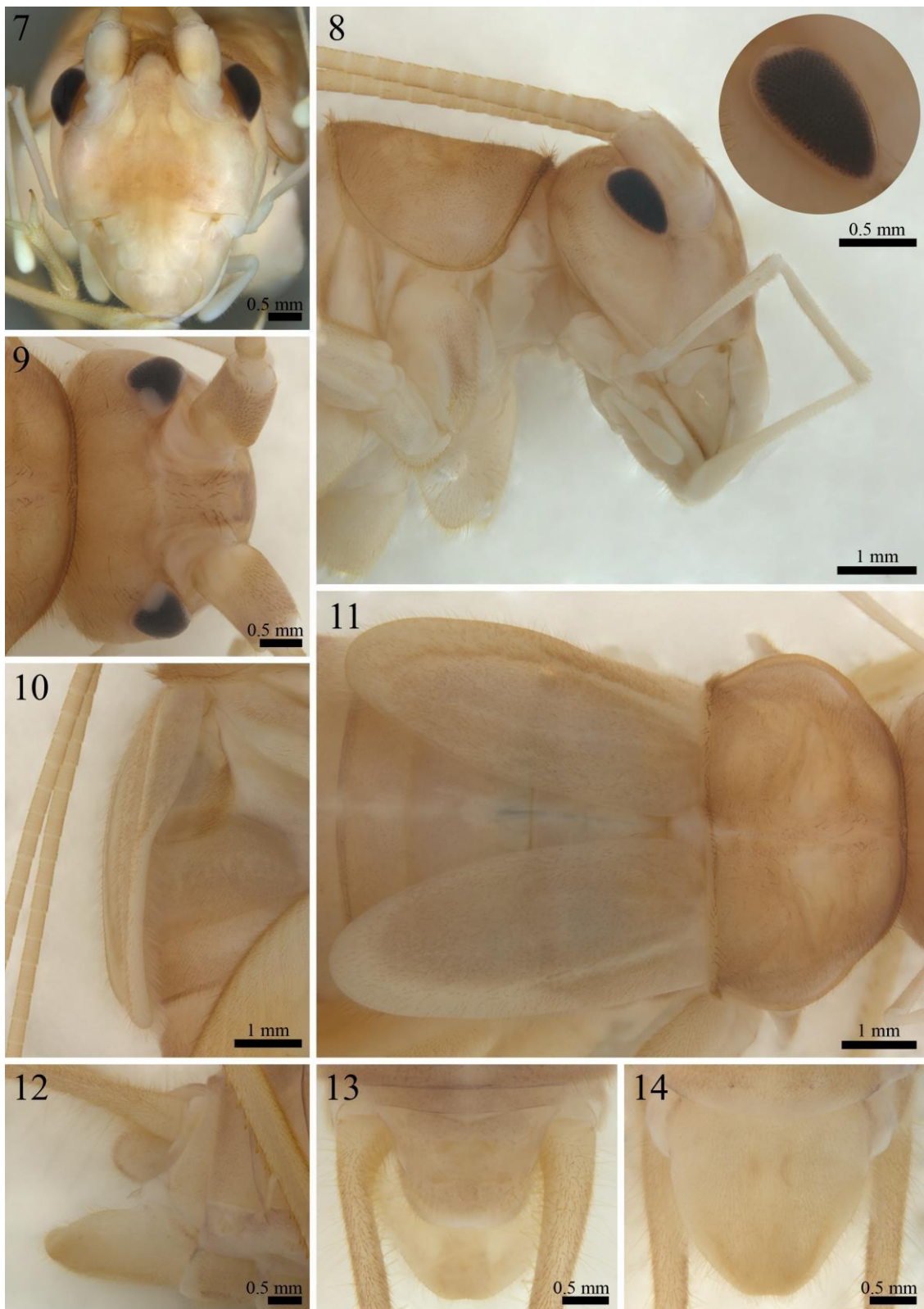


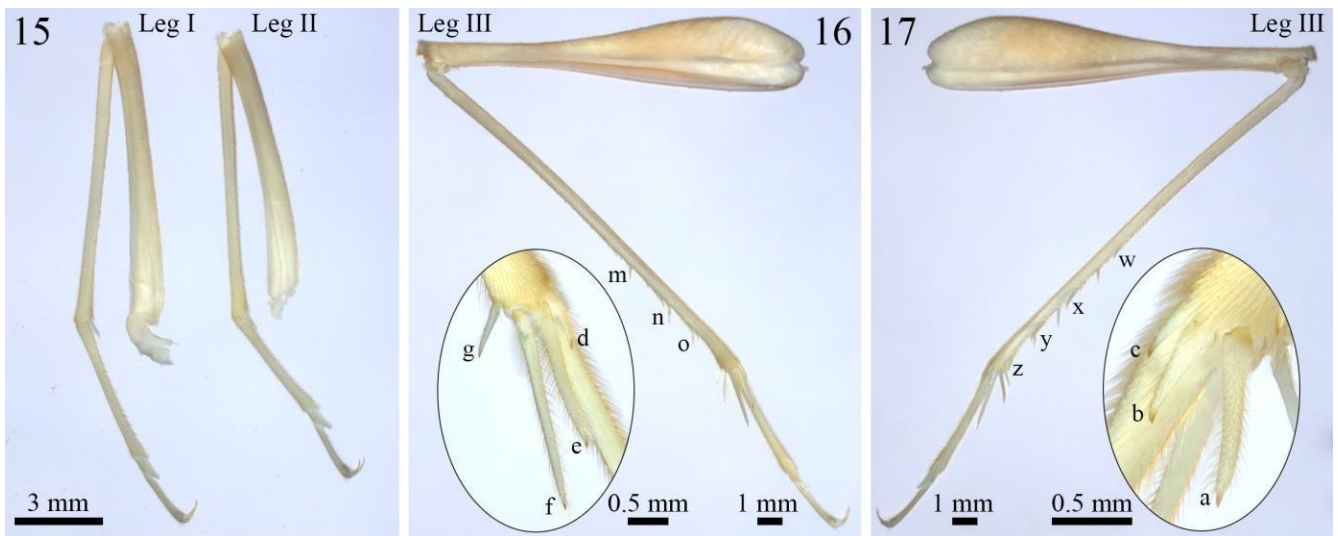
FIGURE 1. Distribution map of *Phaeophilacris* (*Taenacris*) species in the african continent.



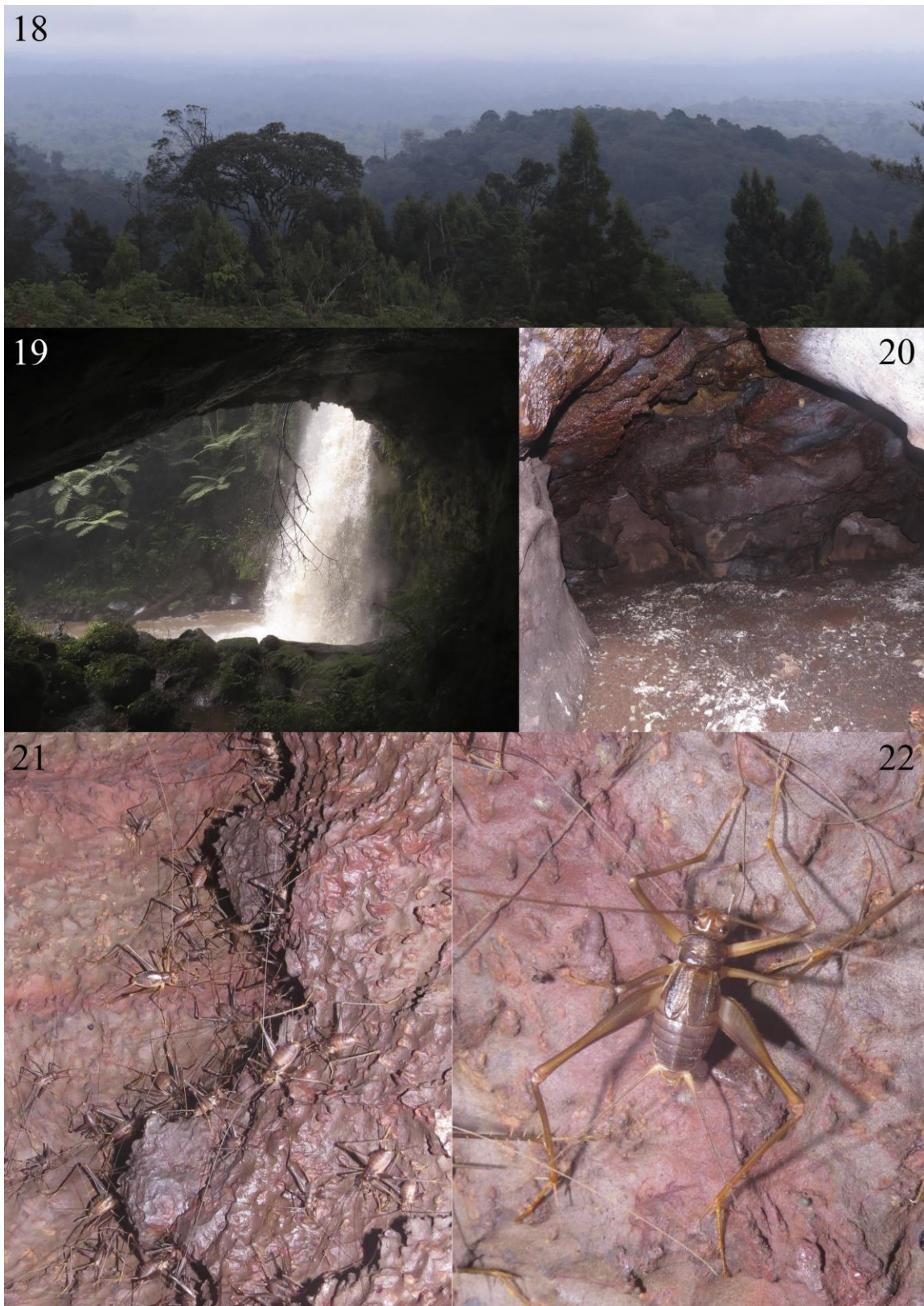
FIGURES 2–6. *Phaeophilacris (Taenacris) n. sp. 1* (holotype) male genitalia. (2) dorsal view, (3) ventral view, (4) frontal view, (5) laterofrontal view, (6) lateral view. Abbreviations: A.p., apodema principale; Ect.av., ectoparameric anteroventral lobe; Ect.pd., ectoparameric posterodorsal lobe; Ep.a., anterior portion of the epiphallus; Ep.p., posterior portion of the epiphallus; Ep.pl., epiphallic posterolateral lobes; F., formula; R., rachis.



FIGURES 7–14. *Phaeophilacris (Taenacris) n. sp. 1* (holotype) male body morphology. (7) head in frontal view; (8) head in lateral view, compound eye highlighted (9) head in dorsal view; (10) tegmina in lateral view; (11) tegmina dorsal view; (12) supra-anal and subgenital plates in lateral view; (13) supra-anal plate in dorsal view; (14) subgenital plate in ventral view.



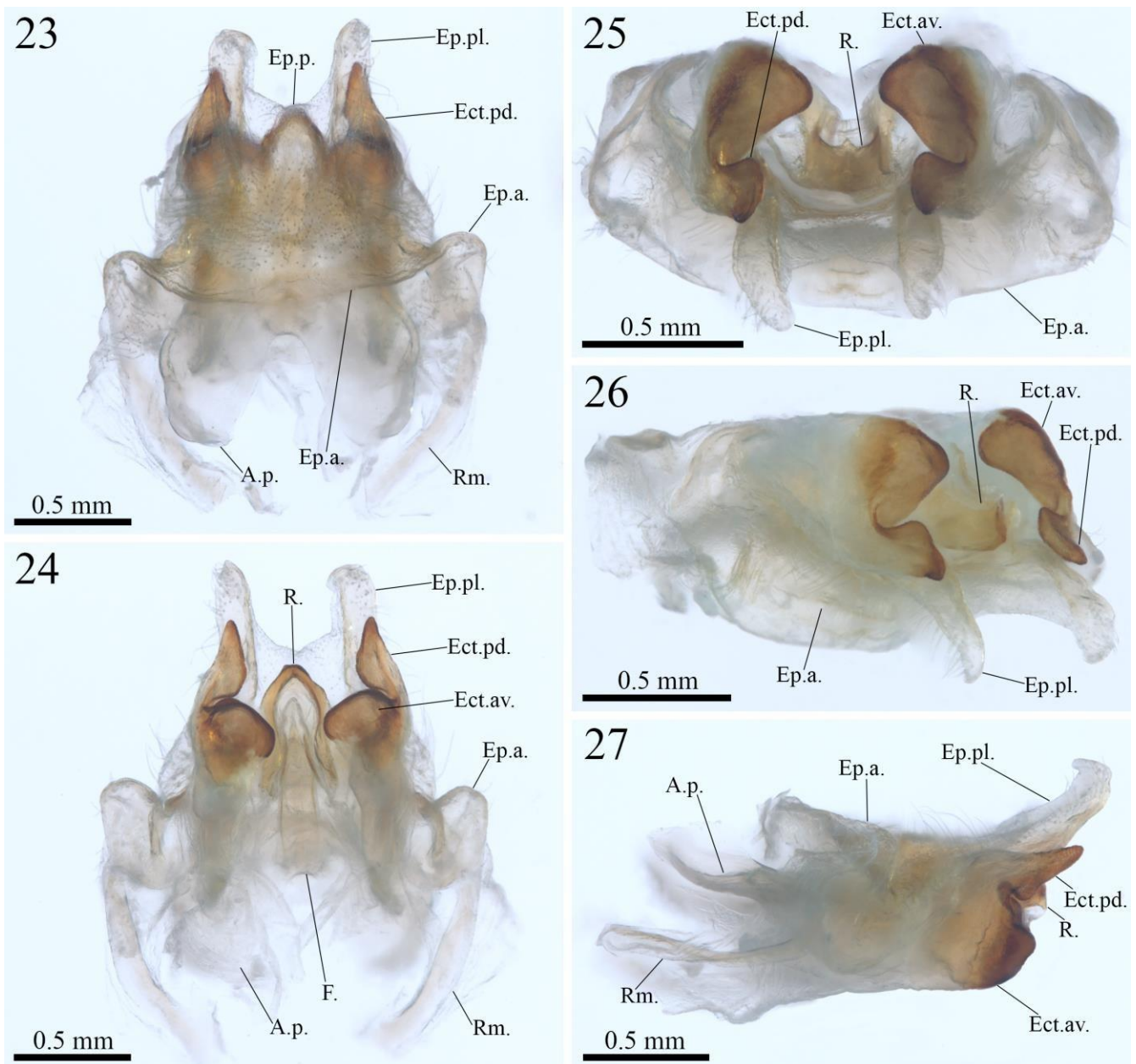
FIGURES 15–17. *Phaeophilacris* (*Taenacris*) **n. sp. 1** (holotype) left legs. (15) legs I and II, outer view; (16) leg III, inner view, apical spurs of the tibia highlighted; (17) leg III, outer view, apical spurs of the tibia highlighted.



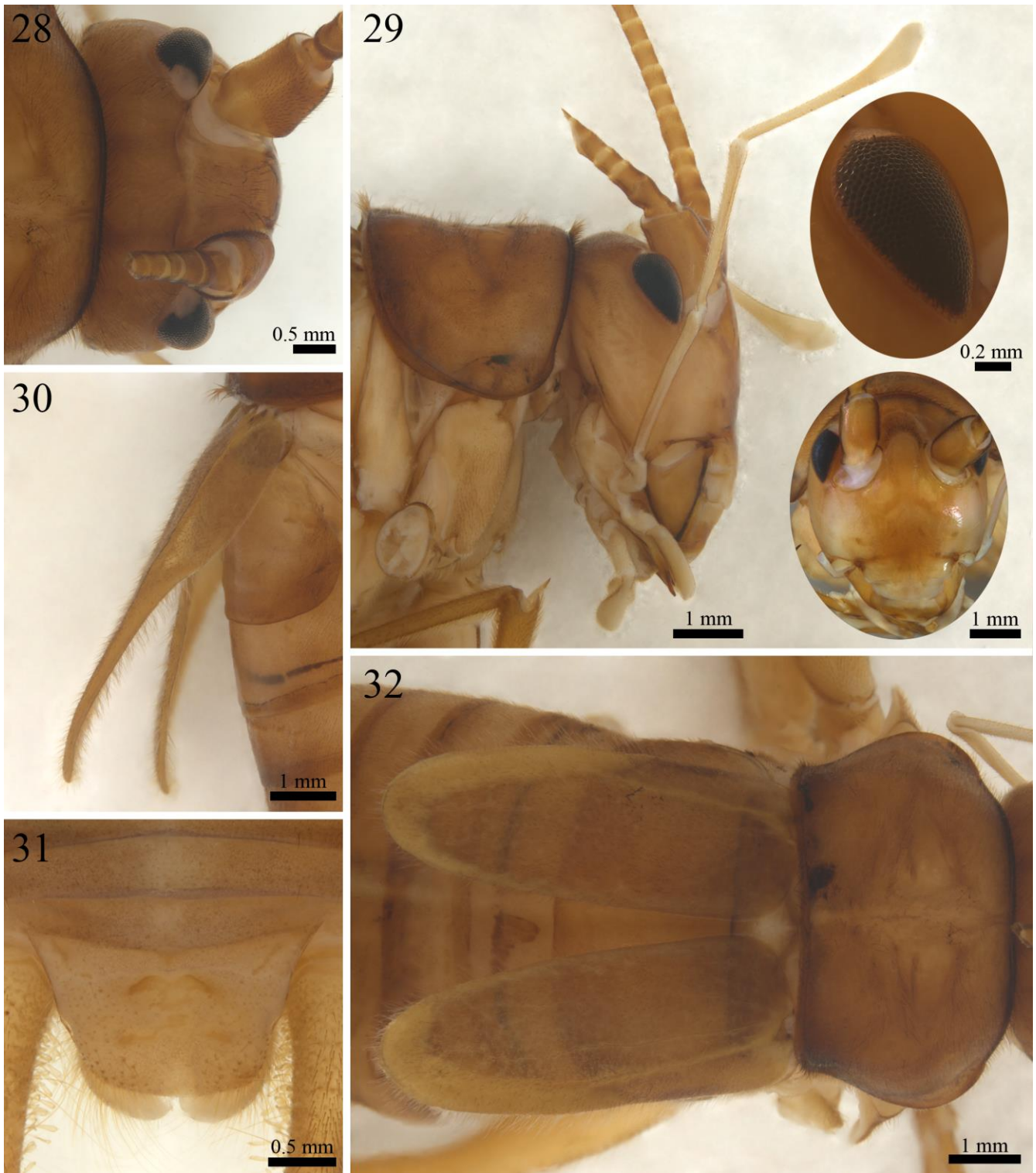
FIGURES 18–22. *Phaeophilacris (Taenacris) n. sp. 1* habitat. (18) Gatamaiyu Forest, Kereita cave external environment; (19) Kereita cave entrance; (20) Kereita cave main chamber; (21) cluster of *Ph. (T.) kereita n. sp.* around crack in the rock formation; (22) adult male of *Ph. (T.) n. sp. 1*.

TABLE 1. *Phaeophilacris (Taenacris) n. sp. 1*, morphological measurements (mm) of two male adult specimens.

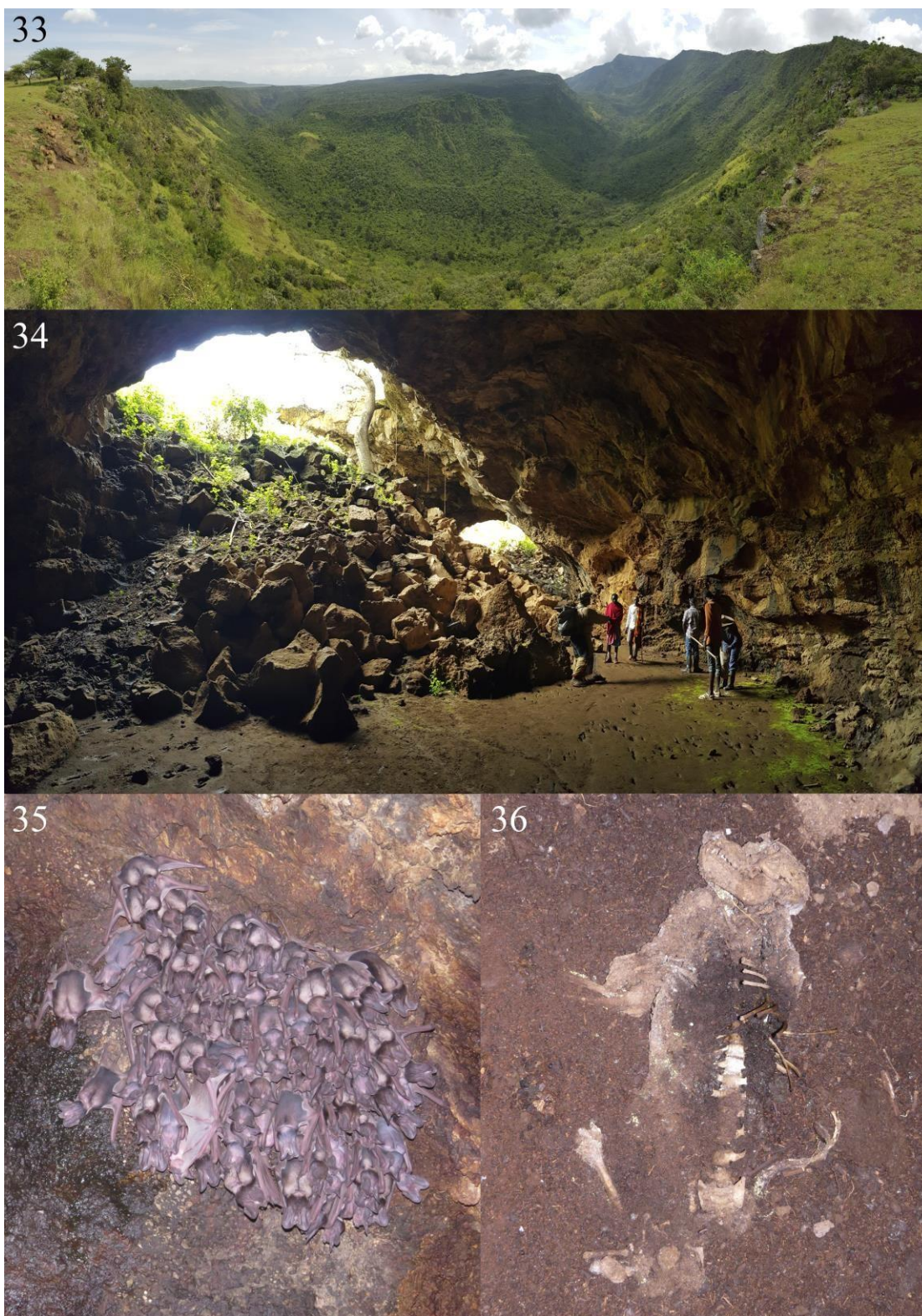
♂	XXXX	YYYY
Head width	3.478	3.833
Head length	2.317	2.24
Intraocular distance	1.939	2.041
Compound eye width	0.583	0.623
Compound eye length	1.111	1.203
Pronotum width	4.775	5.236
Pronotum length	2.898	2.88
Right tegmina width	2.277	2.217
Right tegmina length	5.195	6.079
Left femur I length	10.014	12.061
Left tibia I length	10.226	12.229
Left tarsus I length	7.038	9.036
Left femur II length	9.181	10.922
Left tibia II length	9.621	11.405
Left tarsus II length	6.751	7.523
Left femur III length	15.639	17.82
Left tibia III length	17.601	19.991
Left tarsus III length	7.756	8.383
<u>Body length</u>	<u>18.181</u>	<u>18.188</u>



FIGURES 23–27. *Phaeophilacris (Taenacris) n. sp. 2* (holotype) male genitalia. (2) dorsal view, (3) ventral view, (4) frontal view, (5) laterofrontal view, (6) lateral view. Abbreviations: A.p., apodema principale; Ect.av., ectoparameric anteroventral lobe; Ect.pd., ectoparameric posterodorsal lobe; Ep.a., anterior portion of the epiphallus; Ep.p., posterior portion of the epiphallus; Ep.pl., epiphallic posterolateral lobes; F., formula; R., rachis; Rm., rami.



FIGURES 28–32. *Phaeophilacris* (*Taenacris*) **n. sp. 2** (holotype) male body morphology. (28) head in dorsal view; (29) head in lateral view, compound eye and head in frontal view highlighted; (30) tegmina in lateral view; (31) supra-anal plate in dorsal view; (32) tegmina dorsal view.



FIGURES 33–36. *Phaeophilacris* (*Taenacris*) **n. sp. 2** habitat. (33) Rift Valley, Mount Suswa, Baboons cave external environment; (34) Baboons cave entrance; (35) African Giant Free-Tailed Bats, *Otomops harrisoni*; (36) Baboon carcass.

TABLE 2. *Phaeophilacris (Taenacris) n. sp. 2*, morphological measurements (mm) of the male adult specimen.

♂	<u>ZZZZ</u>
Head width	3.902
Head length	2.361
Intraocular distance	2.163
Compound eye width	0.613
Compound eye length	1.239
Pronotum width	5.213
Pronotum length	3.053
Right tegmina width	2.188
Right tegmina length	5.789
Femur I length	11.624
Tibia I length	11.263
Tarsus I length	8.912
Femur II length	10.275
Tibia II length	10.779
Tarsus II length	7.315
<u>Body length</u>	<u>18.817</u>