



Review of the East African Genus *Chromothericles* (Orthoptera: Eumastacoidea: Thericleidae): Data on Morphology, Distribution and Habitat, with the Description of Four New Species

Author: Hemp, Claudia

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Review of the East African genus *Chromothericles* (Orthoptera: Eumastacoidea: Thericleidae): data on morphology, distribution and habitat, with the description of four new species

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CLAUDIA HEMP

Department of Animal Ecology II, University of Bayreuth, Germany. Email: andreas.hemp@uni-bayreuth.de

Abstract

The genus *Chromothericles* is reviewed. Data on distribution, habitat and ecology are given for most species and four species new to science described. Along with a key to all species (excepting *C. pulchripes* Descamps, for which only the female is known), phenological data are provided for *C. uguenoensis* n. sp. and *C. kanga* Sjöstedt. I discuss climatic fluctuations of the past as the driving force for patterns of allopatric speciation found in several flightless Saltatoria taxa in East Africa.

Key words

new species, speciation, East Africa, grasshoppers, *Chromothericles*, Eumastacoidea

Introduction

The genus *Chromothericles* was erected on *Thericles twigga* Sjöstedt, 1909 from Mt Meru in Tanzania by Descamps 1977 in his comprehensive revision of the Thericleidae. The purely East African subfamily Chromothericleinae Descamps, 1977, contains the three genera *Acanthothericles* (2 species), *Dimorphothericles* (2 species) and *Chromothericles* (6 species) (Table 1). All members of this subfamily are restricted to forests, mostly of high mountains. Their center of diversity is in Tanzania.

Table 1. Species of *Chromothericles*

- C. decoloratus* Descamps, 1977
- C. emaliensis* Descamps, 1977
- C. kanga* (Sjöstedt, 1923)
- C. pulchripes* Descamps, 1977
- C. rubroornatus* Descamps, 1977
- C. twigga* (Sjöstedt, 1909)

The aim of this paper is to review the genus *Chromothericles*, a group of colorful small thericleids, to provide data on species' distributions, habitats and altitudinal spans — and to describe four new species.

Materials and Methods

Identification.— *Chromothericles* species were identified using Descamps (1977). The material was checked again in the entomological collections of the National Museums of Kenya, Nairobi, and at the Natural History Museum, London.

Terminology and specimens.— Images of specimens were taken from

holotype and paratype material of *C. decoloratus*, *C. emaliensis*, *C. rubroornatus* in the collection of the NHML (see below). Holotypes of *C. kanga* and *C. twigga* are stored in Stockholm and could not be accessed in this study; but these latter two species are abundant on Mt. Kilimanjaro and Mt. Meru and were collected there. Images were also taken from material of the NHML, as well as from material held in the collection of C. Hemp. For *C. pulchripes* from Uganda, only the female is described: the male is unknown. Females are in general, very similar among the species and cannot be identified with certainty without males.

Collection plots.—Habitat analyses recording vegetation, altitude and co-occurring Saltatoria were made in forest and forest clearings on various mountains and mountainous areas of Tanzania and Kenya.

Depositories.— MNB: Museum für Naturkunde, Zentralinstitut der Humboldt-Universität zu Berlin. NHML: Natural History Museum London, UK. EDNMK: Entomological Department National Museums of Kenya, Nairobi. All other material remains in the collection of C. Hemp.

Measurements.— Pronotum length: dorsal median line of pronotum; body size: in male, linear distance from fastigium to apex of subgenital plate; in female, linear distance from fastigium to apices of valves. All in mm.

A good diagnostic character facilitating the identification of *Chromothericles* species is their color. Although somewhat more vivid in living specimens, the color does not fade away in preserved specimens and is thus a reliable character. Investigated for color variation in NHML were the following five specimens of *C. twigga*: 1 male, N Tanzania, E of Mt Meru, Ngurdoto N. P., crater lake rim, 22.11.1964, coll. N. D. Jago, det. Descamps 1971; 1 male, N Tanzania, E of Mt Meru, Ngurdoto N. P., crater lake rim, 2.6.1967, coll. N. D. Jago. From my own collection three males from the Monduli Range, Tanzania were studied (montane forest, February 2000, 2150-2180 m, on *Bersama abyssinica*).

Phenology.— A plot at the lower border of the montane forest on the southern slopes of Mt Kilimanjaro was visited 52 times in each year from 1996 to 2008 (results in Fig. 6). During each visit it was noted whether *C. kanga* occurred and whether only nymphs, adults or both were present. Number of visits for each month during 1996-2008: January 6×, February 5×, March 4×, April 4×, May 4×, June 3×, July 4×, August 4×, September 3×, October 4×, November 6×, December 6×.

Results

Generic characters of Chromothericles (based mainly on Descamps 1977).—

Male. All *Chromothericles* species are intensely colored insects; the median carinae of the face and genae are yellow, red or orange. The lateral lobes of the pronotum have a yellow stripe along the lower margin, bordered above by a red or orange macula. Body size is medium to large. The integument is shiny and slightly pubescent. Head and antennae: seen from above, the fastigium of the vertex projects beyond the eyes and is rounded in profile. The eyes are large, hemispherical globose. The width of the intra-ocular distance is much smaller than the diameter of the eye. Carinae of the face are well developed. Lateral ocelli are well developed. Antennae with 13 segments. The antennal organ is located at the 10th segment.

Thorax: apterous. Pronotum subcylindrical, without carinae or with a faint median carina; posterior margin of pronotum straight, lateral lobes subquadrate, posterior margin linear and oblique; anterior and median sulci verrucous.

Legs: Fore and mid femora unarmed, with rounded lunules; hind femora slender, only the dorsomedian carinae with a few spines (4-7); at posterior tip of median carina a stout spine is present. Mid tibia with two external apical spurs; tarsal claws very stout and curved, unequal, the outer one longer. Tibia of hind leg with three spurs to each side; middle spur on internal side enlarged.

Abdomen: posterior margin of last abdominal tergite strongly incurved. Cerci stout, conical. Supra-anal plate simple, large, triangular and fully sclerotized. Subgenital plate completely sclerotized, apically truncate and oriented almost vertically; posterior margin of subgenital plate attains or may even exceed the level of the supra-anal plate (see Fig. 3 arrow). Epiphallus disc-like, with strong lophi, which are obliquely internally oriented. The ectophallus has the shape of a capsule and is little sclerotized; it bears two small lateromedian projections.

Female. Females are less vividly colored than males; their pronota and abdominal apices are colored as the rest of the body. In females interocular distance is greater than in males. The pronotum has a well-developed median carina. Lateral lobes of pronotum sinuous at posterior margin and strongly oblique at anterior margin. Ninth abdominal tergite has well-developed lateral lobes; posterior margin of supra-anal plate unarmed and medially with small triangular projection. Valves of ovipositor comparatively long and strongly serrate. Egg-guide well developed and large.

Key to species of Chromothericles (males)

The male of *C. pulchripes* is unknown.

- 1. Carinae of face green, between eyes evenly and comparatively widely spaced, at height of scapes briefly convergent then diverging downward (Fig. 2D); Kenya, Bahati escarpment *C. decoloratus*
- 1' Carinae of face red or yellow, not markedly convergent at height of scapi 2
- 2 Carinae of face yellow, on lower face more robust (Fig. 1D); Tanzania, Mt Meru, Monduli *C. twigga*
- 2' Carinae of face red, in lower part of face not as prominent . . . 3
- 3 Carinae doubly converged at midface 4
- 3' Carinae without such double convergence 5
- 4 Pronotal lobes with large red macula and shiny white margin (sometimes yellow), genae yellow; posterior part of subgenital plate broadly u-shaped emarginate (Fig. 1K,

- O); Tanzania, Mt Kilimanjaro *C. kanga*
- 4' Pronotal lobes with red macula bordered below by bright yellow; genae dirty yellow directly under eyes; carinae of the face red or red with yellow; posterior part of subgenital plate narrowly u-shaped emarginate (Fig. 2A, K, P); Tanzania, Manyara Escarpment *C. manyara*
- 5 Carinae of face adpressed between eyes, then widening and running almost parallel over their remaining length; red macula of face small, restricted to carinae of lower face; genae white with small red macula, pronotal lobes bordered white below with large red macula above (Fig. 2E, O); Kenya, Mt Kenya *C. keniensis*
- 5' Carinae of face not as adpressed between eyes, then not parallel over whole length 6
- 6 Carinae of face slightly adpressed between eyes and then gradually and evenly diverging downwards; pronotal lobes bordered dirty white with small reddish macula on lobes; genae with large red macula under eyes, surrounded by yellow margins (Fig. 1A, I) *C. rubroornatus*
- 6' Carinae not evenly diverging 7
- 7. Carinae of face slightly undulating, divergent between scapi above and below adpressed; pronotal lobes with small red macula and broad white-colored margin; red macula of face bordered by whitish areas; genae yellow; basal segments of antennae yellow (Fig. 2B, L); Kenya, Ngong Hills *C. ngongensis*
- 7' Carinae of face divergent in upper part, convergent in middle and again convergent in lower part of face 8
- 8. Carinae of face more or less parallel between eyes, becoming at half length distinctly divergent; pronotal lobes with red macula and broad yellow margin, genae with large yellow area and small reddish macula in the middle (Fig. 1B, J); Tanzania, North Pare *C. uguenoensis*
- 8'. Carinae of face parallel between eyes, but in lower part less diverging than in *C. uguenoensis*; pronotal lobes with red macula above white-bordered margin; genae yellow or yellow with red central macula; basal segments of antennae green (Fig. 2C, M); Kenya, Emali range *C. emaliensis*.

***Chromothericles uguenoensis* n. sp.
Figs 1B,E,I,N; 4A,B**

Holotype.—Male: Tanzania, North Pare, lower border of montane forest of Mt Kindoroko, 1750 m a.s.l., UTM zone 36 M 03 50 063 E 95 83 438m S, herbaceous vegetation at forest edge, on bracken, 4/01; depository, MNB.

Paratypes.— One female, same data as holotype; depository MNB. 1 male, 1 female, same data as holotype, but male 2/01; depository NHML. 1 male, 1 female, same data as holotype; depository EDNMK.

Further paratype material studied.— 12 males, 5 females, 2 nymphs, same data as holotype, 2/01 and 4/01, 2/09. 1 male, 1 female, North Pare, Ngofi forest reserve, 1500 m a.s.l., on *Rubus* sp. at forest edge, 10/06, 2/09; material remains in collection of C. Hemp.

Male description.—Color: dark green, conspicuous color patches of yellow or white and red on pronotal lobes, genae and face. Eyes red-brown or a mix of yellow and brown. Tibiae bluish (Fig 1. B, J, Fig. 4 A).

Head and antennae: fastigium of vertex sulcate, very narrow; median carina of head developed. Eyes in living insect of red to red-brown color, in preserved insect hazelnut-brown to dark-brown. Antennae green in living insect, tawny in preserved. Bases of antennae yellow

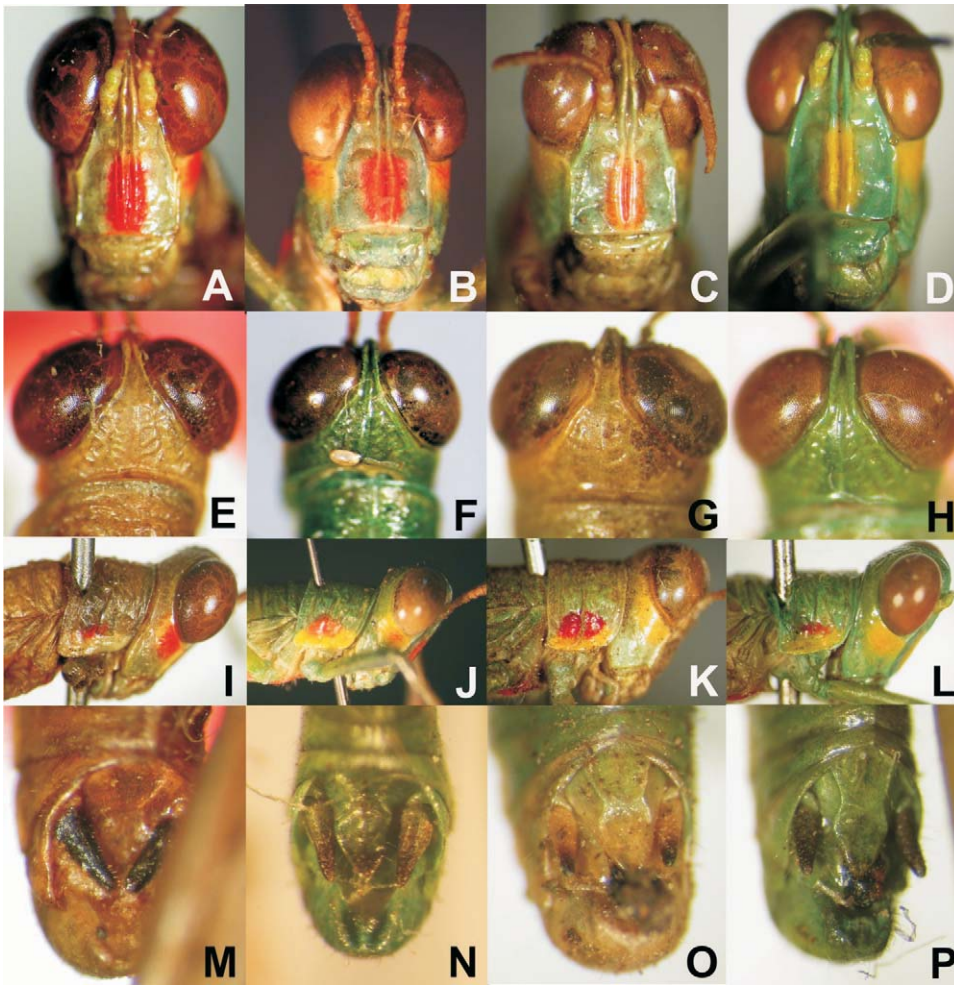


Fig. 1. Males of *Chromothericles* species. A, E, I, M *C. rubroornatus* Descamps, 1977; B, F, J, N *C. uguenoensis* n. sp.; C, G, K, O *C. kanga* Sjöstedt, 1923; D, H, L, P *C. twigga* Sjöstedt, 1909. A-D: face, E-H: dorsal view of head; I-L: lateral view of pronotum and head; M-P: dorsal view of male abdominal apex. For color versions, see Plate VII.

to yellow-green. Frontogenal carinae contiguous, adpressed. Carinae of face more or less parallel in upper part, at half their length markedly divergent in lower part of face and suddenly convergent at lower end. On lower half of face, large area covered by a conspicuous red macula. Face bluish (Fig. 1 B). Genae yellow with small central reddish-orange macula (Fig. 1 J).

Thorax: pronotum with very faint median carina. Two sulci present on pronotal lobes, these not crossing disk of pronotum. Lateral lobes of pronotum broadly bordered yellow with central red macula around first and second sulcus (Fig. 1 J). Sternites of thorax laterally red, centrally whitish. In some specimens also anterior margin of pronotal sternites reddish, but red color in most examined specimens confined to lateral extremities.

Legs: dark green, of same color as body; tibiae in living insect bluish, in preserved tawny to brown. Hind femora dorsally with 5 or 6 black spines in holotype, in other specimens 4 to 6 femoral spines. Hind tibiae dorsally with a double row of 13 to 14 black spines, these becoming larger distally.

Abdomen: dark green, laterally on lower ventral side of abdominal tergites yellowish patches. Medially sternites keeled; sternites bluish. Subgenital plate bluish-green. Cerci stout, tips brownish to black. Apex of supra-anal plate blackish (Fig. 1 N).

Female.— (Fig. 4 B) Much larger, more plump than male. Color uniformly dark green, only eyes a mix of yellow and brown. Median carina of pronotum conspicuous, abdominal medially tergites

keeled. Dorsal valves long and serrated, serration shiny black. Ventral valves smaller and less coarsely serrated than dorsal ones; also here serration black.

Measurements.— In mm. HW: head width; Pro: pronotum length; PFL: posterior femur length; TBL: total body length.

| | males n = 12 | females n = 7 |
|-----|------------------------------|-------------------------------|
| HW | 2.6-2.7 (\bar{x} = 2.6) | 3.1 (\bar{x} = 3.1) |
| Pro | 1.6-1.8 (\bar{x} = 1.7) | 2.3-2.6 (\bar{x} = 2.5) |
| PFL | 8.5-9.3 (\bar{x} = 8.7) | 10.4-12.0 (\bar{x} = 11.4) |
| TBL | 9.4-10.6 (\bar{x} = 10.1) | 18.0-22.0 (\bar{x} = 20.3) |

Habitat and phenology.— *C. uguenoensis* is a species found in montane forest clearings and along forest edges of the North Pare Mts. The two major forest remnants in the North Pares are the Kindoroko forest reserve in the west of this mountain range, and the Ngofi forest reserve in its east. These two forests cover the highest peaks of the Pares and are separated today by cultivated land.

C. uguenoensis is more abundant during the warm period between October and March, while from about May/June to August/September, very few individuals are found. During the cold time of the year sometimes only a few mature females are present, while nymphs are abundant from September/October onwards. Many mature individuals of this species are present December to March. Thus it has a very similar phenology to *C. kanga* (Fig. 6) on Mt Kilimanjaro.

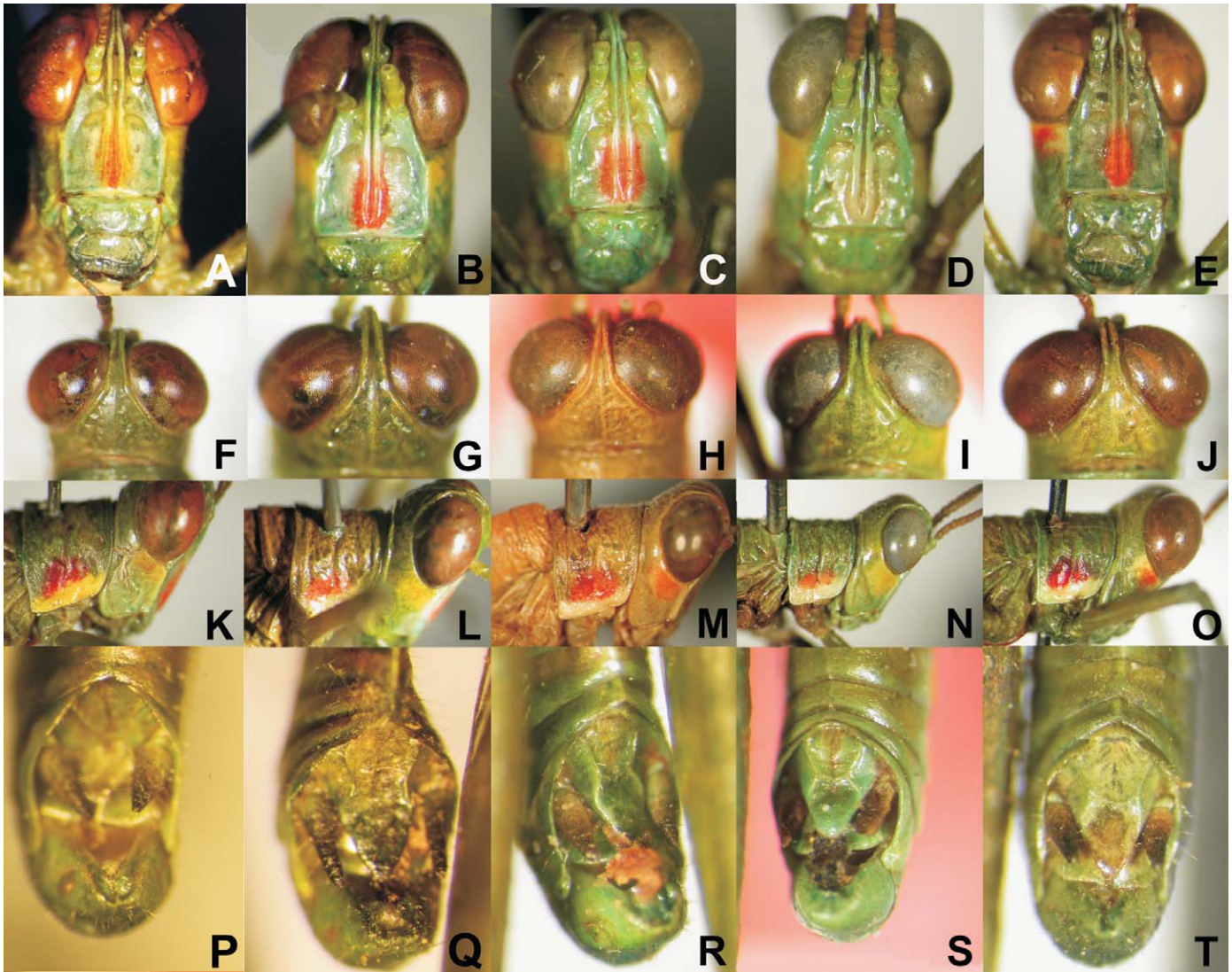


Fig. 2. Males of *Chromothericles* species. A, F, K, P *C. manyara* n. sp.; B, G, L, Q *C. ngongensis* n. sp.; C, H, M, R *C. emaliensis* Descamps, 1997; D, I, N, S *C. decoloratus* Descamps, 1977; E, J, O, T *C. keniensis* n. sp. A-E: face; F-J: dorsal view of head; K-O: lateral view of pronotum and head; P-T: dorsal view of abdominal apex. For color versions, see Plate VIII.

In the North Pares *C. uguenoensis* clusters on *Rubus steudneri*, mostly where bushes of this plant are in a clearing or along the forest edge, in places where basking is possible for at least part of the day. This day-active species is stenotopical, not moving away at night. During night hours individuals were seen resting under or above leaves on the same bushes on which they were found during the daytime. At the lower border of the Kindoroko forest reserve, *C. uguenoensis* was also caught regularly from bracken along the forest edge (see Table 2).

Diagnosis.—*C. uguenoensis* differs from most *Chromothericles* species in having a large conspicuous red macula on its face and in having the carinae of the face parallel in the upper, diverging in the lower half (Fig. 1 B). The carinae of the vertex, bordering the globose eyes and converging to form the fastigium, change course smoothly and gradually, not as in most species abruptly (Fig. 1 F). A similar color pattern is found in *C. rubroornatus* from the West Usambara Mts, a mountain block of the so-called Eastern Arc chain (Fig. 5), separated only from the North Pare Mts by the mountain chain of the South

Pares. *C. rubroornatus* (Fig. 1 A, E) has facial carinae which diverge evenly and the red maculae are larger and of more conspicuous color. Also the genae are dominated, each by a conspicuous red macula (Fig. 1 I), while in *C. uguenoensis* the red macula of the face is not as large and conspicuous and the genae are yellow, suffused with some red (Fig. 1 J). The pronotal lobes of *C. uguenoensis* are bordered brightly yellow, with a red macula in the middle of the lobes (Fig. 1 J), while the pronotal lobes of *C. rubroornatus* are rather inconspicuously colored, with a dirty white margin and a tiny red macula on the lobes (Fig. 1 I). Differences from *C. rubroornatus* are also found in the shape of the subgenital plate. The anterior margin of the subgenital plate is u-shaped in *C. rubroornatus*, lacking the central ridge typical of *C. uguenoensis* (see Fig. 1 M, N).

Chromothericles manyara n. sp.

Figs 2A, E, K, P

Holotype.—Male: Tanzania, Manyara Escarpment, Nou forest reserve, on herbaceous vegetation along forest road, 2100 m, UTM zone 36



Fig. 3. Male holotype of *C. keniensis* n. sp. Lateral view of abdominal apex. Arrow points at vertically oriented subgenital plate – the anterior margin thus coming to be level with the supra-anal plate or even projecting over it. For color versions, see Plate VII.

M 07 80 908 E 95 42 456 m S, 2/05; depository, MNB.

Paratypes.— One female, same data as holotype; depository MNB. 1 male, 1 female, same data as holotype; depository NHML. 1 male, same data as holotype; depository EDNMK.

Further paratype material studied.— Four males, same data as holotype; material remains in collection of C. Hemp.

Male description.— Color: dark green, patches of yellow with a little red on pronotal lobes, genae greenish-yellow; in some specimens a little patch of orange directly under eyes, but this color not very conspicuous; face with small red or red-yellow macula, confined to lower part of carinae (Fig. 2 A). Eyes a mix of brownish patches (Fig. 2 A, F, K).

Head and antennae: fastigium of vertex sulcate, very narrow; median carina of head developed (in some specimens obsolete). Antennae brown, basal segments green. Carinae of the face with a double convergence below scapi; diverging above and below the double convergence (Fig. 2 A); face yellow-green, in some specimens blue-green. Genae green, greenish-yellow or yellow, in some specimens with suffused orange area directly under eyes (Fig. 2 K).

Thorax: pronotum with median carina, faint in some specimens. Two sulci present on pronotal lobes, these almost attaining pronotal disc margins (Fig. 2 K). Lateral lobes of pronotum bordered yellow with central red macula around first sulcus (Fig. 2 K). Sternites of thorax laterally red, centrally whitish; in some specimens also anterior and posterior margins of pronotal sternites bordered red.

Legs: green, of same color as body, tarsi blackish to brown. Hind femora dorsally with 4 to 7 black spines. Hind tibiae dorsally with a double row of 13 to 15 brown spines, spines becoming larger distally; dorsal area of hind tibiae over lower 2/3, brown, same color as spines.

Abdomen: green to yellow-green, laterally on lower ventral side of abdominal tergites with yellowish patches. Sternites keeled medi-

ally, bluish. Subgenital plate green. Cerci stout, brown over whole length, tips darker brown to black; apex of supra-anal plate brown (Fig. 2 P).

Female.— About twice as large and more plump than male. Color green, in one female conspicuous black spots in two rows laterally on pronotum and first five abdominal tergites (Fig. 4 C); spiracles black. In a second female black spots less conspicuous; first female black on genae, second green in area of genae. Median carina of pronotum conspicuous, abdominal tergites medially keeled. Dorsal valves long and serrated, serration brown to black. Ventral valves smaller and not as coarsely serrated as dorsal, but also here serration brown to black.

Measurements.— In mm. HW: head width; Pro: pronotum length; PFL: posterior femur length; TBL: total body length.

| | males n = 7 | females n = 2 |
|-----|-----------------------------|---------------|
| HW | 2.5-2.7 (\bar{x} = 2.6) | 3.2 |
| Pro | 1.5-1.6 (\bar{x} = 1.6) | 2.4-2.5 |
| PFL | 8.0-8.5 (\bar{x} = 8.2) | 10.8-10.9 |
| TBL | 9.5-10.1 (\bar{x} = 9.6) | 20.0-21.0 |

Habitat.— *C. manyara* was seen on herbaceous plants of over 2-m height with large leaves (e.g., *Crassocephalum* sp.) along the montane forest edge of the Nou forest reserve at an altitude of 2100 m, but also on *Rubus* sp. Commonly several specimens were clustered together basking on suitable plants (see Table 2).

Diagnosis.— *C. manyara* is characterized by its color pattern (Fig. 2 A, K), the shape of the subgenital plate (Fig. 2 P), and the carinae of the head (Fig. 2 F). The carinae have a double convergence midway down the face, being set apart both above and below (Fig. 2 A). The genae are mostly green with only a light yellow area directly under the eyes. In all other *Chromothericles* species the genae are far more conspicuously colored, mostly bright yellow or yellow with red. The posterior margin of the subgenital plate is shaped very characteristically, being v-shaped with a small ridge centrally (Fig. 2 P). The carinae of the vertex, running beside the eyes and meeting to form the fastigium, are very narrow (Fig. 2 F). Very narrow carinae of the fastigium and this form of the facial carinae are also seen in *C. kanga*, less so in *C. twigga* (Fig. 1 C, D), from a morphological point of view and biogeographically, the two closest relatives to *C. manyara*. However, in *C. kanga* the double convergence of the carinae of the face is more pronounced than in *C. manyara*; in *C. twigga* the carinae are only constricted slightly at this spot.

C. twigga which occurs on Mt Meru (lying between Mt Kilimanjaro and the Manyara escarpment) has carinae of the head not as elevated as in *C. kanga* and *C. manyara* at the point between the eyes where they conjoin to form the fastigium. Also its color pattern (Fig. 1 D, L) and the shape of the posterior margin of the subgenital plate (Fig. 1 P) are different; however, the colored macula of the face in some specimens of *C. manyara* is a mixture of yellow and red, with the red color sometimes only faintly present and thus resembling the yellow macula of *C. twigga*. Another difference is the lack of the central ridge of the posterior margin of the subgenital plate in *C. kanga* and *C. twigga*.

Chromothericles ngongensis n. sp.

Figs 2B, G, L, Q; 4D-F

Holotype.— Male: Kenya, Ngong Hills, edge of strongly disturbed forest, 2200 m a.s.l., UTM zone 36 M 02 37 150 98 44 853 m S, on

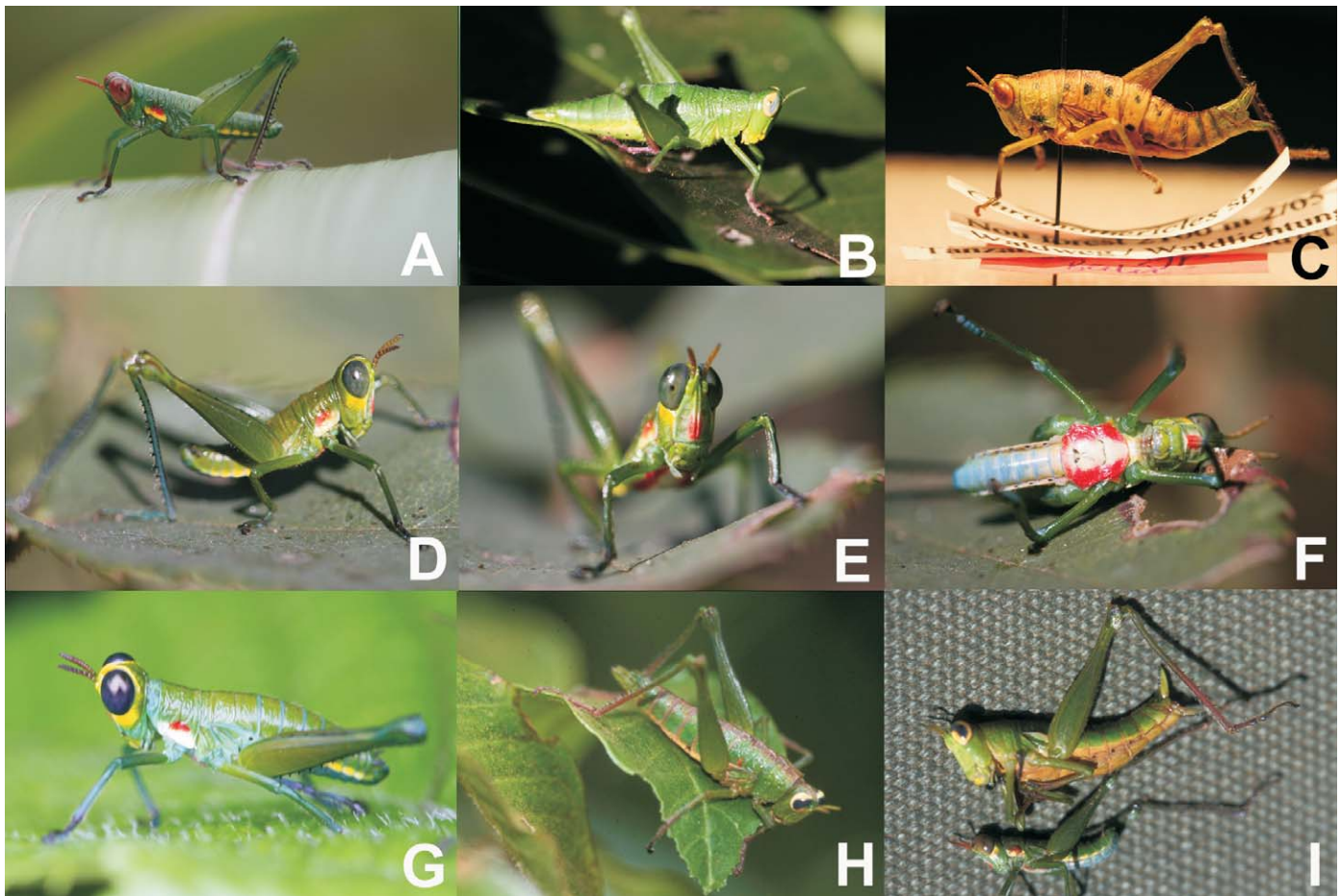


Fig. 4. *Chromothericles* species. A. Male *C. uguenoensis* in a forest edge of the Kindoroko forest reserve, North Pare mountains, Tanzania. B. Female *C. uguenoensis* at forest edge of the Ngofi forest reserve, North Pare mountains. C. Female of *C. manyara*. D-F. *C. ngongensis* from forest remnants of the Ngong Hills, Kenya. G. Male *C. kanga*, Mt Kilimanjaro, southern slopes above Kidia 1710 m. H. *C. keniensis* female. I. Freshly killed male and female *C. keniensis*. For color versions, see Plate VIII.

herbaceous vegetation 12/07; depository: MNB.

Additional material.— 1 male nymph, 1 female nymph. Material remains in collection of C. Hemp.

Male Description.—Color: green, color patches of yellow, white and red on pronotal lobes, genae and face. Eyes grey (Fig. 2 B, L; Fig. 4 D-F).

Head and antennae: fastigium of vertex sulcate, narrow (Fig. 2 G); median carina of head developed. Antennae brown, basal segments green to yellowish. Frontogenal carinae protruding as seen from above (Fig. 2 G). Carinae of face somewhat undulating, diverging in area between scape, more adpressed above and below. Upper part of facial carinae green, then white and finally forming typical facial red macula in their lower part (Fig. 2 B). Rest of face a mix of white, green and blue. Genae yellow directly below eyes (Fig. 2 L).

Thorax: pronotum with median carina. Two deep sulci, present laterally on pronotal lobes, not attaining disk of pronotum (Fig. 2 L); between first and second sulcus of pronotal lobes an interstitial sulcus present laterally on disk of pronotum. Lateral lobes of pronotum bordered shiny white, with central small red macula between first and second sulcus (Fig. 2 L). Sternites of thorax laterally broadly bordered red, centrally white (Fig. 4 F).

Legs: green, of same color as body, tarsi darker. Hind femora dorsally with four minute dark spinules on upper side of right femur, five on

left one. Hind tibiae dorsally with a double row of 13 to 15 grey to brown small spines, becoming a bit larger distad; tibiae blue.

Abdomen: green, laterally on lower ventral side of abdominal tergites yellow to whitish patches. Medially sternites keeled; sternites white, becoming vivid blue more proximally (Fig. 4 F). Subgenital plate green. Cerci stout, brown-green (Fig. 2 Q).

Female.— not known.

Measurements.—In mm. HW: head width; Pro: pronotum; PFL: posterior femur length; TBL: total body length.

| | males n=1 |
|-----|-----------|
| HW | 2.4 |
| Pro | 1.7 |
| PFL | 8.5 |
| TBL | 9.5 |

Habitat.— *C. ngongensis* occurs along the edge of forest remnants of the Ngong Hills crest forest between 2200 m and 2400 m. Here, mostly nymphs, perch commonly on *Rubus* sp. but also on the low herbaceous vegetation of small clearings (see Table 2).

Diagnosis.— *C. ngongensis* may be distinguished by its color pattern, the deep sulci of the pronotal lobes (Fig. 2L), and by the head,

and the protruding carinae comprising the fastigium (Fig. 2G). The shape of the subgenital plate is also very characteristic, the anterior margin being almost square (Fig. 2Q), while in other *Chromothericles* species this part is evenly rounded (v- or u-shaped) or constricted (*C. decoloratus* Fig. 2T). The color pattern is very similar to *C. emaliensis*, differing only in the general coloration of the face (very contrasting white and green-blue in *C. ngongensis* (Fig. 2 B, Fig. 4 E), while it is more green and yellow in *C. emaliensis*) and differing in the size of the red macula of the pronotal lobes (compare Figs 2 L and M). The genae are yellow in *C. ngongensis* while they are red-orange in *C. emaliensis* (Fig. 2 L, M).

Remarks.— The forest cover of the Ngong Hills is largely reduced to small patches on the western slopes below the single peaks. Intensive cattle grazing is a threat to even these remnants. Therefore the forest species, especially endemics such as *Chromothericles ngongensis* must be regarded as being highly threatened. Although the area has been intensively searched over the years, only a few specimens of *C. ngongensis* could be caught, these in December 2007. The forest patches also contain a number of Saltatoria species probably endemic to this mountain range. These are, e.g., *Amytta* sp. and *Horatosphaga* sp., both probably species new to science.

Chromothericles keniensis n. sp.

Figs 2E, J, O, T; 4H, I

Holotype.—Male: Kenya, Mt. Kenya, on *Rubus* sp. along forest road of the Chogoria route, 2200 m a.s.l., UTM zone 36 M 03 34 962 E 99 75 660 m S, 3/03; depository, MNB.

Paratypes.— One female, same data as holotype; depository MNB.

Further paratype material studied.— 1 nymph, same data as holotype, 1 female, same data as holotype but 2400 m. Material remains in collection of C. Hemp. 5 males, 2 females: Kenya, Thiba River, 00235S 3719E, 3.4.72, IADR, Ex Natural Resources Institute BMNH(E) 1996-185. Males with additional numbers: IADR 71/768, IADR 71 839, IADR 71/84, IADR 72/863, IADR 72/862; females: IADR 71/225 and IADR 72/864 (only two males and the two females had the label with the Thiba River locality; the other three males were labelled only with numbers: IADR 71/768, IADR 71/839 and IADR 71/840).

Male description.—Color: green, color patches of yellow, white and red on pronotal lobes, genae and face. Eyes brown (Fig. 2E, O; Fig. 4 H, I).

Head and antennae: fastigium of vertex sulcate, narrow (Fig. 2E, J); median carina of head faint. Antennae brown, basal segments green. Carinae of face vertex after adpression almost parallel (Fig. 2 E). Face green with a little blue-green on lower half; red macula restricted to lower part of carinae. Genae a mix of white and yellow with central red macula below eyes (Fig. 2 O).

Thorax: pronotum with median carina very faint. Two well-developed sulci present laterally on pronotal lobes; these not on disc of pronotum but reaching laterally almost to its margin (Fig. 2 O). Lateral lobes of pronotum bordered white with red macula above beginning before sulcus 1 and extending to sulcus 2 (Fig. 2 O). Sternites of thorax laterally bordered thin wine-red, centrally white (Fig. 4 I).

Legs: green, of same color as body, tarsi brown. Hind femora dorsally with three minute dark spinules. Hind tibiae dorsally with a double row of 12-13 small brown spines, these becoming a bit larger distally;

tibiae dull mottled brown.

Abdomen: green, laterally on lower ventral side of abdominal tergites thinly bordered yellow. Medially sternites keeled; sternites bluish to blue (Fig. 4 I). Subgenital plate blue-green, anterior margin of subgenital plate constricted, elongated. Cerci stout, brown, tips black (Fig. 2 T).

Female.— (Fig. 4 H, I) About twice as large and more plump than male. Carinae of head and pronotum well developed, abdominal tergites keeled; general color of female green, with brown along midline of pronotum and abdomen. Sternites of thorax and abdomen light brown, contrasting with green color of pronotal lobes and abdomen; eyes in living specimens very conspicuously colored in white-yellow with black (Fig. 4 H), in preserved ones dull brown; spiracles marked black. Dorsal valves long, serrated, serration black. Ventral valves smaller, not as coarsely serrated as dorsal valves, but also here serration black.

Measurements.—In mm. HW: head width; Pro: pronotum length; PFL: posterior femur length; TBL: total body length.

| | males n = 6 | females n = 4 |
|-----|-----------------------------|---------------|
| HW | 2.4-2.7 (\bar{x} = 2.5) | 3.3-3.4 |
| Pro | 1.5-1.7 (\bar{x} = 1.6) | 2.5-2.6 |
| PFL | 7.5-8.8 (\bar{x} = 8.1) | 12.5 |
| TBL | 8.8-11.1 (\bar{x} = 9.8) | 21 |

Diagnosis.— *C. keniensis* is well characterized by its color pattern (Fig. 2 E, O, Fig. 4 I), its almost parallel facial carinae (Fig. 2 E) and the much constricted anterior margin of the subgenital plate (Fig. 2 T).

Habitat.— *C. keniensis* was found on the Chogoria route of Mt Kenya between 2200 m and 2400 m a.s.l., beside the steep forest path. All individuals were caught upon *Rubus* bushes of smaller clearings receiving sunlight part of the day and many more individuals were seen along this route in similar situations (see Table 2).

Color variation of *Chromothericles* species

Very little variation was found in the color pattern of *C. uguenoensis*. Specimens were collected from two different localities, the only two larger forest areas of the North Pares. The Ngofi forest reserve is located on the western side of the mountain range and the Kindoroko forest reserve on its extreme eastern side; today both forest reserves are isolated due to heavy deforestation in the North Pare mountains. Specimens were also obtained from these two localities during different years and times of the year. Thus, the color pattern of *C. uguenoensis* seems to be very stable and a good feature by which to identify this species.

In the series of *C. manyara* from the Nou forest reserve, some variation in the color pattern of the males was found. The macula of the face in the area of the carinae is mostly red; in some specimens the red color is restricted to the small area between the carinae while the surround is yellow (also see diagnosis). Some variation is also found with the red-yellow macula of the pronotal lobes. The yellow stripe is always very conspicuous, but the red macula located above it can be reduced to a small patch in some specimens. Nevertheless, the general color pattern is found in all known specimens of this species.

A larger series of *C. kanga* from Mt Kilimanjaro was studied for its color variation (31 males, 27 females collected between 1997 and 2009). *C. kanga* is a frequently encountered species, restricted

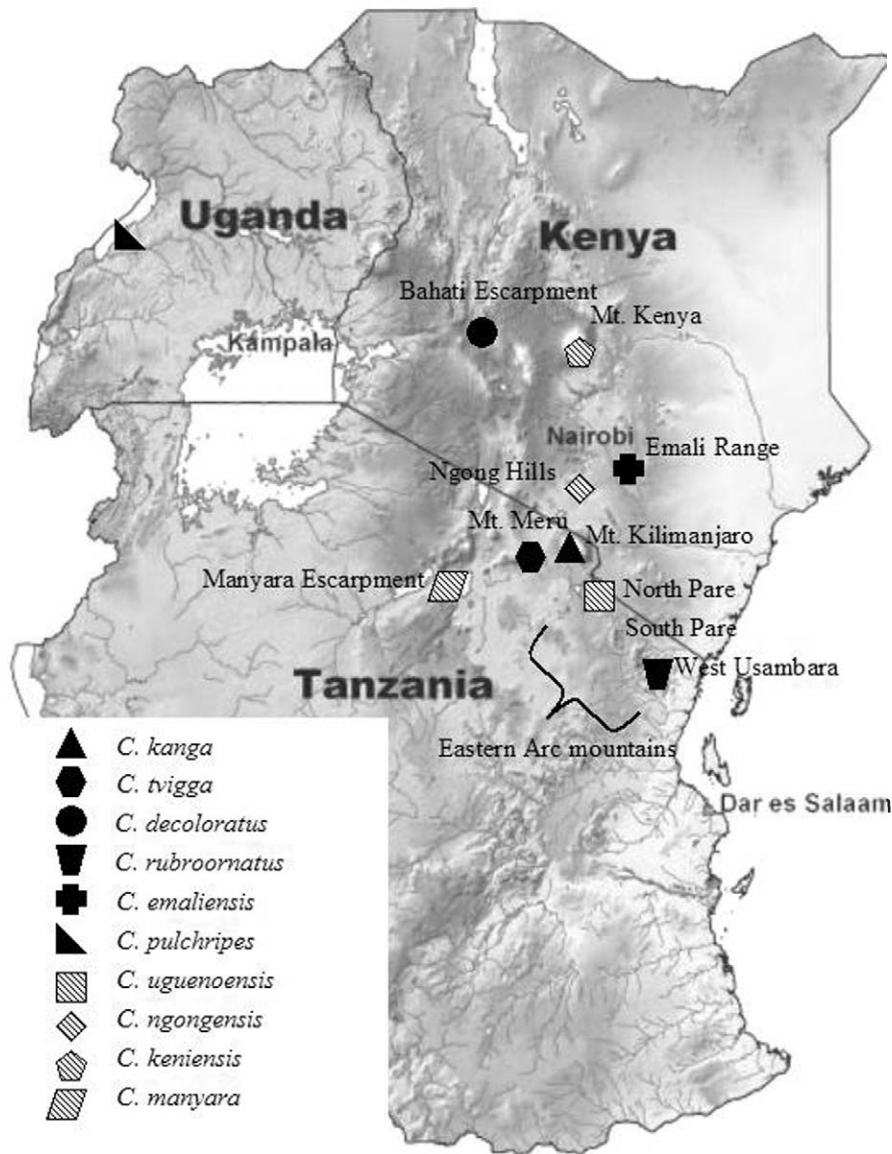


Fig. 5. Distribution of *Chromothericles* species in East Africa.

Six males of *C. keniensis* n. sp. were investigated for variation in their color pattern. The males all showed the same color pattern — a reddish macula on the carinae in the lower area of the face (frons) and a red macula on the pronotal lobes bordered by a white stripe. Differences were found in the color of the genae. The holotype from the Chogoria route of Mt Kenya had yellow genae suffused with red, while the specimens from Thiba River had yellow genae.

Nothing about variation in color pattern can be said for *C. ngongensis*, since only the male holotype is known. Since as well only a few specimens were studied for *C. rubroornatus*, *C. decoloratus* and *C. emaliensis*, nothing can be said about color variation in these species either. However, the study of series of the other species suggests that color pattern is generally very stable (except the coloration of the genae) and, together with the locality, a useful aid in identifying the species.

Distribution and habitat of *Chromothericles*

Ten *Chromothericles* species occur on mountains and in mountainous areas of East Africa (Fig. 5). All species are dwellers of forest edges and clearings of the submontane to montane zone (Table 2).

Phenology and habitat preferences seem to be quite uniform within the genus (however, no data are available for *C. pulchripes* from Uganda). All species are bound to forest of higher elevations and occur there in clearings, along forest paths and along forest edges. All species collected by the author (including the newly

described ones *C. kanga*, *C. twigga*, and *C. rubroornatus*), showed a preference for *Rubus* species. In suitable situations specimens of both sexes, and also nymphs, aggregated, sitting most of the time motionless on the leaves. *Chromothericles* are very visually oriented insects, hiding within the vegetation at the slightest disturbance. At night individuals remain on the same bushes, often hiding under leaves.

to Mt Kilimanjaro, but occurring everywhere round the mountain in suitable habitats at elevations from 1400 to 2700 m. The typical pattern of most individuals of *C. kanga* is a conspicuous red macula upon the facial carinae, dirty yellow to green-yellow genae and a red macula on the pronotal lobes, bordered below by a white or (rarely yellow) stripe. In a few specimens the yellow genae was tinged with red. However, the bright red macula of the face and the pronotal lobe were always present.

Only a few specimens of *C. twigga*, collected from Mt Meru and the Monduli range, were studied. The general color pattern consists of a bright yellow facial macula, yellow genae, and a red macula bordered by a yellow stripe on the pronotal lobes. The yellow stripe on the pronotal lobes was faint and reduced in some specimens and thus not very conspicuous. However, the yellow macula of the face in all investigated specimens, from both mountains, was always bright yellow.

Only two males of *C. emaliensis* are known (both in NHML). Both males showed the same color pattern: pronotal lobes with a red macula bordered by a white stripe, yellow genae with suffused red and the facial carinae colored red.

Notes on the phenology of *C. kanga*

Notes on the phenology of *C. kanga*

More ecological data are available for the two species *C. uguenoensis* from the North Pare mountains (see under *C. uguenoensis*) and especially for *C. kanga* from Mt Kilimanjaro (Fig. 4 G). On a montane forest-edge plot at 1710 m a.s.l, abundancies of Saltatoria species were noted on the southern slopes of Mt. Kilimanjaro in the area of Old Moshi (see also Hemp & Hemp 2003). From 1996 onwards this plot was visited over 50 times. *Chromothericles* was present on all visits, however with variable abundancies and in different stages of development during certain months of the year (see Fig. 6). High densities and many adults were present in most years

during November to February, while only nymphs were registered in the months June, July and August.

Discussion

Chromothericles has its center of diversity in the area of northern Tanzania along the mountain ranges of the Eastern Arcs, the inland volcanoes and westward to the escarpment of the rift valley (Fig. 5). The Kenyan highlands also harbor several species of *Chromothericles*. Probably more species will be found when further high mountains of East Africa are searched. Thus it is very probable that *Chromothericles* is also present on the South Pare mountains, since this mountain range is situated between the West Usambaras, home to *C. rubroornatus*, and the North Pares, where *C. uguenoensis* occurs. The most western-distributed species found to the present, *C. pulchripes*, was described from Mpanga forest in Uganda at an elevation of about 1250 m. Unfortunately only the female of this species is known and ecological information is lacking.

The morphology of all *Chromothericles* species is quite homogeneous, differences being rather small. Also the ecological niche which the species occupy — submontane to montane clearings and forest edges — and even preferred food plants (*Rubus* sp.), are the same for many species in the genus. Furthermore, species of adjacent mountains are most closely related, suggesting allopatric speciation. Generally this speciation mechanism seems to have been the driving force behind several flightless genera which have arrays of closely related species on the high mountains and highlands of East Africa, e.g., the lentulids *Rhainopomma* and *Altiusambilla* (Schultz *et al.* 2007, Hemp *et al.* 2007), as well as the lentulid genus *Usambilla* (Hemp & Hemp 2008), the hexacentrine genus *Aerotegmia* (Hemp 2006, Hemp, in press), the phaneropterid genera *Altihoratosphaga* (Hemp *et al.* in press) and *Monticolaria* (Hemp *et al.* 2009a), the conocephaline genus *Phlesirtes* or the pyrgomorphid genus *Parasphena* (Hemp *et al.* 2009b).

Similar patterns are found in all these taxa, showing sometimes enormous diversity in the area, e.g., *Parasphena* with 17 species on montane to afro-alpine grasslands (Hemp *et al.* 2009b) or the *Phlesirtes* genus group, with almost 40 species in grasslands from the submontane to afro-alpine zone of mountains (31 species yet

undescribed, but molecularly screened by Schultz 2007).

The driving force of this diversity seems to have been climatic fluctuations which occurred in the past, causing vegetation belts to shift up and down the mountains, forests to expand and shrink during different climatic regimes, and even connecting montane to afro-alpine grasslands (as suggested e.g., by the distribution pattern of species of the genera *Parasphena*, *Phlesirtes*, *Uganda*).

Chromothericles species are bound to submontane and montane forest communities, so that a spread under present-day climate is impossible. When the ancestor of *Chromothericles* spread, montane forest must have been more widely distributed, connecting e.g., the mountain ranges of the Eastern Arcs with the inland volcanoes, these with the rift-valley escarpment further west and the Kenyan highlands further north. Since, e.g., Mt Kilimanjaro is not older than 1 to 2 million years (e.g., Griffiths 1993, Schlüter 1997), it must be inferred that the radiation and speciation of members of this genus cannot have transpired earlier than 1 to 2 mya, since especially the younger volcanoes, as Mt Kilimanjaro, Mt Meru and Mt Kenya, currently harbor endemic species of *Chromothericles*. Still molecular data for this genus are lacking and would add much to the understanding of its evolutionary history.

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Literature Cited

Descamps M. 1977. Monographie des Thericleidae (Orthoptera Acridomorpha Eumastacoidea). Musée Royal de L'Afrique Centrale-Tervuren, Belgique. Annales 8, Sciences Zoologiques 216. 475 S.

Table 2. Distribution, habitat and altitudinal spans of *Chromothericles* species in East Africa.

| Species | Distribution | Habitat | Altitude (m) |
|---------------------------------------|----------------------------------|--|--------------------------------------|
| <i>C. decoloratus</i> Descamps, 1977 | Kenya: Bahati escarpment | montane forest (Descamps 1977) | 2400* |
| <i>C. emaliensis</i> Descamps, 1977 | Kenya: Emali range | montane forest | 1500-1800 (Descamps 1977) |
| <i>C. kanga</i> (Sjöstedt, 1923) | Tanzania: Mt Kilimanjaro | submontane clearings, forest edge and lush plantations, montane forest clearings and forest edge | 1400-2700 |
| <i>C. pulchripes</i> Descamps, 1977 | Uganda: Mpanga forest | submontane forest | 1250* |
| <i>C. rubroornatus</i> Descamps, 1977 | Tanzania: West Usambara | submontane and montane forest clearings and forest edge | 1400-2100 |
| <i>C. twigga</i> (Sjöstedt, 1909) | Tanzania: Mt Meru, Monduli range | montane forest clearings and forest edge | 2000-3500 (Descamps 1977 & own data) |
| <i>C. uguenoensis</i> sp. | Tanzania: North Pare | montane forest clearings and forest edge | 1500-2100 |
| <i>C. manyara</i> n. sp. | Tanzania: Nou forest reserve | montane forest clearings and forest edge | 2100 |
| <i>C. ngongensis</i> n. sp. | Kenya: Ngong Hills | montane forest edge | 2200 |
| <i>C. keniensis</i> n. sp. | Kenya: Mt Kenya | montane forest edge | 2200-2400 |

* altitude taken from topographical maps

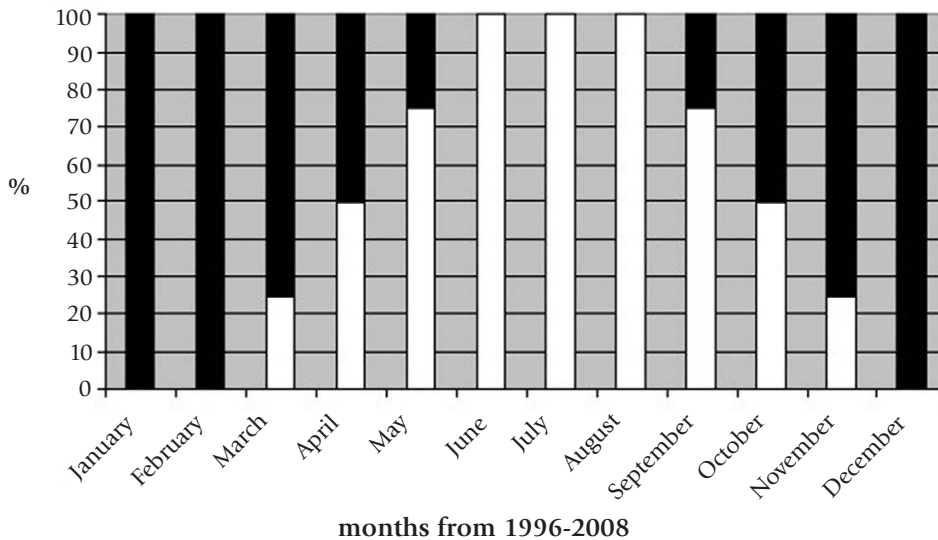


Fig. 6. Percentage of presence of *C. kanga* nymphs (white columns) and adults (black columns) on a montane forest-edge plot on the southern slopes of Mt Kilimanjaro in the area of Old Moshi (1710 m a.s.l.).

Griffiths C.J. 1993. The geological evolution of East Africa, pp. 9-21. In: Lovett J.C., Wasser S.K. (Eds) Biogeography and Ecology of the Rain Forests of eastern Africa. Cambridge University Press, Cambridge.

Hemp C. 2006. *Aerotegmina shengena*, a new species of Listroscelidinae (Orthoptera: Tettigoniidae) from the Eastern Arc mountains of East Africa. Journal of Orthoptera Research: 15: 99-103.

Hemp C. In press. Cloud forests in East Africa as evolutionary motors for speciation processes of flightless Saltatoria species. Chapter 18. In: Bruijnzeel L.A., Scatena E.N., Hamilton L.S. (Eds) Mountains in the Mist: Science for Conservation and Management of Tropical Montane Cloud Forests. University of Hawaii Press, Honolulu.

Hemp C., Hemp A. 2003. Saltatoria coenoses of high altitude grasslands on Mt. Kilimanjaro, Tanzania (Orthoptera: Saltatoria). Ecotropica 9: 71-97.

Hemp C., Hemp A. 2008. A new *Usambilla* species (Acridoidea, Lentulidae) from the northwestern highlands of Tanzania and distribution data on the genus *Usambilla*. Journal of Orthoptera Research 17: 37-42.

Hemp C., Schultz O., Hemp A., Wägele W. 2007. New Lentulidae species from East Africa (Orthoptera: Saltatoria). Journal of Orthoptera Research 16: 85-96.

Hemp C., Voje K., Heller K.-G., Hemp A. 2009a. Biogeography, phylogeny and acoustics of the flightless bush-crickets of the East African genus *Monticolaria* Sjöstedt, 1909, with the description of a new species (Orthoptera: Phaneropterinae). Zoological Journal of the Linnean Society 156: 494-506.

Hemp C., Hemp A., Wägele J.W. 2009b. Description of a new species of *Parasphena* Bolivar, 1884 (Orthoptera: Pyrgomorphidae) from northwestern Tanzania and new data on the biogeography, coenology, habitat and morphology of the genus. Journal of Orthoptera Research 18: 113-119.

Hemp C., Voje K., Heller, K.-G., Warchałowska-Śliwa, E., Hemp, A. In press. A new genus in African Acrometopini (Tettigoniidae: Phaneropterinae) based on morphology, chromosomes, acoustics, distribution and molecular data and the description of a new species. Zoological Journal of the Linnean Society.

Ragge D.R. 1980. A review of the African Phaneropterinae with open tympana (Orthoptera: Tettigoniidae). Bulletin British Museum (Natural History) 40: 1-192.

Schlüter T. 1997. Geology of East Africa. Beiträge zur regionalen Geographie der Erde 27. Bornträger, Berlin.

Schultz O. 2007. Molekulargenetische Analyse zur Evolution der Artenvielfalt in einer 'hot spot' Region: Phylogenie endemischer, flugunfähiger Heuschreckenarten in Ostafrika. PhD Thesis. Ruhr-Universität Bochum.

Schultz O., Hemp C., Hemp A., Wägele W. 2007. Molecular phylogeny of the endemic East African flightless grasshoppers *Altiusambilla* Jago 1981, *Usambilla* (Sjöstedt 1909) and *Rhainopomma* Jago 1981 (Orthoptera: Acridoidea). Systematic Entomology 32: 712-719.