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EAST AFRICAN BRYOPHYTES XXXIV
A preliminary study on the bryodiversity in dryland hilltops of Kitui County, Kenya

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Bryophytes remain undercollected in Kenya with a number of localities especially drylands inadequately represented. The first collection of the bryologically hitherto neglected Kitui County in southeastern Kenya was carried out during 2004 and 2005 biodiversity expeditions targeting isolated mist effected inselbergs surrounded by dry low altitude savanna plains. Bryophytes were collected from at least three inselbergs: Mutha, Nuu and Mumoni Hills, from where altogether 42 liverwort and 24 moss species were documented. *Dibrachiella africana*, *Metzgeria lechleri*, *Schiffneriolejeunea polycarpa*, and *Schlotheimia ferruginea* are new to Kenya. About 69 percent of these bryophytes also occur in the Taita Hills, the most representative part of the Crystalline Eastern Arc range biodiversity hotspot in southern Kenya. On the base of geology and bryoflora composition, these inselbergs of Kitui County therefore seem to belong to northernmost satellite affiliation of the Eastern Arc Mountains.

Key words: Afromontane, Crystalline Eastern Arc, mist forest

INTRODUCTION

Kenya is endowed with various terrestrial ecosystems, which exhibit high floral diversity, estimated to be over 7,000 species of vascular plants (IUCN 1996, Western *et al.* 2015). Most of these species are documented in the montane and other upland forests, compared to dryland biomes which cover closer to eighty percent of the country, yet they face increasing threats in this anthropocene era (Beentje 1990, Malombe *et al.* 2015, Wass 1995). Notwithstanding, drylands have been estimated to harbour *ca* seventy five percent of vascular plants (Grace *et al.* 2010, Malombe *et al.* 2005), influenced especially by the moist and high biodiversity rich misty hilltops described as outliers in arid areas (IUCN 1996). The unique biodiversity is comparable to Eastern Arc mountains due to extreme fragmentation albeit high species endemism (Malombe *et al.* 2015, 2020, Young 1984). The trends in exploration and floral diversity status are postulated to reflect that of bryodiversity.

The known number of liverworts and hornworts in Kenya can be estimated as 257 species (Wigginton 2018), while those of the mosses are 493

(O'Shea 2006). These numbers are much lower than those of the better explored Tanzania with 408 liverworts and hornworts and 764 moss species (O'Shea 2006, Wigginton 2018). However, the bryophyte explorations have concentrated more to the high altitudes and a few locations in Kenya (Chuah-Petiot 2003). Currently the country has a meagre forest cover of about 8.8%, which is fast disappearing especially in the drylands exacerbated by increased competition for natural resources. This studies therefore aimed at enhancing bryophyte documentation in the undercollected drylands of Kenya to inform the importance of continued protection. Bryophytes are indicators of environmental health because of their sensitivity to degradation, and any forest perturbations may lead to their species loss (Malombe *et al.* 2016, Pócs 1996).

Study area

Kitui County (Fig. 1) is located in the Eastern province of Kenya, between 0° 03′–3° 0′ S and 37° 45′–39° 0′ E, mainly covered by Yatta plateau at 600 m but interrupted by various massive hills or inselbergs invariably rising up to 1,800 m a.s.l. It borders Tana River County to the east, Taita-Taveta and Kilifi to the south, Makueni, Machakos and Embu counties to the west and Mbeere, Tharaka Nithi and Isiolo to the North.

The climate is arid and semi-arid with characteristic erratic and unreliable rainfall. Mean annual rainfall ranges from as low as 500 mm in the lowlands to over 1,050 mm in the hilltops. They experience two rainy seasons, long rains between March to June and short rains between October and December. Temperature and evaporation rates are generally high with February and September being the hottest months of the year. Minimum mean annual temperatures vary between 14 °C to 22 °C while maximum mean annual temperatures vary between 26 °C to 34 °C.

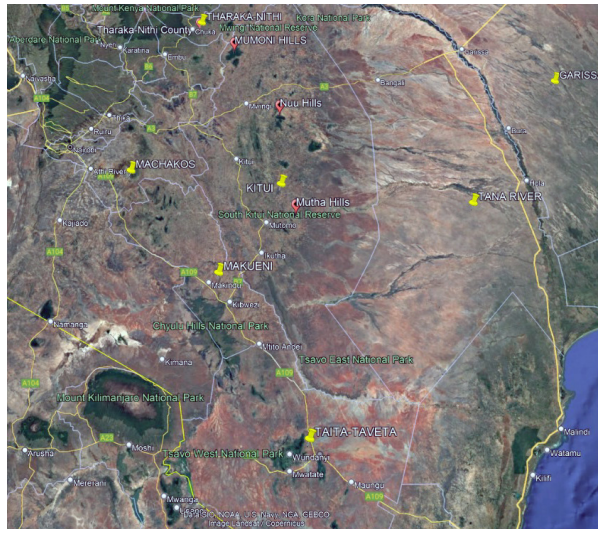


Fig. 1. A map showing location of study sites consisting of Mutha, Endau, Nuu, Mutitu and Mumoni hilltops or inselbergs in Kitui County, Kenya

The hilltops are characterised by ancient crystalline bedrocks of Precam-

brian origin (290–180 Myr BP), similar to the Eastern Arc Mts including the Taita Hills (Burgess *et al.* 2007, Lovett 1985, Saggerson 1957). Although drier than the Eastern Arc Mts, the Kitui hilltops also form the first barrier of moist-laden clouds from the Indian Ocean, which form precipitation in form of mist and rains and are characterised by narrow Afromontane vegetation and flora at their summit (Lillesø *et al*. 2011), and consist of various vascular plant endemics. Similarly, concerted biodiversity explorations since early 2000 in these hilltops have documented numerous species of vascular plants, some restricted to this ecosystem. These include *Oxyanthus pyriformis*, *Strychnos madagascariensis*, *Craibia zimmermannii*, *Monanthotaxis parviflora*, *Dyschoriste keniensis*, *Coffea sessiliflora* subsp. *sessiliflora*, *Syzygium cordatum* (Malombe *et al.* 2015, Malonza *et al.* 2006). Malonza and Wasonga (2023) described species of caecilian genus *Boulengerula*, in Kitui Hills, which are usually endemics of the eastern arc mountains (Mullar *et al.* 2005). Therefore, the inselbergs of Kitui County in southeastern Kenya floristically can be considered as the dissected northeastern satellites of the Crystalline Eastern Arc mountains, surrounded by dry savanna woodlands. This opinion can be supported by the presence of several so called "Lemurian" bryophyte elements in the sense of Tixier (1978) and Pócs (1999), common with Madagascar and other East African islands, as it is presented below.

Vegetation

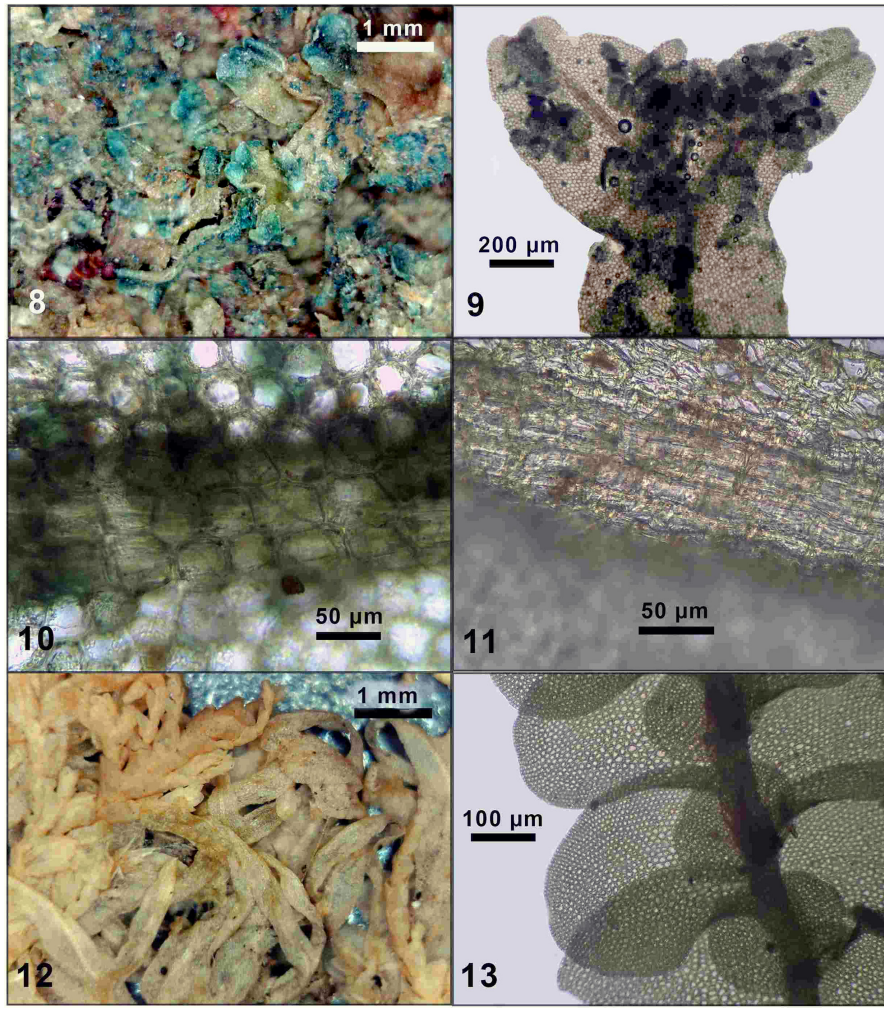
The vegetation in the lower altitudes of the hills (Figs 2–7) less than 1,000 m a.s.l were dominated by the *Acacia-Commiphora* and *Strychnos-Combretum* or *Commiphora* bushland vegetation type (Lind and Morrison 1974). At higher altitudes close to 1,200 m, was characterised by *Croton megalocarpus*, *Rawsonia lucida*, *Manilkara discolor* and *Drypetes* species, resulting in semi-evergreen dry upland forests. Most of this vegetation was secondary owing to settlements and cultivation of some of the sites in the first half of the 20th century. However, the summits above 1,200 m of these massive hills have Afromontane vegetation also with characters of the Crystalline Eastern Arc. For example Mumoni Hill was dominated by *Croton megalocarpus*, *Heywoodia lucens* and *Nuxia congesta* trees, *Rhus natalensis* and *Maytenus putterlickioides* shrubs; and lianas such as *Monanthotaxis parvifolia*. Nuu Hill was made up of *Acacia – Euphorbia* woodland on the southwest side and *Croton-Combretum* vegetation in the northeast, frequently interrupted by bare rock outcrops. Other common taxa belonged to following genera *Vachellia*, *Senegalia*, *Commiphora*, *Albizia*, *Ficus*, and *Newtonia*. Most of the hills contain perennial springs that sustain the dryland human and animal life.

MATERIAL AND METHODS

Ad hoc bryophyte collection was undertaken during the years of 2004 and 2005 in the forest reserves of Mutitu (19.587 km^2), Endau (67.178 km^2), Mutha, Nuu and Mumoni Hills (110.31 km^2) (Fig. 1), which are gazetted for-

Figs 2–7. Landscape and habitats of Munoni Hills, 2: cloud pockets on Munoni hilltops; 3: forest canopy; 4: dry evergreen Afromontane forest on the top of Munoni Hill; 5: hanging epiphyte *Orthostichella rigida* in the mist forest; 6: *Croton megalocapus* debarked for Malaria remedies; 7: Cattle grazing in Munoni Hill forest (photos made by I. Malombe)

ests. They consist of indigenous trees with some small pockets of exotic *Eucalyptus* plantations. Degradation of biodiversity in these areas has continued owing to anthropogenic effects such as illegal harvests of timber, medicine and charcoal burning, among others (GoK 2002). The vegetation description and the collecting work, preparation and sorting the material was done by the first author with the help of Joshua Muasya, Paul Kirika, Geoffrey Mwachala and Muthama Muasya. During this exploration, 65 samples of herbarium material were collected of which two contained lichens and three Semato-



Figs 8–10. *Metzgeria lechleri* Steph., 8: habit on bark; 9: thallus end with copious gemmae;10: dorsal epidermal cell rows of midrib. – *Figs 11–12*. *Metzgeria nudifrons* Steph., collected by T. Pócs and G. Kis in Tanzania, Nguru Mts for comparison, 11: dorsal epidermal cell rows of midrib; 12: habit. – *Fig. 13*. *Schiffneriolejeunea polycarpa* (Nees) Gradst.: habit, ventral view

phyllaceae and Hypnaceae not yet revised in Africa. Many samples contained more than one species. The second author did most of the identification of species including their annotation and evaluation. The voucher specimens are deposited in the East African Herbarium (EA) of the National Museums of Kenya and some of their duplicates in the herbarium of Eszterházy Károly Catholic University in Eger, Hungary (EGR).

RESULTS

The collecting activities were realised in the following three localities (Tables 1–2):

Table 1
The liverwort species collected at the three localities (hills). Species new to Kenya are indicated by boldface setting.

Species name	Locality altitudes (m)		
	Mutha	Nuu	Mumoni
Number of liverwort species	24	10	22
Acanthocoleus aberrans (Lindenb et Gottsche) Kruijt	1,400		
Acrolejeunea pycnoclada (Tayl.) Schiffn.		1,280	
Caudalejeunea hanningtonii (Mitt.) Schiffn.	1,405		
Cheilolejeunea cf. *krakakammae* (Lindenb.) R. M. Schust.	1,305		
Cheilolejeunea rigidula (Nees et Mont.) R. M. Schust.	1,340		1,745
Cheilolejeunea surrepens (Mitt.) E. W. Jones	1,340	1,235	1,750
Cheilolejeunea trifaria (Reinw. et al.) Mizut.	1,400		
Cheilolejeunea unciloba (Lindenb.) Malombe	1,400		
Cheilolejeunea xanthocarpus (Lehm. et Lindenb.) Malombe			1,745
Colura usambarica E. W. Jones[1]		1,235	
Dibrachiella africana (Steph.) X. Q. Shu, R. L. Zhu et Gradst.[2]		1,235	
Drepanolejeunea cultrella (Mitt.) Steph.	1,340		
Drepanolejeunea pocsii Grolle[3]	1,340		
Frullania apiculata (Reinw. et al.) Dum.			1,745
Frullania cf. *serrata* Gottsche			1,745
Frullania ericoides (Nees) Mont.	1,410	1,300	1,745
Frullania obscura (Sw.) Dum. (syn. of *F. arecae*)			1,745
Lejeunea flava (Sw.) Nees	1,340		1,745
Lejeunea flava ssp. *tabularis* (Spreng.) W. Arnell			1,745
Lejeunea helenae Pears.	1,340		
Lejeunea rhodesiae (Sim) R. M. Schust.	1,410	1,280	

Species name	Locality altitudes (m)		
	Mutha	Nuu	Mumoni
Lopholejeunea sp. ster.	1,340		
Mastigolejeunea nigra Steph.			1,745
Metzgeria furcata (L.) Dum.			1,745
Metzgeria lechleri Steph. (= *M. vivipara* A. Evans)[4]	1,305	1,235	1,745
Microlejeunea africana Steph.	1,400		
Odontolejeunea lunulata (F. Weber) Schiffn.	1,340		
Plagiochasma rupestre (J. R. Forst et G. Forst) Steph.		1,235	
Plagiochasma sp.			1,500
Plagiochila lastii Mitt.			1,745
Plagiochila squamulosa Mitt. var. *sinuosa* (Mitt.) Vand. Berghen	1,400	1,235	
Ptychanthus africanus Steph.			1,745
Radula ankefinensis Gottsche ex Steph.	1,340		
Radula quadrata Gottsche	1,305		1,745
Riccia crinita Taylor			1,450
Riccia stricta (Lindenb.) Perold	1,340		1,200
Schiffneriolejeunea pappeana (Nees) Gradst.	1,410		1,745
Schiffneriolejeunea polycarpa (Nees) Gradst. (Fig. 13)	1,340		1,745
Targionia hypophylla L.			1,745

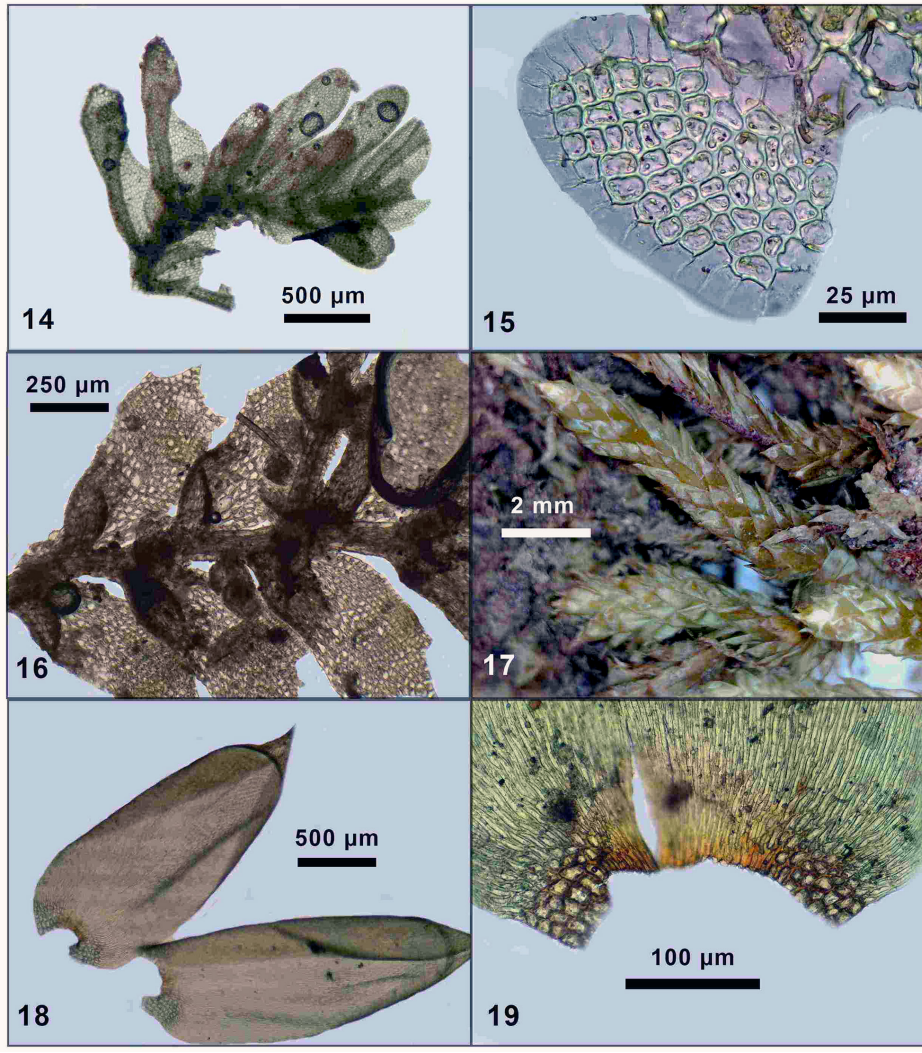
Annotations: **1.** *Colura usambarica* E. W. Jones (Figs 14–15) is a typical Crystalline Eastern Arc endemic occurring in the Mulanje Mts in Malawi, Usambara Mts in Tanzania and from Taita Hills in Kenya (Pócs and Váňa 2015). Its occurrence in the Nuu Hills extends highly its distribution northwards and confirms the belonging of Kitui County inselbergs to the Eastern Arc. Morphologically it is related to *Colura saroltae* Pócs, another Eastern Arc endemic, but differs by its narrower valve with lower number of valve cells (Jones and Pócs 1987). – **2.** *Dibrachiella africana* (Steph.) X. Q. Shi, R. L. Zhu et Gradst. (formerly known as *Archilejeunea africana* Steph.). A widespread African endemic species with relative large size and reniform underleaves (Shi *et al.* 2015, Vanden Berghen 1951). – **3.** *Drepanolejeunea pocsii* Grolle (Fig. 16) is an obligately epiphyllous liverwort restricted its distribution to the Indian Ocean islands (Madagascar, Comoros), and to the Southeast African highlands from Kenya to Malawi and Zimbabwe), that is, a "Lemurian" species in broader sense. Its stands near to *Drepanolejeunea madagascariensis*, from which is distinguished by its large lobe teeth, scattered ocelli and very acute underleaf lobuli (Grolle 1976). – **4.** *Metzgeria lechleri* Steph. (syn.: *Metzgeria vivipara* A. Evans) (Figs 8–10). A strange looking sparsely hirsute species with very wide thallus and almost no marginal hairs. It bears many superficial gemmae with short-hooked hairs. It is widespread in the American tropics with only one record from Réunion in Africa (Kuwahara 1986). So (2004) and Da Costa (2008) doubt in its African presence and suppose that the Réunion plant belongs to the related, African endemic *Metzgeria nudifrons* Steph. (Figs 11–12). The differences between the two are, that *M. lechleri* in dry state often has blue tinged thallus apices and gemmae while *M. nudifrons* in dry state is always golden yellow or yellowish green. In addition, *M. lechleri* has 2–3 rows of dorsal epidermal cells on its midrib, while *M. nudifrons* has 2–4(–5). Comparing the Kitui specimens from the three localities, they all turned out to be *M. lechleri*. The 5 specimens of *M. nudifrons* from different African countries in Herbarium EGR, differ well on the basis of the above characters. The Kenyan occurrence of *M. lechleri* therefore seems to confirm also the former Réunion record and its presence in Kitui inselbergs turns out to be another Lemurian element

Table 2
The moss species at the three localities (species new to Kenya are indicated by boldface setting)

Species name	Locality altitudes (m)		
	Mutha	Nuu	Mumoni
Number of moss species	12	9	8
Acroporium sp. ? (Sematophyllaceae)	1,340		
Aerobryopsis capensis (Müll. Hal.) M. Fleisch.	1,410		1,745
Brachymenium leptophyllum (Müll. Hal.) Jaeg.		1,300	
Erpodium beccarii Müll. Hal. ex Venturi			1,200
Erythrodontium subjulaceum (Müll. Hal) Par.			1,600
Fissidens megalotis subsp. *helictocaulos* (Müll. Hal). Brugg.-Nann.			1,500
Fissidens sciophyllus Mitt.		1,235	
Fissidens submarginatus Bruch in Krauss	1,340		
Hilldebrandtiella phleoides (Desv. ex Brid.) B. H. Allen et Magill[5]	1,340		
Macrocoma tenuis (Hook. et Grev.) Vitt	1,340	1,090	1,745
Macromitrium sp.	1,305		
Macromitrium sulcatum (Hook.) Brid.	1,400	1,280	
Octoblepharum albidum Hedw.		1,235	
Orthostichella rigida (Müll. Hal.) B. H. Allen et Magill			1,745
Orthostichella versicolor (Müll. Hal.) B. H. Allen et W. R. Buck	1,400		
Papillaria africana (Müll. Hal.) Jaeg.		1,280	1,745
Pterobryon flagelliferum Mitt.		1,235	
Racopilum africanum Mitt.			1,450
Rosulabryum keniae (Müll. Hal.) Ochyra	1,400	1,300	
Schlotheimia ferruginea (Bruch. ex Hook. et Grev.) Brid.		1,300	
Stereophyllum radiculosum (Hook.) Mitt.	1,340		
Syrrhopodon asper Mitt.	1,340		
Trachyphyllum inflexum (Harvey) Gepp.	1,010		
Total number of species	36	19	30

Annotation: **5.** *Hildebrandtiella phleoides* (Desv. ex Brid.) B. H. Allen et Magill (syn.: *Hildebrandtiella pachyclada* Besch.) (Figs 17–19). It is a typical, Lemurian element hitherto known only from the islands of Mauritius, Rodriguez, Réunion and in mainland Africa only from the Crystalline Arc in Tanzania (Usambara, Kanga, Nguru and Uluguru Mts (Argent 1973, Kis 1985) and in the Taita Hills (Chawia, Kasigau, Mbololo and Ngangao Hills) southern Kenya (Enroth *et al.* 2019)

A: Kenya, Kitui County, Mutha Hill, near the summit, south facing side, uphill route from Mutha market. 1° 46.43′ S, 38° 34.46′ E, 1,340–1,410 m elevation. Dry "inselberg" cloud forest surrounded by extensive low lying Yatta Plateau. Vegetation of *Commiphora*, *Terminalia*, *Rawsonia*, *Newtonia*, *Cassipourea*, *Vachellia* and *Strychnos.* Coll.: I. Malombe and J. Muasya, 8 October 2004.



Figs 14–15. *Colura usambarica* E. W. Jones, 14: habit; 15: valve, fused to the lobule without hinge. – *Fig. 16*. *Drepanolejeunea pocsii* Grolle: habit, ventral view. – *Figs 17–19*. *Hildebrandtiella phleoides* (Desv. ex Brid.) B. H. Allen et Magill, 17: habit on bark; 18: leaves; 19: leaf base with thickened, brown walled cells (all microphotos made by T. Pócs, from Kitui specimens with the exception of Figs 11–12)

B: Kenya, Kitui County, Nuu Hill, along foot path SE near summit ridge overlooking Nuu market. 1° 02.22′ S, 38° 19.12′ E, 1,090–1,300 m elevation. Dry "inselberg" cloud forest surrounded by extensive low lying Yatta Plateau. Vegetation of *Vachellia-Euphorbia* (southwestern) and *Croton-Combretum* (NE aspect). Coll.: I. Malombe and J. Muasya, 19–21 October 2004.

C: Kenya, Kitui County, Mumoni Hills, top ridge along the road towards NE of the forest station. 0° 31.19′ S, 38° 00.20′ E, 1,200–1,750 m elevation. Dry bushland, mist forest (*Croton megalocarpus*, *Heywoodia lucens* and *Nuxia congesta* trees, *Rhus natalensis* and *Maytenus putterlickioides*) and *Eucalyptus* plantations. Coll.: I. Malombe and J. Muasya, 19–30 October 2004 and I. Malombe, G. Mwachala and P. Kirika, 8–10 May 2005.

CONCLUSIONS

The southeastern inselbergs of Kenya in Kitui County are geologically similar to the Crystalline Eastern Arc mountains of East Africa. Although their climate is much drier and therefore their vegetation cover is different, the mist effected summits have several elements in common with them, with almost 69% of bryophytes affiliated. Only about 19% of the bryophyte species occurs in high mountains of Mount Kenya or the Aberdare Ranges. Therefore they can be considered as the isolated northeastern satellites of the Crystalline Eastern Arc, as a continuation of the Taita and southeastern hilltops in Kitui, Makueni including Nzaui and Emali Hills.

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