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The genus *Hypoxis* L. (Hypoxidaceae) in the East Tropical Africa: variability, distribution and conservation status

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Abstract: A complete key with full descriptions and distributions of all known *Hypoxis* taxa found in the East Tropical Africa is presented in the monograph. The morphology of all species, subspecies and varieties is described, including such important taxonomic characters for this genus like tuber flesh color, tunic type, indumentum and seed testa sculpture. A succulent leaf structure is described for *H. kilimanjarica* var. *prostrata*. The anatomical studies were conducted as a part of taxonomical analysis. They have positively evaluated a taxonomic significance of leaf anatomy characters, such as succulent structure, occurrence of bulliform cells in epidermis outside the keel zone, type and distribution of trichomes. The studies of the *Hypoxis* leaf anatomy added new data concerning anatomical differentiation of the cataphylls and the inner leaves. Also differentiated mesophyll and simultaneous presence of different types of stomata on one leaf are reported. It has been shown that in some species mucilage canals are present in the inner leaves and that this character is not constant. The number of vascular bundles, which can be determined only on the basis of a leaf section, is useful only in species with a small number of veins, not increasing with a plant age. Because of lack of constancy in distribution, number of stomata accessory cells cannot be used as a diversifying character for the East African species of *Hypoxis*. The wax crystals are revealed to exist in many species of *Hypoxis*. The anatomical characters of scapes were also studied in a taxonomic context. A sclerenchyma distribution, as well as number of vascular bundles can be used for a species determination. The presence of sclerenchyma prevents the scapes from bending down after anthesis. The studies of phenology revealed that there are two groups of taxa, one with a resting period and the other without it. It is connected with a climate in which the species occurs. The study of distribution maps of the species occurring in the East Africa are provided for this area, as well as for their entire range. This new knowledge, along with a revision of literature data, led to a new conclusion as to a number of all *Hypoxis* species in Africa, which is now estimated to be 55. The revision demonstrates that distribution of many of the *Hypoxis* species is connected with White's phytochoria. It proves that not only South Africa, but also the Zambesian Region is a very important center of diversity of this genus. The number of endemic taxa of *Hypoxis* for the East Tropical Africa is very low, including only one species and one subspecies. Additionally, a study of vertical ranges of *Hypoxis* is presented. It reveals that most of the species in East Africa grow in the mountains and they show preferences of dispersal in particular altitudinal levels. The analysis of the vertical distribution within the entire ranges of different taxa has showed differences in the altitudinal position depending on the geographic location. The human influence on *Hypoxis* is studied in terms of their use in folk medicine and believes. Most of the species of *Hypoxis* survive quite well in East Africa, being a visible component of various types of grasslands. Some species however are under threat of extinction. This is due to their incapability of surviving in changed habitats, especially in shade of cultivated plants. Another threat is a large-scale collection of species believed to cure the HIV, or sold as a substitute of similar taxa, assumed to possess such qualities. The IUCN categories are proposed for the East African taxa of *Hypoxis*.

Key words: *Hypoxis*, East Africa, taxonomy, morphology, anatomy, phytogeography, phenology, IUCN categories

Contents

1. Introduction

The subject of this monograph is a genus *Hypoxis* L., which belongs to a monocot family Hypoxidaceae R. Br., currently placed within the "lower Asparagales clade". Because of the morpholgical features, different from other Liliopsida members, and the position within the vascular plants system, the Hypoxidaceae family is particularly interesting from the point of view of plant phylogeny. It is considered to be a sister group of Orchidaceae, the family very popular among scientists and gardeners. Therefore *Hypoxis* species are used in phylogenetic studies as a sister group or an outgroup.

The genus *Hypoxis* consists of a relatively small number of species. In Africa there are only 69 species listed by Singh (2006) that are frequently found in grassland ecosystems of this continent. Although, due to distinctive flowers, the recognition of the genus itself is not problematic, determination of the lower taxa is a challenging task. Flowers of various species are often very similar, which in the absence of the leaves often makes determination of the species almost impossible. Moreover, inflorescences are initially surrounded by outer leaves (cataphylls), morphologically different from the proper leaves that often develop after flowering. Because of the similarity to grasses, the non-flowering plants are often overlooked in the field. The underground parts of *Hypoxis* are often difficult to excavate, do not dry well and are therefore not always collected. On the other hand the seeds, which can provide valuable taxonomic features (Wiland-Szymańska 2006), are very small and their sculpture is clearly visible only under scanning microscope. There are documented cases of apomixis in certain *Hypoxis* species (Nordal *et al*. 1985; Zimudzi 1994), which favours formation of new forms. These difficulties have contributed to the fact that the treatment of the genus *Hypoxis* was undertaken by very few botanists. The most recent comprehensive taxonomic study for Africa was done in 1914 (Nel 1914b).

The discovery of East African botanical resources was not uniform in the whole area and there are still parts that have not been sufficiently explored (Beentje & Smith 2001). The first large expeditions were undertaken in the 1860s (Gillett 1962). The research was intensified after The Royal Botanic Gardens, Kew had started a project of a series The Flora of the Tropical East Tropical Africa in 1952 (Beentje & Smith 2001). There are many scientific centers currently involved in intensive botanical studies in the East Tropical Africa. The main aim of these institutions are environment protection and education and to much lesser extent basic research. Among the most active organizations in this aspect are Plant Conservation Assessment in the Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya and the Missouri Botanical Garden in St. Louis, USA.

First floristic works concerning the East Tropical Africa, in which the genus *Hypoxis* was mentioned, were published by Baker (1898) and Baker *et al*. (1905). Nel (1914b) has described many new species from Africa, including 20 from this region. He has listed in total 26 *Hypoxis* species from this area. The names of only five of them are still valid nowadays. The rest was included as synonyms of other species or not confirmed for this region. *Hypoxis* was subsequently listed in general descriptions of the flora of the East Tropical Africa (Jex-Blake 1948; Lind & Morrison 1974; Sapieha 1990) and in more detailed descriptions concerning particular regions (Engler 1894; Williams 1949; Heriz-Smith 1962; Lind & Tallantire 1962; Blundell 1982; Cribb & Leedal 1982; Schmitt 1991; Agnew & Agnew 1994; Friis & Vollesen 2005). All in all, there were 32 *Hypoxis* species names recorded for East Africa: 4 in Uganda, 11 in Kenya (including 1 endemite), and 31 in Tanzania (including 16 endemites). This demonstrates the problems, encountered by taxonomists working on the genus *Hypoxis*, concerning difficulties in defining variability of both vegetative and generative organs.

Although the genus *Hypoxis* is a significant element of grassland ecosystems in the East Africa, its next more detailed treatment for this region was published in 1985 (Nordal *et al*. 1985). Later, a taxonomic study of the Flora of the East Tropical Africa (Wiland-Szymańska & Nordal 2006) has systematized the nomenclature of *Hypoxis* in this area. Beside these last two works, no attempt was made in a comprehensive study of this genus in the East Africa. In the literature, there was a lack of detailed descriptions and distribution maps for all taxa as well as a full graphical documentation of their morphology.

The genus *Hypoxis* was so far studied for some regions of Africa (e.g. Nordal & Zimudzi 2001; Wiland-Szymańska 2001), but a complete and acceptable treatment of the species nomenclature for the whole continent is still lacking. The first effort to address this subject was made by Singh (2006), but the list included in her paper did not contain all publications concerning the African *Hypoxis* species (e.g. Demissew *et al*. 2003; Wiland-Szymańska & Nordal 2006). Except for endemic taxa found in the regions, for which detailed treatments have been published (Nordal *et al*. 1985; Wiland-Szymańska 2001), for a majority of *Hypoxis* species there are no complete range maps. The understanding of geographic distribution and the unification of nomenclature are very important, because *Hypoxis* species are well recognized by native inhabitants. They are utilized as medicinal and magical plants. The use of *Hypoxis* is not limited to a folk medicine. Certain species are also used as a supplement to a treatment of cancer and HIV (Drews & Horn 1999; Mills *et al*. 2005). These properties may, however, cause extinction of some species,

due to their overcollection. Such a threat concerns not only the medicinal species, but also all other taxa that are similar and difficult to distinguish.

The anatomy of the *Hypoxis* species has been so far only partially studied. The anatomical fatures of leaves and scapes of the species from the same region were never analyzed in terms of their usefulness in distinguishing closely related species.

The aim of this work is a comprehensive treatment of all *Hypoxis* species found in East Tropical Africa. The key, together with detailed descriptions, allows precise determination of not only the species, but also lower taxa found in this region. The morphological and anatomical features, essential for distinguishing all of the *Hypoxis* species in the field, and in the herbarium, were examined during field and laboratory studies. The distribution maps for particular species summarize and enhance the knowledge of the chorology of *Hypoxis* in Africa. For the first time, the data on the vertical distribution of *Hypoxis* species are presented and an account of preferences for the altitudinal vegetation zone belts is studied. The correlation between the fenology of the species and the climate conditions in various parts of East Tropical Africa are analysed. It has been also demonstrated that there is a correlation between anthropopression and the expansion or extinction of *Hypoxis* species in particular regions. This allowed a determination of the categories of threats for these species in the East Tropical Africa.

2. Material and methods

The studies were conducted on herbarium materials of 750 collector numbers, stored in the herbaria belonging to: The Botanical Garden and Museum of Botany, Berlin-Dahlem (B), The Natural History Museum in London (BM), National Botanical Garden of Belgium (BR), Botanical Museum and Library of the University of Copenhagen (C), Botany Department of the University of Dar es Salaam (DSM), East African Herbarium, National Museums of Kenya (EA), The Royal Botanic Gardens, Kew (K), The Missouri Botanical Garden in St. Louis (MO), National Herbarium of Tanzania, Tropical Pesticides Research Institute (NHT), Natural History Museum in Oslo, Botanical Museum (O), National Museum of the Natural History, National Herbarium of Paris, Department of Systematics and Evolution (P), The Natural History Collections of the Faculty of Biology of the Adam Mickiewicz University (POZG), Museum of Evolution, Botany Section (Fytoteket), Evolutionary Biology Center of the Uppsala University (UPS), Department of Botany, The Natural History Museum in Vienna (W) and The Natural History Museum of the Wroclaw University (WRC). The abbreviations

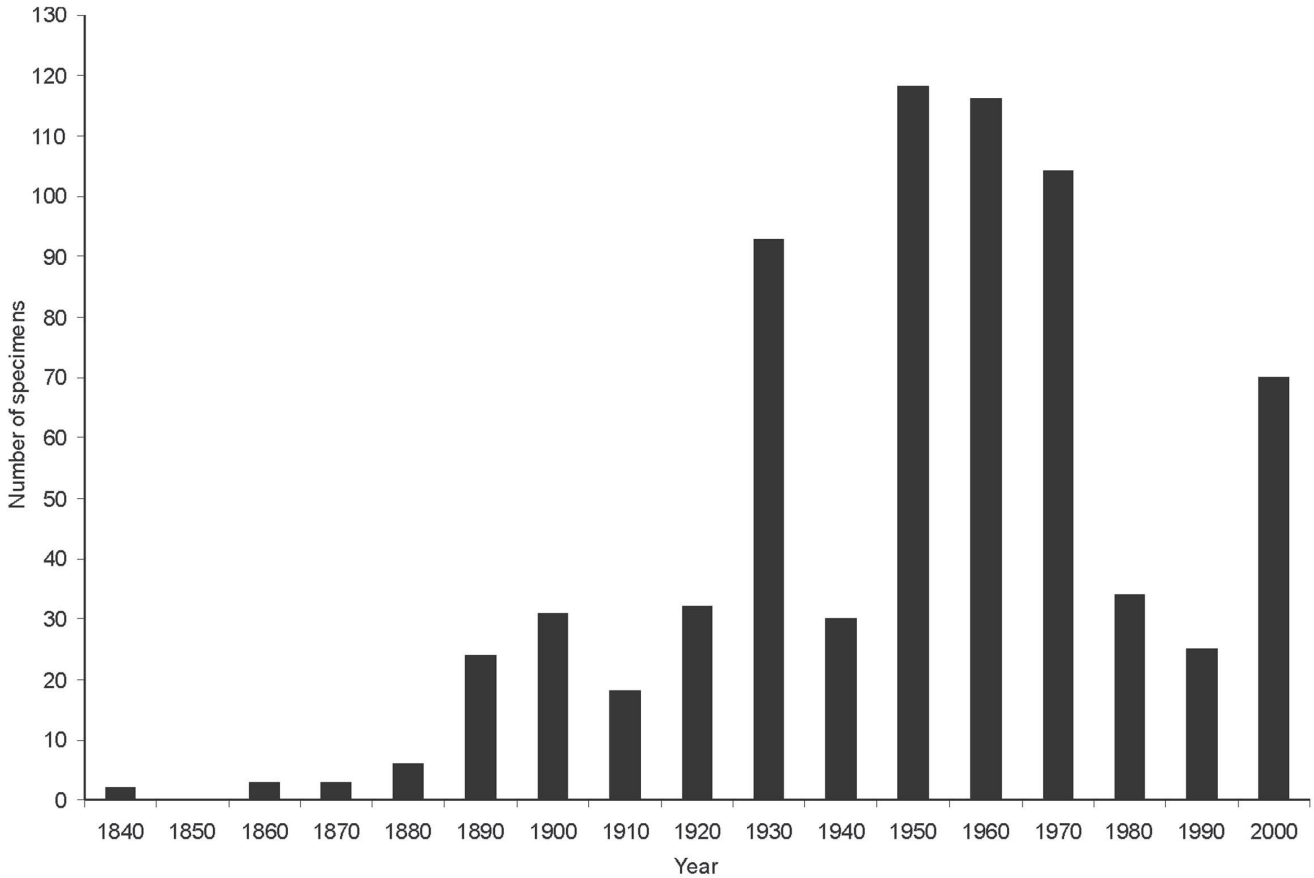


Fig. 1. Amounts of herbarium collector's numbers of *Hypoxis* gathered over decades in East Africa

Table 1. Materials used for anatomical analysis

Taxon	Voucher	Herbarium
H. angustifolia	*Wiland & Mboya 174*	NHT, POZG
H. filiformis	*Wiland & Mboya 148*	POZG
H. fischerii var. *hockii*	*Wiland & Mboya 99*	MO, NHT, POZG
H. fischerii var. *hockii*	*Wiland & Mboya 105*	NHT, POZG
H. fischerii var. *zernyi*	*Wiland & Mboya 87*	NHT, POZG
H. fischerii var. *zernyi*	*Wiland & Mboya 132*	POZG
H. galpinii	*Wiland & Mboya 57*	POZG
H. goetzei	*Wiland & Mboya 81*	NHT, POZG
H. goetzei	*Wiland & Mboya 97*	NHT, POZG
H. gregoriana	*Wiland & Mboya 172*	MO, NHT, POZG
H. kilimanjarica	*Natural Collections s.n.*	POZG
H. nyasica	*Wiland & Mboya 74*	MO, NHT, POZG
H. nyasica	*Wiland & Mboya 75*	NHT, POZG
H. nyasica	*Wiland & Mboya 102*	MO, NHT, POZG
H. nyasica	*Wiland & Mboya 104*	MO, NHT, POZG
H. nyasica	*Wiland & Mboya 106*	MO, NHT, POZG
H. nyasica	*Wiland & Mboya 114*	NHT, POZG
H. nyasica	*Wiland & Mboya 119*	NHT, POZG
H. obtusa	*Wiland & Mboya 85*	MO, POZG
H. polystachya	*Wiland & Mboya 159*	POZG
H. polystachya	*Wiland & Mboya 161*	POZG
H. rigidula	*Wiland & Mboya 68*	POZG
H. rigidula	*Wiland & Mboya 121*	POZG
H. urceolata	*Wiland & Mboya 171*	MO, POZG

Explanations: the abbreviations are consistent with the *Index Herbariorum* (Explanations in the text); country of origin – Tanzania

are consistent with the *Index Herbariorum* (Thiers continuously updated). Materials for anatomical studies were collected during a field trip to Tanzania in 2001. Comparative studies of plants from other African countries were performed on materials from the herbaria mentioned above and stored in: Department of Organismic Biology, Free University of Bruxelles (BRLU), Compton Herbarium, South African National Biodiversity Institute (NBG), KwaZulu-Natal Herbarium, South African National Biodiversity Institute (NH) and Botany Department, Rhodes University (RUH). Additional comparative materials were collected during a field trip in the Republic of South Africa in 2002. The herbarium materials, available for this study, were gathered over a period of more than 150 years. The summary of time of collection for *Hypoxis* specimens used in this work is presented in Fig. 1. The most intensive gathering took place in 1930s, 1950s, 1960s and 1970s. A significant number of herbarium sheets from the beginning of XXIth century reflects a collection made for this work.

Taxonomic studies were performed using methods of classical plant taxonomy based on the comparison of type specimens and biometric measurements. Seeds' morphology and the leaves' surface anatomy were studied using scanning microscopy (Philips SEM 515). Some of the scanning microscopy data were kindly provided by Professor Inger Nordal from Oslo University, Norway. The anatomy of leaves was studied on the material belonging to 13 taxa collected in Tanzania and preserved in ethanol (Table 1). The leaf epidermis was separated using the preparation needle. The leaves inserted between two *Sambucus nigra* L. stem cores were cut into thin slices using the Ernst Litz Wetzlar microtome. The slices were embedded in glicero-gelatine. The observations and measurements of selected features were performed using a regular light microscope and light microscope with a polarizer. The quantity of stomata was estimated using Lucia Measurment and Nikon DS, Version 5.00. Photographs of vegetation and living plants as well as taken under the light microscope, including these in polarized light, were made by the author. The SEM photographs were made in the Electron and Confocal Microscope Laboratory of the Faculty of Biology of the A. Mickiewicz University. Exceptions are photographs number 25F, 28, 34A, 36, 53A, 53C, 56, 61D, 70B and 73E, which were helpfully provided by Professor Inger Nordal. Figures were drawn by Kinga Gawrońska, except number 64C made by the author.

The data on the geographic distribution of taxa, their environment, biology and practical use were taken from herbarium tags, literature as well as personal observations in the field. The electronic database was compared and updated according to the database concerning herbarium material made by Professor Inger Nordal from the Oslo University. The geographic names, phytogeographic division of the area and geographic coordinates were taken mostly from the „FTEA Index of Collecting Localities" (Polhill 1988).

The IUCN categories are provided according to the guidelines published in the IUCN Red List Version 3.1 issued by The International Union for Conservation of Nature and Natural Resources (2001), and for the East Tropical Africa the guidelines prepared by the IUCN/ SSCR Regional Applications Working Group (Gärdenfors *et al*. 2001).

In the analysis of geographic ranges of species, both horizontal and vertical distributions were taken into consideration. The plots showing the altitudinal ranges above sea level were drawn using Corel Draw. In the East Tropical Africa large differences in altitudinal distribution of the altitudinal vegetation zone belts correlated with their geographic location is observed. Therefore during the analysis of species preferences as to these belts, not only height above see level, but also local vegetation patterns, based on literature (Walter 1973; Pócs 1976a, 1976b; Schnell 1977; Cribb *et al*. 1982), are taken into consideration.

The histograms were used to determine the height ranges in which particular species are found most often. It was, however, possible only for species with a sufficient number of specimens available for the analysis. The statistical analysis was done using the programme STATISTICA (version 6.0). The differences were considered as statistically significant at the level of $p<0,05$ (Stanisz 2006). Because the detailed data concerning occurence of analyzed taxa at particular heights in other countries are not available, the analysis was based on the general data, published for various phytogeographic regions of Africa. These floras were arranged on charts in NW to SE sequence and compared with vertical ranges determined for particular phytogeographic provinces of East Tropical Africa as well as overall vertical ranges of *Hypoxis* species for this area.

The overall range maps were prepared based on the point distribution maps for East Africa and the data from the literature for other countries. If the point distribution maps were missing, the country or province (if provided) borders were used as the range limits. The areas, for which the detailed location of the *Hypoxis* taxa is not known, are indicated with lines on the maps showing the general distribution.

The analysis of flowering times was based on the collection dates given on herbarium labels. Due to the similarity of the leaves of some *Hypoxis* species to grasses and other monocot groups, their specimens are rarely collected in a vegetative state. The yellow flowers, that are very well visible, often attract general collectors. In this analysis numbers of specimens collected in particular months were taken into account. For *H. goetzei,* specimens after flowering period, collected during the fieldwork in February 2001, were omitted in the analysis. Lack of herbarium material for particular species collected in a given month was considered as an indication of them being without inflorescences or during a resting period.

3. Geography, climate and vegetation of East Africa

3.1. Geography

The Flora of the Tropical East Africa, published by The Royal Botanic Gardens in Kew, defines the territory of East Africa as an area of three countries: Uganda, Kenya and Tanzania (Beentje & Smith 2001). They comprise in total the land of 1.766.500 square km.

East Africa shows a great variability in terms of geomorphology. Most of the area constitutes the East African Highland reaching 900-1500 m a.s.l. It is separated from the Indian Ocean by a narrow strip of lowlands. In the west it ends with a steep fault of Central African Rift Valley with tectonic lakes. The ridges of the rift valley are formed by mountain ranges. The deepest depression of the Central African Rift Valley is at the bottom of the Tanganika Lake. In the northern part, the volcanic massifs and calderas surround the southern part of the East African Rift Valley. In the central part of the East African Highland there are vast plateaus e.g. Masai Steppe, Wembre Steppe and Serengeti Plain. In the south the plateaus are replaced by highly eroded mountain ranges (Rubeho, Uluguru, Mbarika), and farther beyond the Rufiji Valley, by Mozambique Highland. The coasts and islands of Zanzibar, Pemba and Mafia are surrounded by coral reefs (Falkowski & Kostrowicki 2001).

Through East Africa goes the continental divide between Atlantic and Indian Oceans basins. Part of the area is drained directly into the Indian Ocean by Rufiji, Wami, Ruvu, Pangani and Ruwuma rivers. The river network within the areas of coast lowlands stripe and the Lake Tanganika is relatively dense and permanent. In the center of the East African Highland it is much more dispersed and comprises primarily temporary rivers (Kalisiewicz 1999). The Lake Victoria is located within a vast syncline on the border of Democratic Republic of the Congo, Uganda and Tanzania at the altitude of 1134 m a.s.l. With the area of 68800 km^2, it is the largest lake in the world. Particularly interesting are also salt lakes within the Central and East African Rift Valleys that drain central parts of the East African Highland (Kalisiewicz 1999).

The East African Highland is composed of prekambrian crystalline rocks. The Great Rift Valleys landscape was formed in the Tertiary by endogenic factors. The seismic and volcanic activities responsible for the origin of the rift valleys have been observed until now. The northern part of the East African Rift Valley comprises relatively recent volcanic formations. The coast lowlands stripe is formed by the tertiary and quaternary sediments, and in its southern part and on

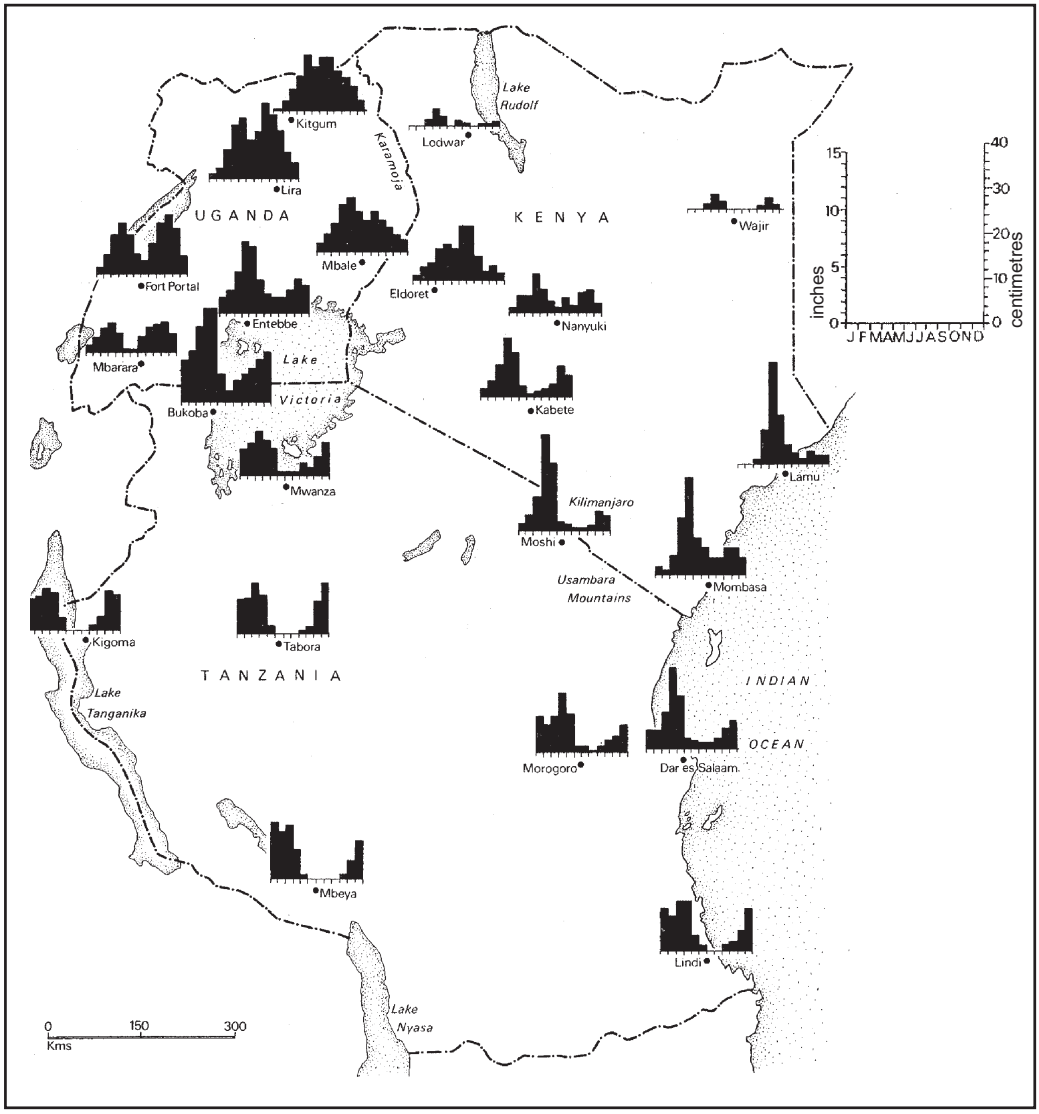


Fig. 2. Seasonal rainfall regimes in East Africa (after Kenworthy 1966 from Lind & Morrison 1974, partially modified)

the islands by calacareous rocks (Jelonek 1996). The geological evolution of the area was described in details by Griffiths (1993).

The most fertile red soils (nitrosoles) formed on the volcanic rocks are found at the feet of Kilimanjaro and Meru massifs. Around Lake Victoria and north of Lake Malawi there are fertile vertisoles and alluvia in the river valleys (e.g. Rufiji). In the southern and western parts of the East African Highland, the most common are ferralitic soils. In the north, e.g. Masai Steppe, there are red-brown soils of the dry grasslands, and on the gneisses in the vicinity of the Lake Victoria there are yellow soils (Jelonek 1996). In the east, red soils of dry subequatorial forest and woodlands are present. Near Lake Niasa there are red soils of temporarily wet subequatorial forests and high grass grasslands (Mityk 1975). In the East Tropical Africa one can often observe several types of soil in a small area, a phenomenon called a soil catena (Lind & Morrison 1974).

3.2. Climate

The ranges of climate zones in the East Tropical Africa are influenced by the highland-plateau character of the landscape and its location on both sides of the equator. Warm sea currents along the Indian Ocean coast bring precipitation to the coastal plains. East Africa is dominated by the subequatorial dry or humid climate depending on the distance from the oceans (Jelonek 1996). During the year there is at least one rain season with the exception of a small area with two rain seasons. The mountain ranges are characterized by mountain climate (Pócs 1974, 1976a; Martyn 2000). In many regions there is a distinct dry season. The variations in the climate can be observed in Tanzania. The average temperatures in the coldest month (July) range from 16°C, in the central part, to 24°C on the coast. In the warmest January they reach from 22°C to 28°C, respectively. The average precipitation per year is only 300-500 mm in the central part of the East African Highland (west of Tabora

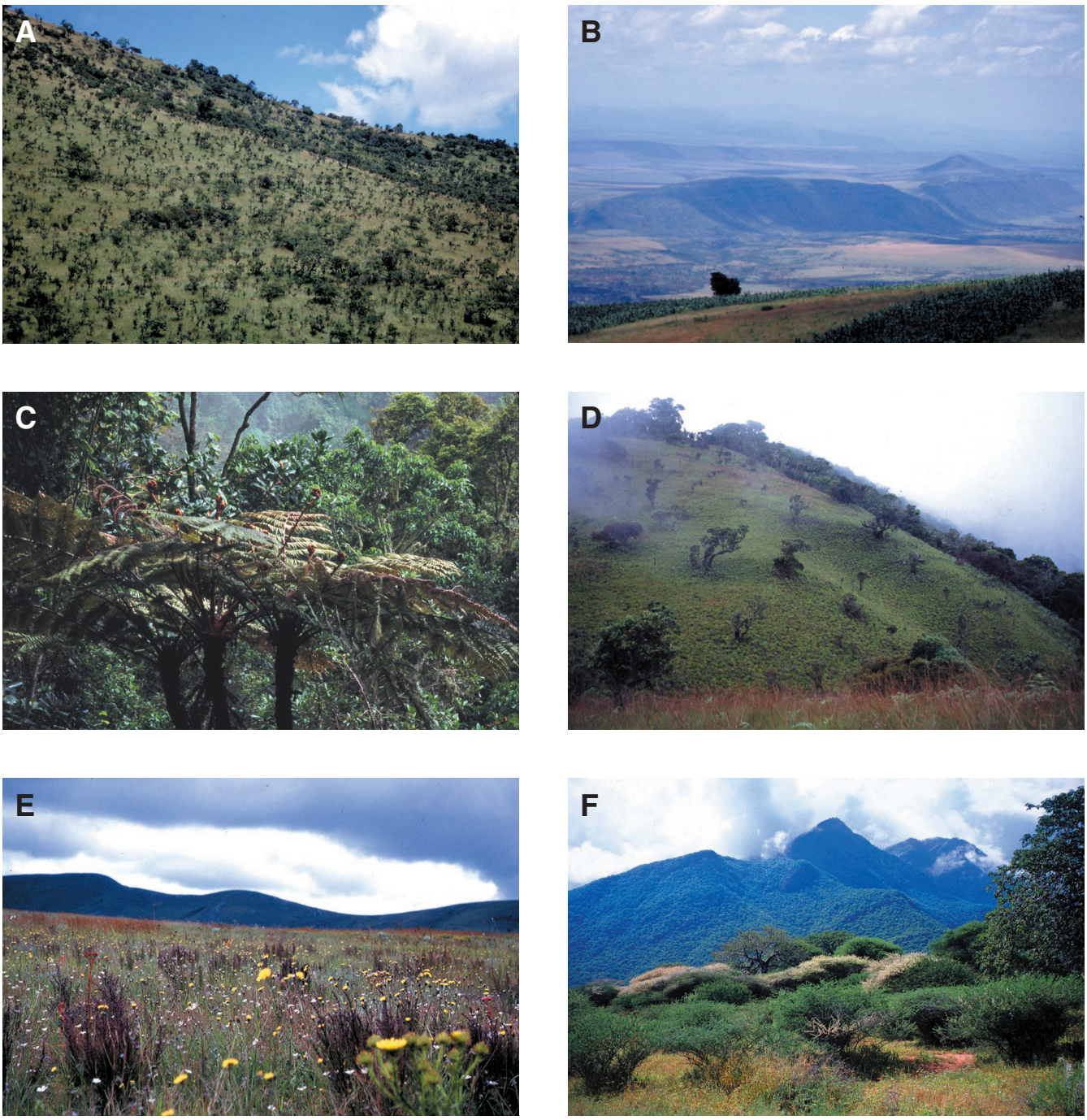


Fig. 3. Selected types of vegetation of Tanzania
Explanations: A – wooded grassland on the Essimingori Mountain, B – grassland in Arumeru District, C – mountain forest in the Uluguru Mountains, D – grassland on the Lukwangule Plateau in the Uluguru Mountains, E – afroalpine grassland on the Kitulo Plateau in the Kipengere Range, F – woodland in Mbeya (photo J. Wiland-Szymańska)

and in the vicinity of Lake Natron), 1000-1500 mm on the northern coast, islands and on the slopes of Kilimanjaro and Meru and 2000 mm at Lake Malawi and western coast of Lake Victoria. On the mountaintop of Kibo (Kilimanjaro) there is a polar climate and the permanent snow line is at the height of 4500 m a.s.l. (Ratajski 1966; Jelonek 1996) (Fig. 2). In the past, the East Tropical Africa went through drastic climate changes that had a profound influence on its vegetation (Lind & Morrison 1974; Lovett 1993; White 1993; Verschuren *et al*. 2000; Thompson *et al*. 2002; Ryner *et al*. 2006).

3.3. Vegetation

The main vegetation types encountered in the region include (Beentje & Smith 2001): coastal forest, upland and mountain forest, woodland (miombo), wooded grassland on the slopes of highlands, bushland, grasslands derived through burning, true grasslands on swamps, semi-desert, afroalpine vegetation, mangroves and inland wetlands (Fig. 3). A general distribution of these types is shown in Fig. 4. A detailed description of the vegetation types in East Tropical Africa can be found in Lind & Morrison (1974) and other literature (e.g.

Fig. 4. General distribution of the main types of vegetation in East Africa (after Lind & Morrison 1974, partially modified)

Engler 1894, 1900, 1902; Werth 1901; Busse 1902; Goetze & Engler 1902; Troll & Wien 1935; Troll 1936a, 1936b; Hedberg 1968; Knapp 1973; Walter *et al*. 1973; Schnell 1976, 1977; Tweedie 1976; Pócs 1976b).

Within volcanic massifs one can distinguish from 5 to 6 typical vegetation zone belts (Lisowski 1996).

1. Submountain parts, 1200-1600 m a.s.l., are covered by vegetation types that are similar to lowlands: forests and grasslands. The forests are lacking bryophytes on the ground, just like in the lowland forests. However, the trees are lower with minor presence of lianas and higher occurrence of epiphytes.
2. Mountain rain forests, 1600-2700 m a.s.l., are characterized by much lower trees (15-25 m). They are very rich in epiphytes, exhibit low presence of lianas and lash undergrowth of ground bryophytes. The trees are evergreen and sclerophytic. There are two sub-zones: the lower one composed primarily of gymnosperms and the higher one with bamboo wood.

3. Subalpine zone (afro-subalpine), 2700-3800 m a.s.l., covered with xerophytic forests with Ericaceae Juss. and Hypericaceae Juss., numerous epiphytes and thick bryophyte undergrowth.
4. Afro-alpine zone (above 3800 m a.s.l.), is occupied by open grasslands with giant *Dendrosenecio* B. Nord and *Lobelia* L. plants as well as shrublet vegetation.
5. The highest mountain parts belong to a nivale altitudinal zone with contemporary moraines, rock outcrops and glaciers. The vegetation is very poor, open and composed primarily of bryophytes and lichens.

The altitudinal stratification of vegetation zones varies greatly between particular mountain ranges and their slopes. A more detailed analyses of a distribution of altitudinal vegetation zones in various East African mountains have been described in several publications (Walter 1973; Lind & Morrison 1974; Pócs 1976a, 1976b; Schnell 1977; Cribb *et al*. 1982).

Currently, there are over 12000 species of vascular plants described in East Tropical Africa. Their quantity for each country is different, reaching about 5000 for Uganda (243.000 km^2), 6000 for Kenia (583.000 km^2), and 10 000 for Tanzania (942.000 km^2) (Beentje & Smith 2001). Such a large number of species is primarily due to a great diversity of habitats, and particularly the water and soil conditions (Beentje & Smith 2001).

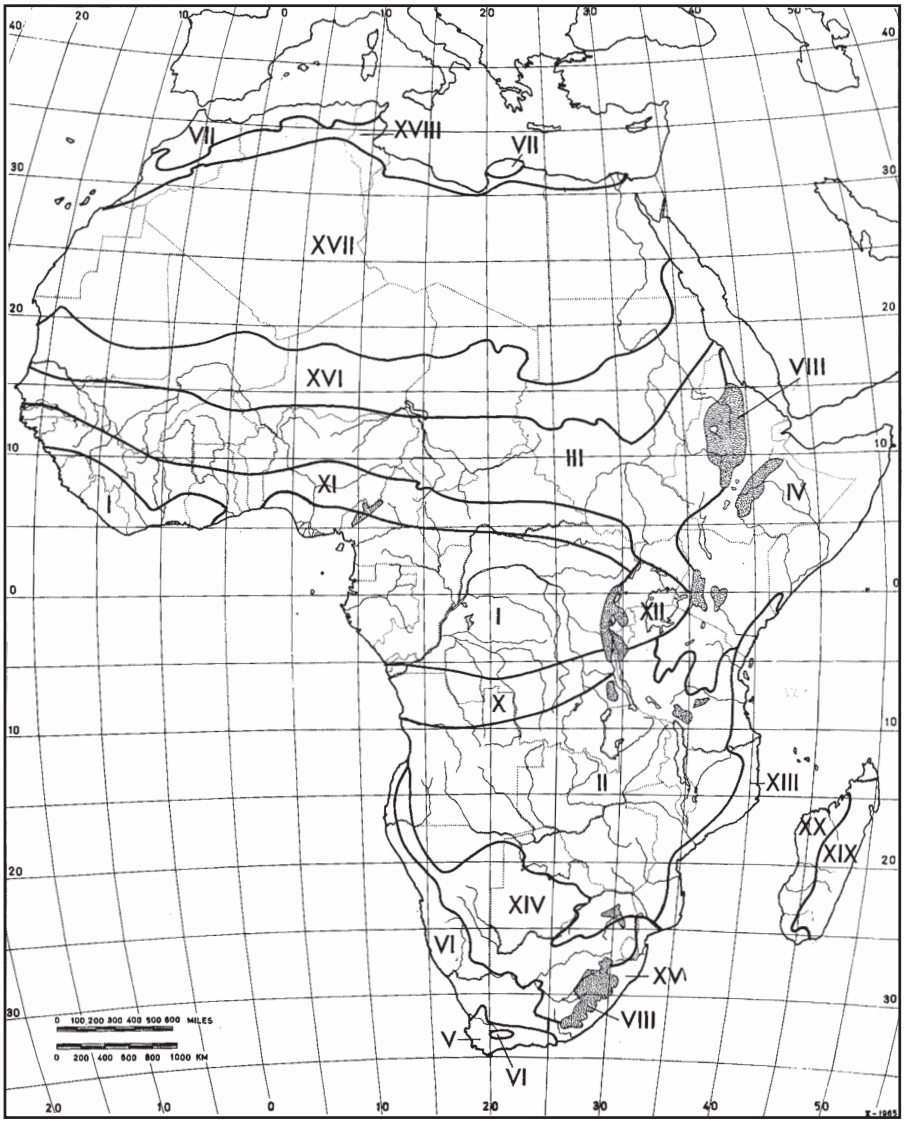


Fig. 5. The phytochoria of Africa and Madagascar (according to White (1993; reproduced from Bull. Jard. Bot. Nat. Belg. 62: 237 (1993), with permission)

Explanations: I – Guineo-Congolian regional centre of endemism, II – Zambezian regional centre of endemism, III – Sudanian regional centre of endemism, IV – Somalia-Masai regional centre of endemism, V – Cape regional centre of endemism, VI – Karoo-Namib regional centre of endemism, VII – Mediterranean regional centre of endemism, VIII – Afromontane Archipelago-like regional centre of endemism, IX – Afroalpine Archipelago-like regional centre of endemism, X – Guinea-Congolia/Zambezia regional transition zone, XI – Guinea-Congolia/Sudania regional transition zone, XII – Lake Victoria regional mosaic, XIII – Zanzibar-Inhambane regional mosaic, XIV – Kalahari-Highvel regional transition zone, XV – Tongoland-Pondoland Regional Mosaic, XVI – Sahel regional transition zone, XVII – Sahara Regional transition zone, XVIII – Mediterranean/Sahara regional transition zone, XIX – East Malagasy regional centre of endemism, XX – West Malagasy regional centre of endemism

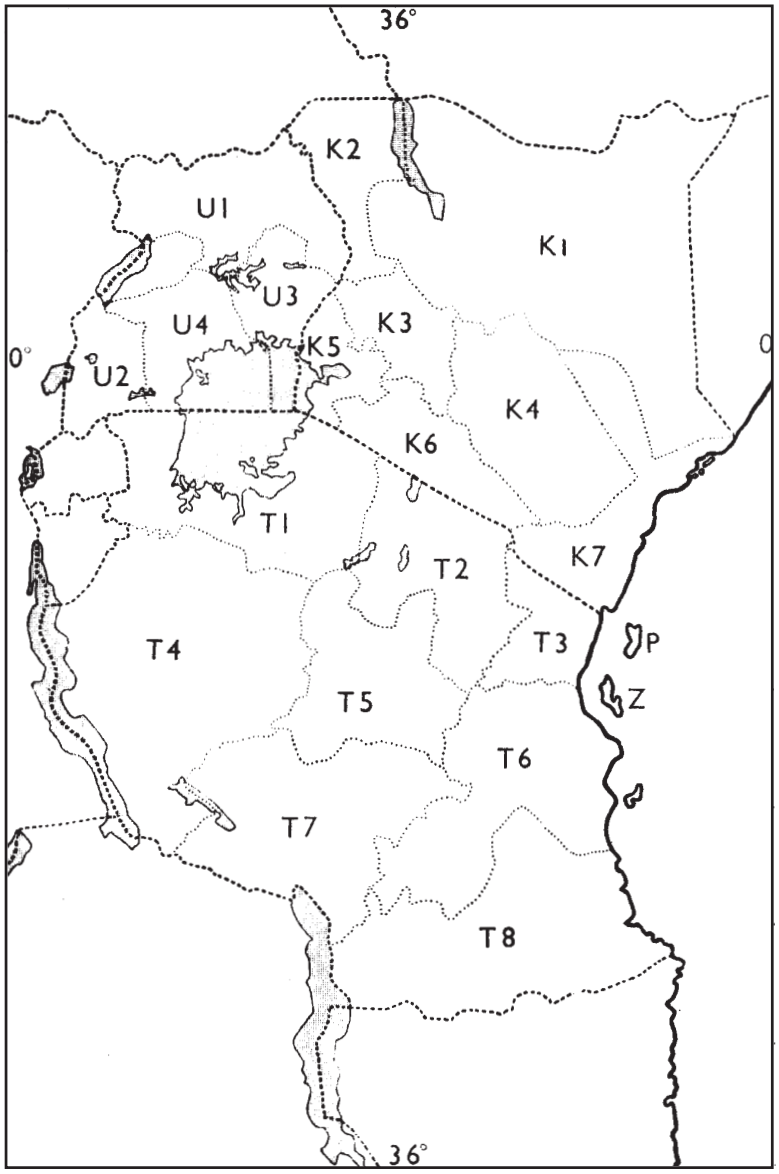


Fig. 6. Geographical divisions of the flora (after Polhill 1988)
Explanations: Uganda, U1 – Northern Province, U2 – Western Province, U3 – Eastern Province; Kenya, K1 – Northern Frontier Province, K2 – Turkana Province, K3 – Rift Valley Province, K4 – Central Province, K5 – Nyanza Province, K6 – Masai Province, K7 – Coast Province; Tanzania, T1 – Lake Province, T2 – Northern Province, T3 – Tanga Province, T4 – Western Province, T5 – Central Province, T6 – Eastern Province, T7 – Southern Highlands Province, T8 – Southern Province; Z – Zanzibar Island; P – Pemba Island

The diversity of species in the area is not evenly distributed. The particularly interesting is the flora of the mountain ranges, with many centers of the local endemism. Numerous areas of high plant diversity can be distinguished in the Afromountain Regional Centre of Endemism (Beentje & Smith 2001). The Eastern Arc Mountains belong to the richest biodiversity hot-spots in the world (Myers *et al*. 2000). These are the regions of the highest endemism levels of vascular plants and some groups of animals, which are currently endangered by human activity. The Eastern Arc Mountains have the highest number of endemic higher plant (75) and land vertebrate species per 100 square kilometres in the world (Myers *et al*. 2000). More than 1200 plant species are endemic to the FTEA region (Beentje & Smith 2001). The best-known endemic genus in this region is a popular ornamental plant – *Saintpaulia* H. Wendl. – the African violet (Beentje & Smith 2001).

Great significance of species diversity in this region is discussed in several works (Lovett 1990, 1998; Burgess *et al*. 2007). East Tropical Africa is also interesting in terms of its biogeography. Its area is under infuence of floras from both southern and northern part of the continent. It exists as an ecological bridge connecting grassland vegetation from both hemispheres (Beentje & Smith 2001).

3.4. Phytogeographic division of the flora

According to White's phytochoria (White 1983, 1993), the area of the East Tropical Africa belongs to: the Sudanian Regional Centre of Endemism in N Uganda and W Kenya; the Somali-Masai Regional Centre of

Endemism in Kenya and N Tanzania; the Zambesian Regional Centre of Endemism in central and S Tanzania; the Lake Victoria Regional Mosaic in S Uganda, W Kenya and NW Tanzania, with the elements of the Guineo-Congolian Regional Centre of Endemism in Uganda; the Zanzibar-Inhambane Regional Mosaic in coastal Kenya and Tanzania; the Afromontana Regional Centre of Endemism in the high mountains in the all three countries (Fig. 5).

The phytogeographic division of the East Tropical Africa consists of eight provinces and two islands (Polhill 1988) (Fig. 6). However, the ranges of these provinces do not reflect geomorphology or natural regions, but are based on the colonial administrative partition of the countries in 1948.

4. The genus *Hypoxis* in the East Tropical Africa: results and discussion

4.1. Morphology and anatomy

4.1.1. Tuber

The underground organs of the East Tropical African species of the genus *Hypoxis* are quite variable in size, what is correlated with their taxonomic affiliation and age. They attain from a few to about 20 cm in length and up to 10 cm in diameter (Figs. 30B, 44F, 47G, 58C, 61D, 67F, 67G). Figures presenting morphology, phenology and distribution of the studied species are included in the chapter 4.7. and accompany taxa descriptions). Their dimensions tend to be different in fresh and dry states, but this variation is not a large one, especially in species producing small quantities of sap in their tubers. Morphological characters of tubers are listed in a Table 2.

Stems are usually elongated, ovoid or turbinate. They are growing larger with age, what indicates secondary growth. At the same time a brown or black disc of decaying tissue is situated at a bottom of the organ (Fig. 67G), what influences their shape, and changes it into conical. The only exception is an underground organ of *Hypoxis schimperii* Baker, because on herbarium sheets the remains of the last year stem with roots, connected to the bottom part of the new stem, are sometimes visible.

The old tubers tend to divide in apical part into young shoots in such taxa as *H. fischerii* var. *zernyi* (Schulze) Wiland & Nordal, *H. goetzei* Harms, *H. galpinii* Baker, *H. gregoriana* Rendle, *H. rigidula* Baker (Fig. 67G). A particular tendency for a vegetative division of a tuber can be observed in *H. nyasica* Baker. In this species tubers are often in large connected groups or divided into many smaller sprouts in apical part. Sometimes few tubers are connected with stolonlike roots (Fig. 58C). Also two tubers one above the other arranged in a moniliform assembly were observed in this species as well as in *H. filiformis* Baker (Fig. 30B). Therefore, it is not unusuall to observe a tuft of shoots with larger and smaller rootstocks, which are derived from one old specimen.

The tubers are usually situated vertically in the ground. The only exception is *H. rigidula*, which rootstocks might be sometimes horizontal (Fig. 67F).

A tunic is persistent in the apical part of the tuber, and is fibrous or/and membranous. Its texture depends a quantity of sclerenchymatous fibers in leaves. It is especially prominently developed in *H. obtusa* Burch. ex Ker-Gawler, where it can have a form of a large brown clump of fibers (Fig. 61D).

Adventitious roots, growing from the tuber, are white or light brown-yellowish (Figs. 30B, 44F, 47G, 58C, 61D, 67F-G). Some of them are very thick with a transverse wrinkling of the surface tissues. They sometimes tend to grow through the decaying disc of tissue in the bottom part of the tuber (Fig. 67G).

Table 2. Morphological characters of tubers of the *Hypoxis* taxa from East Africa

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Single tuber	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Moniliform arrangement	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Tubers connected with stolon-like roots	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Tuber divided in apical part	.	.	+	+	.	+	.	.	.	.	.	+	+	+	+	.	+	.
Tuber flesh white or cream	+	+	+	+	.	+	+	+	+	.	+	.	.	.	.	.	.	.
Tuber flesh yellow	.	.	.	+	+	.	.	.	+	+	+	+	.	+	+	+	+	+
Tuber flesh orange	.	.	.	.	.	.	.	+	.	+	.	+	+	+	+	+	+	.
Tuber flesh getting bluish on air	.	.	.	.	.	+	?	+	.	.	+	+	.	.	+	+	+	+
Sap sparse	+	+	+	+	+	.	?	.	.	.	.	.	+	.	.	.	.	+
Sap abundant	.	.	.	.	.	+	?	+	+	+	+	+	.	+	+	+	+	.

Explanations: 1 – *H. angustifolia,* 2 – *H. kilimanjarica* subsp. *kilimanjarica*, 3 – *H. kilimanjarica* subsp. *prostrata*, 4 – *H. filiformis*, 5 – *H. schimperii*, 6 – *H. goetzei*, 7 – *H. bampsiana* subsp. *tomentosa*, 8 – *H. polystachya*, 9 – *H. fischerii* var. *colliculata*, 10 – *H. fischerii* var. *fischerii*, 11 – *H. fischerii var. hockii*, 12 – *H. fischerii* var. *zernyi*, 13 – *H. galpinii*, 14 – *H. gregoriana*, 15 – *H. nyasica*, 16 – *H. obtusa*, 17 – *H. rigidula*, 18 – *H. urceolata*

The tubers are brown outside, but after cutting vivid colors of their flesh are visible. Observed tints were white (Fig. 47G), cream (Fig. 30B), yellowish, light yellow, deep yellow, dark yellow or orange (Figs. 44F, 58C, 61D, 67G) and ochre. This color is not persistent. After exposure of the tissue to air, the chemical components are rapidly getting oxidated and all shades change to brown. In some species, additionally, a blue tint emerges in the apical part of the tuber (Fig. 61D). The color of tuber flesh is usually intraspecifically constant. For example all corms of *H. goetzei* and *H. angustifolia* Lam. were white (Fig. 47G). In some taxa, however, e.g. *H. fischerii* var. *hockii* (Wiland) Wiland & Nordal, this character shows a great variability. In one population, plants with white, creamy, slightly yellowish, yellow or dark yellow tubers have been observed in Tanzania.

A transparent gelatinous sap is flowing out of the tuber after cutting (Fig. 61D). Exactly as tuber flesh, it is getting rapidly brown after exposing to air. Its amount in different species varies, however in some of them, e.g. *H. goetzei* and *H. polystachya* Welw. ex Baker, it is so abundant, that one can see it also among the leaves at the base of a rosette.

An unpleasant smell is discernible just after cutting tubers of H. *filiformis*, *H. fischerii* var. *zernyi* and, *H. gregoriana*.

In the present work, a tuber is understood as a subterranean, compact, swollen stem, which is usually vertical and accumulates water and nutrients. In *Hypoxis* it contains large quantities of starch (Carano 1905; Bews & Vanderplank 1930) and other carbohydrates, composition of which is changing seasonally (Bews & Vanderplank 1930).

So far in literature, the underground organ of *Hypoxis* was described as a corm (e.g. Nordal *et al.* 1985; Agnew & Agnew 1994; Thulin 1995), a rhizome or a rootstock (Heideman 1983), or a tuber (Baker 1878a; Nel 1914a). This lack of name unification is connected with an insufficient knowledge of a development process of this organ.

A corm is a structure regrowing back annually, which is found in perennials. It is present in at least three other genera of Hypoxidaceae: *Spiloxene* Salisb., *Pauridia* Harv. and *Empodium* Salisb. (Thompson 1976). These corms never attain such dimensions as tubers of *Hypoxis*. There is also a difference in a tunic structure between corms and tubers. In corms the bases of outer leaves encircle the stem from its base. In tubers, the fibrous or membranous remains of old leaves are present only in the apical part, around the base of the leaf rosette. Therefore, it can be stated, that an underground structure found in the East Tropical African species of *Hypoxis* is definitely not a corm, but a tuber.

The studies of the *Hypoxis* tuber morphology and anatomy were conducted by Scharf (1892) and especially thoroughly by Carano (1905). According to this author, this stem is a reduced form of an uniparous helicoid cyme. A vegetative leaf subtends each of its branches. This ramification is not visible, because the subsequent nodes are developing very closely one by another. From a branch, only a short basis is persisting and adding to the tuber length, whereas a free part, including the inflorescence, is drying out and decaying. In his theory there is however no mentioning about two types of leaves, which develop on *Hypoxis* stems. Another character, suggesting a branching of the tuber, is a presence of numerous rings of vascular bundles in the cortex, of which each stele belongs to a different branch. The secondary growth of the tuber is connected with a development of the parenchyma of the cortex and stele (Carano 1905). The mucilage canals are very abundant inside the stele (Pirotta 1892-1894; Carano 1905; Rudall *et al.* 1998) and their number is growing together with dimensions of the tuber (Carano 1905).

Carano (1905) has also described a vegetative division of the *Hypoxis* tuber. According to this author, new shoots are growing vertically, building a new tuber at the base of the old leaf rosette. Therefore sometimes, in old plant groups, short and thick rootstocks are found, and the oldest tuber is not easily recognizable. Similar observations were made by Heideman (1983), who has observed even from 20-40 tubers, connected with each other by short stolones. As mentioned above, similar divisions of tubers were observed in the East Tropical Africa (Fig. 67G). For the first time, however, a moliniform arrangement of tubers (Fig. 30B) is documented, as well as an occurrence of different types of division observed in one *Hypoxis* species (*H. nyasica*).

The adventitious roots are quite long, and can certainly reach 15 cm in length (Nel 1914a), however, they are rarely completely dug up. The field observations in Tanzania confirm them to be contractile, as mentioned in earlier papers (Arber 1925; Heideman 1983; Fahn & Cutler 1992), because the older is the tuber, the deeper it is growing underground. There are several papers dealing with the anatomy of the *Hypoxis* roots (Scharf 1892; Arber 1925; Stern *et al.* 1993; Kauff *et al.* 2000).

The color of the *Hypoxis* tuber flesh was so far taken as a character in one work (Wiland-Szymańska & Nordal 2006). This character was rarely observed and noted, because often the tuber, growing deep in soil, was not excavated during the collection and not preserved in the herbarium. Moreover, the color is not persistent in dry or pickled materials. This character is however very useful, especially in determination of species in which it is constant. It is quite valuable, when the inner leaves are not fully developed or the inflorescences are already decaying. What needs to be answered, is the intraspecific variability of this character in *H. fischerii* Pax and

H. polystachya. Therefore, all future collectors are encouraged to collect specimens of Hypoxidaceae with tubers and to add a description of their flesh color seen just after cutting (Figs. 30B, 44F, 47G, 58C, 61D, 67G).

The morphology of a *Hypoxis* tunic is rarely mentioned in papers. It was for a long time considered as an uninformative character in this genus (Nel 1914a). So far, it was only once used in descriptions of species occurring in Central Africa (Wiland-Szymańska 2001). The tunic form provides valuable taxonomic information in case when it is described in the field and/or it is collected and preserved. This character might be very important, when only freshly developed inflorescences are available and no mature leaves are present. Membranous remains of old leaves are characteristic for the species with a small quantity of sclerenchyma fibers. *Hypoxis angustifolia* can be in this way easily distinguished from *H. filiformis*, because the latter tends to develop a distinctively fibrous tunic. Another example is a large and brown tunic of *H. obtusa*.

4.1.2. Leaves

4.1.2.1 Morphology

Between of the East Tropical African species of *Hypoxis* the leaf rosettes are quite variable in size. The minute species, such as e.g. *H. kilimanjarica* Baker (Fig. 53A-B) Baker or *H. filiformis*, and also some forms of *H. angustifolia,* do not exceed 10 cm in height. From the other side, species like *H. polystachya* and *H. rigidula* attain about one meter of height (Figs. 64B, 67A, 67E)

There are few types of habit observed in these species. The first group contains species with shoots spreading trifariously from the base and with falcate leaves tightly stacked above each other in three ranks. To this group belong also plants, which shoots are first recurved, and later in season spirally twisting upwards. In the East Tropical Africa this type is represented by: *H. angustifolia* (Fig. 25A, 25D), *H. bampsiana* Wiland, *H. filiformis* (Fig. 30A), *H. fischerii* (Figs. 38A, 41A, 41E-F), *H. galpinii* Baker (Fig. 44E), *H. goetzei* (Fig. 47A-B, 47F), *H. malaissei* Wiland, *H. nyasica* (Fig. 58A-B), *H. obtusa*, *H. polystachya* (Fig. 64B) and *H. urceolata* Nel (Fig. 73A, 73E). In the case of *H. gregoriana,* grazing by herbivores has a great impact on its habit form. On pastures, plants are small, with short leaves (Fig. 50E). In the places without animal influence, plants are quite tall, with long and erect leaves.

Another group contains plants in which cataphyll bases form a long pseudostem, sheathing a trigonal leaf column above ground. It is represented by *H. rigidula* (Fig. 67A, 67E).

The third type of habit is found in *H. kilimanjarica* subsp. *prostrata* Holt & Staubo, which leaves are so much recurved, that they are practically prostrated on the ground (Fig. 53B-C).

All leaves are basal and arranged in a rosette. After a resting period, the outer leaves appear as first. Their basal parts completely surround the leaf rosette, creating partially joined sheath. The free parts of their blades are ovate (e.g. *H. goetzei*) or elongate (e.g. *H. obtusa*) and are cuspidate or acuminate at apex. Their keel is not well developed and u-shaped. These leaves are usually shorter and wider than the inner leaves. The oldest of them, placed most externally, are the shortest. The younger of them are longer, sometimes very similar in their length to the inner leaves. All are often recurved.

The inner leaves, which are the main assimilation organs, develop later. In the contrary to the outer leaves, the shortest of them are in the middle of the rosette. Their bases are also in the form of a sheath, but shorter than in the inner leaves. Their growth is rapid during the rain season and they are usually much longer than the outer leaves. The inner leaf shape may be oval, lanceolate, oblong or linear. Filiform leaves are found only in some forms of *H. filiformis* Bak. and *H. kilimanjarica* var. *kilimanjarica*. The veins visible on the leaf surface are those which sclerenchyma girder extends to epidermis on at least one side of the leaf. The epidermal cells in this places are different in shape and therefore nerves are observable. They are usually of different size, rarely similar. They can be placed one by another in dry material, but are usually dispersed in the fresh leaf. The midrib is almost always the largest vein and is convex on the lower side of the lamina. The other veins are discernible on both sides of the blade, or only on one of them. In some species, on both sides of the midrib, about the middle of the blade, two especially large veins are present. In these species leaves are distinctively carinate. This character is apparent in living plants (Figs. 50E, 58B, 64B, 67E) and on leaf sections (Figs. 7D, 8C).

The very special type of leaf belongs to *H. kilimajarica* var. *prostrata* (Fig. 7C). Leaves of this species are truly canaliculate and succulent, with a lot of water tissue. Such leaves were never described for this genus.

The leaves of *Hypoxis* are usually grass green or yellowish green. Their especially vivid, light green color is seen in young specimens of *Hypoxis goetzei* (Fig. 47F). With age they are getting darker, get brown flecks, and finally are turning reddish brown, when drying out. The only other East Tropical African species, for which such color is typical in dry stage, is *H. galpinii* (Fig. 44E). In other species leaves are yellowish brown or greenish after drying, and reddish brown color is almost never found. Only in *H. nyasica* the darker brown edges are visible under magnification. The subterranean leaf bases of all *Hypoxis* species are white (Figs. 30B, 44F, 47F). An additional flush of red or rose pigments, like in *Hypoxis colchicifolia* Baker (Fig. 24) is often found in close to the ground parts of lamina of: *H. fischerii* var. *zernyi*, *H. fischerii* var. *fischerii, H. nyasica,*

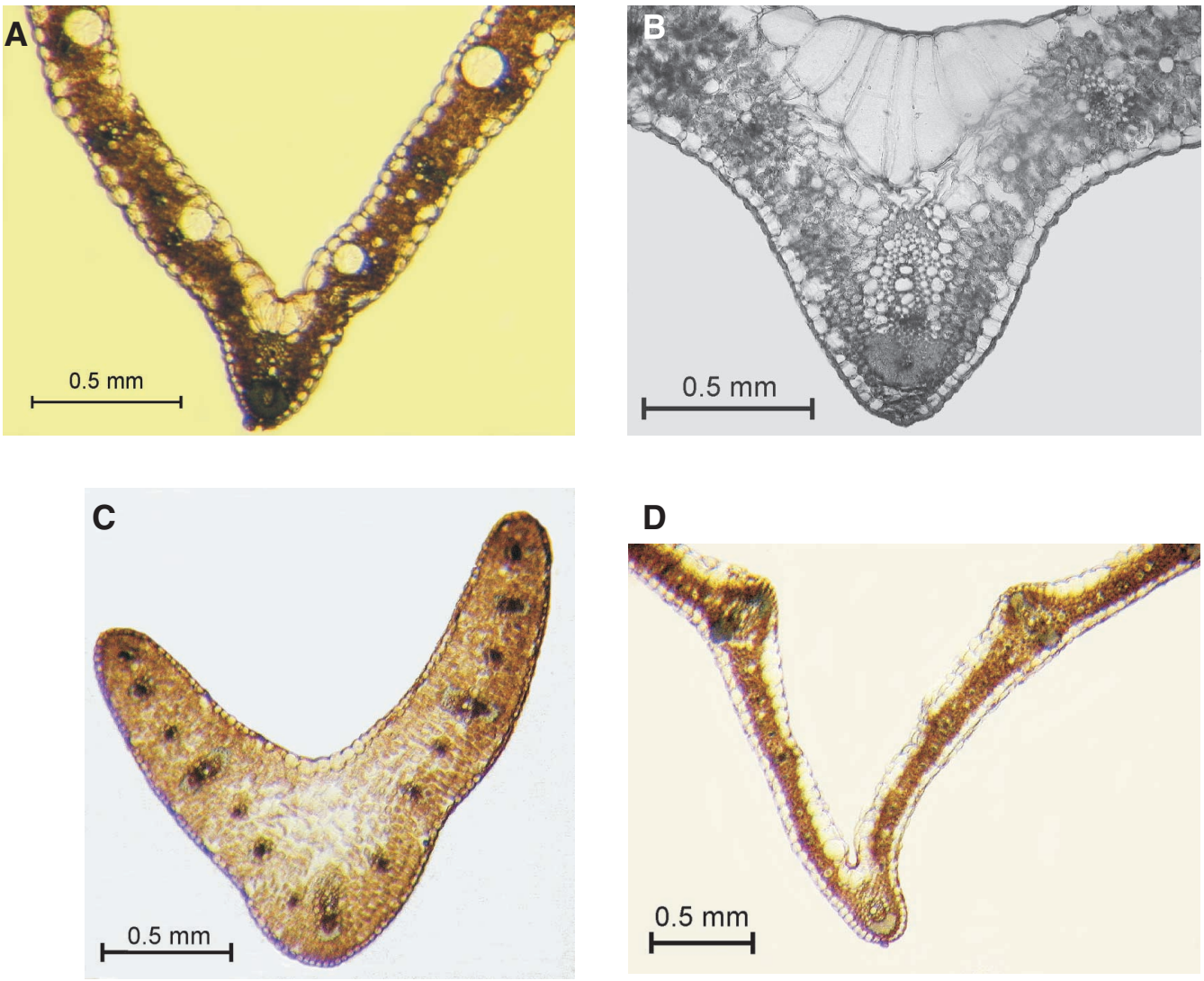


Fig. 7. The leaf cross-section
Explanations: A – *H. galpinii* (from *Wiland & Mboya 57*), B – *H. goetzei* (from *Wiland & Mboya 81*), C – *H. kilimanjarica* subsp. *prostrata* (from *Natural Collections s.n.*), D – *H. angustifolia* var. *luzuloides* (from *Wiland & Mboya 174*)

H. polystachya, H. obtusa and *H. filiformis*. The nervation is of this same color as the rest of the blade except the lighter shade of the midrib of *H. kilimanjarica* var. *prostrata* and *H. galpinii*.

The leaf color is dependant on the type of vestiture. Hyaline trichomes covering the whole blade make it appear lighter than the grasses around. It is especially noticeable in *H. fischerii* var. *hockii* (Fig. 38F). In the East Tropical African species of *Hypoxis* trichomes are hyaline, grey or yellowish in a fresh state (Fig. 41F). However, during drying their color often changes into much darker, golden or brownish. The only species with brown hairs on a living plant is *H. goetzei*, but in herbarium such indumentum's color can be observed also in *H. bampsiana*, *H. filiformis* and *H. nyasica*.

Generally there are two types of trichomes observed on the leaves of the East Tropical African species of *Hypoxis*: two-branched (Figs. 25B-C, 25E, 38C, 41B, 41G, 53D, 58D, 67B, 73B-C) and tufted (Figs. 38B, 38D, 38G, 41G, 44B-C, 44G, 47C-D, 50B-C, 67C). Numbers of branches of the tufted trichomes vary from 3 to more than 10. Also their length may differ between species. Usually trichomes growing on the edges and midrib are longer than on the other parts of the lamina. Indumentum can change during leaf development, because with age hairs tend to fall off from the blade surface. Therefore young leaves possess sometimes trichomes on the lamina, and the older are glabrous, except edges and the midrib. In some species, e.g. *H. angustifolia*, there is a large variability of the indumentum's density, some specimens being totally covered with trichomes, whereas other only ciliate.

The vestiture of the outer and inner leaves is alike in many taxa: *H. angustifolia* var. *luzuloides*, *H. goetzei*, *H. kilimanjarica* subsp. *kilimanjarica*, *H. kilimanjarica* subsp. *prostrata*, *H. nyasica, H. obtusa, H. polystachya* and *H. schimperii*. In other species, differences in indumentum of both types of leaves occur. The outer

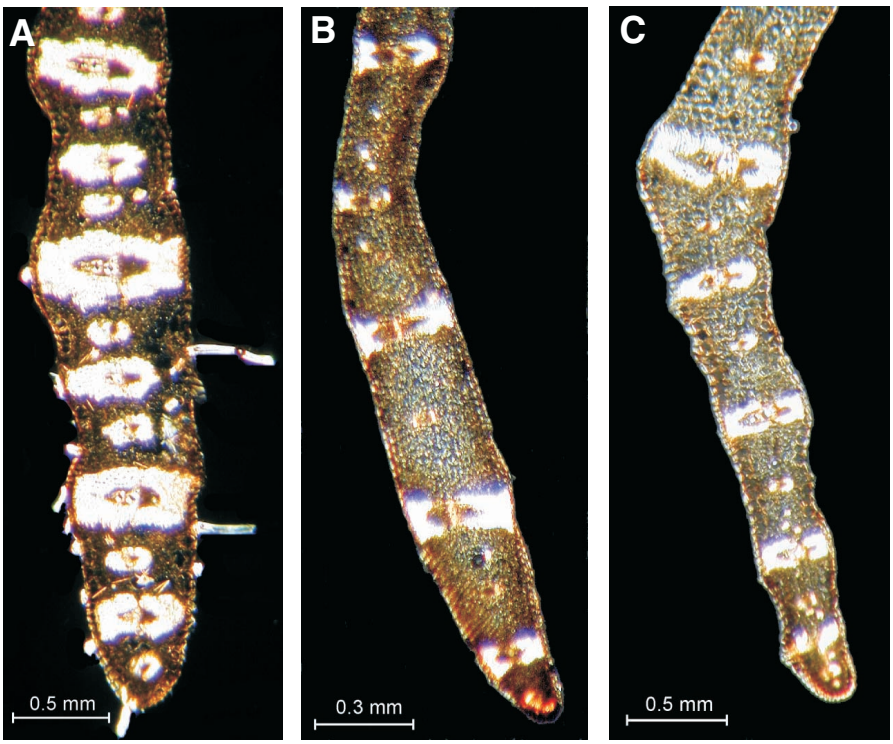


Fig. 8. Cross-section of part of a leaf blade in polarized light
Explanations: A – *H. fischerii var. zernyi* (from *Wiland & Mboya 132*), B – *H. filiformis* (from *Wiland & Mboya 148*), C – *H. urceolata* (from *Wiland & Mboya 171*)

Table 3. Distribution of different trichome types on leaves of the East African taxa of the genus *Hypoxis*

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Outer leaves																				
Lamina ciliate on midrib and edges																				
sparsely with 2-branched trichomes	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.
densely with 2-branched trichomes	+	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	+	.
densely with tufted trichomes	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.
Entire lamina covered with trichomes																				
all trichomes 2-3-branched	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
trichomes on midrib and edges tufted, on lamina 2-branched	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	+
all trichomes tufted	.	+	.	+	+	.	.	+	.	+	.	.	.	.	.	.	.	+	.	.
Trichomes on midrib, edges and abaxial side of the lamina																				
all trichomes tufted	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.
all trichomes 2-branched	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
trichomes tufted and/or 2-branched	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Inner leaves																				
Lamina ciliate on midrib and edges																				
sparsely with 2-branched trichomes	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.
densely with 2-3-branched trichomes	+	.	+	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	+	.
densely with tufted trichomes	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.
Entire lamina covered with trichomes																				
all trichomes 2-3-branched	+	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.
trichomes on midrib and edges tufted, on lamina 2-branched	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	+	.	+
all trichomes tufted	.	+	.	+	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.
Trichomes on midrib, edges and abaxial side of the lamina																				
all trichomes tufted	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.

Explanations: 1 – *H. angustifolia* var. *luzuloides*, 2 – *H. bampsiana* subsp. *tomentosa*, 3 – *H. filiformis*, 4 – *H. fischerii* var. *colliculata*, 5 – *H. fischerii* var. *hockii*, 6 – *H. fischerii* var. *fischerii*, 7 – *H. fischerii* var. *katangensis*, 8 – *H. fischerii* var. *zernyi*, 9 – *H. galpinii*, 10 – *H. gregoriana*, 11 – *H. goetzei*, 12 – *H. kilimanjarica* subsp. *kilimanjarica*, 13 – *H. kilimanjarica* subsp. *prostrata*, 14 – *H. malaissei*, 15 – *H. nyasica*, 16 – *H. obtusa*, 17 – *H. polystachya*, 18 – *H. rigidula* var. *rigidula*, 19 – *H. schimperii*, 20 – *H. urceolata*

Table 4. Average values of quantitative anatomical characters of *Hypoxis* leaves

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14
H. angustifolia	56.8	75.2	63.2	68.8	18.8	36.6	8.0	21.2	35.6	52.0	324.8	5	11	0
H. filiformis	26.4	39.2	28.8	31.2	35.2	30.4	51.0	18.4	27.2	46.0	268.8	16	27	0
H. fischerii var. *hockii*	68.8	72.0	57.2	56.8	40.0	66.0	1.5; 11.5	39.6	67.2	11.5; 17	468.8	25	51	0
H. fischerii var. *zernyi*	62.8	52.0	54.4	52.8	58.0	55.6	20.0	40.4	56.4	21.3	549.6	47	101	0
H. galpinii	56.8	58.4	40.8	45.6	36.8	56.8	28.0	41.6	56.8	34.4	497.6	35	79	0
H. goetzei	64.8	77.6	68.8	79.2	35.2	66.4	10.0	37.6	68.8	12.0	608.0	19	63	0
H. gregoriana	40.0	40.8	40.8	48.0	27.2	42.4	32.0	35.2	44.0	43.5	251.2	7	23	0
H. kilimanjarica subsp. *prostrata*	31.2	48.0	24.8	32.0	23.2	42.4	15.5	28.0	48.0	42.0	419.2	5	15	0
H. nyasica (cataphyll)	73.2	66.0	51.6	54.8	33.6	38.4	0; 3	34.8	40.4	11.0	431.2	15	28	0; 4
H. nyasica (inner leaf)	69.4	69.0	54.6	57.4	31.2	50.4	0; 2; 17.5	34.2	50.9	20.2	380.2	16	31	0;5.5
H. obtusa	65.6	54.4	49.6	60.8	37.6	58.4	26-27	38.4	58.6	29.0	536.0	45	37	0
H. polystachya (cataphyll)	57.6	79.2	52.0	66.4	35.2	60.0	4.5	26.4	52.0	17.0	982.4	31	95	16
H. polystachya (inner leaf)	74.4	76.0	48.0	60.0	35.2	60.8	32.0	34.4	61.6	38.3	657.6	41	141	0
H. rigidula	56.8	65.2	45.6	58.4	46.0	54.8	22.5	32.8	50.4	26.3	402.4	12	27	0
H. urceolata	54.4	76.8	41.6	54.4	29.6	52.8	6.0	36.8	44.8	23.0	579.2	15	37	1

Explanations: 1 – Height of the upper epidermis cells [µm], 2 – Width of the upper epidermis cells [µm], 3 – Height of the lower epidermis cells [µm], 4 – Width of the lower epidermis cells [µm], 5 – Width of stomata of the upper epidermis [µm], 6 – Length of stomata of the upper epidermis [µm], 7 – Quantity of stomata of the upper epidermis (per 1 mm^2), 8 – Width of stomata of the lower epidermis [µm], 9 – Length of stomata of the lower epidermis [µm], 10 – Quantity of stomata of the lower epidermis (per 1 mm^2), 11 – Leaf blade thickness [µm], 12 – Average number of large vascular bundles including a midrib, 13 – Average number of all vascular bundles including a midrib, 14 – Number of mucilage channels in ½ of the blade width

leaves are more hairy, especially on the lower side of the blade. In *H. filiformis* the inner leaves are only ciliate, whereas the outer ones are totally covered with indumentum. In *H. galpinii,* hairs are found on the blades of the inner leaves, but not in such quantity as on the outer leaves. Outer leaves of *H. malaissei* are not only more covered with trichomes, but they are tufted, unlike two-branched trichomes on inner leaves. Similarly in *H. rigidula* var. *rigidula* and *H. fischerii* var. *katangensis* (De Wild.) Wiland & Nordal on the whole leaf surface of the outer leaves tufted trichomes are present. On inner leaves of these species this type of hairs is present only on the midrib and the edges. Distribution of different trichome types on leaves is shown in the Table 3.

Heideman (1983) has distinguished three basic types of habit in the genus *Hypoxis*, basing on her studies of species occurring in the area of Witwatersrand in South Africa. The first group contains plants with shoots spreading trifariously from the base and with falcate leaves tightly stacked above each other in three ranks. To this group belong also plants, which shoots are not so strictly trifarious, leaves are not stacked and falcate, but they are first recurved and spirally twisting upwards later in season. The second group incorporates species

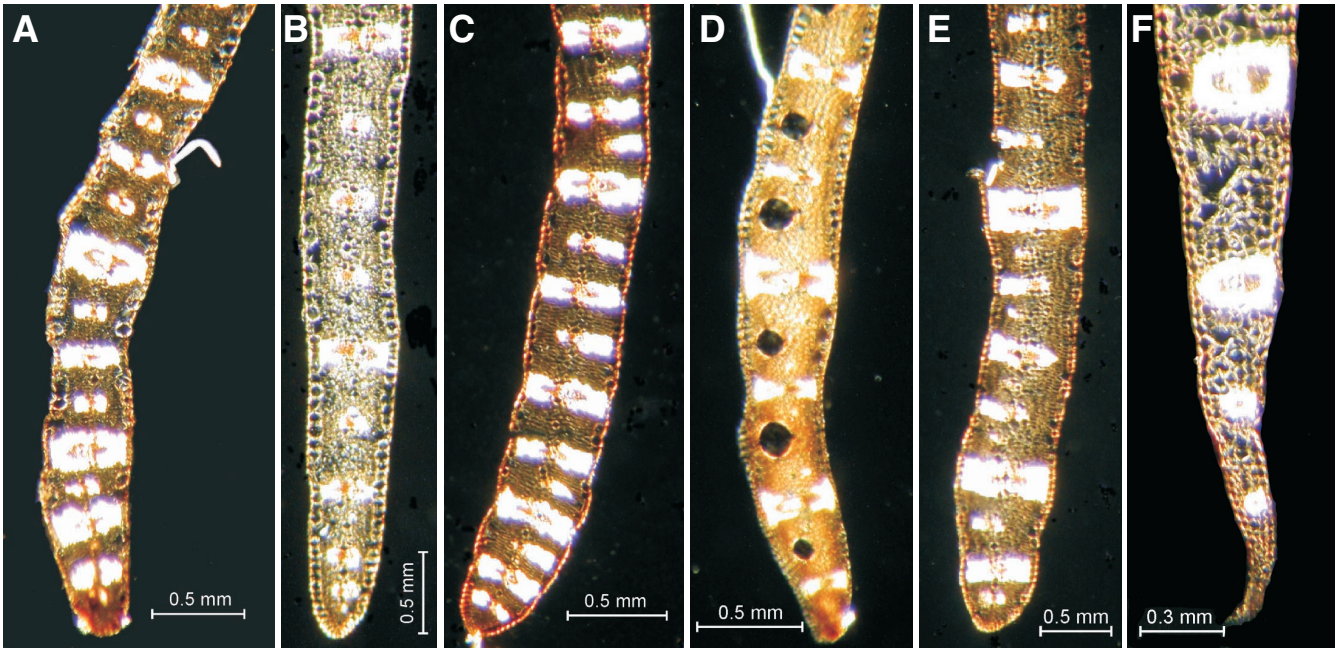


Fig. 9 . Cross-section of part of a leaf blade in polarized light
Explanations: Inner leaf, A – *H. fischerii var. hockii* (from *Wiland & Mboya 99*), B – *H. goetzei* (from *Wiland & Mboya 81*), C – *H. obtusa* (from *Wiland & Mboya 85*), D – *H. nyasica* (from *Wiland & Mboya 102*), visible mucilage channels, E – *H. polystachya* (from *Wiland & Mboya 161*); Cataphyll, F – *H. polystachya* (from *Wiland & Mboya 159*)

Table 5. Shapes of sclerenchyma girders around the large vascular bundles in leaves of *Hypoxis* taxa from East Africa

Taxon	Crescent-shaped	Crossbar-shaped	T-shaped
H. kilimanjarica subsp. *prostrata*	+	.	.
H. urceolata	+	.	.
H. polystachya	+c	.	+l
H. fischerii var. *hockii*	+	.	+
H. nyasica	+	.	+
H. goetzei	+	+	+
H. filiformis	.	+	+
H. galpinii	.	+	+
H. obtusa	.	+	+
H. gregoriana	.	+	+
H. angustifolia var. *luzuloides*	.	+	+
H. fischerii var. *zernyi*	.	.	+
H. rigidula var. *rigidula*	.	.	+

Explanation: c – cataphyll, l – leaf

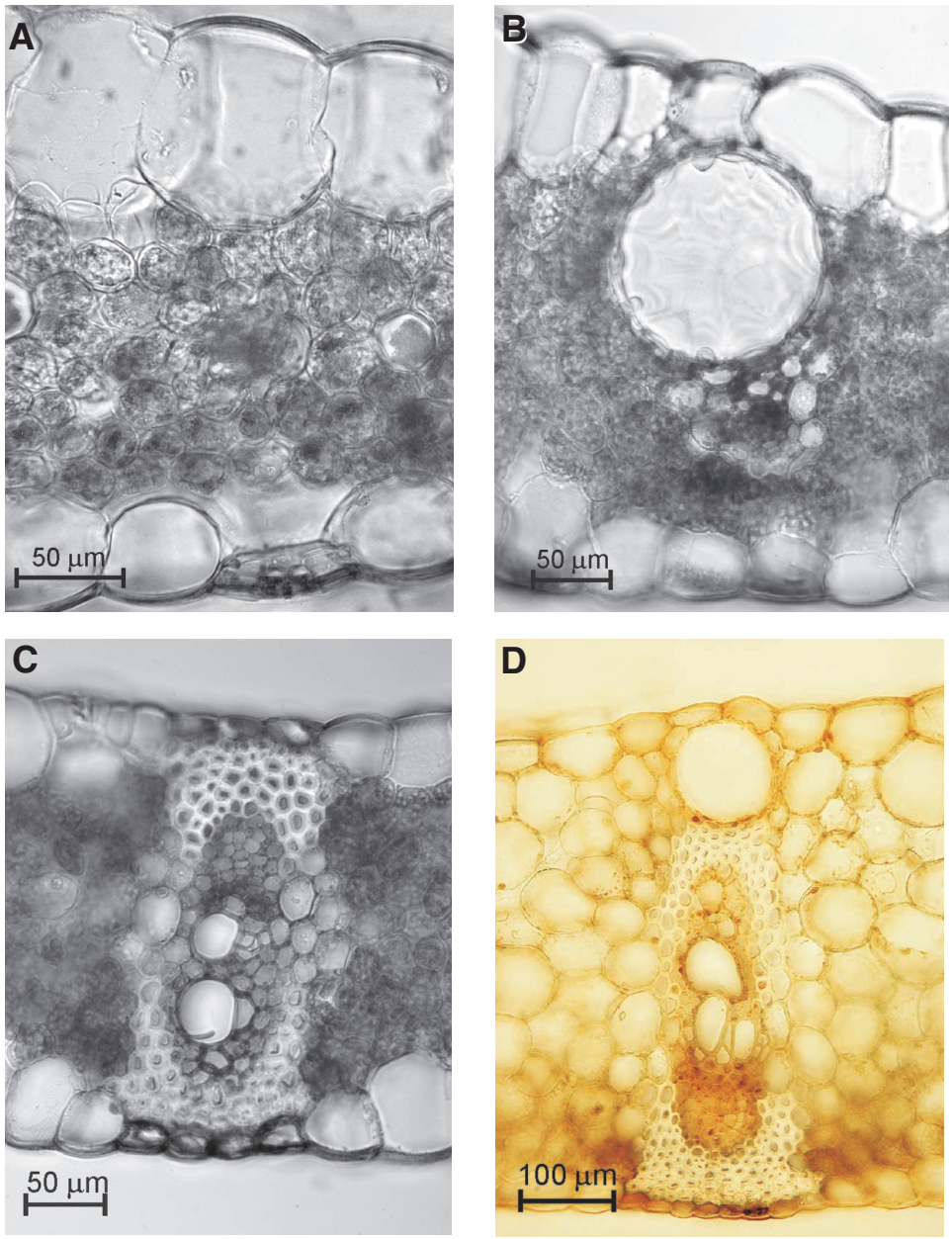


Fig. 10. Leaf anatomy
Explanations: A – bulliform cells in the epidermis of *H. angustifolia* var. *luzuloides* (from *Wiland & Mboya 174*), B – strand and a mucilage channel in a leaf of *H. nyasica* (from *Wiland & Mboya 74*), C – large vascular bundle with a T-shaped sclerenchyma girder from a leaf of *H. nyasica* (from *Wiland & Mboya 74*), D – large vascular bundle with crossbar-shaped sclerenchyma girder with a mucilage channel above, from a cataphyll of *H. polystachya* (from *Wiland & Mboya 159*)

in which cataphyll bases form a long pseudostem, which sheaths a trigonal leaf column above the ground. The third group includes plants with funnel shaped shoots and leaves growing vertically upwards, only slightly separated from each other (Heideman 1983).

This division of habit forms can be partially used in connection with the East Tropical African species of *Hypoxis*. The habits of most of these taxa are fitting into the first group distinguished by Heideman (1983), as for example *H. obtusa*, included here already by this author. The second group, exactly as in the South Africa (Heideman 1983) is represented by *H. rigidula* (Fig. 67A, 67E). Contrary to Heideman's observation (1983), *H. filiformis* is included in a study presented here into the first, and not the second group, because no distinctive aerial pseudostem was observed in this species. Most of the *Hypoxis* species possess a short pseudosteme at the rosette bottom, created by sheathing bases of the leaves. Usually it is white and subterranean, or covered with tunic fibers (Figs. 30B, 47G). Into the third group with funnel shaped shoots, Heideman (1983) has included *Hypoxis galpinii*. Specimens of this species from Tanzania do not possess such a habit (Fig. 44A), and were incorporated into the first group.

A habit type found in *H. kilimanjarica* subsp. *prostrata*, with succulent leaves prostrated on the ground (Fig. 53B), has never been so far described for this genus. It is apparently connected with climatic conditions found at the high altitudes, where this taxon grows.

In most species of *Hypoxis* there is a certain interval between a development of inflorescences and different types of leaves. The inflorescence can develop as first, like e.g. in *H. goetzei*. The outer leaves are developing just after them and creating true inflorescence bracts, as was suggested by de Wildeman (de Wildeman 1913a, b). The cataphylls also protect the developing inflorescences and young inner leaves. Their sheaths are relatively long, and they are often more hairy than the inner leaves. When inner leaves start to develop, the outer ones are staying outside, the oldest of them always as the shortest. In some species, e.g. *H. rigidula* (Fig. 67E), *H. nyasica* (Fig. 58B) and *H. polystachya* (Fig. 64A), flowers develop together with the inner leaves. When the latter are not fully grown, it is very hard to distinguish them from the outer leaves, because their length

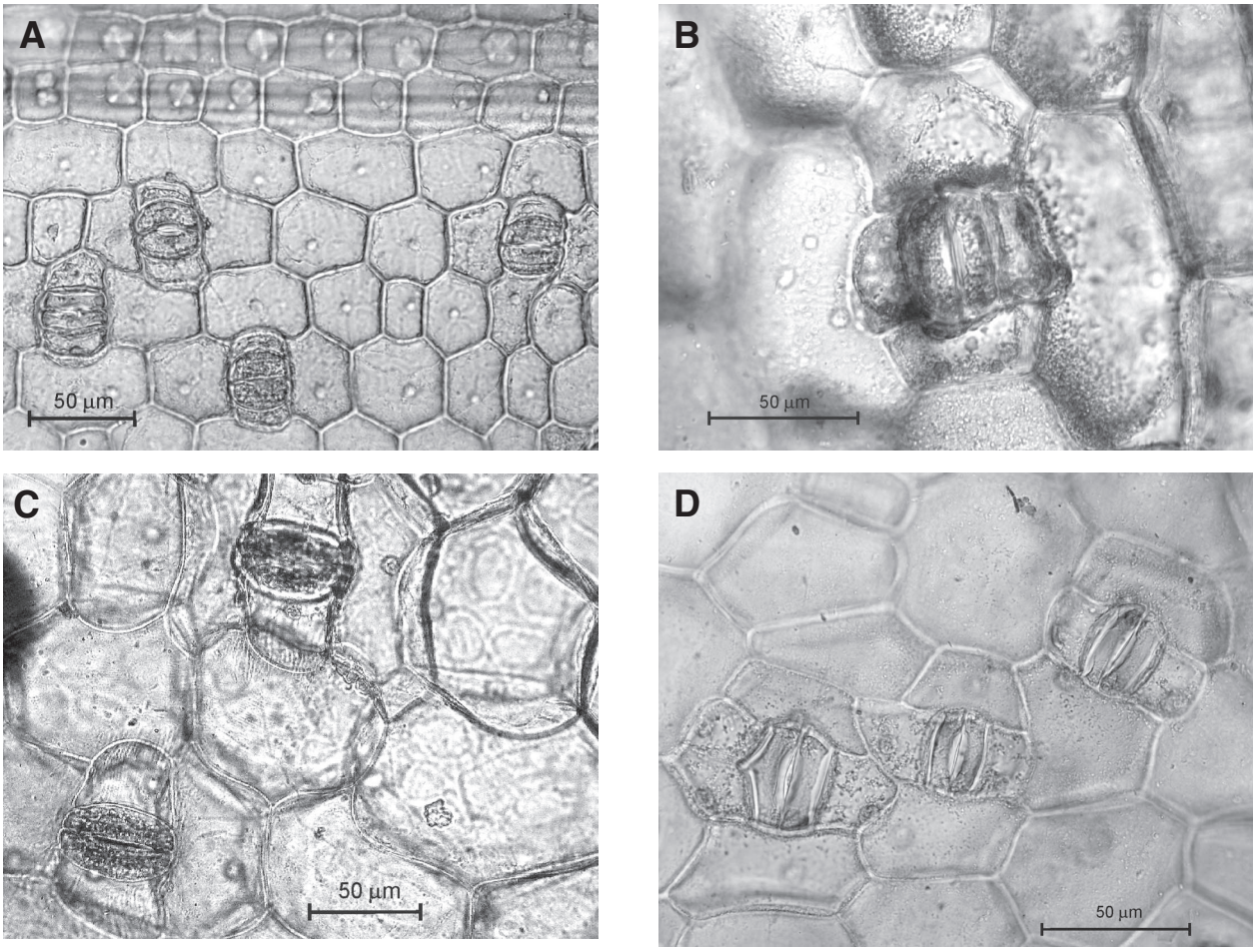


Fig. 11. The epidermis with stomata
Explanations: A – *H. filiformis* (from *Wiland & Mboya 148*). In the upper part of the photograph smaller cells with crystals, which are laying over sclerenychma girders of vascular bundles are visible, B – *H. urceolata* (from *Wiland & Mboya 171*), a tetracitic stoma, C – *H. galpinii* (from *Wiland & Mboya 57*), the epidermis with wrincled cuticle, D – *H. nyasica* (from *Wiland & Mboya 74*), a stoma on the left side of the photograph has five accessory cells

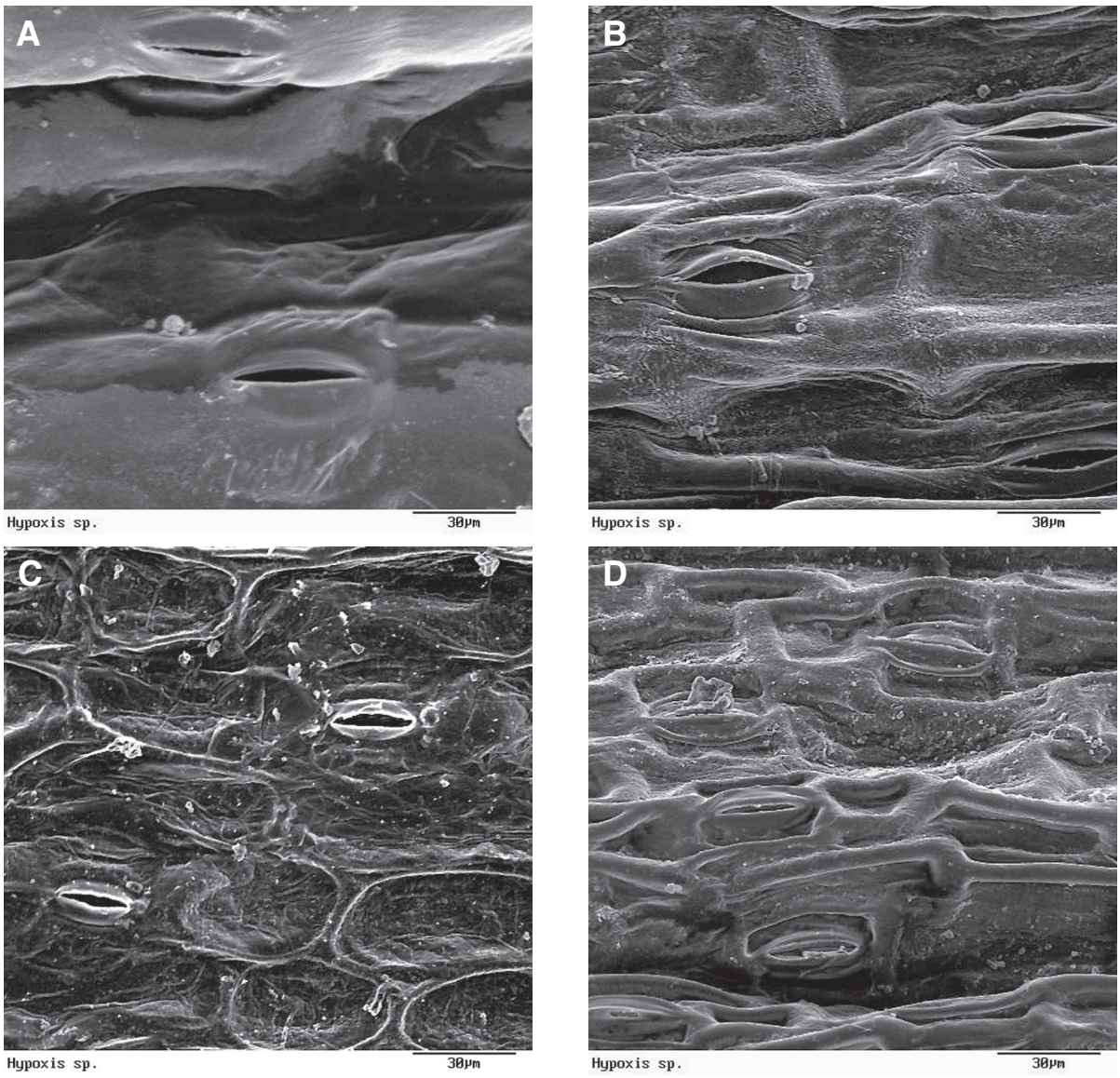


Fig. 12. The epidermis with stomata
Explanations: A – *H. urceolata* (from *Wiland & Mboya 171*), B – *H. rigidula* var. *rigidula* (from *Wiland & Mboya 130*), C – *H. angustifolia* var. *luzuloides* (from *Wiland & Mboya 174*), D – *H. kilimanjarica* subsp. *prostrata* (from *Natural Collections s.n.*)

is similar. This can lead to confusion, because in comparison with other monocot genera, like *Philodendron* Schott or *Crocus* L., cataphylls of *Hypoxis* are often not distinguishable at the first sight.

Different authors observed morphological differences between these two types of leaves, but names given to these organs were different. They were described as: scape bracts (de Wildeman 1913a, b), cataphylls (Nordal & Zimudzi 2001) or just outer leaves (Wiland-Szymańska 2001). The fact of heterophylly in the genus *Hypoxis* was not taken into consideration by Nel (1914b), Pirotta (1892-1894) and Carano (1905). It is especially problematic in case of Nel's description of new species of *Hypoxis* (1914b), often based on general leaf morphology and the number of vascular bundles observed on the surface of a blade. After examination of type material of most species described by this author, one can state, that the large number of species described is partially connected with a fact, that he did not recognize different types of leaves. Nel was describing sometimes the same species as different taxa once with inner leaves and once with outer, e.g. in *H. nyasica* and *H. fischerii*.

4.1.2.2. Anatomy

All leaves are bilateral. The epidermal cell walls are thin and straight. Chosen quantitive characters of the *Hypoxis* leaf anatomy are presented in the Table 4 and Table 5. All observations concern inner leaves except *H. nyasica*, and *H. polystachya* where also cataphyll anatomy is described.

Hypoxis angustifolia var. *luzuloides*

Blade is prominently v-keeled (Fig. 7D). Vascular bundles number reaches 11 on average; the average number of large ones among them is 5. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which is separated from the lower epidermis by one layer

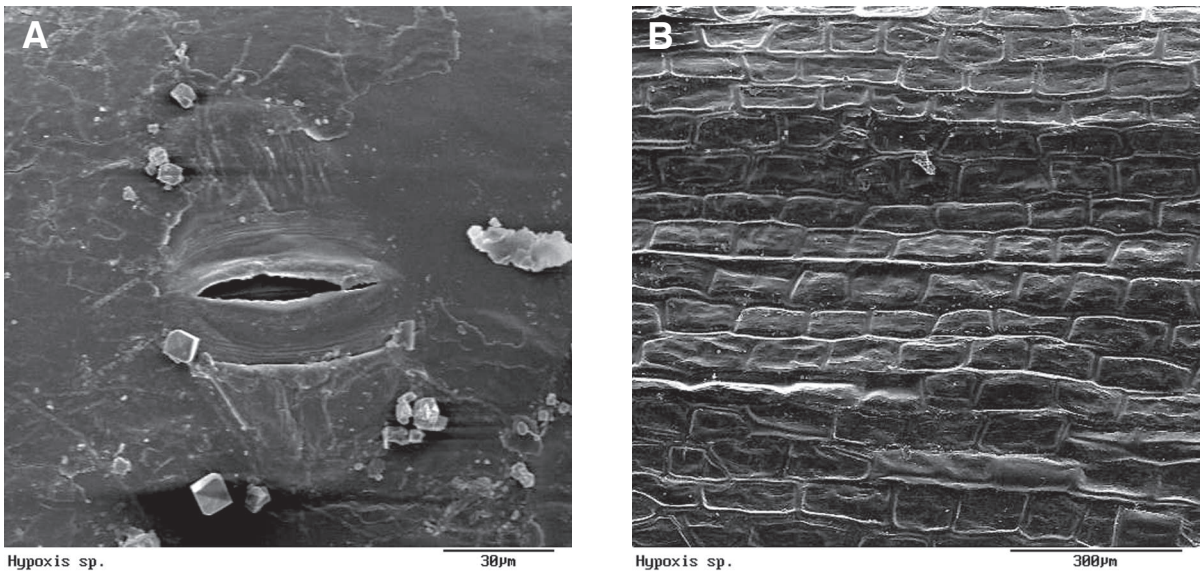


Fig. 13. The epidermis surface
Explanations: A – Stoma of *H. fischerii* var. *hockii* (from *Wiland & Mboya 99*), B – Epidermis of *H. polystachya* (from *Wiland & Mboya 161*)

of mesophyll cells, and extends to the bulliform cells in the upper epidermis. On both sides of the lamina, one very prominent vascular bundle is present, at which a lamina tends to bend itself. The sclerenchyme girders around the large vascular bundles extend to the epidermis on both sides of the leaf. The small bundles, with thinly schlerenchyme sheaths, are surrounded by mesophyll.

The upper epidermis is assembled almost exclusively from bulliform cells (Fig. 10A). Also cells of the lower epidermis are very large in comparison with the mesophyll cells. The epidermal cells are hexagonal in shape, except elongated cells above sclerenchyma girders. Stomata are paracytic, sparse on the upper and frequent on the lower epidermis (Fig. 12C). Trichomes are two-branched, with long and delicate branches (Fig. 25B, 25 E). The epidermal cells are covered with thick cuticle. Wax in form of a flat layer was observed (Fig. 12C).

The mesophyll is undifferentiated (Fig. 10A), composed of several layers of small cells. Idioblasts with raphids present.

Hypoxis filiformis

Blade is v-keeled. Vascular bundle number reaches 27 on average; the average number of large ones among them is 16. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis. The girder is divided from the bulliform cells in the upper epidermis by one layer of mesophyll cells and another one of water cells. The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the leaf and are especially prominent due to two large bundles close to the leaf edges. The small bundles, with thinly schlerenchyma sheaths, are surrounded by mesophyll, or their sheath extends to the lower epidermis (Fig. 8B).

The epidermal cells are small, tetragonal, pentagonal or hexagonal in shape. Over schlerenchyma girders cells are smaller and elongated, with rhomboidal crystals (Fig. 11A). Stomata are very numerous in comparison to other *Hypoxis* species, more abundant on the lower epidermis. Number of accessory cells vary from two to five. Trichomes are two-branched, with rather short and quite thick branches (Fig. 30C). The epidermal cells are covered with thick cuticle. Wax in the form of a flat layer and irregular crystalloids was observed.

The mesophyll is undifferentiated, composed of several layers of round cells, containing single needle-shaped calcium oxalate crystals. Idioblasts with raphids are present.

Hypoxis fischerii var. *hockii*

Inner leaf

Blade is prominently v-keeled. Vascular bundle number reaches 51 on average; the average number of large ones among them is 25. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which is separated from the lower epidermis by two layers of mesophyll cells. The girder is divided from the bulliform cells in the upper epidermis by one layer of water cells. On the edges of the keel angle the water cells are sometimes laying in two layers. The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides. The small bundles, with thin schlerenchyma sheaths, are surrounded by mesophyll, or their sheath extends to the upper or lower epidermis (Fig. 9A).

The epidermal cells are usually pentagonal or hexagonal and rarely tetragonal in shape. Above schlerenchyma girders, cells are smaller and elongated. Because bulliform cells occur in epidermis on both sides of the

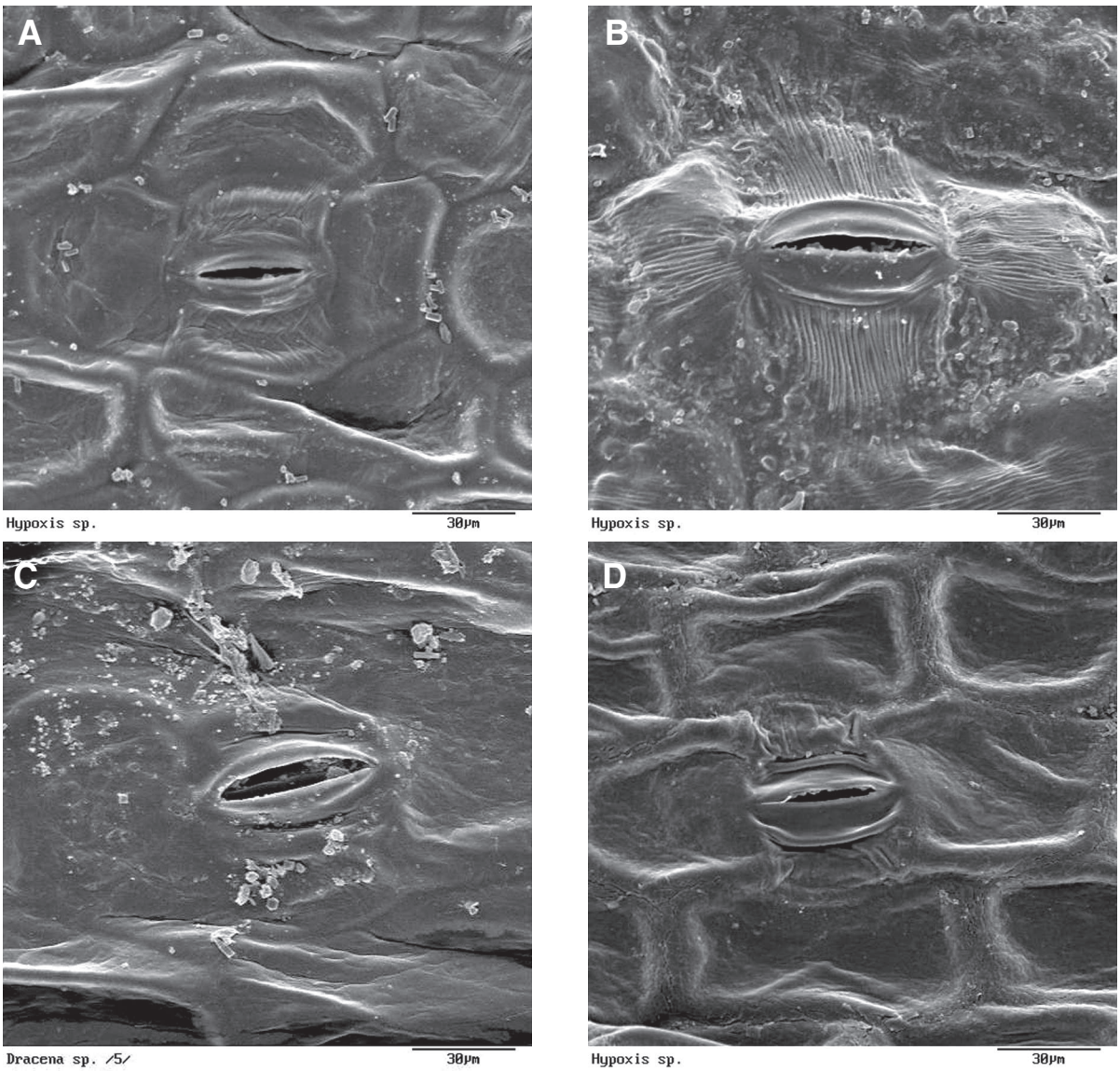


Fig. 14. Stomata
Explanations: A – *H. gregoriana* (from *Wiland & Mboya 172*), B – *H. goetzei* (from *Wiland & Mboya 81*), C – *H. nyasica* (from *Wiland & Mboya 114*), D – *H. galpinii* (from *Wiland & Mboya 57*)

large vascular bundles, the latter are protuberant. Tetracitic stomata are not very abundant on both sides of the leaf (Fig. 13A). Long branched trichomes are mainly tufted, exceptionally two-branched (Fig. 38B-D). The epidermal cells are covered with thick cuticle, which is striate on bulliform cells in the keel. Wax in the form of a flat layer and more or less regular crystalloids was observed (Fig. 9A).

The mesophyll is undifferentiated, composed of several layers of elongated cells, containing single needle-shaped calcium oxalate crystals. Idioblasts with raphids present.

Hypoxis fischerii var. *zernyi*

Inner leaf

Blade is prominently v-keeled. Vascular bundle number reaches 101 on average; the average number of large ones among them is 47. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which is separated from the lower epidermis by three layers of mesophyll cells. The girder is divided from the bulliform cells in the upper epidermis by two layers of water cells. On the edges of the keel angle, the water cells are laying in one layer. The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the leaf. The small bundles, with thinly schlerenchyma sheaths, are surrounded by mesophyll (Fig. 8A).

The epidermal cells are tetragonal, pentagonal or hexagonal in shape. Over schlerenchyma girders cells are more elongated. Because bulliform cells occur in epidermis on both sides of the large vascular bundles, the latter are protuberant. Paracitic stomata are not very abundant on both sides of the leaf. Trichomes have quite thick branches. On the edges and midrib, hairs are tufted, while they are two-branched on the lamina surface (Fig.

41B- C). The epidermal cells are covered with thick cuticle, which is striate on stomata accessory cells, around trichome feet and on the bulliform cells in the keel. Wax in the form of a flat layer, scurfs and irregular crystalloids was observed.

The mesophyll is undifferentiated, composed of several layers of round or elongated cells, containing single needle-shaped calcium oxalate crystals. Idioblasts with raphids present.

Hypoxis galpinii

Inner leaf

Blade is only slightly v-keeled. Vascular bundle number reaches 79 on average; the average number of large ones among them is 35. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis. The girder is separated from the big bulliform cells by one layer of large water cells. On the edges of the keel angle the water cells are laying in two layers (Fig. 7A). The sclerenchyma girders around the large vascular bundles extend to the lower epidermis or to both sides of the blade. The small bundles, with thin schlerenchyma sheaths, are surrounded by mesophyll.

The epidermal cells are pentagonal or hexagonal in shape. The cells placed above the schlerenchyma girders are smaller and elongated. Most of the paracitic stomata occur in the lower epidermis (Figs. 11C, 14D). Trichomes are tufted (Fig. 44B-C). The epidermal cells are covered with thin cuticle, which is striate on stomata accessory cells and on the bulliform cells in the keel (Fig. 11C). The wax in the form of a flat layer and irregular crystalloids was observed (Fig. 14D).

The mesophyll is undifferentiated, composed of several layers of round or elongated cells. Small linear crystals were observed in some of the mesophyll cells. Idioblasts with raphids present.

Hypoxis goetzei

Inner leaf

Blade is prominently v-keeled. Vascular bundle number reaches 63 on average; the average number of large ones among them is 19. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis. The girder is separated from the bulliform cells in the upper epidermis by one layer of water cells (Fig. 7B). The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the leaf. The small bundles, with thin schlerenchyma sheaths, are surrounded by mesophyll (Fig. 9B).

The epidermal cells are pentagonal or hexagonal in shape. Over schlerenchyma girders cells are more elongated. Tetracitic stomata are in similar quantity on both sides of the leaf (Fig. 14B). Trichomes tufted, with short and thick branches (Fig. 47C-D). The epidermal cells are covered with thick cuticle, which is striate especially noticeably on stomata accessory cells (Fig. 14B). Wax in the form of scurfs and irregular crystalloids was observed.

The mesophyll is slightly differentiated, with a subepidermal layer of elongated cells, and single water cells present. Single small rhombohaedral and linear crystals were observed in the mesophyll cells. Idioblasts with raphids present.

Hypoxis gregoriana

Inner leaf

Blade is prominently v-keeled. Vascular bundle number reaches 23 on average; the average number of large ones among them is 7. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis. It is separated from the bulliform cells in the upper epidermis by one layer of water cells. Bulliform cells are not very large. The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the leaf. The small bundles, with thin schlerenchyma sheaths, are surrounded by mesophyll, and sheaths of only a few of them are adjacent to the upper epidermis.

The epidermal cells are regularly pentagonal or hexagonal in shape. Above schlerenchyma girders, cells are elongated. Both in the lower and upper epidermis single bulliform cells are present. Stomata paracitic, more abundant on the lower epidermis (Fig. 14A). Trichomes tufted, with long and delicate branches. The epidermis is covered with a thin layer of cuticle. Wax in the form of irregular and tubular crystalloids was observed.

The mesophyll is not differentiated. Idioblasts with raphids very numerous.

Hypoxis kilimanjarica subsp. *prostrata*

Inner leaf

Blade is u-channeled, succulent, not keeled (Fig. 7C). Vascular bundle number reaches 15 on average; the average number of large ones among them is 5. Crescent sclerenchyma girders are present only around the large bundles. The small ones are provided with schlerenchyma caps placed towards the lower side of the blade. All bundles are covered with a thick layer of mesophyll.

The epidermal cells are hexagonal and elongated in shape. Small bulliform cells are placed above the midrib. Paracitic stomata are almost double abundant on the lower epidermis (Fig. 12D). Trichomes are two-branched, with short and delicate branches (Fig. 53D). The epidermis is covered with a thin layer of cuticle. Wax in the form of irregular crystalloids was observed.

Below a lower epidermis, one layer of elongated chlorophyllous mesophyll cells occur. Other cells are round. Above the midrib, a thick layer of water tissue

composed of large round cells is present. Idioblasts with raphids present.

Hypoxis nyasica

Cataphyll

Blade is u-channeled (Fig. 15D). Vascular bundle number reaches 28 on average; the average number of large ones among them is 15. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis. It is separated by one layer of the mesophyll cells from the bulliform cells in the keel. These bulliform cells are smaller than the other cells of the epidermis. The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the leaf, or is divided from it by one or two layers of parenchyma cells. The small bundles, with thin schlerenchyma sheaths, are mainly surrounded by mesophyll. However the sheaths of these bundles, which are close to the keel, are adjacent to the upper epidermis. One mucilage canal placed between a vascular bundle and the upper epidermis was observed. The epidermal cells are tetragonal, pentagonal or hexagonal in shape, not much larger than mesophyll cells. Above schlerenchyma girders, cells are smaller, elongated, with rhomboidal crystals. Both in the lower and upper epidermis single bulliform cells are present, also outside the keel zone. Stomata are paracitic. Leaves areamphistomatic, with a much lower number of stomata on the upper than on the lower epidermis or hypostomatic. Trichomes are two-branched and/or tufted, with rather long and delicate branches. The epidermis is covered with a thick layer of cuticle. Wax in the form of irregular crystalloids was observed.

The mesophyll is slightly differentiated. The chlorophyllous cells are smaller and located below the lower epidermis. Below the upper epidermis larger cells, almost entirely lacking chlorophyll, are placed. Idioblasts with raphids are present.

Inner leaf.

Blade is prominently v-keeled (Fig. 15C). Vascular bundle number reaches 31 on average; the average number of large ones among them is 16. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis or is separated from it by one layer of mesophyll cells. Its girder extends also to the bulliform cells in the upper epidermis, or is divided from them by one layer of water cells. On the edges of the keel angle, the water cells are laying in one or two layers. The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the blade (Figs. 9D, 10C). The small bundles, with thin schlerenchyma sheaths, are surrounded by mesophyll.

The mucilage canals were observed in 4 specimens of 7 studied (Figs. 9D, 10B, 15C). They are placed in mesophyll above small vascular bundles, lacking schlerenchyma sheath.

The epidermal cells are pentagonal or hexagonal in shape. Above schlerenchyma girders, cells are smaller, elongated, with rhomboidal crystals. Both in the lower and upper epidermis single bulliform cells are present also outside the keel zone. Stomata are most often paracitic, but the number of accessory cells varies from 2-5 (Figs. 11D, 14C). Leaves are amphistomatic or hypostomatic. Trichomes are two- or three-branched (Fig. 58D). The epidermis is covered with a thick layer of cuticle. Wax in the form of irregular crystalloids was observed (Fig. 14C).

The mesophyll is undifferentiated, composed of round cells. Small rhombohaedral and linear crystals were observed in the mesophyll cells. Idioblasts with raphids are present.

Hypoxis obtusa

Inner leaf

Blade is prominently v-keeled. Vascular bundle number reaches 67 on average; the average number of large ones among them is 45. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis and to two bulliform cells in the upper epidermis. The bulliform cells in the keel are very well developed, with one layer of water cells located beneath them. The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the leaf. The smaller schlerenchyma sheaths of the small vascular bundles are adjacent to the upper epidermis (Fig. 9C).

The epidermal cells are pentagonal or hexagonal in shape. Above schlerenchyma girders, cells are smaller, elongated, with rhomboidal crystals. Paracitic or tetracitic stomata are more abundant on the lower epidermis. The epidermal cells are covered with thick cuticle, which is striate on stomata accessory cells. Trichomes tufted, with long branches. The wax in the form of a flat layer and irregular crystalloids was observed.

The mesophyll is differentiated. Under epidermis on both sides of the leaf a palisade mesophyll is located. Cells of the sponge mesophyll are dispersed in the middle of the leaf tissue. Idioblasts with raphids are present.

Hypoxis polystachya

Cataphyll

Blade is u-channeled (Fig. 15B). Vascular bundle number reaches 95 on average; the average number of large ones among them is 31. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis. It is separated from the bulliform cells in the upper epidermis by two

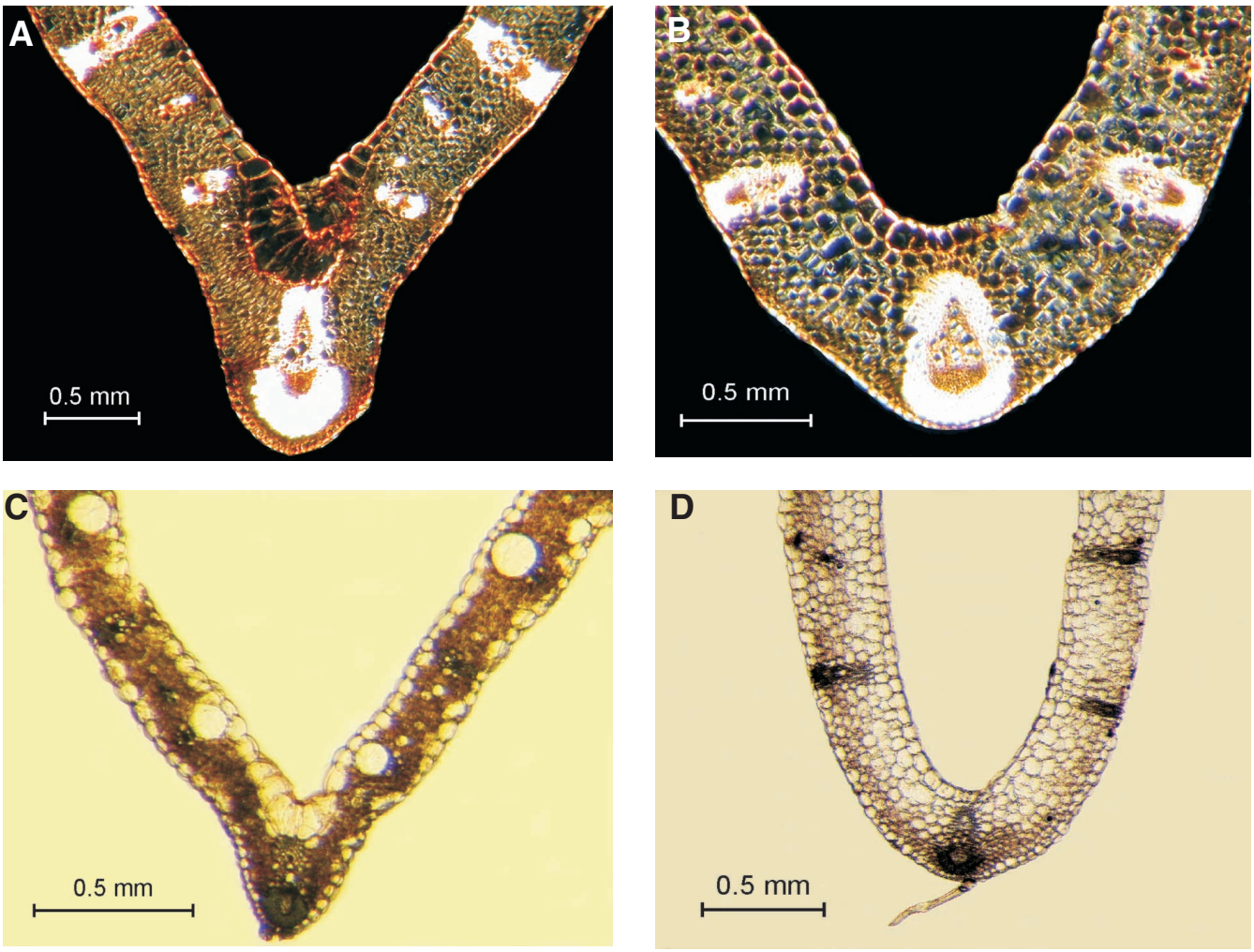


Fig. 15. The keel zone of a leaf
Explanations: *H. polystachya,* A – inner leaf (from *Wiland & Mboya 161*), B – cataphyll (from *Wiland & Mboya 159*), A-B in polarized light; *H. nyasica*, C – inner leaf (from *Wiland & Mboya 119*), D – cataphyll (from *Wiland & Mboya 106*)

layers of mesophyll cells. Bulliform cells are not very large. The crescent sclerenchyma girders occur around the large vascular bundles and some of them extend to the lower epidermis (Fig. 9F). From the upper epidermis some of the bundles are separated by mucilage canals (Fig. 10D), while others by one or several layers of the mesophyll cells.

The epidermal cells are tetragonal in shape on the upper side of the blade and pentagonal or hexagonal on the lower. Above schlerenchyma girders, cells are much smaller. Stomata are paracitic. Amphistomatic leaves possess a low number of stomata on the upper epidermis. Trichomes tufted, with rather long and delicate branches. The epidermis is covered with a thick layer of cuticle. Wax in the form of irregular crystalloids was observed.

The mesophyll cells are slightly differentiated. The chlorophyllous cells are smaller and located below the lower epidermis. Below the upper epidermis larger cells almost without chlorophyll are present. In the middle of the blade tissue, conglomerations of water cells are placed. In some cells of mesophyll small rhombohaedral crystals are present. Idioblasts with raphids are very rare.

Inner leaf

Blade is prominently v-keeled (Fig. 15A). Vascular bundle number reaches 141 on average; the average number of large ones among them is 41. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis. It is separated from the bulliform cells in the upper epidermis by one layer of mesophyll cells. Bulliform cells are well developed. The T-shaped sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the leaf. The smaller schlerenchyma sheaths of the small vascular bundles are sometimes adjacent to the upper epidermis (Fig. 9E). The epidermal cells are tetragonal in shape (Fig. 13B). Stomata are paracitic, more abundant on the lower epidermis. Trichomes reach up to c. 3 mm length, and are tufted, with 3-10 arms, which are ascending or spreading.

The epidermal cells are covered with thick cuticle, which is striate on the bulliform cells in the keel. The wax in form of a flat layer and irregular crystalloids was observed.

The mesophyll is differentiated. Under the epidermis on both sides of the leaf a palisade mesophyll is situated. Single small rhombohaedral crystals were observed in the mesophyll cells. Idioblasts with raphids are present.

Hypoxis rigidula var. *rigidula*

Inner leaf

Blade is more or less prominently v-keeled. Vascular bundle number reaches 27 on average; the average number of large ones among them is 12. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which extends to the lower epidermis and to the bulliform cells the upper epidermis. The bulliform cells in the keel are well developed, with one layer of water cells located beneath them. The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the leaf. The sclerenchyma sheaths of the small vascular bundles are separated from epidermis by mesophyll cells. Mucilage canals, placed above small vascular bundles, were found in every second specimen studied. The cells of epithelium are small, obovate and depressed.

The epidermal cells are pentagonal or hexagonal in shape, much larger than the mesophyll cells. Above schlerenchyma girders, cells are smaller, often with rhomboidal crystals. Stomata are paracitic (Fig. 12B). Trichomes are tufted and 2-3 branched, with long branches (Fig. 67B-C, 67H). The epidermal cells are covered with moderately developed cuticle, which is striate on the stomata accessory cells, and outlined by a ridge. The wax in the form of a flat layer and irregular crystalloids was observed (Fig. 12B).

The mesophyll is undifferentiated, composed of ovoid or round cells. Idioblasts with raphids are present.

Hypoxis urceolata

Inner leaf

Blade is slightly v-keeled. Vascular bundle number reaches 35 on average; the average number of large ones among them is 15. The vascular bundle in the midrib is surrounded by a girder of schlerenchyma, which is separated from the lower epidermis by one layer of mesophyll cells. It is divided from the bulliform cells in the upper epidermis by one layer of water cells. On both sides of the midrib one very prominent vascular bundle is present, at which a lamina tends to bend itself. The sclerenchyma girders around the large vascular bundles extend to the epidermis on both sides of the leaf. The sclerenchyma sheaths of the small vascular bundles are separated from epidermis by mesophyll cells (Fig. 8C). Only one mucilage canal placed above one of the large vascular bundles was observed.

The epidermal cells are hexagonal in shape. Over schlerenchyma girders cells are much more elongated, smaller, sometimes with small rhomboidal crystals. Bulliform cells are present in epidermis outside the keel region, too. Paracitic or brachyparatetracitic stomata (Figs. 11B, 12A) are present on the upper epidermis. Trichomes are tufted and 2-3 branched. The epidermal cells are covered with moderately developed cuticle. The wax is in the form of a flat layer was observed (Fig. 12A).

The mesophyll is differentiated. Chlorophyllous cells are located mainly below the lower epidermis. In the keel part of the leaf blade, one layer of water cells lacking chlorophyll is laying under the upper epidermis. Numerous small needle like and occasionally rhombohaedral crystals are present in mesophyll cells. Idioblasts with raphids are present.

The anatomical differences between outer and inner leaves of *Hypoxis* have been so far never investigated. It's worth noticing that a cataphyll of *H. polystachya* is apparently thicker than the inner leaf (Table 4). Other differences are discussed below along with other anatomical characters.

The epidermis cells are differentiated. They are thin walled with straight borders and seen from above they are hexagonal or pentagonal, and sometimes tetragonal in shape. They are usually of the same outline for both sides of the leaf except a cataphyll of *H. polystachya*, where epidermis cells are tetragonal on the upper and multiangular on the lower surface. In vertical cross-section they are rectangular in shape with rounded edges. Average dimensions of cells on the lower and upper epidermis can be distinctively different, with the upper epidermis cells being much larger. The smallest epidermis cells are found on average in *H. filiformis* and *H. kilimanjarica* subsp. *prostrata* (Table 4). Elongated, rectangular cells, which are smaller in cross section, are found above larger schlerenchyma girders of the vascular bundles. Occurrence of two types of cells was reported by Rudall (Rudall *et al.* 1998), but not connected with their specific location on the leaf blade. In *H. filiformis, H. obtusa*, *H. rigidula*, *H. urceolata*, and *H. nyasica*, rhomboidal crystals were observed in cells located over schlerenchyma girders. For the two former species it was reported earlier by Heideman (1983). When comparing with mesophyll cells, epidermis cells are usually of similar dimensions, but in *H. angustifolia* and *H. nyasica* they are distinctively larger. A similar observation was made by Scharf (1892) for the South American species *Hypoxis decumbens* L.

In the keel zones of all leaves, bulliform cells were noted. Observations of these cells in *Hypoxis* were given

by Löv (1926) and Rudall (Rudall *et al*. 1998). These cells are very distinctive and well developed in the inner leaves, only in *H. kilimanjarica* subsp. *prostrata* they are not very prominent. In cataphylls, bulliform cells are not much larger than other epidermis cells, or even smaller. Bulliform cells are located sometimes also beside a keel zone especially close to the largest vascular bundles like in *H. angustifolia* (Rudall *et al*. 1998, this study), *H. fischerii*, *H. nyasica* and *H. urceolata* (this study). A location of bulliform cells in this part of a leaf is interpreted in connection with mechanism responsible for leaf folding in dry conditions (Löv 1926).

Leaves of *Hypoxis* are usually amphistomatic. Stomata are more numerous on the lower epidermis (Table 4), only in *H. goetzei* their number is similar. The highest numbers of stomata per 1 mm^2 were observed in *H. filiformis*, what suggests that this species is more xerophilous than others in this genus. Number of stomata on cataphylls was lower than on the inner leaves. In *H. nyasica,* 5 samples out of 7 have yielded hypostomatic blades, with 0-1 stoma per $1mm^2$. This state was found both on inner and outer leaves. So far in literature no information stating the number of stomata in *Hypoxis* was published.

In literature concerning the genus *Hypoxis*, information about both paracitic (Heideman 1983, Rudall *et al*. 1998) and tetracitic stomata (Scharf 1892; Heideman 1983; Stern *et al*. 1993) were published. The clearly paracitic stomata were observed in the East Tropical African taxa in: *H. angustifolia*, *H. fischerii* var. *zernyi*, *H. galpinii*, *H. kilimanjarica*, *H. polystachya* and *H. rigidula*. Tetracytitic stomata were noted by *H. fischerii* var. *hockii*, *H. goetzei* and *H. urceolata*. Heideman (1983) reported tetracitic stomata also for *H. galpinii*, but it was not confirmed in the material observed.

The accessory cells are distinctive from the other epidermis cells in being smaller and crescent. The main problem is an interpretation of function of accessory cells adjacent to the stoma poles. Depending on species, they are more (*H. urceolata*) or less (*H. filiformis*) similar to other epidermis cells. In *H. nyasica,* it is sometimes difficult to interpret a number of accessory cells on one leaf. Even 5 accessory cells were sporadically observed in *H. nyasica* (Fig. 11D) and *H. filiformis*. In the rest of species both types of stomata were present on leaves or intermediate forms were observed like in *H. gregoriana*. One can state that in the genus *Hypoxis* both paracytic and tetracytic stomata are present, but this character is variable. Though such observations were never so far made for *Hypoxis*, a similar situation was described in *Curculigo* Gaertn. (Shah & Gopal 1970), another genus of Hypoxidaceae.

The cuticle on epidermis is rather thick, except *H. kilimanjarica*, *H. gregoriana* and *H. galpinii*. Smooth cuticle was observed in *H. urceolata*, *H. nyasica*, *H. galpinii* and *H. gregoriana*. The cuticle in the keel zone, in species with well-developed bulliform cells, is thick and parallel striate. In *H. goetzei*, the cuticle is lined on the whole leaf surface. In *H. fischerii* var. *zernyi*, striae are visible only around accessory cells and trichome feet. Striation on the cuticle around stomata of *H. obtusa* and *H. galpinii*, also observed in the current study, were reported before (Heideman 1983; Rudall *et al*. 1998). Similarly, a cuticular ridge outlining subsidiary cells of *H. rigidula* described by Heideman (1983), was confirmed in the East Tropical African material.

In most of the species studied, wax on the cuticle is in the form of a flat layer, sometimes splintered. Additionally wax scurfs occurred on the leaf surface of *H. goetzei* and *H. fischerii* var. *zernyi*. Irregular crystalloids were observed in *H. obtusa*, *H. nyasica*, *H. kilimanjarica* subsp. *prostrata*, *H. gregoriana*, *H. goetzei*, *H. galpinii*, *H. fischerii* var. *zernyi* and *H. filiformis*. The tubular wax crystalloids were seen in *H. gregoriana*. In *H. fischerii* var. *hockii*, regular crystalloids and minute pebbles are visible. A presence of wax crystals on the surface of the most species studied contradicts a statement made by Frölich & Barthlott (1988), that this character is uncommon in the genus and found only in *H. oligotricha* Baker.

Trichomes and indumentum types in the genus *Hypoxis* were described most notably in papers of Nordal (Nordal *et al.* 1985) and Wiland-Szymańska (2001). The trichome types of the East African species do not differ from those described from the Central Africa: simple trichomes occur on bracts of *H. urceolata* and *H. angustifolia*, two-branched trichomes are most frequent on leaves and rare on inflorescences, tufted trichomes occur on all aerial organs. The distribution of hair types on different organs is taxon specific. Types of hairs and indumentum are useful characters in recognition of the *Hypoxis* taxa (Nordal *et al* 1985; Wiland-Szymańska 2001; Wiland-Szymańska & Nordal 2006).

The largest vascular bundle is located in the midrib. It was also noted by Scharf (1982). However, there are two exceptions from this rule, namely *H. angustifolia* var. *luzuloides* and *H. filiformis*. In these species two prominent bundles, one on each side of the midvein, appear to be larger. It was noted by Rudall (Rudall *et al*. 1998) that in *H. angustifolia* and *H. villosa* L. f. main lateral veins may be prominent, making a leaf to be slightly plicate.

The midrib in the inner leaves is usually protuberant on the lower side of the leaf. The exception is *H. kilimanjarica* subsp. *prostrata*, because a leaf blade of this taxon is succulent. In the outer leaves the midrib is not protuberant. There are differences in extension of the sclerenchyma girders of vascular bundles towards the epidermis, sometimes specific for one taxon or

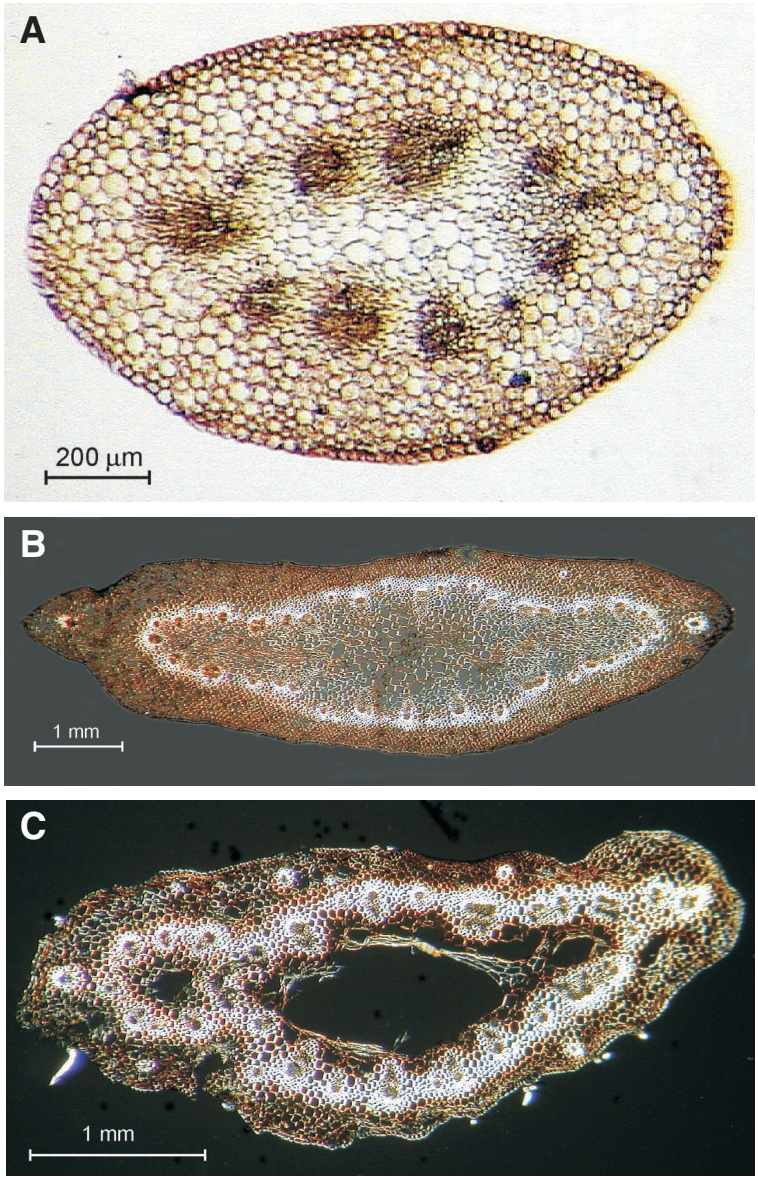


Fig. 16. Scape cross-sections
Explanations: A – *H. gregoriana* (from *Wiland & Mboya 172*), B – *H. polystachya* (from *Wiland & Mboya 161*), C – *H. fischerii* var. *hockii* (from *Wiland & Mboya 99*), B-C in polarized light

a group of taxa (this study). The sclerenchyma girder around the midvein is especially prominent on the lower side of the blade. In most of the species it is connected with the lower epidermis, but in some it is divided from it by one (*H. angustifolia* var. *luzuloides*, *H. urceolata*, partially *H. nyasica*), two (*H. fischerii* var. *hockii*) or three (*H. fischerii* var. *zernyi* and *H. kilimanjarica* subsp. *prostrata*) layers of the mesophyll. On the upper side of the blade, the sclerenchyme girder of the midrib is connected with the bulliforme cells or separated from them by an additional layer (layers) of water and mesophyll cells (this study).

There are two kinds of lateral veins. The prominent veins possess well-developed sclerenchyma girders, which usually extend up to epidermis (Rudall *et al.* 1998). Small strands are assembled mainly from phloem with smaller or none sclerenchyme sheaths (Scharf 1892; Heideman 1983). The large and small bundles alternate in 1:2 pattern (Heideman 1983). In *H. gregoriana* however, the number of prominent veins versus the number of strands is like 1:3. The sclerenchyme girders of the large bundles can be divided from epidermis by mesophyll cells or mucilage canals (cataphyll of *H. polystachya*) (this study). The small bundles are usually totally encircled by mesophyll, but occasionally the sclerenchyme sheath is elongated and extends up to upper (*H. polystachya* inner leaf, *H. obtusa*, *H. gregoriana*), lower (*H. filiformis*, *H. angustifolia*) or upper and lower epidermis (*H. fischerii* var. *hockii*, *H. nyasica*). In a succulent leaf of *H. kilimanjarica* subsp. *prostrata* all bundles are immersed deeply in the mesophyll.

Heideman (1983) has distinguished three types of fibrous girders in *Hypoxis* leaves: crescent-shaped, cross-bar-shaped and T-shaped. According to her observation

occurrence of different types of these girders is species specific. Taking as an example species which occur also in the East Tropical Africa, she has associated crescent-shaped girders with *H. galpinii*, crossbar-shaped with *H. obtusa* and *H. filiformis* and T-shaped with *H. rigidula* var. *rigidula*. After study of the East Tropical African materials of *Hypoxis* it is however clear, that this character is not always stable within one species (Table 5) and between different types of leaves. An interpretation of the girder type poses a great difficulty, especially between crossbar and T-shaped forms. In the studied material, the observations of Heideman (1983) were only partially confirmed. In *H. obtusa* for example, not only crossbar-shaped, but also T-shaped girders were observed. This last type was described for this species by Rudall (Rudall *et al*. 1998). Only three species studied show a stability of shape of the girders. Therefore, this character can be used as an additional, but certainly not as a main one in determination of the *Hypoxis* taxa.

Ayensu (1973) has compared the leaf sclerenchyma patterns of the genera of Velloziaceae J. Agardh and compared them with Hypoxidaceae. He has stated that the most primitive type of girders in Velloziaceae is a crescent shape found in *Xerophyta* Juss., which he thought to be most similar to Hypoxidaceae. However, in *Hypoxis* also a T-shaped type, as in *Barbacenia* Vand., is found. Sometimes, a mix between these two types is observed, like in *Vellozia* Vand. Therefore, Ayensu's estimation, as to the type of schlerenchyma girders found in leaves of Hypoxidaceae, was not correct.

Descriptions of vascular bundles of some species of *Hypoxis* were made by Scharf (1892). However, their importance as a diagnostic character in this genus was for the first time recognized by Nel (1914a, 1914b). Practically, on all herbarium specimens studied by this author, a sketch of a leaf cross-section is visible. It was one of the main characters on which his division of the genus into sections was made. Nel did not recognize a difference between the inner and the outer leaves.

The number of vascular bundles can be different between species. For example, in *H. angustifolia* it is about 11, *H. kilimanjarica* 15 and *H. polystachya* 141. This character is visible only after cutting of the leaf and under a microscope, because the strands are not discernible on the leaf surface. Also the discernible number of vascular bundles in the leaf is not stable within a species and therefore its estimation will be connected with an amount of samples available. In some species it can be also connected with the plant age, because leaves of older plants are much larger than of younger ones. This has probably let to a delimitation of many species by Nel (1914a, 1914b), which are now included into synonymy of *H. nyasica*.

In the paper concerning the anatomy of *Hypoxis*, Rudall *et al*. (1998) have stated, that the mucilage canals are present only in the tuber. Leaf cross-sections, lacking mucilage canals, presented in this paper, are of: *H. angustifolia*, *H. rooperi*, *H. hygrometrica* and *H. decumbens*. Only the first of them was examined during the current study, and no mucilage canals were found. However, Pirotta (1892-1894) has reported occurrence of the mucilage canals in the cataphylls of *H. erecta* L. (North American species, current name *H. hirsuta* (L.) Coville), where they are usually present under the vascular bundle and rarely above it. He did not found them in the inner leaves of this species. An information about presence of the mucilage canals in the basal part of the leaf of *Hypoxis lanata* Eckl. *ex* Baker and *H. krebsii* Fisch. is found also in the work of Scharf (1892).

During the current studies it was observed, that the mucilage canals in leaves are present also in such species as *H. polystachya* (cataphylls), *H. urceolata* (inner leaves), *H. nyasica* (cataphyll and inner leaves) and *H. rigidula* (inner leaves). The epithelium cells are smaller than the mesophyll cells, obovate and depressed in a cross section. The distribution of mucilage canals in leaves can however vary even within one species. In *H. nyasica* and *H. rigidula* they were present in about a half of the leaves studied.

This variability of the occurrence of the mucilage canals in leaves needs certainly more studies at the population level. It can be connected with leaf age, its position in the rosette or other factors.

So far, the leaf mesophyll of *Hypoxis* was discussed only in the work of Scharf (1892). In this paper he states, that the parenchyma is usually chlorophyllous and evenly distributed. The spongy mesophyll is found only on the lowermost parts of the leaf. He indicates also, that a hypodermal layer of water cells is present in *Hypoxis*.

Among the species studied such undifferentiated mesophyll was found in *H. angustifolia*. In some other species: *H. filiformis*, *H. galpinii*, *H. fischerii*, *H. gregoriana*, *H. rigidula* and *H. nyasica*, the inner leaves comprise additionally at least one layer of water cells. In other species mesophyll is more or less differentiated. Elongate, hypodermal palisade mesophyll cells were observed in *H. polystachya*, *H. goetzei*, and *H. obtusa*. In *H. urceolata* such cells are present below the lower epidermis. In *H. goetzei* single water cells are dispersed in mesophyll. In *H. kilimanjarica* subsp. *protrusa* leaves are succulent with a large amount of sponge parenchyma and water cells.

In the cataphylls, the chlorophyllous cells are placed below the lower epidermis. Beneath the upper epidermis large parenchyma and water cells are mainly present.

Idioblasts with raphids were visible in all samples studied. Single small rhombohaedral and linear crystals were observed sometimes in the mesophyll cells. Similar

information about crystals in mesophyll can be found in literature concerning other species of *Hypoxis* (Scharf 1892; Rudall *et al*. 1998).

4.1.3. Inflorescence

4.1.3.1 Scape anatomy

Scapes in a genus *Hypoxis* are more or less compressed and in many species narrower in a basal part. On a cross-section, the shape of a scape reminds a more or less regular ellipse (Figs. 16-17). In some species it is elongated and in some obtuse at the ends.

The peduncle epidermis, in all samples studied, is one layered and covered with a thick layer of cuticle. In the lowest third of the scapes are shortly winged and glabrous. Above this part no alae are developed, but the peduncle starts to be more or less covered with hairs, first on edges and then, on the whole surface, especially on the flowering axis, pedicels and also ovaries and outer tepals. This indumentum is composed of tufted trichomes, also in the species which possess other types of trichomes on the leaves. The two-branched hairs occur only on scapes of *H. kilimanjarica*, *H. angustifolia* and as ciliae in the lower part of the scape of *H. filiformis*.

H. angustifolia var. *luzuloides*

About 5 layers of chlorenchyma with numerous idioblasts are present under epidermis. Six vascular bundles, among them four large and two small strands, are arranged in a regular ellipse. The sclerenchyma is weakly developed in the form of crescent fiber caps outside the large bundles. The pith cells are filled with numerous small needle like and rhomboidal crystals. Idioblasts are sparse.

H. filiformis

About 4 layers of chlorenchyma are present under epidermis. Eight vascular bundles are arranged in a regular ellipse with two additionall singular bundles on its both polars. The sclerenchyma produces a well developed ring around the bundle ring. Idioblasts are sparsely distributed in the pith.

H. fischerii var. *hockii*

About 5-7 layers of chlorenchyma are present under epidermis with water cells dispersed among them. The central ellipse is irregular and divided, composed of 29-37 vascular bundles of different size, sometimes with a few single strands separated on its sides (Fig. 16C). The slerenchyma produces a well developed band around the central ring. The parenchyma cells are filled with small single needle like and rhomboidal crystals. Idioblasts are sparse.

H. fischerii var. *zernyi*

In some samples, chloroplasts were observed in epidermal cells. About 6-10 layers of chlorenchyma are present under epidermis. The central ellipse is regular or irregular and divided, composed of 30-45 vascular bundles of different size, sometimes with a few single strands separated on its sides. The sclerenchyma produces a well developed band around the central ring. The parenchyma cells are filled with small single needle like and rhomboidal crystals. Idioblasts are numerous.

H. galpinii

About 5-6 layers of chlorenchyma and numerous idioblasts are present under epidermis. The central ellipse is irregular and divided, composed of about 20 vascular bundles of different size. The sclerenchyma produces a well developed band around the central rings, thicker above large bundles. One scape wing observed was atypically long, reaching to the part with flowers. Idioblasts are present.

H. goetzei

Numerous layers of thin walled parenchyma and water cells are present under epidermis. Cells with chlorophyll are dispersed among them creating a band around the ellipse of vascular bundles. The central ellipse is regular, composed of about 34 vascular bundles of different size. The sclerenchyma is absent. The parenchyma cells are filled with small single needle like and rhomboidal crystals. Idioblasts are sparse.

H. gregoriana

Epidermal cells are as large as the parenchyma cells. About 6 layers of chlorenchyma are present under epidermis. The central ellipse is regular, composed of about 11 vascular bundles of different size (Fig. 16A). The sclerenchyma is absent. The parenchyma cells are filled with small single needle like and rhomboidal crystals. Idioblasts are numerous.

H. kilimanjarica subsp. *protrusa*

Single cells with chlorophyll are present just below epidermis. The central ellipse is regular, composed of about 8 vascular bundles of equal size, except one of smaller dimensions. The sclerenchyma is absent. Idioblasts are numerous.

H. nyasica

About (2-) 5-6 layers of chlorenchyma are present under epidermis. The central ellipse is regular, composed of about 14-25 vascular bundles of different size (Fig. 17A). Only in one sample it was irregular. Additionally one or two bundles may be present on the poles of the oval. The sclerenchyma usually produced in a well developed ring around the bundle ellipse, but thinner in

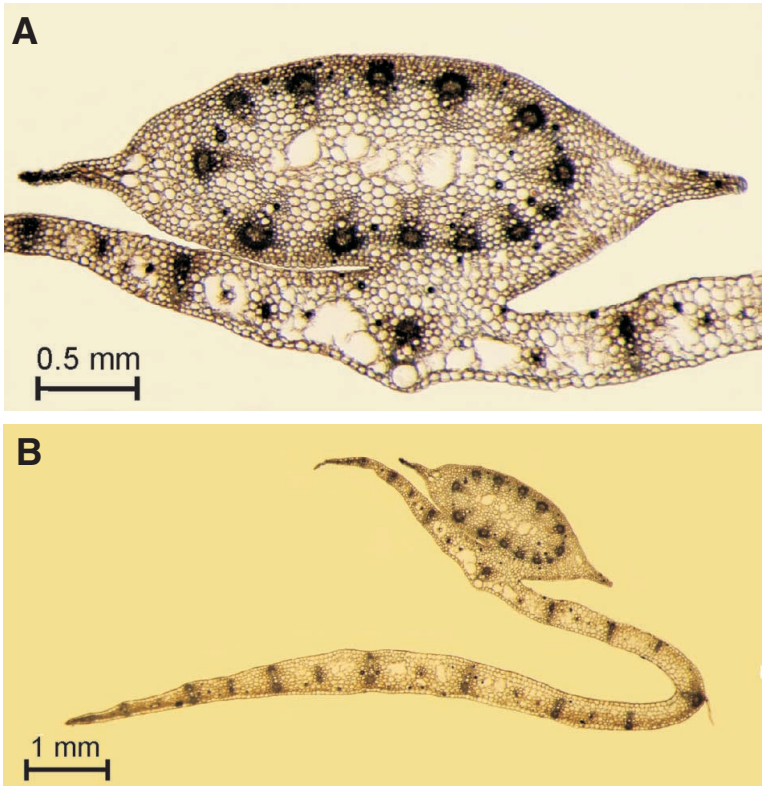


Fig. 17. *Hypoxis nyasica* (from *Wiland & Mboya 106*)
Explanations: A – Scape cross-section, B – Cross-section of a leaf fused with a scape

some specimens. The parenchyma cells are filled with small single needle like and rhomboidal crystals. Idioblasts are numerous. In one specimen, a joining between tissues of the scape and the cataphyll was observed (Fig. 17).

H. polystachya

About 5-8 layers of chlorenchyma with dispersed water cells are present under epidermis. The central ellipse is regular, composed of 40-60 vascular bundles of different size, with two separate strands on the edges (Fig. 16B).The sclerenchyma produces a well developed band around the central ring. The pith is partially composed of water cells. Idioblasts are sparse.

H. rigidula

About 5-7 layers of chlorenchyma are present under epidermis. The central ellipse is irregular and compressed at one side, composed of 19-35 vascular bundles of different size, sometimes with one separate strand on the edge. The sclerenchyma produces a well-developed band around the central ring. The parenchyma cells sometimes filled with small crystals. Numerous idioblasts are present.

Epidermis

The one layered epidermis covered with cuticle covering the stem is a common feature for all *Hypoxis* species (Scharf 1892; Schulze 1893). During this study, in some samples from *H. fischerii* var. *zernyi* chloroplasts were observed in the epidermal cells, what was not reported before. The epidermal cells are usually smaller than these of parenchyma, except *H. gregoriana*, where they are of similar dimensions. The general observation on the scape indumentum in *Hypoxis* was given by Wiland-Szymańska (2001) and is confirmed for the East Tropical African species.

Parenchyma

Up to 10 layers of chlorenchyma were observed under the epidermis in most of the species studied. Similar observations were made before for other species of *Hypoxis*, with 4-6 layers reported (Scharf 1892; Schulze 1893). Also occurrence of idioblasts with raphids and small crystals in the cells of parenchyma were reported in these papers.

In the materials studied additionally, water cells were seen in the outer layers of the scape parenchyma in *H. fischerii* var. *hockii* and *H. polystachya*. In two species, *H. goetzei* and *H. kilimanjarica* subsp. *prostrata*, no chlorenchyma was observed. In the former, the green cells are located beneath several layers of parenchyma, close to vascular bundles. In the latter, solitary cells with chlorophyll can be seen under the epidermis. Such state is understandable for *H. kilimanjarica* subsp. *prostrata* with the subterranean scape. It is however interesting, why it is so in the aerial scapes of *H. goetzei*.

Vascular bundles

The vascular bundles in the peduncles of *Hypoxis* species were observed by Scharf (1892) and Schulze (1893). These authors were describing the vascular bundle ellipse or ring as regular. However, in the East Tropical African material it was not always a case, and often irregularity in its shape and at least partial division into two rings were observed.

Scharf (1892) has reported an amount of vascular bundles in the scape to be about 13. In the East African species this quantity varies from less than ten in *H. angustifolia* var. *luzuloides*, *H. kilimanjarica* subsp. *prostrata* and *H. filiformis,* to a dozen or so in *H. gregoriana*, and *H. nyasica*, and more than 20 in other species, reaching 60 in *H. polystachya*. The vascular bundles differ considerably in size, are often irregular in their shape and connected together.

Scharf (1892) has reported a separate vascular bundle in each corner of the compressed scape. In samples studied it was not always a case, sometimes with only one strand separated, and the other included into the main ellipse. Moreover, additional strands outside the main ellipse were observed in *H. fischerii* var. *zernyi*.

Phloem is composed of thin walled cambiform cells and sieve tubes. Xylem is made of numerous vessels and tracheids with circular, spiral, ladderlike or net thickenings (Scharf 1892; Schulze 1893).

Closed or open sclerenchyma rings around the vascular bundles have been observed in many species of *Hypoxis*. They are composed of several layers of hexagonal cells (Scharf 1892; Schulze 1893). This character is however not universal for this genus, and has implications for the scape firmness. Peduncles are rigid and erect (Figs. 41E, 44E, 64A, 67E) or recurved and bending, especially under weight of flowers and fruits, e.g. *H. kilimanjarica* subsp. *kilimanjarica* (Fig. 53A), *H. angustifolia* (Fig. 25D). Bending of scapes of *Hypoxis* under weight of flowers and fruits was described before for *H. kilimanjarica* subsp. *kilimanjarica* and *H. monanthos* Baker (Wiland-Szymańska 2001) and for South African species by Hilliard & Burtt (1978, 1983). The latter authors were trying to explain it in connection with life in wet habitats, as a case of a geocarpy. However, the East Tropical African species which peduncles bend after anthesis, occur also in dryer habitats. Therefore this explanation does not seem totally correct. This phenomenon has certainly a basis in the scape anatomy. It occurs in species lacking sclerenchyma ring in their scapes (*H. gregoriana*, *H. goetzei* and *H. kilimanjarica* subsp. *prostrata*) or only with small crescent schlerenchyma caps at the vascular bundles (*H. angustifolia*). *H. angustifolia* and *H. gregoriana* have thin scapes, bending during fruiting stage. In *H. kilimanjarica* subsp. *prostrata* the scape is short, not exceeding the pseudosteme, and virtually underground. In *H. goetzei*, the inflorescences are short-lived, drying out and bending when the inner leaves develop. Schulze (1893) reported the lack of sclerenchyma in the scapes of other *Hypoxis* species of small dimensions. The scape of *H. goetzei* is however 5 mm wide.

Quite another case is observed in the species with a well-developed sclerenchyma ring in the scape. Inflorescences of these species are rigid after anthesis or only slightly bend. For example, in *H. rigidula* the infrutescences are still high above ground on an elastic stem. Because a capsule splits in the apical part, the seeds are wind dispersed (baleochory). The development of schlerenchyma ring in the scape is therefore connected with the peduncle orientation in a fruiting stage.

The pith is composed of large cylindrical cells, often with small crystals inside (Scharf 1892; Schulze 1893). In the material studied, no idioblasts were observed in this part of the stem. The water cells were noted in *H. goetzei* and *H. polystachya*.

The anatomy of scapes provides features that can be useful for determination of the East Tropical African *Hypoxis* species. They are particularly important in specimens in which leaves are not yet fully developed. Although, in many species, the anatomic structures of scapes are very similar, the degree of sclerenchyma development, the presence of water cells in the parenchyma, as well as the number of vascular bundles may provide important clues for the correct determination of the species.

In the materials studied two developmental anomalies were observed. The first one is an elongate scape wing in *H. galpinii*. Usually two wings are developed only in the lowest third of the peduncle, not reaching the base of the inflorescence axis. Secondly, a scape joined together with a lower side of the outer leaf was recorded in *H. nyasica*.

4.1.3.2. Flowers

In East Tropical African *Hypoxis* species the number of flowers growing on a single scape is variable and has a taxonomic implication. Exclusively single flowers are found only in *H. kilimanjarica* subsp. *prostrata* (Fig. 53B). They can be also observed in other taxa, including *H. kilimanjarica* subsp. *kilimanjarica*, *H. angustifolia* and *H. filiformis*. In these species however they are often subtended by two bracts, what suggests that another undeveloped bud was produced on the stem. In *H. schimperii* most plants produce single flowers (Fig. 70A), but there are exceptions with 2-4 flowers on one peduncle.

A well-distinguished type of the inflorescence in the genus *Hypoxis* is a raceme. The typical racemes, with the oldest flowers on the longest pedicelles placed at the lowest nods, and the youngest flowers, almost sitting

at the upper nodes are found in *H. bampsiana*, *H. nyasica* (Fig. 58A-B), *H. obtusa*, *H. urceolata* (Fig. 73A, 73E), *H. fischerii* var. *zernyi* (Fig. 41E), *H. fischerii* var. *katangensis* and *H. fischerii* var. *hockii* (Fig. 38A). When the pedicelles are not very long, such inflorescence sometimes reminds a spike. As an example *H. fischerii* var. *fischerii* can be mentioned. The inflorescence axis in this species is getting narrower at each node, in which usually two or three flowers are developed. In *H. fischerii* var. *zernyi*, the pedicelles of first three flowers are almost equal in length, therefore inflorescences are primarily subumbellate, later elongating into a typical raceme. In *H. rigidula* (Fig. 67A, 67E) and *H. galpinii* (Fig. 44A, 44E), racemose inflorescences bear at each node one alternating flower only. The raceme of *Hypoxis polystachya* is dense and cylindrical (Fig. 64A). Sometimes it is also branched in apical part and panicle-like, with an undetermined flowering sequence (Fig. 64C). Most often the total number of flowers in racemes is from 4 to 12. In this respect exceptional are *H. fischerii* var. *fischerii* and *H. polystachya* in which a single inflorescence may consist of 30 and 26 flowers, respectively. Besides these two species in the East Tropical Africa only *H. rigidula* produces up to 23 flowers, but its inflorescence type is quite different. Another type of a racemose inflorescence found in *Hypoxis* is a corymb. In this case the pedicelles of flowers of different ages are usually long in comparison to the flower size and flaccid. They are found in *H. malaissei*, *H. schimperii* and *H. angustifolia* (Fig. 25A). Their number of flowers varies from 2 to 6.

In some species of *Hypoxis*, cymose inflorescences, with the oldest flowers on the top of the inflorescence axis, are found. An inflorescence, very similar in appearance to the corymb, is the one found in *H. gregoriana* (Fig. 50A, 50E). It is also lax, with long pedicelles, but the position of the oldest flower on the top of the axis suggests that it is a determined inflorescence. This species produces 2-4 (-6) flowers per peduncle. A very interesting cymose inflorescence is found in *H. filiformis*. The oldest flower develops on the top of the inflorescence axis, and his pedicel is the longest in the whole cluster. The second flower develops in the nearby node, but below the node of the oldest flower, and it is almost sitting. If a third flower comes into being, it grows from the same node as the first flower, and its pedicel is long. A fourth flower comes out from the same node and its pedicel is very short. An inflorescence of *Hypoxis goetzei* looks at the first sight as a typical spike (Fig. 39A). It is however a cymose, determined inflorescence, because the flowering sequence starts from the top of the axis. It produces from 4 to 14 flowers per scape. The oldest flowers, in the apical part of the cluster, are with longer pedicels, whereas these at the lowest nodes are almost sitting.

Each flower is subtended by a bract, which is usually subulate and acute at the apex. It has at least one vein, but the larger bracts, accompanying by older flowers can have up to 5 veins (e.g. *H. fischerii* var. *fischerii*). The veins of the bracts are especially prominent in *H. obtusa*. The bracts are covered with the indumentum on the lower side, at least along the midrib, or on the whole surface. In *H. urceolata*, *H. angustifolia*, *H. polystachya*, *H. fischerii* var. *zernyi, H. nyasica* and *H. goetzei* they are ciliate on the edges. In *H. galpinii*, ciliae on the bract edges are present at the beginning of the anthesis only. Red coloration of the whole bracts is found in *H. fischerii* var. *fischerii* and of the midvein alone in *H. angustifolia*.

The number of tepals is usually 6, but it can be reduced to 5, 4 or 3. In the East Tropical Africa such variation was observed in *H. galpinii*, where on one scape, flowers with different numbers of tepals were found (Fig. 44A, 44E). An occurrence of only four tepals is very common in *H. schimperii* and sporadic in *H. filiformis*.

A perigon is persistent after anthesis. Tepals are arranged in two whorls. In the East Tropical Africa they are of different shades of yellow. The outer tepals are greenish outside, and in *H. angustifolia* with a red strip on the midvein. They are larger and more hairy outside than the inner tepals. On their apex there is a small hood with an appendage. The inner tepals are shorter, wider and apparently less hairy. They are obtuse at the apex. The venation of the tepals is not very regular and it shows some variability at the species level.

The flowers are usually open before noon, in full sun, and at this time they are very noticeable in the field. However, in the afternoon, or when it is clouded, they close and, because of the green coloration of the outer tepals, are almost invisible.

The field observations made in Tanzania indicate, that almost solely small beetles, attracted by pollen and eating tepals, visit the flowers. Small ants visited only inflorescences of *H. fischerii* var. *zernyi*. The flowers of this taxon give off a sweet scent. A faint, very sweet smell was also noted for *H. goetzei* (*Richards 11701,* BR, EA, K).

The stamens are arranged in two whorls, in the same number as the tepals. Subulate or filiform filaments are all of the same length or shorter in the inner circle. Sagittate anthers are basifixe emarginate or fused at the apex.

A three-locular inferior ovary is covered with hairs. It is usually obconical in shape. A style can be terete or trigonous in the cross-section, widened in the basal part. Its length, in comparison to the stigma, is quite variable. The stigma is tripartitous. It can be pyramidal, composed of three rows of papillae or composed of three more or less free lobes, variously covered with papillae.

A type of a fruit found in *Hypoxis* is always a hairy, dehiscent capsule. It is usually turbinate or ovoidal. It opens with a circumscissile slit in the apical part. Additionally, it can split into three valves as in *H. angustifolia*. The dispersal modes of *Hypoxis* are described above, in a paragraph 4.1.3.1.

Morphology of seeds of the East Tropical Africa species of *Hypoxis* was detailed by Wiland-Szymańska (2006). In this work 9 types of the seed testa sculpture were presented. The seeds can be divided into two main morphological groups: with a layer of cuticle, which is thick and wrinkled (Figs. 25F, 47H, 64D, 64E, 70B), and with the cuticle thin and smooth (Figs. 30D-E, 34A, 36, 41H-I, 44H-I, 50F-G, 53E, 56A-B, 58E-F, 61E, 67I-J, 73F-G). The colour of the first type is brown both when fresh or after drying. The only exception is *H. polystachya*, which seeds are black in the field. This exception is connected with a fact that the cuticle on the testa is wrinkled, but strongly adhering to it (Fig. 64E). The seeds covered with wrinkled cuticle are matt. On the other hand, seeds covered with smooth cuticle are always black and more or less glossy. The outer periclinal walls can be concave, flat or more or less convex. In some taxa they are very elongate and forming mammiliforme papillae in *H. fischerii* var. *fischerii* (Fig. 34A) or pointed protrusions in *H. fischerii* var. *katangensis*.

Nel (1914a) stated, that an analysis of the inflorescence types in *Hypoxis* is very difficult due to their variability. He has described two types of racemose inflorescence in the genus in form of the racemes and corymb. The most important character, considered by him, was a pedicel length.

Heideman (1983) studied inflorescences of the *Hypoxis* species growing in Witwatersrand in the South Africa. Her sketches, however, do not show a flowering sequence in the cluster. Depictions of the inflorescences of *H. galpinii*, *H. rigidula* and *H. filiformis* are similar to forms observed in the East Tropical Africa.

The inflorescences diversity of the East Tropical Africa species was described by Nordal (Nordal *et al.* 1985). In this paper, drawings of the inflorescences of different species are presented. Unfortunately, the taxonomy of a large group of species was not clear at the time, and they were referred to as the "*Hypoxis obtusa*-complex". Also an inflorescence of *H. filiformis* (*H. malosana*, Fig. 2j in Nordal *et al.* 1985) was presented. Apparently because of an editing error, the flowering sequence indicated is not correct. Nordal stated, that the inflorescence types found in *Hypoxis* show all intermediate stages between typical racemes and corymbs. She also points out a correlation between the number of flowers and the inflorescence type defining few flowered clusters as corymbs, and many flowered as racemes. The current study does not confirm this account, because corymbs, racemes and cymes of *Hypoxis* can possess the same number of flowers. The more important character useful in their recognition is the arrangement of flowers and the flowering sequence. Sometimes it is really difficult to determine a type of an inflorescence observed, when flowers are only two or three. The shape of the inflorescence is also connected with its development state. For example, the inflorescences of H. *fischerii* var. *zernyi* are first corymbs, and later elongated racemes. The number of flowers, at least in some species, is also connected with plant age. The older the plant, the more flowers it produces per inflorescence, up to the highest quantity for the taxon.

In the paper of Nordal (Nordal *et al.* 1985) it is stated, that among the racemose inflorescences of *Hypoxis*, two types with an acropetal (from the base to the top) and basipetal (from the top to the base) flowering sequence can be noted. This account is however not completely correct, because a determined inflorescence of *H. goetzei* is cymose and not racemose. Moreover, an irregular flowering sequence is observable in the panicles of *H. polystachya*.

Nordal (Nordal *et al.* 1985) reports that the flowers are usually opposite, but sometimes whorls composed of three flowers can be found. Moreover single flowers can be observed in nodes between those with two. This statement was generally confirmed during the current study. The inflorescences of *H. rigidula* and *H. galpinii* always bear only a single bud at a node, and flowers are alternate, what was observed before by Heideman (1983).

The structure and morphology of pedicelles and bracts of the East Tropical Africa taxa of *Hypoxis* is similar to other species of this genus (Wiland-Szymańska 2001).

The phenomenon of development of less than six tepals in *Hypoxis* was already described in literature (Ludwig 1889; Nel 1914a; Wiland-Szymańska 2001). For the species distributed in the East Tropical Africa the occurrence of only four tepals was reported before for *H. filiformis* and *H. kilimanjarica* (Wiland-Szymańska 2001).

The coloration and structure of the *Hypoxis* flowers is very conservative within the genus. Floral structure and development of an African species *H. villosa* was described by Kocyan & Endress (2001). Unfortunately, this species name can be applied only sensu lato (Singh 2006), because a taxonomical status of this taxon is not clear. The yellow coloration of the flowers in the East Tropical Africa is the most typical for the genus. White flowers are found only in a few species, e.g. *Hypoxis parvula* var. *albiflora* B.L. Burtt in South Africa.

Information about pollination of an American species, *Hypoxis decumbens*, indicates that its flowers are producing only pollen as an attractant for animals (Knuth 1904). They were visited by the hymenoptera with short mouthparts, the dipterans with short and long

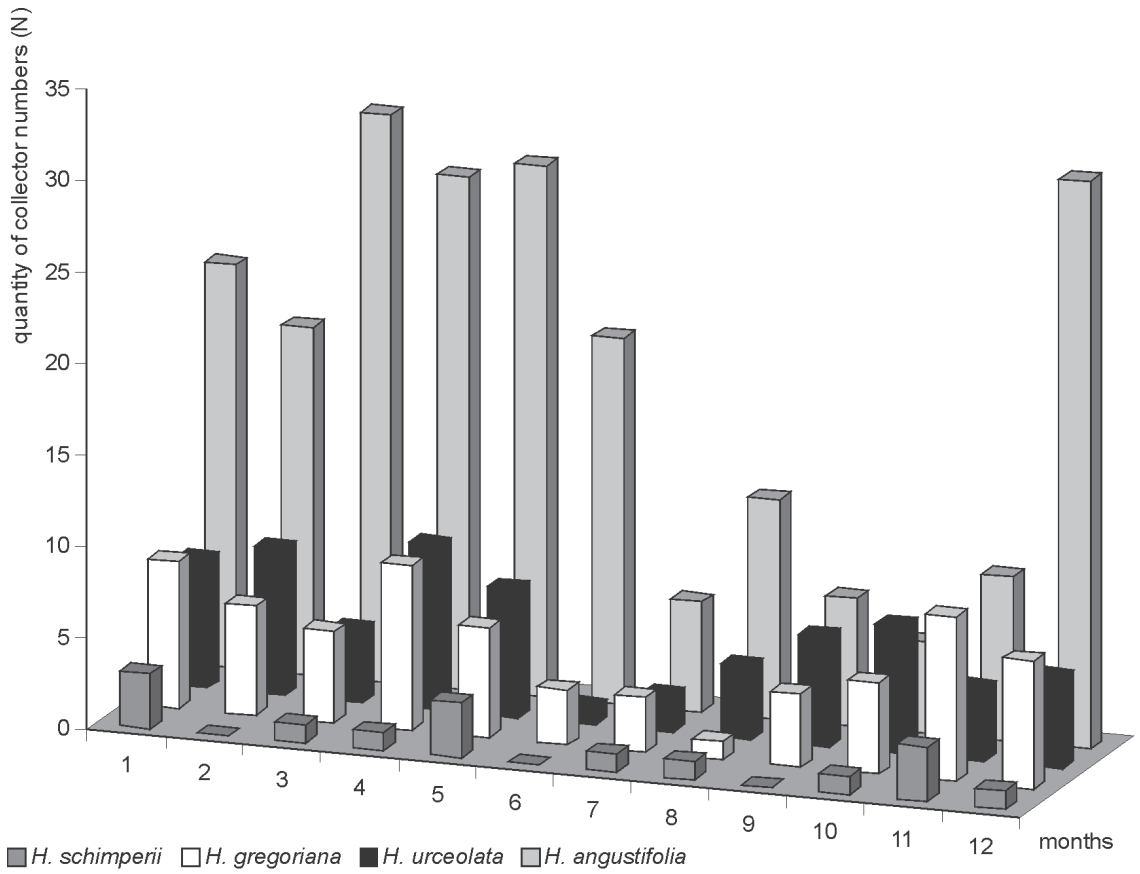


Fig. 18. Frequency distribution of flowering periods of *Hypoxis* species without a resting phase

mouthparts and the beetles. In South Africa, solitary bees and honeybees were observed on flowers of *Hypoxis* (Singh 1999). Small beetles were observed on the flowers of the East Tropical Africa taxa. Observations related to the sweet smell of two species, *H. goetzei* and *H. fischerii* var. *zernyi*, are so far unique for this genus, as well as visiting its flowers.

The anther anatomy of *Hypoxis* was described by Schaeppi (1939) and Johri *et al*. (1992). The pollen grains are elongate, oval and monosulcate (Erdtman 1971; Nordal *et al.* 1985; Johri *et al.* 1992). Observations concerning microsporogenesis and pollen development were made by Wilsenach (1967), Wilsenach & Papenfus (1967), Wilsenach & Warren (1967), Rudall *et al*. (1997) and Furness & Rudall (1998).

The number of anatropic ovules was reported by Nel (1914a) to be from 4 to 20. The embryo development of *Hypoxis* was described by Stenar (1925), Govindappa (Govindappa & Shamakumari1967) and Wilsenach & Warren (1967). The seed anatomy of this genus was studied by several authors (Nemirowicz-Danchenko 1985; Johri *et al*. 1992; Oganezova 1995).

The importance of the seed testa sculpture in the taxonomy of *Hypoxis* was first noted by Brackett (1923) in American species. Its taxonomic value for African taxa was confirmed in several papers (Nordal *et al*. 1985; Wiland-Szymańska 2001, 2006; Wiland-Szymańska & Nordal 2006). This character is very valuable, taxon specific and often correlates with other taxonomically important characters. It has unfortunately one disadvantage. It can be observed correctly under the scanning microscope, or at least under a good light microscope, and therefore is not very useful in the field. It is, however, so important in recognition of the *Hypoxis* taxa, that it was also used in the key presented in the chapter 5.

The number of chromosomes and problems concerning apomixis in the genus *Hypoxis* was discussed in papers of Nordal (Nordal *et al.* 1985) and Zimudzi (1994). A possibility, that in case of several taxa of *Hypoxis* one is dealing with an apomictic complex does not change the fact, that such groups are recognizable in the field. Moreover, they have to be classified somehow for the conservation and other purposes. Therefore one of the aims of the current study has been to provide a scientist working in the filed with a usable determination tool. The most problematic group is *H. fischerii*, which varieties sometimes grow one by another. Though they are very similar in the herbarium materials, their difference is better visible in the field. Hopefully this work will encourage more field studies on the *Hypoxis* taxonomy.

4.2. Phenology

The flowering periods are very important for plants' reproductive success. It requires co-occurence of several factors including the presence of pollinators and the time for the development of seeds (Johnson 1992). The analysis of flowering periods may uncover the relationships between species' geographical range and its ecological preferences.

Flowering phenology of *Hypoxis* species in Africa has never been analyzed before. Published data (e.g. Pooley 1998; Wiland-Szymańska 2001) concerned only flowering periods of the species occurring in the East Tropical Africa.

After analysis of the information from the herbarium material one can conclude that the East Tropical Africa *Hypoxis* species can be divided into two phenological groups. The first group includes plants collected throughout the whole year (Fig. 18). The second group comprises species for which there is a well-defined break in flowering and fruiting (Fig. 19).

The four taxa, *H. angustifolia* var. *luzuloides*, *H. schimperii*, *H. urceolata* and *H. gregoriana* were collected in the East Tropical Africa throughout the whole year (Fig. 18), although there are periods of more abundant flowering. For *Hypoxis angustifolia* var. *luzuloides*, although it was collected in all months, particularly abundant were specimens collected from December to June (Fig. 27). This may reflect its wide ranges both horizontal and vertical. It occurs in the areas with variable precipitation periods and in various altitudinal vegetation zones. Flowering specimens can be found throughout the whole year, because the separated populations do not flower at the same time. *Hypoxis schimperii*, a species occurring primarily in the wetlands was also collected during the whole year, although in small numbers and with short breaks (Fig. 72). In Capensis, the species with longer flowering periods are also typical for wetlands that do not dry completely in the dry period (Johnson 1992). *Hypoxis urceolata* and *H. gregoriana*, found in the northern part of the East Tropical Africa show very similar plots of flowering periods. Both species were collected throughout the whole year, but there is a marked drop in the number of specimens gathered during the dry period from June to August (Figs. 52, 75). The highest precipitation in this area occurs in April, October and November (Fig. 2), which is reflected in the large number of herbarium sheets from these periods.

All other *Hypoxis* species in the East Tropical Africa show well-defined flowering seasons followed by a resting period. The taxa, for which southern part of

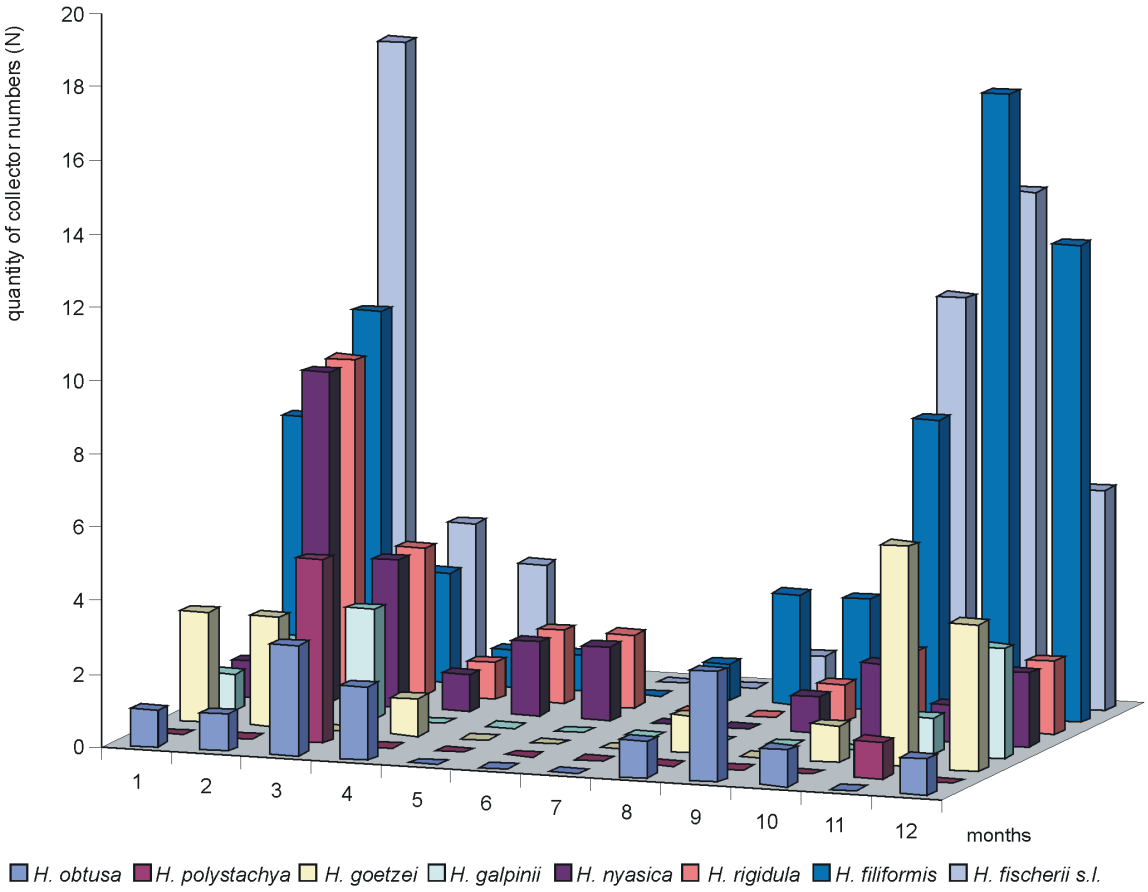


Fig. 19. Frequency distribution of flowering periods of *Hypoxis* species with a resting phase

Tanzania is a center of abundance, including *H. goetzei*, *H. polystachya*, *H. nyasica*, *H. obtusa*, *H. filiformis*, *H. rigidula*, *H. fischerii* var. *zernyi* and *H. fischerii* var. *colliculata*, have flowering period starting in the end of July and ending at the end of April (Figs. 19, 43). For most of these species, there are two periods of intensified flowering in November/December and in February/March. Between the flowering periods there is a resting period lasting from one to seven months that coincides with the dry season from the end of May till September (Walter *et al.* 1960; Walter 1973; Pócs 1976a) (Fig. 2). It indicates that the species studied belong to ephemeral xerophytes.

Hypoxis galpinii flowers from November through March (Fig. 46). It occurs mainly on the Lukwangule Plateau, an area that is not easily accessible, and therefore the herbarium material may not reflect the total flowering period of this species. The highest precipitation in March through May make climbing to this plateau impossible (Pócs 1976a). The dry season in Morogoro Mountains lasts from June till the end of September, and for *H. galpinii* it is a resting period.

Hypoxis kilimanjarica occurs exclusively in the mountains. The macroclimatic data are not suitable for the analysis of occurrence of *H. kilimanjarica* due to specific and highly diverse microclimatic conditions in particular altitudinal zones in the mountains. Available data indicate two breaks in the flowering period that are different in each of the two subspecies of *H. kilimanjarica* (Fig. 55). One flowering period is common for both subspecies and lasts from August till October. The second one is observed in January for *H. kilimanjarica* subsp. *kilimanjarica* and from March through May for *H. kilimanjarica* subsp. *prostrata*. Such a shift in the second flowering period may be due to differences in the climate at altitudes at which the two taxa occur.

In the case of *H. fischerii*, intensive flowering was observed in October, November and February (Fig. 43). There are differences in flowering periods between varieties. Due to a more dispersed range of *Hypoxis fischerii* var. *fischerii* its flowering period is stretched in time and occurs from August through April. Another species with a wide geographic range – *H. fischerii* var. *hockii* – flowers from October till April. On the other hand, the flowering periods of the species occurring only in the southern Tanzania are significantly shorter. *H. fischerii* var. *zernyi* flowers from September till February, *H. fischerii* var. *colliculata* from October till December and *H. fischerii* var. *katangensis* only in November.

Due to a very small number of specimens it is difficult to assess the periods of flowering for the remaining two species – *H. bampsiana* and *H. malaissei*, although it seems that they also depend on the rainy season.

It is remarkable, that many species with a marked break in flowering and fruiting periods occur primarily south of the East Tropical Africa. They reach northern limits of their geographical ranges in Tanzania. Some of these taxa (*H. goetzei*, *H. polystachya*, *H. nyasica* and most of the *H. fischerii* subspecies) are linked to the Zambesian Region according to White's classification (1983). Others (*H. obtusa*, *H. filiformis*, *H. galpinii* and *H. rigidula*) have very wide ranges reaching South Africa. Interestingly in South Africa, *H. rigidula* flowers from August till March and *H. filiformis* from July till April (Pooley 1998). In the East Tropical Africa, the flowering period of *H. filiformis* is one month longer (Fig. 32). In the case of *H. rigidula*, one can observe that the flowering period in the East Tropical Africa (September-June) is significantly different (Fig. 69).

In the analysis of flowering patterns of the Cape Province Flora, Johnson (1992) points to the correlation between flowering and winter rains season. Similarly, in southern part of Tanzania, the flowering period of *Hypoxis* taxa is linked to a very distinct rainy season. It has been also noted that related species in the Cape flora tend to have similar flowering seasons (Johnson 1992). In the East Tropical Africa flora, such a phenomenon is confirmed by similar flowering periods of *H. fischerii* varieties.

There are two *Hypoxis* species in which uncoupling of the leafing and flowering phenophases is observed. For example *H. goetzei* usually flowers before the leaves are formed and before the rainy season. Flowers also develop before the appearance of leaves in *H. filiformis* and *H. obtusa,* but the inflorescences last longer and it is possible to observe specimens with both flowers and well-developed leaves. An intermediate case is *H. fischerii* var. *fischerii*, in which flowers appear first and last till the development of leaves. It is possible due to storage materials in the tubers. A separation of flowering and leaves development may be significant for competition in attracting the pollinators in much the same way as explained for the South African species (Johnson 1992). The evidence from field observations that would support such a notion is so far missing. In the species with seeds unable to sustain a prolonged rest period, the flowering must be correlated with the season, in which there are optimal conditions for germination and growth (Johnson 1992; Dreyer *et al.* 2006). This is not the case for *Hypoxis*, because their seeds possess a thick phytomelan crust. However, flowering at the onset of the rainy season allows the development of seedlings before the start of next dry season.

In summary, one can conclude that there is a clear correlation between flowering periods and the rainy season for most of the *Hypoxis* species in the East Tropical Africa. Exceptions include taxa with very wide geographical ranges and the species occurring in the mountains and wetlands, which are less dependent on macroclimatic conditions.

The flowering periods of *Hypoxis* species are also influenced by periodic fires typical for the subequatorial zone. The significance of fires for the flowering of *Hypoxis* was so far analyzed only for American species (Herndon 1988). One conclusion drawn from these studies was that fire indeed stimulates flowering. In the field notes from the East Tropical Africa, recent fires are mentioned in the descriptions of several species, including *H. angustifolia*, *H. goetzei*, *H. filiformis*, *H. fischerii* s.l., *H. fischerii* var. *colliculata*, *H. fischerii* var. *hockii*, *H. fischerii* var. *fischerii*, *H. fischerii* var. *zernyi*, *H. gregoriana*, *H. nyasica*, *H. obtusa*, *H. rigidula* and *H. urceolata*. For eight taxa: *H. galpinii*, *H. kilimanjarica* subsp. *kilimanjarica*, *H. kilimanjarica* subsp. *prostrata*, *H. schimperii*, *H. fischerii* var. *katangensis*, *H. malaissei*, *H. polystachya* and *H. bampsiana* there is no such information. The first three species are found high in the mountains where fires are uncommon or completely absent due to high humidity or the type of vegetation. The lack of information concerning fires might be due to the rarity of other taxa in the herbarium material.

Fire is not the only factor that stimulates flowering of the *Hypoxis* species, but many members of this genus are pyrophilic and show adaptations (tubers, tunic) that allow them to survive of periodic fires.

4.3. Distribution

Currently, there are no complete data on overall ranges of all *Hypoxis* species. Until 1970s, the distribution maps were only created for American species (Tralau 1972). There is only one paper that presented data on the distribution of *Hypoxis angustifolia* for the whole Africa (Wickens 1976). According to the Wickens' phytogeographic division of Africa (Wickens 1976), *H. angustifolia* was classified as belonging to the Sudano-Zambezian and Madagascan floristic categories. Later on, the point distribution maps of several *Hypoxis* species in floras of various parts of Africa were compiled (Nordal *et al*. 1985; Wiland-Szymańska 2001; Demissew *et al*. 2003). So far, there was no comprehensive treatment of geographical ranges of *Hypoxis* species, which was also partly due to taxonomic problems.

Point distribution maps for *H. angustifolia*, *H. goetzei*, *H. schimperii*, *H. kilimanjarica* and *H. filiformis* in the East Tropical Africa were already published by Nordal (Nordal *et al*. 1985). For *H. angustifolia* there were 136 locations (Nordal *et al*.1985), while in the present work their number is 185. For other species the old and new numbers of localities are respectively: *H. schimperii* 10/15, *H. goetzei* 12/21, *H. filiformis* 31/43, *H. kilimanjarica* subsp. *kilimanjarica* 6/10, *H. kilimanjarica* subsp. *prostrata* 4/5. In the earlier work (Wickens 1976) 25 sites for *H. angustifolia* in the East Tropical Africa were published. However, the differences in numbers may also be a consequence of using differently scaled maps. The distribution maps of the remaining species for the East Tropical Africa have never been published before.

Most of the material, 452 herbarium sheets, used in the analysis was collected in Tanzania (Fig. 20), where all of the 20 of the East Tropical Africa *Hypoxis* species

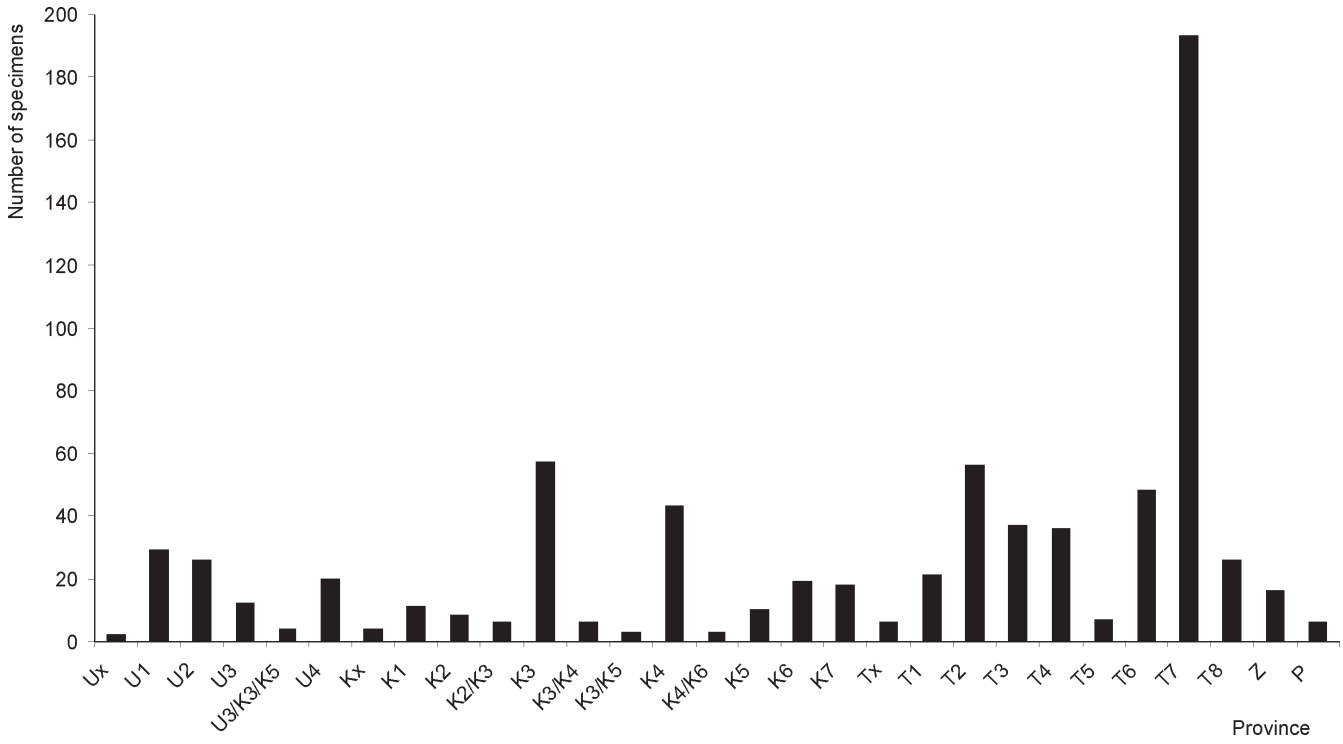


Fig. 20. Amounts of herbarium collector's numbers gathered in different phytogeographic provinces of the East Tropical Africa

Table 6. Distribution of *Hypoxis* taxa in the countries of East Africa

Taxon	Uganda	Kenya	Tanzania
H. angustifolia var. *luzuloides*	+	+	+
H. bampsiana subsp. *tomentosa*	.	.	+
H. filiformis	+	.	+
H. galpinii	.	.	+
H. goetzei	.	+	+
H. gregoriana	+	+	+
H. fischerii var. *colliculata*	.	.	+
H. fischerii var. *fischerii*	+	+	+
H. fischerii var. *hockii*	+	.	+
H. fischerii var. *katangensis*	.	.	+
H. fischerii var. *zernyi*	+	.	+
H. kilimanjarica subsp. *kilimanjarica*	+	+	+
H. kilimanjarica subsp. *prostrata*	.	+	+
H. malaissei	.	.	+
H. nyasica	.	.	+
H. polystachya	.	.	+
H. obtusa	+	+	+
H. rigidula var. *rigidula*	+	+	+
H. schimperii	.	+	+
H. urceolata	+	+	+
Total	10	10	20

can be found (Table 6). Much lower number of specimens originated form Kenya (188) and Uganda (93) (Fig. 20) with 10 species represented in each country (Table 6).

In Uganda, the largest number of species (6) occurs in the Northern province (Table 7) (Fig. 21), but only two of them: *H. angustifolia* var. *luzuloides* and *H. urceolata*, are widely distributed. The remaining species were collected in a limited number of isolated locations. Northern province was a source of the largest number of *Hypoxis* specimens (Fig. 20). The Western province (U2), represented by slightly lower number of herbarium sheets (Fig. 20), shows less diversity with only four taxa of *Hypoxis* described in this region (Fig. 21) (Table 7).

In Kenya, the Rift Valley province (K3) is exceptional in terms of the number of *Hypoxis* taxa (Table 7). Nine out of total ten Kenyan *Hypoxis* species have been reported from this area (Fig. 21). Such diversity may be due to a high habitat variety, but may also reflect the high number of herbarium sheets coming from this region (Fig. 20). On the other hand, although there was also a relatively high number of specimens from the Central province (K4), only four *Hypoxis* taxa were reported from there (Figs. 20-21).

Table 7. Distribution of *Hypoxis* taxa in the phytogeographic provinces of East Africa

Taxon	U1	U2	U3	U4	K1	K2	K3	K4	K5	K6	K7	T1	T2	T3	T4	T5	T6	T7	T8	Z	P
H. angustifolia var. *luzuloides*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
H. bampsiana subsp. *tomentosa*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
H. filiformis	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	.	.
H. fischerii var. *colliculata*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.
H. fischerii var. *fischerii*	+	.	+	.	.	.	+	.	.	.	.	+	.	.	+	.	.	+	.	.	.
H. fischerii var. *hockii*	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.	.
H. fischerii var. *katangensis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
H. fischerii var. *zernyi*	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	+	+	.	.
H. galpinii	.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	+	+	.	.	.
H. gregoriana	.	.	.	+	+	.	+	+	.	+	.	+	+	.	.	.	.	.	.	.	.
H. goetzei	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	+	+	.	.
H. kilimanjarica subsp. *kilimanjarica*	.	+	.	.	+	.		.	.	+	.	.	+	+	.	.	.	.	.	.	.
H. kilimanjarica subsp. *prostrata*	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.
H. malaissei	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	+	.	.	.
H. nyasica	.	.	.	.	.	.		.	.	.	.	.	.	.	+	.	+	+	+	.	.
H. obtusa	+	.	.	.	.	.	+	.	.	.	.	+	+	+	.	.	.	+	.	.	.
H. polystachya	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.	+	.	.	.
H. rigidula	.	.	.	.	.	+	+	.	+	.	+	+	.	+	.	+	+	+	.	.	.
H. schimperii	.	.	.	.	.	.	+	+	+	.	+	.	+	.	+	+	.	+	+	.	.
H. urceolata	+	+	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	.	.	.	.
Total	6	4	4	3	4	3	9	4	3	4	4	6	8	5	12	5	7	14	7	1	1

Explanations: see Fig. 6

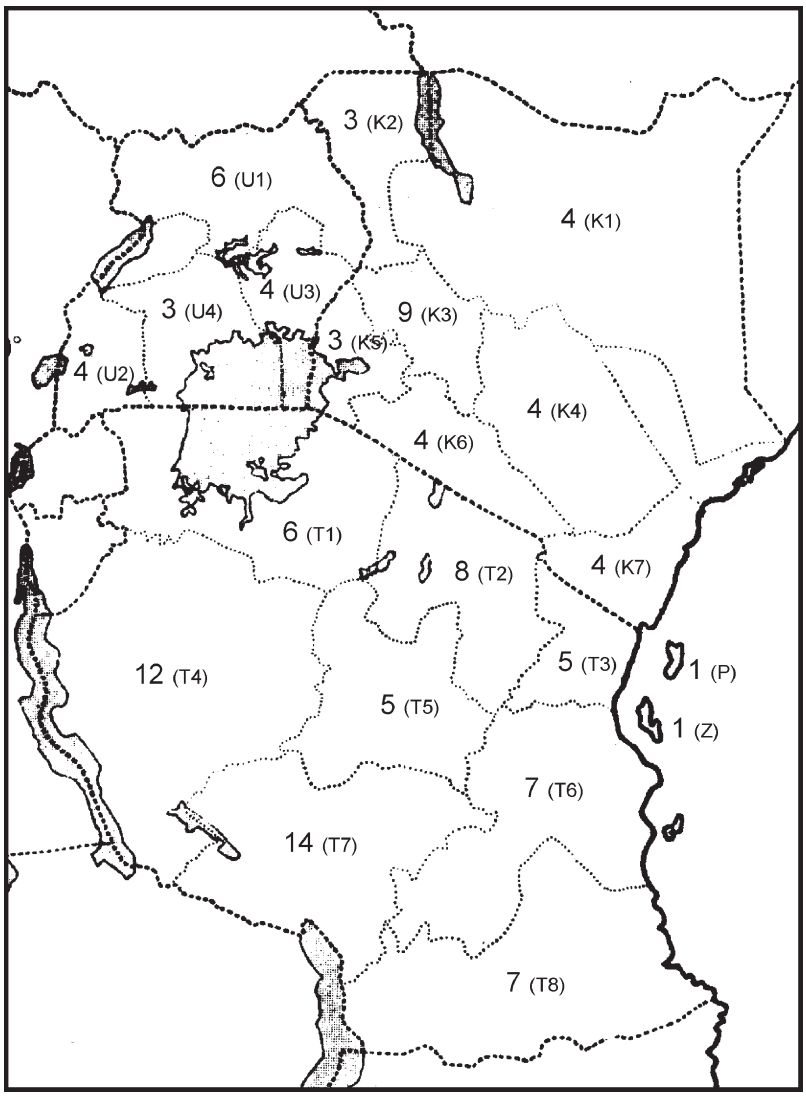


Fig. 21. Number of the *Hypoxis* taxa occurring in different phytogeographic provinces of the East Tropical Africa

The largest number of analyzed *Hypoxis* specimens originated from Southern Highlands (T7) in Tanzania (Fig. 20). The three districts, Mbeya, Iringa and Njombe, are represented by 55 herbarium numbers. These three districts possess the largest number (14) of *Hypoxis* taxa (Table 7). Interestingly, in the neighboring Western province (T4), 12 *Hypoxis* taxa have been reported, although the number of herbarium sheets originating from this region is significantly lower (Figs. 20-21). These results clearly show that the diversity observed in herbarium material does not necessarily depend on the sample size.

The analysis of the *Hypoxis* taxa in particular provinces of the East Tropical Africa clearly shows that the center of diversity and abundance in the East Tropical Africa is located in the southern part of Tanzania. Often, several *Hypoxis* species occur there side by side. For example, in the Mbeya district (T7), one can observe *Hypoxis polystachya*, *H. fischerii* and *H. goetzei* in close proximity. In Iringa, *H. rigidula* and *H. nyasica* are also often found together. A large number of taxa in these regions are due to a vicinity of the Zambesian region in the Democratic Republic of the Congo and Zambia, which is very rich in *Hypoxis* species (Nordal *et. al.* 2001; Wiland-Szymańska 2001).

In the northern part of the area analyzed there are four species: *H. kilimanjarica*, *H. urceolata* and *H. gregoriana* and widely distributed *H. angustifolia*. The majority of the remaining East Tropical Africa species occurs in the Rift Valley region in Kenya.

In this work an attempt was made to create maps of the overall ranges of *Hypoxis* species in Africa. So far, such maps were available only for *H. angustifolia* (Wickens 1987). The point distribution maps were compiled earlier for *Hypoxis* species from Central Africa (Wiland-Szymańska 2001) and Ethiopia and Eritrea (Demissew *et al.* 2003). For other regions there were data available for smaller phytogeographic (e.g. Nordal & Zimudzi 2001) or administrative (e.g. Snijman & Singh 2003) units. The maps presented in the current work show detailed range limits of *Hypoxis* species in East and Central Africa as well as Ethiopia and Eritrea

Table 8. Distribution of *Hypoxis* taxa from East Africa in the phytogeographic provinces of White (1993)

	Phytochoria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
I	Guineo-Congolian Region	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
II	Zambezian Region	+	+	+	+	+	+	+	+	+	+	+	.	.	.	+	+	+	+	+	.	.
III	Sudanian Region	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+
IV	Somalia-Masai Region	+	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	+	.	+	.	+
V	Cape Region	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
VIII	Afromontane Region	+	.	.	.	.	.	.	.	.	+	+	.	+	+	.	.	.	.	.	+	.
X	Guinea-Congolia/Zambezia Transition Zone	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
XI	Guinea-Congolia/Sudania Transition Zone	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
XII	Lake Victoria Regional Mosaic	+	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+
XIII	Zanzibar-Inhambane Regional Mosaic	+	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
XIV	Kalahari-Highvel Transition Zone	+	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	+	.	.
XV	Tongoland-Pondoland Regional Mosaic	+	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
XIX	East Malagasy	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
XX	West Malagasy	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Explanations: 1 – *H. angustifolia*, 2 – *H. bampsiana*, 3 – *H. filiformis*, 4 – *H. fischerii* s.l., 5 – *H. fischerii* var. *fischerii*, 6 – *H. fischerii* var. *colliculata*, 7 – *H. fischerii* var. *hockii*, 8 – *H. fischerii* var. *katangensis*, 9 – *H. fischerii* var. *zernyi*, 10 – *H. galpinii*, 11 – *H. goetzei*, 12 – *H. gregoriana*, 13 – *H. kilimanjarica* subsp. *kilimanjarica*, 14 – *H. kilimanjarica* subsp. *prostrata*, 15 – *H. malaissei*, 16 – *H. nyasica*, 17 – *H. obtusa*, 18 – *H. polystachya*, 19 – *H. rigidula* var. *rigidula*, 20 – *H. schimperii*, 21 – *H. urceolata*

(Figs. 26A, 29A, 31A, 33A, 35A, 37A, 39A, 40A, 42A, 45A, 48A, 51A, 54A, 59A, 62A, 65A, 68A, 71A, 74A). For other regions indicated with stripes, the maps will require refining in the future.

Based on the geographical ranges of *Hypoxis* taxa in the East Tropical Africa one can distinguish four groups of species: endemic (*H. gregoriana, H. kilimanjarica* subsp. *prostrata*), sub-endemic (*H. kilimanjarica* subsp. *kilimanjarica, H. urceolata, H. fischerii* var. *zernyi, H. fischerii* var. *hockii*), with northern and eastern range limits (*H. bampsiana* subsp. *tomentosa, H. filiformis, H. galpinii, H. goetzei, H. malaissei, H. nyasica, H. obtusa, H. polystachya, H. rigidula, H. fischerii* var. *katangensis, H. fischerii* var. *colliculata*) and transition species (*H. angustifolia, H. fischerii* var. *fischerii, H. schimperii*).

The East Tropical Africa, and particularly Tanzania, is known for the large number of the endemic species that occur primarily in the mountainous regions belonging to the biodiversity "hot-spots" (Myers *et al.* 2000). Only two endemic taxa have been confirmed for the area analyzed. *H. gregoriana* (Fig. 51A) and *H. kilimanjarica* subsp. *prostrata* (Fig. 54B). In earlier works 17 species were regarded to be endemic (Rendle 1895; Nel 1914b; Schulze 1939). These species names are now considered as synonyms based on the new taxonomic division for the East Tropical Africa (Wiland-Szymańska & Nordal 2006).

The four sub-endemic species: *H. urceolata* (Fig. 74A), *H. kilimanjarica* subsp. *kilimanjarica* (Fig. 54A), *H. fischerii* var. *zernyi* (Fig. 42A) and *H. fischerii* var. *hockii* (Fig. 39A) occur primarily in the East Tropical Africa, while in the bordering regions they are rarely observed. There are only three transition taxa: *H. angustifolia* var. *luzuloides* (Fig. 26A), *H. schimperii* (Fig. 71A) and *H. fischerii* var. *fischerii* (Fig. 35A).

In the analyzed region, predominantly occur taxa (11) that are of southern origin and reach their eastern and northern limits in the East Tropical Africa (Table 8). This observation supports the importance of the East Tropical Africa, and Tanzania in particular, as a region of concentration of range limits of the species from the southern hemisphere (Figs. 29A, 37A, 39A, 40A, 42A, 45A, 48A, 59A, 62A, 65A, 68A).

When comparing the overall ranges of the *Hypoxis* taxa in Africa in a manner similar to that of Meusel (1943) for European plant species, one can distinguish certain common tendencies. It is noticeable that distribution of most of the *Hypoxis* species in the East Tropical Africa is correlated with the White's phytochoria (Table 8).

The four species: *H. filiformis*, *H. galpinii*, *H. rigidula* and *H. obtusa*, that have northern limits of their ranges in Tanzania, are widely distributed in the southern part of the continent and reach South Africa. According to the phytochoria as delimited by White (1983), all of these species occur in Zambesian Region and Kalahari-Highveld Transition zone. *H. rigidula* and *H. obtusa* are also present in the Sudanian and Somalia-Masai Regions. *H. filiformis* and *H. galpinii* are found together in Zanzibar-Inhambane Regional Mosaic and Tongoland-Pondoland Regional Mosaic. A scattered, island-like ranges limited to Afromontane Archipelago-like regional centre of endemism are characteristic for *H. kilimanjarica* and *H. schimperii*. *H. gregoriana* and *H. urceolata* have ranges limited to the northern part of East Africa and are found together within the Somalia-Masai Region and the Lake Victoria Regional Mosaic. *H. urceolata* is also found in the Sudanian Region. *H. fischerii* var. *fischerii* shows an island-like range, and together with *H. angustifolia* represent the only two *Hypoxis* taxa that occur both in eastern and western parts of the continent. The ranges of the remaining nine taxa of the East Tropical Africa *Hypoxis* are linked to the Zambesian Region (Table 8). Some of them, including *Hypoxis bampsiana* subsp. *tomentosa* (Fig. 29A),

Fig. 22. Habit of *Hypoxis hemerocallidea*

H. nyasica (Fig. 59A), *H. polystachya* (Fig. 65A) and *H. malaissei* (Fig. 57A) do not occur outside this area. On the other hand, *H. goetzei* and *H. fischerii* can be found at isolated locations north of the Zambesian Region.

The Zambesian region is particularly important center of distribution of the genus *Hypoxis*. One can find there several South African species. Some of these, e.g. *H. hemerocallidea* F. & Mey. (Fig. 22), reach their northern limit of range while others (e.g. *H. obtusa*) extend farther to the north. In this region one can also find species occurring also in the more northern localities, like *H. schimperii*, *H. fischerii* and *H. goetzei*.

In a checklist of African *Hypoxis* species, Singh (2006) listed 69 valid names. After comparing them with the classifications presented by Wiland-Szymańska (Wiland-Szymańska 2001; Wiland-Szymańska & Nordal 2006) and Demissew (Demissew *et al*. 2003) one can conclude, that there are 55 *Hypoxis* species in Africa (Table 9). South Africa is indicated as a center of

Table 9. List of *Hypoxis* species from Africa and Madagascar

South Africa	Zambesian Region	Other parts of Africa
Endemic species (22)	Endemic species (12)	Endemic species (9)
H. acuminata, *H. argentea*, *H. colchicifolia*, *H. costata*, *H. exaltata*, *H. flanaganii*, *H. floccosa*, *H. gerrardii*, *H. interjecta*, *H. kraussiana*, *H. ludwigii*, *H. membranacea*, *H. multiceps*, *H. neliana*, *H. obliqua*, *H. parvula*, *H. sagittata*, *H. sobolifera*, *H. stellipilis*, *H. tetramera*, *H. uniflorata*, *H. zeyherii*	*H. bampsiana*, *H. canaliculata*, *H. lejolyana*, *H. lusalensis*, *H. malaissei*, *H. monanthos*, *H. muhilensis*, *H. nyasica*, *H. polystachya*, *H. robusta*, *H. symoensiana*, *H. upembensis*	*H. camerooniana* (Cameroon), *H. suffruticosa* (Cameroon), *H. abyssinica* (Ethiopia and Eritrea), *H. boranensis* (Ethiopia), *H. tristycha* (Ethiopia), *H. gregoriana* (East Tropical Africa), *H. kilimanjarica* (East Tropical Africa and E part of the DRC), *H. urceolata* (East Tropical Africa and E part of the DRC), *H. graminea* (Madagascar)
Non-endemic species (9)	Non-endemic species (13)	Non-endemic species (7)
H. angustifolia, *H. filiformis*, *H. galpinii*, *H. hemerocallidea*, *H. longifolia*, *H. obtusa*, *H. parvifolia*, *H. rigidula*, *H. villosa*	common with South Africa – *H. galpinii*, *H. hemerocallidea*, *H. longifolia*, *H. parvifolia*, *H. villosa* common with other parts of Africa – *H. angustifolia*, *H. filiformis*, *H. fischerii*, *H. goetzei*, *H. obtusa*, *H. rigidula*, *H. schimperii*	*H. angustifolia*, *H. filiformis*, *H. fischerii*, *H. goetzei*, *H. obtusa*, *H. rigidula*, *H. schimperii*

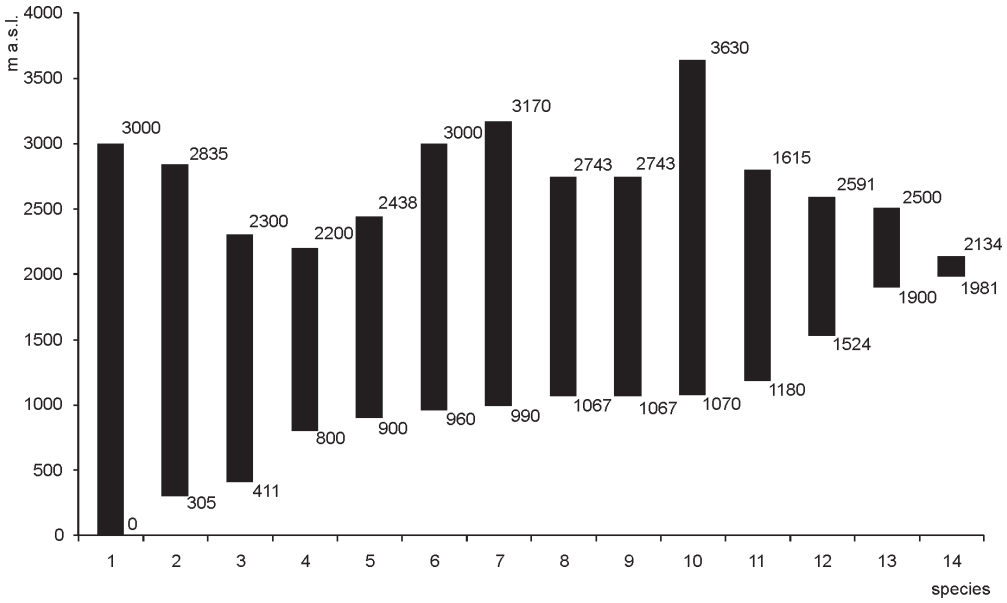


Fig. 23. Ranges of vertical distribution of the *Hypoxis* species in East Africa
Explanations: 1 – *H. angustifolia*, 2 – *H. urceolata*, 3 – *H. nyasica*, 4 – *H. ridigula*, 5 – *H. goetzei*, 6 – *H. filliformis*, 7 – *H. schimperii*, 8 – *H. fischeri i*, 9 – *H. kilimanjarica*, 10 – *H. gregoriana*, 11 – *H. polystachya*, 12 – *H. obtusa*, 13 – *H. galpinii*, 14 – *H. bampsiana*

diversity and endemism for this genus (Nordal 1998). Singh (2006) lists 31 species in South Africa, including 22 endemites. Because no detailed maps of their distribution are available, it is not possible to ascertain in which White's phytochoria (White 1983) they occur. From the Zambesian Region, 24 species have been reported, out of which 12 are endemic (Nordal & Zimudzi 2001, Wiland-Szymańska 2001, this study). Currently, there are only nine African species that have not been reported in the two above-mentioned regions (Table 9). It is evident that the nature protection is crucial for preserving the diversity of the genus *Hypoxis* not only in South Africa, but also in the Zambesian Region. The distribution of particular species in Africa clearly shows that the genus *Hypoxis* is more associated with the southern hemisphere, where the centers of endemism are located, in Africa, South America (Brackett 1923) and Australia (Henderson 1987). The diversity and endemism of the Zambesian Region flora is sometimes explained by a high concentration of heavy metals in the soil (Malaisse 1983). However, there are no results that would justify such a connection in case of *Hypoxis*.

So far, the vertical ranges of *Hypoxis* species were not analyzed. There were available data in the literature and herbarium specimens, concerning the heights at which a given taxon was encountered. The altitudinal limits of range of species from the East Tropical Africa are presented on Fig. 23 and at each taxon (Figs. 26C, 29C, 31C, 33B, 45C, 48C, 51C, 54D, 59C, 62C,65C, 68C, 71C, 74C). From the analysis of the frequencies of occurrence of particular species at different heights it is evident that the minimal and maximal

Table 10. Distribution of *Hypoxis* taxa in altitudinal vegetation zone belts in the mountains of East Africa

Taxon	Submountain level	Mountain level	Afro-subalpine level
H. malaissei	+	.	.
H. polystachya	+	.	.
H. angustifolia var. *luzuloides*	+	+	.
H. fischeri s.l.	+	+	.
H. goetzei	+	+	.
H. nyasica	+	+	.
H. obtusa	+	+	.
H. rigidula var. *rigidula*	+	+	.
H. schimperi	+	+	.
H. urceolata	+	+	.
H. bampsiana subsp. *tomentosa*	.	+	.
H. filiformis	.	+	.
H. gregoriana	.	+	.
H. kilimanjarica subsp. *kilimanjarica*	.	+	+
H. kilimanjarica subsp. *prostrata*	.	.	+
H. galpinii	.	.	+

levels do not reflect the preferred heights (Figs. 26D, 31D, 33C, 45D, 48D, 51D, 59D, 62D, 68D, 71D, 74D). The histograms show that only a small fraction of plants were observed at the range limits. Some species also show preference for a particular altitudinal zone. Similar analyses of the frequency of occurrence of individual plant species in various altitudinal zones were done for the Tatra Mountains in Poland (Piękoś-Mirkowa *et al*. 1996). A differentiaton of altitudinal distribution of one species in various mountain ranges was made for example by Mirek (Mirek & Piękoś-Mirkowa 1984).

Of all taxa analyzed in this work, only one, *H. angustifolia*, occurs in the East Tropical Africa at the sea level (Fig. 23). All other species show clear preference for the mountains, and for most of them the highest number of locations was observed for submountain and mountain levels (Table 10). Two species are linked to the submountain level and two to the afro-subalpine zone. Endemic taxa are limited primarily to the mountain and afro-subalpine levels, what supports the idea of the important role of vertical isolation in the northern part of the East Tropical Africa.

Many of the taxa analysed in this work show a wide distribution in various climatic zones. The geographic range of a taxon is three-dimensional and the geographic localization influences shifting of the boundaries of the vertical range. The phenomenon of the wedge-shaped geographical distribution or shifting of the vertical range depending on the geographical latitude was analyzed earlier for trees and the whole vegetation formations (Szafer 1975). It results from the similarities of climatic conditions at lower heights in higher latitudes and at higher heights in lower latitudes (Szafer 1975). The shifting of the upper limits of the vertical range is also influenced by the continentalization of climate (Szafer 1975) that in Africa is amplified by large mountain ranges (Martyn 2000). The height ranges within the whole geographic ranges of each taxon were compared in a search of a correlation between vertical and horizontal distribution. The plots show the height ranges for each species in particular phytogeographic provinces of the East Tropical Africa as well as other parts of Africa (Figs. 26E, 29D, 31E, 33D, 35C, 37C, 39C, 40B, 45E, 48E, 51E, 54E, 59E, 62E, 65D, 68E, 71E, 74E). The data for these analyses were taken from literature, herbarium specimens and personal observations.

Only *Hypoxis gregoriana*, endemic for the East Tropical Africa, does not show significant differences of vertical ranges in different provinces (Fig. 51E). It is notable that the widest range of this species is observed in K4. This may be due to the fact that it was the most abundant species in herbarium material collected in this province, which is its center of abundance. On the other hand, most of the specimens were collected in the vicinity of Nairobi, an area often visited by botanists coming to Kenya.

The remaining taxa can be grouped together depending on the direction in which the lower limit of their vertical distribution is shifting. The altitudes of the species vertical range grow towards north (2) (Figs. 29D, 65D), west (3) (Figs. 35C, 39C, 54E), north and west (8) (Figs. 26A, 33D, 40B, 48E, 59E, 62E, 68E, 74E), north and east (3) (Figs. 37C, 45E, 62E), north, east and west (1) (Fig. 31E) and south (2) (Figs. 54E, 71E) (Table 11). The vertical ranges of 13 taxa show shift towards higher altitudes towards north. These include both typical southern hemisphere species, as well as the transition species, *H. angustifolia*. In both cases it is most probably due to increase in average annual temperatures, decreased precipitation during rain period and shifting of the vegetation zones towards higher altitudes. Such continentalization of climate sets limits for *Hypoxis* species, which store water in order to survive a dry period and to flower at the onset of the wet period. That is why the regions with higher precipitation in high mountains are preferred locations for these plants. The species that reach their northern range limits in the East Tropical Africa often achieve their upper vertical range limits there. The exceptions in this regard are *H. nyasica* and *H. rigidula*, which are found at higher altitudes in the region of Flora Zambesiaca (Nordal & Zimudzi 2001). Two taxa, *H. kilimanjarica* ssp. *prostrata* and *H. schimperii*, are characterized by a limit of vertical distribution shifting towards South. In the case of the former taxon one could explain this by the fact that its southern range limit is on Kilimanjaro. On this mountains, so close to the equator, the subalpine zone is shifted towards higher altitudes when compared with the mountains of Kenya. On the other hand, in the case of *H. schimperii* it may be due to a well-defined dry

Table 11. Division of *Hypoxis* species according to the direction in which their bottom limit of altitudinal range is shifting towards higher altitudes

Taxon	West	North	East	South
H. fischerii var. *fischerii*	+	.	.	.
H. fischerii var. *hockii*	+	.	.	.
H. kilimanjarica subsp. *kilimanjarica*	+	.	.	.
H. angustifolia var. *luzuloides*	+	+	.	.
H. fischerii var. *katangensis*	+	+	.	.
H. fischerii var. *zernyi*	+	+	.	.
H. goetzei	+	+	.	.
H. nyasica	+	+	.	.
H. rigidula	+	+	.	.
H. urceolata	+	+	.	.
H. fischerii s.l.	+	+	.	.
H. filiformis	+	+	+	.
H. bampsiana subsp. *tomentosa*	.	+	.	.
H. polystachya	.	+	.	.
H. fischerii var. *colliculata*	.	+	+	.
H. galpinii	.	+	+	.
H. obtusa	.	+	+	.
H. kilimanjarica subsp. *prostrata*	.	.	.	+
H. schimperi	.	.	.	+

period in the southern part of its range (Martyn 2000). Wet locations, in which *H. schimperii* occurs, are more often found higher in the mountains.

The distribution of *Hypoxis* taxa in the East Tropical Africa shows less or more recurrent tendencies that manifest themselves in the abundance of given species in some provinces, the horizontal range limits and the variability of vertical ranges. Although, the East Tropical Africa is known as one of the endemism hotspots for flowering plants this is not the case for the genus *Hypoxis*.

4.4. Uses

From the very beginning, the genus *Homo* L. showed interest in *Hypoxis* as a potential source of food (Brain & Shipman 2004). It is believed that its large and juicy tubers were used as food by early hominids in South Africa, although today they attract mainly the uitkomst baboons (Brain & Shipman 2004). Although underground parts of some species have an unpleasant, bitter taste (Singh 1999), in the Democratic Republic of the Congo *Hypoxis goetzei* (De Wildeman 1913b), *H. fischerii* var. *colliculata* and *H. filiformis* (Wiland-Szymańska 2001) were used as a vegetable. Tubers of *H. angustifolia* were an important human food source on Soqotra and its leaves serve there as a forage for livestock till today (Miller & Morris 2004).

In the herbarium notes of the specimens from the East Tropical Africa there is often information concerning culinary applications of the *H. angustifolia* and *H. gregoriana* tubers. They were eaten dried or fresh. Tubers of some other species are eaten by wild animals like baboons and francolins. This may be a source of the indigenous name of *H. angustifolia* – "Dioko di ngumbi" (a partridge tuber) – reported from the Democratic Republic of the Congo (Gillet & Pâque 1910). The leaves of *H. angustifolia* i *H. gregoriana* are eaten by wild and domesticated grasseaters. The same applies to *H. rigidula*, tubers of which are also eaten by monkeys.

Various *Hypoxis* species were used for a long time as medicinal plants, initially in the traditional medicine, and recently also in drugs produced by pharmaceutical industry. The review paper on this subject was published by Nicoletti (Nicoletti *et al.* 1992). Active compounds are primarily the glycosides (Bettolo *et al.* 1982; Drewes *et al.* 1984; Sibanda *et al.* 1990; Nicoletti *et al.* 1992). Other chemical substances isolated from *Hypoxis* were described by Gibbs (1974) and Hegnauer (1963, 1986). Medical applications of *Hypoxis* species are best developed in South Africa, where *Hypoxis hemerocallidea* (old name *H. rooperi* Moore) (Fig. 22) and *H. colchicifolia* (Fig. 24) are collected from natural environment on a mass scale (Singh 1999). *Hypoxis hemerocallidea* commonly known as "the African potato"

Fig. 24. Habit of *Hypoxis colchicifolia*

(Drewes & Horn 1999) is used for the isolation of compounds that show the activity of immunostimulants and inhibit growth of cancer cells especially of tumors of the urinary and reproductive systems (Singh 1999; Drewes & Horn 1999; Van Wyk & Wink 2008). Because of the potential commercial value of *H. hemerocallidea*, attempts have been made at its cultivation (Hawker *et al.* 1999; Gillmer & Symmonds 1999). It is however suspected that certain chemical compounds present in the plant may have adverse effects and lower the efficiency of antiretroviral drugs used in AIDS treatment (Mills *et al.* 2005). Interestingly, the slaves from Africa in the Antiles started to use the local species *Hypoxis decumbens* as a cure for tumors of the testicles (Hartwell 1967).

The species occurring in the East Tropical Africa are used for medical purposes. The most common one, *H. angustifolia*, was used as a treatment for skin ulcers and infected wounds in the Democratic Republic of the Congo (Gillet & Pâque 1910). The extract prepared from boiled tubers of *H. urceolata* was used as a purgative for newborns (Wiland-Szymańska 2001). Watt (Watt & Breyer-Brandwijk 1962) reported that *H. rigidula* was applied as a remedy for a gall sickness in cattle. *Hypoxis nyasica* was administrated to relieve cough by Nyanja tribe (Watt & Breyer-Brandwijk 1962).

In Tanzania a drink from boiled tubers of *H. fischeri* var. *hockii* and *H. fischeri* var. *zernyi* is said to be used to stop swelling of testes. The same application was reported for the tubers of *H. polystachya*. Sap from *H. fischerii* is used as a remedy for various skin diseases. Moreover, fresh ground tubers of *H. polystachya* are used to treat fungal infection of scalp called "kinyuri" (Kingoni dialect). Its sap is a treatment in cases of skin lesions. In Iringa, tubers of *H. rigidula* are given to chickens as a medicine.

Tubers of *H. nyasica* are probably gathered in Tanzania and sold in Zambia as a treatment for AIDS. One has to keep in mind that except for *H. hemerocallidea*, the therapeutic properties of these species have not been confirmed by independent scientific studies.

In South Africa, the leaves of *H. rigidula* are used for tying firewood (Berry 1980) and making ropes (Watt & Breyer-Brandwijk 1962; Singh 1999). They are particularly useful for these purposes because of the presence of numerous long sclerenchymal fibres.

In the East Tropical Africa, roots of *H. urceolata* has been used in Uganda for gum. In Kenya tubers of *H. angustifolia* and *H. gregoriana* were utilized as toys. Children stick sticks into the bulbs to make toy waterlike wheels. They cut out the middle of the bulb to make a miniature gourds which they fill with milk and pretend to drink. Interestingly, both species have not only similar use but also similar names in native languages.

Indigenous tribes also ascribe magical properties to some of the *Hypoxis* species. In the South Africa the Socho use this genus as a charm against thunder, lightning and storms (Watt & Breyer-Brandwijk 1962; Singh 1999). In Iringa, Tanzania, to stop rain, a medicine man cuts a tuber of *H. rigidula* and presents it in a certain direction.

The East Tropical African species of *Hypoxis*, which can be used as a potential source of food and medicinal substances, were not so far gathered on a large scale. The only species that is more intensively collected is *H. nyasica*. In Mbeya, the medicine man has grown several plants of *H. polystachya* in a garden next to his hut.

Some indigenous tribes have the names for the genus *Hypoxis*, but seldom the distinction between species is made. The same name is therefore used for several different species, as for example, in Kenya for *H. angustifolia*, *H. greogriana* and *H. kilimanjarica* in Masai and Kipsigis. In the south of Tanzania, in Wanji, the name "Ngilingisi" is used collectively for all *Hypoxis* species.

4.5. IUCN Categories

The International Union for Conservation of Nature categories (The IUCN Red List Version 3.1, 2001) were never used to estimate a threat of extinction of the East Tropical African species of the genus *Hypoxis*. The sole work containing information on the conservation status of the species of Hypoxidaceae was the Southern African Plant Red Data Lists (Golding 2002), which includes countries in the southern part of the continent. Few species of those occuring in the East Tropical Africa are discussed in this work at a local scale. All *Hypoxis* species from Zambia, Swaziland, Namibia and Lesotho are included there into a Data Deficient group, what shows a lack of knowledge of general distribution of these taxa (Golding 2002).

The human impact on the vegetation of the East Tropical Africa is profound, especially as a process of deforestation and fire dependant grasslands promotion (Maitima 1995; Coe *et al.* 1999). Contemporary climate changes have also an influence on condition of vegetation in this area (Agrawala *et al.* 2003).

The classification according to the IUCN categories is not always very straightforward. This was also the case for the *Hypoxis* species. One has to keep in mind that for particular species, the categories may be different for another region or for lower taxa. The data given in this work concern only the regions within currently recognized limits of geographical range, based on herbarium material and observations in the field, that are limited to only several taxa. The status of the taxa less known should therefore be confirmed in the field.

LC – Least Concern

This category includes seven of the East Tropical African *Hypoxis* species that can be further divided into

three groups. In the first group there are three species: *H. angustifolia* var. *luzuloides*, *H. filiformis* and *H. rigidula* var. *rigidula*, that are widely distributed in the whole Africa. The range of *H. angustifolia*, even goes beyond Africa, as it was also found on the neighboring islands on the Indian Ocean and Arabian Peninsula. In the East Tropical Africa, there are locations, where these three species are very common. *H. angustifolia* and *H. filiformis* show a wide spectrum of tolerated soil conditions. They are also resistant to limited anthropopressure, including burning, grazing and chopping down of grassland. Although useful, they are rarely gathered on a large scale. *H. filiformis* and *H. rigidula* were classified for Zambia in Data Deficient group (Golding 2002). The analysis of herbarium material shows, however, that the former species is quite common both in Tanzania and in the Democratic Republic of the Congo. The same applies to *H. rigidula* that is very often observed in southern Tanzania and the South Tropical Africa.

The two other species belonging to the LC group, *H. nyasica* and *H. goetzei,* have smaller range than the ones mentioned earlier, and in East Africa they reach their range limits, but at some places they are very common. They are not intensively collected by local inhabitants. The greatest threat for *H. nyasica* is a fact that it is considered as a cure for AIDS, which, in the future, may pose a significant threat to this species. However, at present, its populations seem to be quite stable due to vegetative reproduction and resistance towards anthropopressure. On the other hand, *H. goetzei* was classified by Golding (2002) as Extinct & Threatened. However, in the southern part of Tanzania this species is very abundant.

Two species, particularly connected with the area of this research, the endemic *H. gregoriana* and subendemic *H. urceolata*, can also be classified as least concern. There are numerous populations and although these plants are useful, there is very limited gathering. Both species well tolerate limited anthropopressure and a wide spectrum of ecological conditions.

Hypoxis fischerii has a wide geographical range, but it is not continuous. This species is very abundant in certain locations, and as a whole it can be classified as the least concern. However, individual subspecies must be treated separately. The centers of abundance of *H. fischerii* var. *hockii* and *H. fischerii* var. *zernyi* are located in the southern part of Tanzania, and there are several known isolated populations in the East and Central Africa. Golding (2002) classified the whole *H. fischerii* species as Extinct & Threatened which reflects difficulties in recognition of this taxon in the field.

NT – Near Threatened

The near threatened group in the East Tropical Africa includes five taxa of *Hypoxis*. The first, *H. schimperi*, is widely distributed in Africa, but its range is island-like. This species never occurs in large quantities, and the latest herbarium sheet available from the East Tropical Africa was collected in 1986. *H. bampsiana* subsp. *tomentosa* have seven scattered populations in Africa (Wiland-Szymańska 2008). In the East Tropical Africa, its occurrence was recorded only in two close locations in the middle of the 20th century. Although no information concerning medicinal uses of this species was available, it is possible that it might be taken as a subsitute for other more commonly used *Hypoxis* species. An overgrazing of the grassland ecosystems, tree cutting and soil erosion, as well as agriculture are threats for this taxon. *H. obtusa* and *H. galpinii* are species of least concern in their general ranges, however they are near threatened in the East Tropical Africa. In this area, their distribution areas are disjunct and reach northern limits. *H. obtusa* does not occur in large populations, but it is regularly gathered for herbarium collections. *H. galpinii* is found in an abundant and stable population on the Lukwangule Plateau in Uluguru Mountains. Because of the inaccessibility of this area, the population is not threatened, but it is totally isolated.

Hypoxis fischerii var. *fischerii* has a very broad, but scattered, island-like range. Because of possible damage, its habitat is considered as near threatened.

V – Vulnerable

There are two species, which may be recognized as vulnerable. *H. polystachya* is a vulnerable species because of a disjunctive distribution. The East Tropical Africa populations are grouped in a very small area that is under a very strong antropogenic pressure. Moreover, it is a medicinal plant collected from the field, and also grown in the house gardens. *H. kilimanjarica* is subendemic to the East Africa and has a distinctly disjunct distribution. Subspecies *kilimanjarica* is more widely spread, but also more vulnerable to human activities, because it occurs at lower altitudes. It does not survive in cultivated fields or after fires. Subspecies *prostrata* occurs at higher altitudes, where no cultivation is taking place. It has however only four known populations and is not abundant. Both taxa can be also influenced by an increasing tourist activity in the high mountains, especially on Kilimanjaro. They are recognized therefore as vulnerable.

H. fischerii var. *colliculata* is known from only four collections in the East Tropical Africa. That is why this taxon was classified as vulnerable.

CE – Critically Endangered or E – Extinct

H. malaissei is known from one location only, and needs to be confirmed in the field. It was collected in 1971 and was not recollected since. The only one other collection is known from the Democratic Republic of

the Congo, made the very same year. This species must therefore be recognized as critically endangered, unless it is already extinct.

H. fischerii var. *katangensis* is known from only one collection made in 1908. Its occurrence in the East Tropical Africa needs to be confirmed. In Central Africa it was collected three decades ago. There are no data concerning this species from Zambia. This taxon must therefore be recognized as critically endangered, unless it is already extinct.

In summary, out of the 20 East Tropical African taxa two are critically endangered or extinct (*H. fischerii* var. *katangensis, H. malaissei*), four are vulnerable (*H. fischerii* var. *colliculata, H. kilimanjarica* var. *kilimanjarica, H. kilimanjarica* var. *prostrata, H. polystachya*), five are near threatened (*H. bampsiana* subsp. *tomentosa, H. fischerii* var. *fischerii, H. galpinii, H. obtusa, H. schimperii*) and nine are of least concern (*H. angustifolia* var. *luzuloides, H. filiformis, H. fischerii* var. *hockii, H. fischerii* var. *zernyi, H. gregoriana, H. goetzei, H. nyasica, H. rigidula* var. *rigidula, H. urceolata*). These results indicate differences in the resistance to anthropopressure between *Hypoxis* species. Some of them can tolerate its lighter forms including extensive agricultural activity, while others are close to extinction.

The greatest threats for *Hypoxis* in the East Tropical Africa are anthropogenic changes of the environment including overgrazing and farming and particularly large coffee, tee and pyrethrum plantations as well as cultivation of non-native tree species (e.g. pines). Intensive soil exploitation takes over the traditional extensive agriculture (Podedworny 1973; Dobosiewicz 1982; Falkowski & Kostrowicki 2001) that is particularly true for so called "cash crops" plantations. Large monocultures of shrubby and tree plants limit the area of habitats favorable for the development of *Hypoxis*.

Hypoxis does not occur in urbanized areas, except for lawns and road edges, where one can frequently observe *H. angustifolia*. One of the threats for *Hypoxis* is production of the charcoal, which results in soil degradation and landslides.

In South Africa, there are at least two endangered species: *H. hemerocallidea* and *H. colchicifolia*, that are gathered in large amounts in the wild due to their use in traditional medicine. In the East Tropical Africa exploitation on such scale was not observed, but it is not excluded that certain species occurring in Tanzania may become substitutes for these two medicinal plants.

One has to take into account that the anthropogenic forest fires in the mountainous regions contribute to enlarging the area of open vegetation formations (Maitima 1995), preferred by *Hypoxis*. An example of such human influence is the secondary expansion of the subalpine grassland on the Lukwangule Plateau in the Morogoro Mountains (Pócs 1976b). It is, therefore, possible that at least some of the species migrated to the East Tropical Africa only in holocene, when the climatic changes and human activity enabled them to grow in the locations formerly occupied by the forests.

4.6. Key to the East Tropical African taxa of the genus *Hypoxis*

1 Leaves canaliculate, prostrate on the ground, succulent; flowers single, close to the ground, scape never exceeding 4 cm, subterranean; indumentum on scape sparse ..... 8b. *H. kilimanjarica* subsp. *prostrata*

1* Leaves more or less carinate, rigid or recurved, but never prostrate on the ground, nor succulent; flowers single or in inflorescences, scapes aerial, longer then 4 cm; indumentum on scape abundant 2

2. Inflorescence spicato-racemose, flowers solitary at each node, alternating along the rhachis 3

2*. Inflorescence of a different type, if spicato racemose at least two opposite flowers are growing at each node 4

3. Plants growing up to 100 cm, with an aerial pseudosteme from 6 to 15 cm long .... 13. *H. rigidula* var. *rigidula*

3*. Plants growing up to 40 cm, with a subterranean pseudosteme ……..... 5. *H. galpinii*

4. Leaves glabrous except midrib and edges, where ciliate with brownish tufted trichomes; inflorescences spiciforme; flowering senquence from apex to base ..... 6. *H. goetzei*

4*. Leaves more or less covered with trichomes; flowers not spiciforme inflorescences with a flowering senquence from apex to base 5

5. Inflorescence loose, corymbiforme, with distinctive pedicels 6

5*. Flowers single or in compact inflorescences 9

6. Seeds brown, with wrinkled cuticle; tunic membranous ..... 1. *H. angustifolia* var. *luzuloides*

6*. Seeds black with smooth cuticle; tunic fibrous 7

7. Inner leaves at least 10 mm wide, covered with tufted trichomes ..... 7. *H. gregoriana*

7*. Inner leaves up to 4 mm wide, covered with two-branched trichomes 8

8. Seed testa honeycombed, cataphylls covered with tufted trichomes ..... 9. *H. malaissei*

8*. Seed testa colliculate, cataphylls covered with two-branched trichomes ..... 3. *H. filiformis*

9. Flowers single or two 10

9*. Flowers in compact inflorescences of at least three flowers 17

10. Seeds brown, covered with wrinkled cuticle 11

10*. Seeds black, covered with thin, smooth cuticle .. 12

11. Tunic membranous, tepals up to 8 mm long .... 1. *H. angustifolia* var. *luzuloides*

11*. Tunic fibrous, tepals up to 12 mm long .... 14. *H. schimperii*

12. Tunic membranous, scape recurvate after anthesis ..... 8a. *H. kilimanjarica* subsp. *kilimanjarica*
12*. Tunic fibrous, scape erect after anthesis 13
13. All trichomes on inner leaves two-branched 14
13*. At least trichomes on leaf edges and midrib of the inner leaves tufted 16
14. Leaves 3-22 mm wide ..... 10. *H. nyasica*
14*. Leaves up to 4 mm wide 15
15. Seed testa honeycombed, cataphylls covered with tufted trichomes ..... 9. *H. malaissei*
15*. Seed testa colliculate, cataphylls covered with two-branched trichomes ..... 3. *H. filiformis*
16. All trichomes on the inner leaves tufted .... 7. *H. gregoriana*
16*. Trichomes on leaf edges and midrib of the inner leaves tufted, on the lamina surface two-branched ..... 15. *H. urceolata*
17. Inner leaves glabrous except midrib and edges ...18
17*. At least abaxial side of the inner leaf lamina totally covered with trichomes 19
18. Flowering senquence from apex to base; trichomes on the leaves brownish both in the herbarium and in the field, seeds brown, with wrinckled cuticle .... 6. *H. goetzei*
18*. Flowering sequence from base to apex, trichomes on the leaves always white, seeds black with smooth cuticle ..... 11. *H. obtusa*
19. Inner leaves covered with trichomes only on the outer side of the blade; inflorescence sometimes branched ..... 12. *H. polystachya*
19*. Inner leaves covered with trichomes on both sides of the blade; inflorescence never branched 20
20. Seeds brown, covered with wrinckled cuticle .... 2. *H. bampsiana* subsp. *tomentosa*
20*. Seeds black with smooth cuticle 21
21. Indumentum of the leaves very dense, tomentose both on edges and lamina surface 22
21*. Indumentum of the leaves more profound on the edges and midrib, and sparse on the rest of the lamina ... 24
22. Flowers from 12 to 30, seed testa with mammiform papillae ..... 4a. *H. fischerii* var. *fischerii*
22*. Flowers from 6 to 11, testa colliculate 23
23. Leaves erect, totally covered with long tufted tichomes ..... 4c. *H. fischerii* var. *hockii*
23*. Leaves recurved, covered with short tufted trichomes on edges and midrib, and with two branched trichomes on the lamina surface .... 4e. *H. fischerii* var. *zernyi*
24. Seed testa flat, and dull, with micropapillation ..... 4b. *H. fischeri* var. *colliculata*
24*. Seed testa other, glossy 25
25. Flowers from 4 to 7, seed testa colliculate, with more or less convex papillae ..... 15. *H. urceolata*
25*. Flowers from 8-13, seed testa echinate with long pointed papillae ..... 4d. *H. fischerii* var. *katangensis*

4.7. Descriptions of taxa

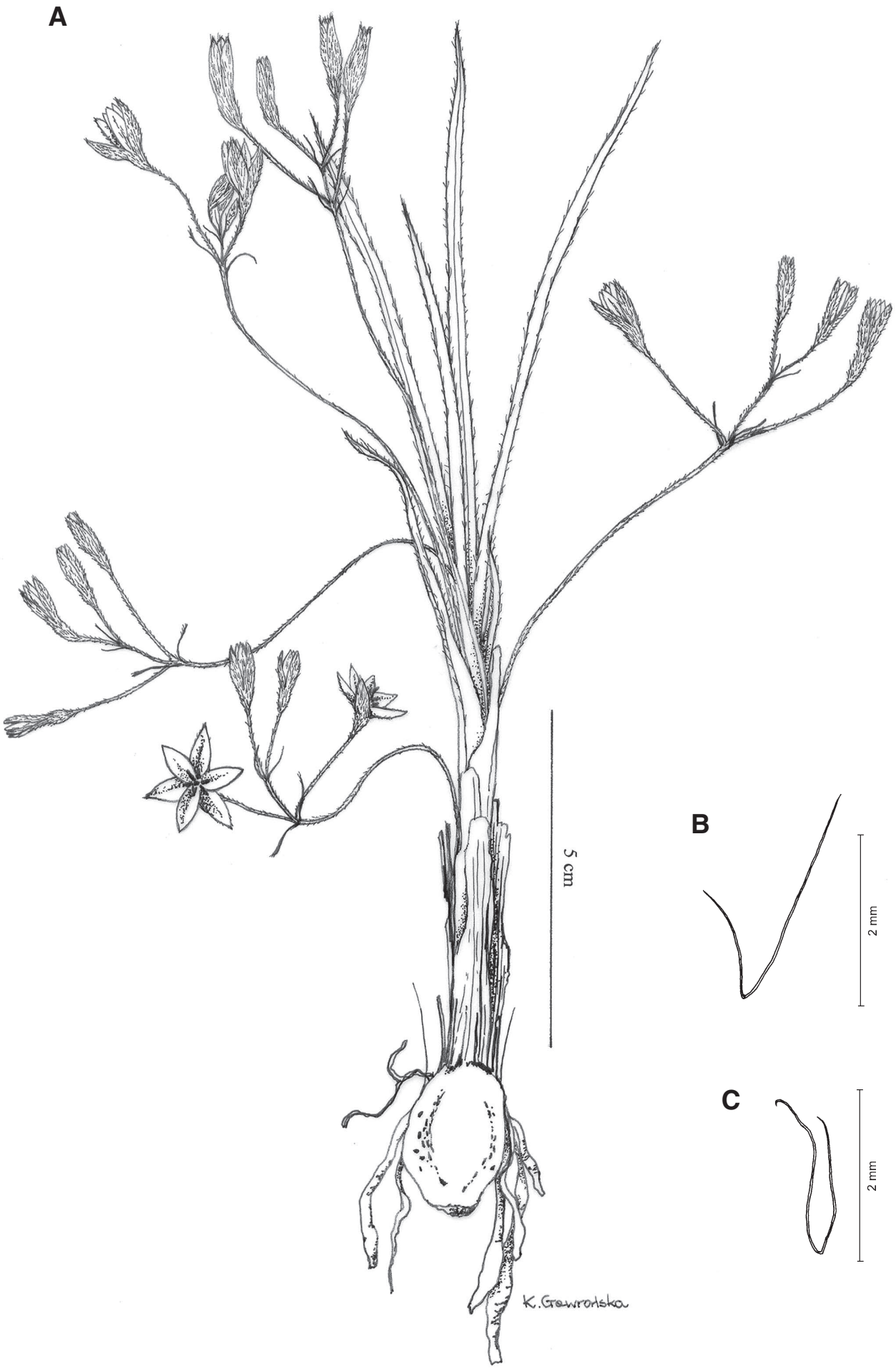
1. *Hypoxis angustifolia* Lam. In Encycl. Méth. Bot. 3: 182 (1789). TYPE: Mauritius, *Commerson* s.n. (P!, holotype)

Baker (1877: 369; 1878a: 111; 1878b: 265; 1898: 378); Engler (1894: 58), De Cordemoy (1895: 158); Durand & Schinz (1895: 231, 1896: 260); Rendle (1895: 407); De Wildeman & Durand (1896: 61); De Wildeman & Durand (1901: 52); Engler (1908: 352); Durand & Durand (1909: 554); De Wildeman (1910: 175); Gillet & Pâque (1910: 16); Nel (1914b: 303); De Wildeman (1921a: 33); Bews (1921: 64); Hutchinson & Dalziel (1936: 394); Cufodontis (1939: 328); Guinea Lopez (1946: 258); Jex-Blake (1948: 130); Williams (1949: 302, Fig.); Perrier de la Bâthie (1950: 10-12, Fig. II, 1-4); Martineau (1953: 16); Robyns & Tournay (1955b: 388); Andrews (1956: 306); Troupin (1956: 207, p.p.); Lind & Tallantire (1962: 212); Hepper (1968: 172); Morton (1968: 31, Pl. IX.34); Cufodontis (1971: 1577); Jackot Guillarmod (1971: 148); Geerinck (1971: 5, Fig.) *pro parte*; Troupin (1971: VI.277); Ross (1972: 132); Cole (1974: 205, Fig. 3L); Jeppe (1975: 22, Pl. 17c); Compton (1976: 129); Tweedie (1976: 255); Wickens (1976: 160, Map 165); Marais (1978: 1, Fig.); Jaeger & Adam (1981: 183, Fig. 71); Cribb & Leedal (1982: 167, Pl. 46B); Nordal *et al.* (1985: 24, Fig. 2a-c, Fig. 3d & 3e-j, Fig. 4b, Fig. 5e, Fig. 12); Champluvier (1987: 84, Fig. 27); Nordal & Iversen (1986: 48, Pl. 10 & Pl. 11A); Nordal & Iversen (1987: 34, Pl. 8, Pl. 12A); Schmitt (1991: 210); Agnew & Agnew (1994: 313, t. 142); Thulin (1995: 31, Fig. 20); Zimudzi (1996: 15); Nordal (1997: 87, Fig. 189.5-7); Wood (1997: 405); Pooley (1998: 232, photo); Vollesen *et al.* (1999: 112); Nordal & Zimudzi (2001: 6); Wiland-Szymańska (2001: 309, Figs. 3, 18H & I, 21); Wiland-Szymańska & Adamski (2002: 142, Fig. 2); Demissew *et al.* (2003: 170, Fig. 143), Da Silva *et al.* (2004: 127); Miller & Morris (2004: 387); Wiland-Szymańska & Nordal (2006: 5).

var. *luzuloides* (Robyns & Tournay) Wiland in Novon 12: 148, Fig.1, Fig. 2A-B (2002). Singh (2006: 14), Wiland-Szymańska & Nordal (2006: 5, Fig. 1.6)

– *Hypoxis luzuloides* Robyns & Tournay in Bull. Jard. Bot. Belg. 25: 254 (1955a); TYPE: Democratic Republic of the Congo, *de Witte* 1130 (BR!, holotype). Robyns & Tournay (1955b: 390, Pl. LIII).
= *Hypoxis angustifolia* var. *angustifolia sensu* Snijman & Singh (2003).
= *Hypoxis argentea* var. *sericea* (Baker) Baker *sensu* Singh (2007) *pro parte*
= *Hypoxis villosa* L. *sensu* Baker (1898) *pro parte*
= *Curculigo baguirmiensis* A. Chev. in Etudes Fl. Afr. Centr. Fr.: 305 (1913). TYPE: Chad, *Chevalier 9485* (K!, holotype; BR!, isotype)

Slender herb, 10-53 cm high (Fig. 25A, 25D). Tuber globose or ovoidal, 1-3.6 cm long, 0.8-2.2 cm wide, white inside; sap not abundant; roots white or light brown-yellowish in a bottom part; tunic membranous, sometimes with some thin fibers black or dark reddish brown. Leaves pale green, yellow green or grass green, grouped in a whitish pseudostem; outer leaves rarely present, if present not numerous, ovoid and spathe-like in basal part, linear in upper part, acute, to 10 cm long, ca. 7 mm wide, pilose along midrib and margins beneath with 2-branched white trichomes; nervation composed of 5 to 13 veins of unequal size; inner leaves 3 to 12, grass-like, linear, tapering towards apex, keeled, often recurved along two prominent lateral veins, acute at


A
5 cm
B
2 mm
C
2 mm
K. Gawrońska

apex, 10-50 cm long, 0.3-0.8 cm wide, ciliate on margins and midrib beneath or very sparsely pilose on entire surface; trichomes 2- (3-) branched, 1.3-2.5 mm long, golden or white, soft (Fig. 25B, 25E); nervation composed of 5 to 13 (23) veins of unequal size with two lateral veins prominently larger than other. Scapes 1 to 6, 5-20 cm high, ca. 1 mm wide, white below, pale green above, compressed, winged and glabrous in lower half, ciliate in upper half and pilose only beneath inflorescence; trichomes 2- or 3-branched (Fig. 25C); flowers single or in a lax 2- to 6-flowered corymb; bracts green, subulate or sword-shaped, acute, often two subtending a solitary flower, sometimes those subtending first two flowers much larger than upper ones, 12-17 mm long, (0.5) 1.0-1.7 mm wide, keeled, 1- or 3-veined, midrib sometimes red, always villous abaxially, sometimes ciliate on margins; pedicels 12-25 mm long, pubescent. Tepals 6 (exceptionally 4), outer tepals inside deep yellow, light green outside with cream edges, sometimes with a red or brownish stripe along midrib, ovate, acute at apex, 5-8 mm long, 2-3 mm wide, adaxially with a clavate appendage below apex, 5- to 7-veined with irregular veins, villous abaxially; inner tepals yellow inside, light yellow-green outside, ovate, obtuse, 4-7 mm long, 3-4 mm wide, 5- to 7-veined with irregular veins, pilose along midrib abaxially to ľ of its length; stamens usually unequal, outer longer than inner; filaments subulate, greenish yellow; outer stamens 3-4 mm long with filaments 2.5-3.0 mm long; inner stamens 2-3 mm long with filaments 1.5-2.0 mm long; anthers linear, deeply sagittate at base, retuse at apex, 1.5-3.0 mm long, bright yellow or orange; ovary obconical, 2-5 mm long, 1-3 mm wide, green, villous; style green, 1-3 mm long; stigma yellow, 0.7-2.5 mm long, both variable in shape. Capsule turbinate, 7-14 mm long, ca. 3 mm in diameter, green, pubescent, surmounted by persistent perigon, often splitting in three lobes; *seeds* numerous, ovoid, ca. 2.0 mm long, 0.65-0.80 mm wide, with short papillose appendage at apex, brown; papillae pyramidal, testa covered with wrinkled cuticle (Fig. 25F).

Distribution. A sub-Saharan part of the African continent: Guinea, Sierra Leone, Liberia, Nigeria, Cameroon, Chad, Central African Republic, Sudan, Ethiopia, Somalia, Equatorial Guinea, Gabon, Congo, Democratic Republic of the Congo, Ruanda, Burundi, Uganda, Kenya, Tanzania, Angola, Zambia, Zimbabwe, Malawi, Mozambique, Republic of South Africa, Yemen and Soqotra, Madagascar, Mauritius and Reunion

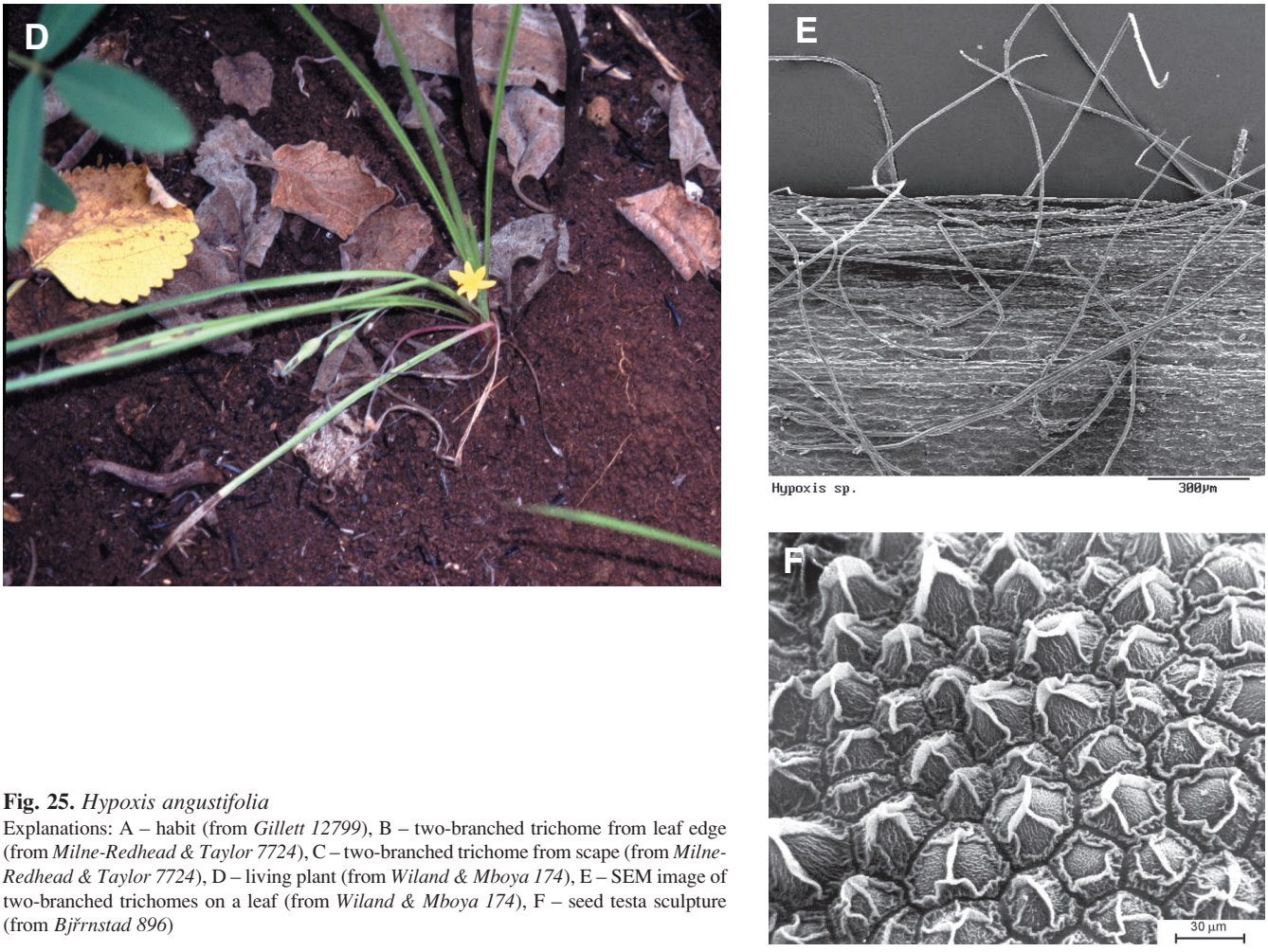


Fig. 25. *Hypoxis angustifolia*
Explanations: A – habit (from *Gillett 12799*), B – two-branched trichome from leaf edge (from *Milne-Redhead & Taylor 7724*), C – two-branched trichome from scape (from *Milne-Redhead & Taylor 7724*), D – living plant (from *Wiland & Mboya 174*), E – SEM image of two-branched trichomes on a leaf (from *Wiland & Mboya 174*), F – seed testa sculpture (from *Bjřrnstad 896*)

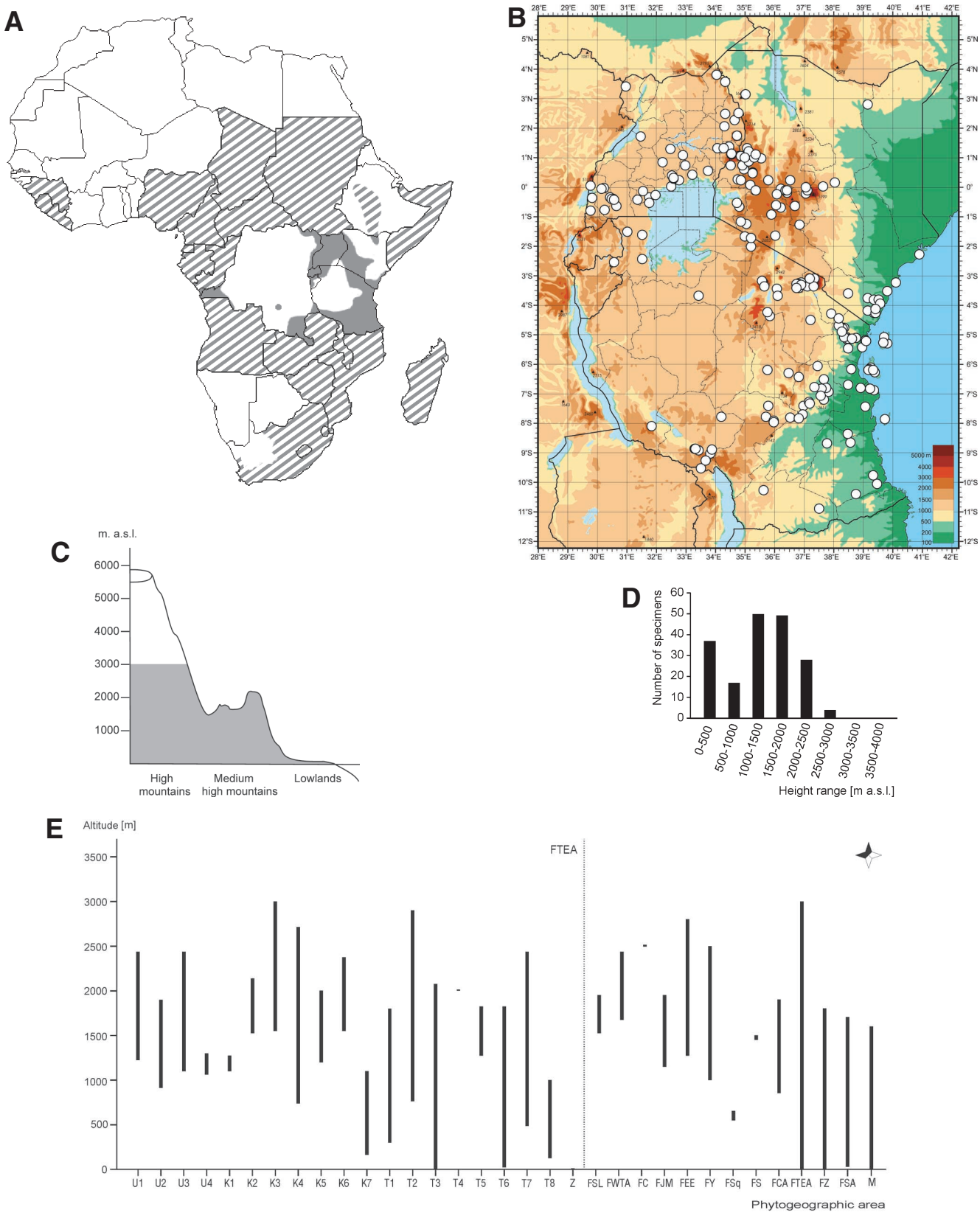


Fig. 26. *Hypoxis angustifolia* var. *luzuloides*

Explanations: A – distribution range in Africa, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions: black arrows show the corner of the world in which direction the bottom limit of a vertical range of the taxon is elevating; FCA – Flora of Central Africa (Democratic Republic of Congo, Rwanda, Burundi) (Wiland-Szymańska 2001, and this study), FC – Flora of Cameroon (Nordal *et al*. 1987), FEE – Flora of Ethiopia and Eritrea (Demissew *et al*. 2003), FJM – Flora of Jebel Mara (Sudan) (Wickens 1976), FS – Flora of Somalia (Thulin 1995), FSA – Flora of Southern Africa (Namibia, Botswana, Republic of South Africa, Lesotho, Swaziland) (Snijman *et al*. 2003), FSL – Flora of Sierra Leone (Jaeger *et al*. 1981), FSq – Flora of Soqotra (Miller et al. 2004), FTEA – Flora of Tropical East Africa (Uganda, Kenya, Tanzania) (this study), FWTA – Flora of the West Tropical Africa (all territories in West Africa South of latitude 18° N and to the West of Lake Chad, and Fernando Po) (Hepper 1968), FY – Flora of Yemen (Wood 1997), FZ – Flora Zambesiaca (Caprivi Strip, Botswana, Zambia, Zimbabwe, Malawi, Mozambique) (Nordal *et al*. 2001), M – Flora of Madagascar and Mascareignes (Humbert 1950)

(Fig. 26A). It occurs in most of White's phytogeographical regions: Guineo-Congolian Region, Zambezian Region, Sudanian Region, Somalia-Masai Region, Cape Region, Afromontane Region, Guinea-Congolia / Zambezia Transition Zone, Guinea-Congolia / Sudania Transition Zone, Lake Victoria Regional Mosaic, Zanzibar-Inhambane Regional Mosaic, Kalahari-Highvel Transition Zone – Eastern part, Tongoland-Pondoland Regional Mosaic, East Malagasy, West Malagasy.

Although it is a taxon with a widest horizontal and vertical range of all African species of *Hypoxis*, it reaches partial limits of its range in Tanzania (Fig. 26B) and a Northern limit of its total range in Kenya.

H. angustifolia var. *luzuloides* occurs in the East Tropical Africa between 0-3000 m a.s.l. (Fig. 26C). A majority of collections was made between 1000-2000 m (Fig. 26D), in a submountain and mountain levels, but numerous specimens were gathered also at lower altitudes. An analysis of the vertical range of this taxon in different phytogeographical provinces of the East Tropical Africa shows visible differences in altitudinal distribution (Fig. 26E). In this area, the lowest limit of the taxon vertical range is getting lower towards East. A comparison of vertical ranges from other areas of distribution of *H. angustifolia* (Humbert 1950; Hepper 1968; Wickens 1976; Jaeger & Adam1981; Nordal & Iversen 1987; Thulin 1995; Wood 1997; Nordal & Zimudzi 2001; Wiland-Szymańska 2001; Demissew *et al*. 2003; Snijman & Singh 2003; Miller & Morris 2004) allow to observe a lowering of a lowest limit of the total vertical range towards South-East (Fig. 26E). In Western and Central Africa this species is not found below 1000 m a.s.l., while in the East and South Africa it was collected almost on the see shore.

Habitat. Grassland, primary and secondary, often seasonally wet, swampy in flood plains, glades, scattered tree grassland, miombo forest, forest margins, rocky outcrops, pastures, road sides, mountain trails; on shallow, mineral soils on rocky granitic, lava, coral or calcareous outcrops; on sandy, white, yellow, reddish, dark soils; on gray, rich light brown humic loam; red ferralitic soil; heavy clay; volcanic soil; black cotton soil and on termitaria.

Phenology. Inflorescences develop together with inner leaves, short after the beginning of the rainy season, often after fire. Flowers open succesively, one after another, only in the full sun, especially at noon. Scape after anthesis tends to recurve towards ground. Plants with flowers were collected throughout the whole year, but especially often from December to June (Fig. 27).

Uses. Food: Edible (*Graham 1928*, EA, G, K, PRE); tubers eaten dried, taste of roast cheastnuts (*Newbould 7175*, EA); children of Masai and Kipsigis eat white inside of tubers (*Glover, Gwynner & Samuel 1225*, EA, K, PRE). Toy: Children play with tubers, making toy

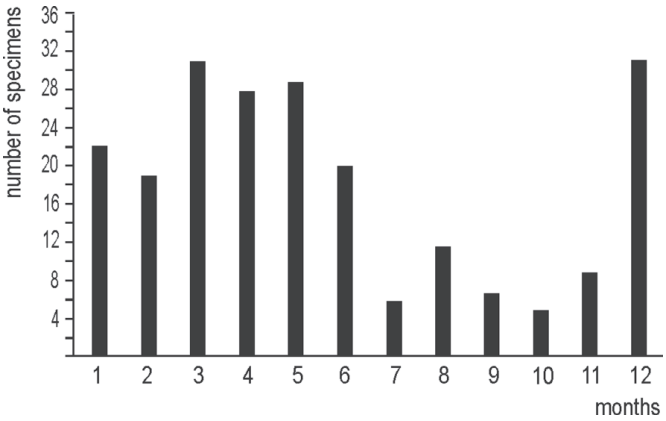


Fig. 27. Flowering periods of *Hypoxis angustifolia*

water wheels or miniature gourds (*Glover, Gwynne & Samuel 617*, EA, K). Forage: Grazed by all domestic stock (*Glover, Gwynne, Samuel & Tucker 1846*, EA, K). The tubers are eaten by francolins (*Magogo & Glover 498*, BR, EA, K, PRE) and baboons (*de Sayalel 1150*, DSM).

Vernacular names. Akanyasiswa (Ankole; *Jarrett 55*, EA, K); Ndogo (Digo; *Magogo & Glover 211*, EA & *Magogo & Glover 311*, EA, K, MO, PRE); Ndiko (Digo; *Magogo & Glover 498*, BR, EA, K, PRE); Obulolo (Kakamega; *Carroll 29*, EA, K); Chepkimiet (Kipsigis; *Glover, Gwynne, Samuel & Tucker 1846*, EA, K), Chepkimniet (Kipsigis; *Glover, Gwynner & Samuel 617*, EA, K & *1225* EA, K, PRE & *Glover, Gwynne, Samuel & Tucker 1846*, EA, K); Engaimalasiyai (Masai; *Glover, Gwynner & Samuel 1225*, EA, K, PRE), Engaimalasiyagete (Masai; *Glover, Gwynne, Samuel & Tucker 1846*, EA, K); Fireambuzi (Swahili; *Frontier Tazania Coastal Forest Research Programme 1951*, MO); Kikoninga (Swahili; *Graham 1928*, EA, G, K, PRE); Esoteh (Turkana; *Newbould J.B. 7175*, EA); Kivulenze (dialect not stated; *Bruce 419*, K); Mdago (dialect not stated; *Williams 18*, K, *Wallace 811*, K).
IUCN conservation status. Least Concern.

Observations. An abundand and common species with quite a large ecological scale in terms of edaphic conditions. It occurs both on acidic and alcaline soils. It prefers sunny but not too dry places, with possible inundation. It grows also at the bottom of sunny, deciduous forests. It does not occur in a very dry, continental climate or at the bottom of shady forests. In the latter case it can be found only on the road edges or places of clearing.

The redescription presented here includes all available measurments of this taxon.

Specimens studied. **UGANDA. Northern (U1).** Duleka hill, Ulongo, 08.1914, *Maitland 15* (K) & *Maitland 15 AB* (K). **West Nile**. Koboko, 06.1938, *Hazel 544* (K). **Karamoja**. Timu forest, 5500 ft (= 1676 m), 06.1946, *Eggeling 5668* (EA); Napak, 7300 ft (= 2225 m)-8000 ft (= 2438 m), 06.1950, *Eggeling 5967* (EA); Lodoketeminit [Lodoketemit], 4000 ft (= 1219 m), 27.04.1959,

Kerfoot 994 (EA); Lodoketemit, 4500 ft (= 1372 m), 20.05.1963, *Kerfoot 4958* (EA); ibid., 4400 ft (= 1341 m), 20.05.1963, *Kerfoot 4960* (EA); Morongole Mt., 7000 ft (= 2134 m), 04.1960, *Wilson 902* (EA, K); Kasuneri Ridge, Moroto, 5000 ft (= 1524 m), 05.1971, *Wilson 2071* (EA); base of Mt. Debasien [Kadam], near Mornita, 05.1948, *Eggeling 5798* (K); Kukumongole, 4000 ft (= 1219 m), 27.05.1939, *Thomas 2852* (K).**Western (U2). Bunyoro**. Busingiro Forest Station, 05.1941, *Eggeling 4377* (K). **Toro**. 3 m W of Kasenyi, Lake George, 3100 ft (= 945 m), 09.03.1968, *Lock 68/33* (EA); E shore of Lake Ruisamba, 3000 ft (= 914 m), 26.08.1906, *Bagshawe & Camb 1189* (BM); Ruwenzori, 6000 ft (= 1829 m), 1893-1894, *Scott Elliot 7799* (BM, K). **Toro/Ankole/Kigezi**. E side, Albert, Edward Lake, 1893-1894, *Scott Elliot 8074* (K, BM). **Ankole**. Kashari County, Kilaro, 1550 m, 29.01.1995, *Rwaburindore 2064* (MO); Mbarara, 4500 ft (= 1372 m), 31.08.1956, *Harker 440* (EA); ibid., 4800 ft (= 1463 m), 03.1939, *Purseglove 602* (K); Bwizibwera, 1400 m, 14.02.1995, *Rwaburindore 3851* (MO); Buhweju, Kasharara, 1900 m, 06.09.1984, *Rwaburindore 1872* (MO); Nyagoma-Rugongo, 1550 m, 27.03.1994, *Rwaburindore 3674* (MO); Ruizi River, 4300 ft (= 1311 m), 15.05.1950, *Jarrett 55* (EA, K); Queen Elizabeth National Park, 2-3 km NE of Kateta on Congo road to Kinshasa, ca. 1000 m, 25.09.1970, *Bjørnstad A. AB 560* (K). **Eastern (U3). Teso**. Bukedea, 1100 m, 09.05.1970, *Katende K226* (K). **Busoga**. Butembe Bunya, on S slopes of Wanyange Hill, 5 miles E of Jinja, 4200 ft (= 1280 m), 22.08.1952, *Wood 354* (EA, K); on lower NW slopes of Bugiri Hill, 0,5 miles from Saza Headquarters, NE of the road to Jinja, 3850 ft (= 1173 m), 19.04.1953, *Wood 702* (K). **Mbale**. Kapchorwa, Mount Elgon, 7000 ft (= 2134 m), 07.09.1954, *Lind 244* (K); NE Elgon, Makerere, 7500 ft (= 2286 m)-8000 ft (= 2438 m), 05.06.1957, *Lind 2150* (EA); NE Elgon, 7600 ft (= 2316 m), 03.1953, *Tweedie 1110* (K); N Bugisu, Muyembe escarpment, 4000 ft (= 1219 m), 24.04.1955, *Norman 256* (K). **Buganda (U4). Masaka**. Masaka, 08.1943, *Bush 212* (EA); Mawogola County, 1-2 km E of Kikoma, 1200 m, 19.10.1969, *Lye 4440* (EA, K, UPS); Bukoloto County, swamp near Kirumba, 1300 m, 26. 10.1969, *Lye & Rwaburindore 4591* (K); Buddu, 4100 ft (= 1250 m), 12.1904, *Brown 135* (K); ibid., 4000 ft (= 1219 m), 1905, *Brown 315* (K); ibid., 4000 ft (= 1219 m), 1905, *Dawe 315* (K); Buddu, near Buwangire in Jubiya Forest, 1140 m, 19.05.1969, *Lye & Morrison 2953* (K). **Mengo**. 2,5 miles E of Nakasongola, 3500 ft (= 1067 m), *Langadale-Brown 1938* (EA); Wakyato-Luwero, 3530 ft (= 1076 m), 21.04.1956, *Langadale-Brown 2067* (EA, K); 6,1 miles N of Bale, 3425 ft (= 1044 m), 02.07.1956, *Langadale-Brown 2142* (K); Kipayo, 4000 ft (= 1219 m), 03.1915, *Dümmer 2437* (BM, K) & *2437a* (BM); Busana, Bugerere, 3900 ft (= 1189 m), 03.1932, *Eggeling 527* (K); Entebbe District, 3900 ft (= 1189 m), 08.1905, *Brown 293* (K); Kawanda near Kampala, 3900 ft (= 1189 m), 12.1935, *Chandler 1514* (K); Kampala, 4000 ft (= 1219 m), 05.1933, *Fishlock 1217* (K). **KENYA. Northern Frontier (K1). Northern Frontier**. Moyale, 4200 ft (= 1280 m), 24.06.1951, *Kirrika 89* (EA, K); ibid., Kunturi (Boran), 3600 ft (= 1097 m), 16.04.1952, *Gillet 12799* (B, BM, BR, EA, K, P, PRE, S, W). **Turkana (K2). Turkana.** Moruassigar (Murua Nyssigar), 7000 ft (= 2134 m), 16.02.1965, *Newbould 7175* (EA). **West Suk.** Kapenguria, 7000 ft (= 2134 m), 13.05.1932, *Napier 1907* (EA); Suk escarpment, 5000 ft (= 1524 m), 07.05.1934, *Mortimer 278* (K). **Rift Valley (K3). Trans-Nzoia**. Cherangani, *Symes 44* (EA); ibid., 2000 m, 23.05.1949, *Maas Geesteranus 4789* (K); Kitale, 02.1935, *Thorold 2751b* (EA); ibid., 6200 ft (= 1890 m), 18.04.1953, *Bogdan 3720* (K); ibid., near houses on Pasture Research Station, 6200 ft (= 1890 m), 06.05.1954, *Rayner 550* (K); near Kapenguria road ca. 8 miles from Kitale, 6300 ft (= 1920 m), 05.1954, *Rayner 543* (K); Mt. Elgon, Endebess Bluff, 2500 m, 04.07.1997, *Wesche 1506* (K); Endebess, Suam, Kaboyoyan Farm, 09.1961, *Brown 12487* (EA); E slope of Mt. Elgon close to Swam River [Suam], 2100 m, 01.05.1948, *Hedberg 815* (K); Hoey's Bridge [Moi's Bridge], 6000 ft (= 1829 m), 15.08.1963, *Heinz-Smith & Paulo 896* (EA). **Uasin Gishu**. Uasin Gishu, 7200 ft (= 2195 m), 04.1932, *Harvey 141* (EA, K); Eldoret District, 6900 ft (= 2103 m), 10.04.1951, *Wiliams 98* (EA,K, PRE); near Eldoret, 7000 ft (= 2134 m), 24.04.1952, *Cooke 25* (K); Eldoret, 7000 ft (= 2134 m), 22.04.1952, *Cooke 29* (K); Kipkarren, 1931, *Brodhurst-Hill 173* (K); near Kipkarren, 6000 ft (= 1829 m), 28.03.1952, *Cooke 19* (K). **Nandi.** 8 km S of Nandi Hills, 1730 m, 8.03.1974, *Davidse 7121* (EA, MO). **Elgeyo.** Cherangani Hills, 10 km SW of Kapsowar on road to Kitale, 2300 m, 17.04.1975, *Hepper & Field 5049* (K); ibid., Kipsait, 3000 m, 08.02.1985, *Townsend 2368A* (K). **Baringo**. Tugen [Kamasia] Hills, Kibimjor Range, 2100-1150 m, 21.06.1986, *Beentje 2866* (K). **Laikipia**. Rumuruti, 8200 ft (= 2499 m), 21.04.1946, *Starzeński s.n.* (BR, KRA). **Nakuru**. Ol Bolossat, 7000 ft (= 2134 m), 22.05.1938, *Leakey 7* (EA, K); Subukia, 23.06.1949, *Bally 7369* (K); Menengai, 1940 m, 09.05.1949, *Maas Geastranus 4573* (BR, K, L, PRE); SW Mau Forest Farm 1645, 8200 ft (= 2499 m), 09-11.1956, *Whittal 188* (K). **Nakuru/Naivasha.** Eburu Mountains, 9000 ft (= 2743 m), 04.1963, *Heinz Smith 12866* (EA). **Naivasha**. Ol Bollosat Lake, 1800 m, 03.07.1972, *Bally 15190* (EA). **Rift Valley/ Central (K3/K4).** NW Aberdares, 7000 ft (= 2134 m), 09.1916, *Dowson 607* (EA, K); Mount Aberdare, 2000 m, 18.01.1922, *Fries R.E. & Th.C.E. s.n.* (EA); ibid., W part, Forest Station, 03.04.1922, *Fries R.E. & Th.C.E. 2769* (UPS). **Naivasha/Fort Hall/South Nyeri.** Kinangop, 8800-8900 ft (= 2682-2713 m), 04.1938, *Chandler 2329* (K); ibid., 8000 ft (= 2438 m), 02.1933, *Ward 3315* (EA). **Rift Valley/ Nyanza (K3/K5). Trans-Nzoia/North Kavirondo,** Mount Elgon, 7600-7800 ft (= 2316-2377 m), 06.1942, *Webster 9021* (EA); SE slopes of Mount Elgon, 5000 ft (= 1524 m), 03.05.1953, *Padwa 18* (EA, K). **Central (K4). North Nyeri**. 3 miles SE of Nanyuki, 19.06.1943, *Moreau Mr.& Mrs. 31* (EA); W Mount Kenya, Forest Station, 2300 m, 26.12.1921, *Fries R.E. & Th.C.E. 365* (UPS); ibid., ca. 2300 m, 12.01.1922, *Fries R.E. & Th.C.E. 365 a* (UPS, WAG); Cole's Mill, ca. 2000 m, 23.12.1921, *Fries R.E. & Th.C.E. 290* (EA, UPS); ibid., 18.01.1922, *Fries R.E. & Th.C.E. 1070* (EA, UPS, WAG). **Kiambu/Machakos**. Vlei near 14 Falls, Thika-Donyo Sabuk Road, 01.12.1957, *Verdcourt 1965* (EA, K). **Meru**. Mbeyu Meru, 3000 ft (= 914 m), 11.1955, *Adamson 529* (EA, K); Meru National Park, S of point 40, on N bank of Kiolu river, 2400 ft (= 731 m), 16.05.1972, *Ament & Magogo 248* (EA, K). **Nyanza (K5). North Kavirondo.** Elgon District, 1905, *James s.n.* (K); SW slopes of Mount Elgon, 1934, *Tweedie 151* (K); Kakamega, 5100 ft (= 1554 m), 03.1944, *Carroll 29* (EA, K); Kakamega Forest, near Forest Station, 1600 m, 10-13.10.1981, *Gilbert & Mesfin 6647* (K). **South Kavirondo**. 2 miles Oyugis-Kendu Road, 28.05.1967, *Hanid & Kiniaruh 651* (MO); Manga Berge, 1200 m, 23.03.1912, *Grote 3563* (EA, K). **Kisumu-Londiani**. Tinderet Forest Reserve, Camp 4, 2000 m, 29.06.1949, *Maas Geesteranus 5220* (BR, G, L, K, MO, PRE, S). **Masai (K6). Masai.** Nguruman Range, 01.1961, *van Someren 12225* (EA); Olosendo Area, Trans-Mara Mountain Range, 5118 ft (= 1560 m), 19.06.1961, *Glover, Gwynne, Samuel & Tucker 1846* (EA, K); Orengitok about 12 miles from Narok on the road to Olokurto, 7600 ft (= 2316 m), 17.05.1961, *Glover, Gwynner & Samuel 1225* (EA, K, PRE); Ol'legesegonyek on Narok Kilgoris road near Mara Bridge, on Cis-Mara side, 5600

ft (= 1707 m), 15.04.1961, *Glover, Gwynne & Samuel 617* (EA, K). **Coast (K7). Teita.** Mount Barra, 1100 m, 08.1897, *Sacleux 2291* (P). **Kwale**. Kwale, *Graham 1928* (EA, G, K, PRE); Shimba Hills, 01.1964, *Verdcourt 3911 A* (K); ibid., Longo ya Mwagandi, 442 m, 06.03.1968, *Magogo & Glover 211* (EA); ibid., 1250 ft (= 381 m), 16.03.1968, *Magogo & Glover 311* (EA, K, MO, PRE); ibid., Pengo Hill, 445 m, 25.01.1979, *Bamps 6331* (BR); Pengo Hill area, 1500 ft (= 457 m), 27.03.1968, *Magogo & Glover 498* (BR, EA, K, PRE). **Kwale**. Near Kaya Fungo, 200 m, 16.06.1994, *Luke 4006* (K); Near Taru, between Samburu and Mackinnon Road, 350 m, 03.09.1953, *Drummond & Hemsley 4152* (K). **Kwale/Kilifi.** Maji ya Chumvi, 520 ft (= 158 m), 26.03.1902, *Kässner 453* (BM, K). **Kilifi**. Malindi district, 1959, *Rawlins 665* (EA); Sokoke west Coast, 05.05.1948, *Jeffrey K592* (EA); Rabai hills, 07-09.1885, *Taylor s.n.* (BM); ibid., 1886, *Taylor s.n.* (BM). **Lamu**. North of Mombassa to Lamu and Witu, 1902, *Whyte s.n.* (BM, K, P). **TANZANIA.** Visadal (?), *de Sayalel 1150* (DSM); Coast, *Sacleux s.n.* (BR). **Lake (T1). Bukoba.** Kiaka to Kikagati Road, 3900 ft (= 1189 m), 02.04.1957, *Gane 108* (EA); Magemga Estate, 1000 ft (= 305 m), 10.05.1953, *Faulkner 1206* (B, BR, K, S). **Biharamulo/ Bukoba**. Ruiga River Forest Reserve, 4200 ft (= 1280 m), 05.12.1956, *Gane 92* (EA, K). **Ngara**. Kabogo, near Shanga, 5900 ft (= 1798 m), 06.03.1961, *Tanner 5857* (K). **Shinyanga**. Shinyanga, 01. 1932-3, *Bax s.n.* (K); near Shinyanga, 01.1933, *Romola & Bax s.n.* (K). **Musoma**. Serengeti National Park, near Lobo, 1800 m, 06.01.1974, *Bjørnstad I. 896* (O); ibid., Tabora-Kluris Camp Water shed, 22.12.1963, *Turner 12915* (EA); Wogakuria Hill, 5600 ft (= 1707 m), 30.12.1964, *Greenway & Turner 12007* (EA, K, PRE). **Northern (T2). Masai.** Ngorongoro Carter, 2500 ft (= 762 m), 21.01.1950, *Kruppier T2* (BM); ibid., 5900 ft (= 1798 m), 15.02.1959, *Heady 1553* (EA, MO); Ngasumet, 4800 ft (= 1463 m), 10.01.1965, *Leippert 5404* (EA); Monduli, Essimingori Forest Reserve, 1380 m, 18.03.2001, *Wiland & Mboya 174* (NHT, POZG). **Mbulu**. Great North Road, between Magugu and Babati, 95 miles S from Arusha, 3550 ft (= 1082 m), 07.05.1962, *Polhill & Paulo 2373* (B, BR, EA, K, LISC, PRE); Tarangire National Park, boundary road, 1066 m, 24.11.1969, *Richards 24763* (K); Humpay, NE of Karatu (NHFR), 1660 m, 20.01.1989, *Pócs & Chuwa 89032/S* (K). **Arusha**. Arusha National Park, 4900 ft (= 1494 m), 30.03.1971, *Richards 26880* (M); ibid., Reydon's farm, 1400 m, 17.11.1972, *Richards 28132* (DSM); ibid., Losokonoi, 5100 ft (= 1554 m), 29.03.1969, *Vesey-FitzGerald 6152* (EA); Mount Meru, E slope, N of Tululusie Hill [Tulusia], 5800 ft (= 1768 m), 12.03.1968, *Greenway & Kanuri 13377* (EA, K, M, PRE); ibid., Tulusia Hill, 1800 m, 21.02.1968, *Richards 23091* (K); ibid., E side, Momela, 5200 ft (= 1585 m), 09.1966, *Beesley 208* (K); ibid., E slope, road to crater, 1900 m, 16.01.1970, *Bjørnstad I. 233* (DSM, EA, K, O); Ngongongare, 5000 ft (= 1524 m), 02.1926, *Haarer B158* (K); Nduruma, 2800 ft (= 853 m), 12.1927, *Haarer 970* (EA, K); Engongo Engare, Njoro Lkatende, 1700 m, 12.11.1901, *Uhlig 447* (EA); Tengeru, 4500 ft (= 1372 m), *P. J. G. 584* (NHT). **Moshi**. Kilimanjaro, 2900 m, 07.12.1932, *Geilinger 4364* (K); ibid., Kibohoehe, 1050 m, 03.1909, *Endlich 304a* (M); ibid., near Kwa-Sadala, 1020 m, 07.04.1994, *Grimshaw 94320* (K); Sanya River Moshi, 4000 ft (= 1219 m), 03.1928, *Haarer 1213* (EA, K); Sanya Inn, 1959, *Date 1362* (NHT); 10 miles on the Moshi to Arusha road, 3250 ft (= 991 m), 15.12.1961, *Polhill & Paulo 987* (B, BR, EA, K, P, PRE, S). **Tanga (T3). Pare**. South Pare Mountains, Chome Forest Reserve boundary, Shengena Forest, 2070 m, 23.01.1999, *Mlangwa 73* (MO, POZG). **Lushoto**. Lushoto, 01.11.1927, *Peter s.n.* (B); Korogwe, 296 m, 13.02.1963, *Archbold 135* (DSM, K); ibid., 1000 ft (= 305 m), 20.05.1969, *Archbold 1007* (DSM, K); 12 km E of Old Korogwe, before Kerenga, 350 m, 19.06.1990, *Eriksson, Kalema & Leliyo 572* (NHT); flats by Lwengera River, 2.5 miles E of Korogwe, 300 m, 16.07.1953, *Drummond & Hemsley 3335* (B, BR, EA, K, LISC); between road & Pangani river, about 10 miles towards Moshi from Korogwe, 1000 ft (= 305 m), *Batty 1384* (DSM); Monga, 03.1916, *Zimmermann 7574* (EA); ibid., 1917, *Zimmermann 8333* (EA); Monga Tea Estates, 17.04.1968, *Renvoize & Abdallach 1531* (EA, K, P, PRE); Mombo, 05.1917, *Zimmermann 8334* (EA); Vugiri, 765 m, 02.06.1963, *Archbold 204* (K); West Usambara Mountains, Lutindi, 07.1893, *Holst 3265* (K, M, WRSL); ibid., Kwai valley, 1600 m, 25.04.1953, *Drummond & Hemsley 2249* (B, BR, EA, K); ibid., Magamba, near Magamba Secondary School, 1725 m, 02.07.1996, *Faden, Phillips, Muasya & Macha 96/24* (K); Magamba, 24.01.1950, *Faulkner 516* (S, BR, K); Magamba area, 23.04.1968, *Renvoize & Abdallach 1710* (EA, K, P, PRE). **Lushoto/Handeni**. Handeni-Korogwe road, 1000 ft (= 305 m), 03.03.1954, *Faulkner 1360* (K). **Lushoto/Tanga.** Usambaras near Oaklands, 5200 ft (= 1585 m), 17.03.1970, *Batty 959* (K). **Tanga**. East Usambara Mountains, Mlinga peak, near the southern summit, 1010 m, 05.11.1986, *Borhidi, Iversen, Ruffo & Steiner 86484* (K); Kivindani, 0 m, 13.04.1965, *Faulkner 3486* (K); Machui, Tanga-Pangani Rd., 0 m, 02.06.1955, *Faulkner 1645* (BR, K); ibid., 0 m, 10.04.1956, *Faulkner 1844* (B, BR, K). **Pangani**. 5 km NE of Pangani, 20 m, 14.12.1973, *Bjørnstad I. 743* (O); Kolendoni Farm, 60 m, 11-12.1992, *Coastal Forest Research Program Frontier Tanzania 3317* (K). **Western (T4). Ufipa**. Nsanga Forest, 2000 m, 02.01.1962, *Robinson 4869* (K, M). **Central (T5). Kondoa**. Kikori [Kikore], 4200 ft (= 1280 m), 07.02.1930, *Burtt 2786* (K). **Dodoma**. Road to Homboro from Great North Road (near Dodoma), 1300 m, 07.03.1966, *McCusker 98* (DSM, EA, K). **Mpwapwa**. Kiboriani Mtns., 6000 ft (= 1829 m), 09.12.1938, *Hornby & Hornby 2096* (EA, K). **Eastern (T6). Kilosa**. Mikumi National Park, 05.05.1984, *de Nevers & Charnley 3453* (MO); ibid., hills E of road, 03.04.1984, *de Nevers, Norton & Charnley 3189* (BR, MO); Mikumi village, 27.12.1971, *Bjørnstad I. 550* (O); Rubeho to Mandege Road, Ukaguru Mountains, 5000 ft (= 1524 m), 07.03.1959, *Gane 147* (EA, K). **Morogoro**. Ulugurus, 2250 ft (= 686 m), 03.01.1936, *Bruce 419* (K); ibid., 1000 m, 14.01.1933, *Schlieben 3245* (B, BR, K, LISC, MO, PRE); Morogoro, 2000 ft (= 610 m), 25.12.1931, *Wallace 90* (K); 59 miles from Dar es Salaam on road to Morogoro, 500 ft (= 152 m), 21.06.1955, *Welch 296* (BR, EA, K); Mgeta, 26 km straight SSW of Morgoro, 1000 m, 31.12.1970, *Wingfield 2313* (DSM); Mkata Ranch, 30 km W of Morogoro, 420 m, 09.03.1974, *Wingfield 2647* (DSM); ca. 35 km along the Morogoro to Dodoma road, NNW of Morogoro, ca. 450 m, 29.12.1970, *Harris 2118* (EA); Mindu Hill Forest Reserve, N slope of Mindu Hills above Kasanga 2 Village, 510-530 m, 07.02.2001, *Wiland & Mboya 42* (MO); Maskati Mission, Nguru Mountains, 6000 ft (= 1829 m), 11.12.1966, *Robertson 374 A* (EA); E.A.T.R.O. Camp, 8 m NE of Kingolwira station, 1500 ft (= 457 m), 17.12.1957, *Welch 460* (EA, K). **Uzaramo**. Dar es Salaam, near University College, 80 m, *Bjørnstad I. 361* (O); Dar es Salaam University College, 08.04.1966, *Harris 244* (DSM); ibid., 250 ft (= 76 m), 01.12.1967, *Harris 1234* (DSM); between Kambiji and Mjimwema, about 15 miles S of Dar es Saalam, 01.08.1971, *Batty 1347* (DSM, MO); 1 km of Lukanga, 25 m, 18.12.1973, *Bjørnstad I. 753* (O); Kibaha, Sugar Cane Research Station, 31.08.1977, *Abdallah 87* (NHT); Kibaha Research Station, 1977, *Banda 314* (NHT); Kazimzumbwi Forest, Pugu Hills, S of Kisarawe, 150 m, 03.1991, *Coastal Forest Research Program*

Frontier Tanzania 1951 (MO). **Rufiji**. Mafia Island, 24.03.1933, *Wallace 811* (K); ibid., Kissimoni, 14.04.1909, *Kränzlin 3015* (EA); Selous Game Reserve, W of Lungonya R, 120 m, 04.12.1967, *Rodgers 127* (EA). **Southern Highlands (T7). Mbeya**. Mbeya Range, 8000 ft (= 2438 m), 01.12.1961, *Kerfoot 3304* (EA); Mount Mbeya, 4600 ft (= 1402 m), 16.03.1938, *MacInnes 168* (BM); Mbeya-Chunya Road, ca. 9 km from Mbeya, 2000 m, 16.03.1975, *Hooper, Townsend & Nicholson 818* (K); Ruaha National Park, at Isiki River near the Magangwe Ranger Post, 1320 m, 14.12.1972, *Bjørnstad A. AB 2076* (DSM, K). **Mbeya/Rungwe**. Ipoka, Undali, 4900 ft (= 1494 m), 07.02.1972, *Leedal 1015* (EA). **Iringa**. Iringa, 28.12.1971, *Bjørnstad I. 561* (O); Kidatu, 03.11.1971, *Mhoro 424* (DSM); Udzungwa Mountains National Park, Mwanihana Hills Forest Reserve, 2020 m, 04.04.1999, *Mwangulango & Dold 255* (MO); Nyangolo Scarp, 35 miles of Iringa, 4100 ft (= 1250 m), 04.02.1962, *Polhill & Paulo 1340A* (EA, K); Kisinga, 1540 m, 13.02.2001, *Wiland & Mboya 79* (MO, NHT, POZG); near Isele Village, 1620 m, 13.02.2001, *Wiland & Mboya 73* (MO, NHT, POZG); Nduru Forest Reserve, 1600 m, 07.10.2000, *Luke, Bytebier, Butynski, Ehart, Perkins & Kimaro 7064* (EA, K). **Njombe**. Chimala Escarpment, 1800 m, 06.01.1957, *Richards 7513* (K). **Rungwe**. Ipinda-Unyakyusa, Ndago-Nyakyusa, 1600 ft (= 488 m), 31.07.1972, *Leedal 15466* (EA). **Southern (T8). Songea**. 3 km NW of Gumbiro, 820 m, 27.12.1973, *Bjørnstad I. 845* (O). **Kilwa.** Selous Game Reserve, Mtawatawa, 14 km S of Kingupira, 400 ft (= 122 m), 25.05.1975, *Rodgers, Pesambili, Vollesen 2377* (DSM, EA); Madaba, 1000 m, 16.01.1986, *De Leyser 79* (K). **Tunduru**. About 1,5 km. E of Mawese, 450 m, 19.12.1955, *Milne-Redhead & Taylor 7724* (EA, K). **Lindi**. Tendaguru, 06.1925, *Migeod 31* (BM); ibid., 19.03.1926, *Migeod 123* (BM); ibid., 600 ft (= 183 m), 12.12.1930, *Migeod 1022* (BM); Lutamba-See, 240 m, 06.12.1934, *Schlieben 5692* (LISC) & *Schlieben 5693* (B); Nachingwea, 1400 ft (= 427 m), 23.12.1953, *Anderson 947* (EA, NHT). **ZANZIBAR. Zanzibar (Z). Zanzibar Island.** Zanzibar, 1847, *Boivin s.n.* (P); ibid., 1847-1852, *Boivin s.n.* (P); ibid., 1864, *Grandidier 28* (P); ibid., 02.1869, *Kirk s.n.* (K); ibid., 06.1873, *Hildebrandt 1050* (BM, K, L); ibid., 05-06.1883, *Revoil s.n.* (P); ibid., 1927, *Toms 131* (K); ibid., 19.06.1929, *Spurrier H17/29* (EA); ibid., 1888, *Sacleux 151* (P); ibid., 1890, *Sacleux 1495* (P); near town of Zanzibar, 02.1872, *Kirk s.n.* (K); Onkirk, 02.1969, *Harchell 4469* (B); Marahubi, 0 m, 16.11.1961, *Faulkner 2940* (BR, K); Jozani Forest, *Mturi 101* (DSM); Kizimbani, 300 ft (= 91 m), 20.05.1959, *Faulkner 2262* (K). **Zanzibar & Pemba**. 06.10.1914, *Dowson 130* (EA, K). **Pemba (P). Pemba Island**. *Vaughan 465* (K); Tundaua, *Vaughan 352* (EA); ibid., 06.1928, *Vaughan 332* (BM); Chandani [Chundani], 14.02.1929, *Greenway 1441* (EA, K); Aerodrome Road, 19.04.1950, *Williams 18* (K); Weti, 06.06.1930, *Taylor 58* (EA, K).

2. *Hypoxis bampsiana* Wiland in Bull. Jard. Bot. Belg. 66: 207, Figs. 1 & 20 (1997); TYPE: Democratic Republic of the Congo, *Lisowski, Malaisse & Symoens 7653* (POZG!, holotype).

Nordal & Zimudzi (2001: 1); Wiland-Szymańska (2001: 312, Figs. 4 & 5A-B, 22); Singh (2006: 14); Wiland-Szymańska & Nordal (2006: 9); Wiland-Szymańska (2008: 271, Fig. 1)

subsp. *tomentosa* Wiland in Novon 18: 272-273, Figs. 1-3 (2008); TYPE: Malawi. Central Region, Lilongwe District. Dzalanyama Forest Reserve, valley northwest of Kazuzu Hill, on flat rock and shallow gravel in *Brachystegia-Julbernardia* woodland, with *Xerophyta* etc., alt. 1420 m, 24 Feb. 1982, *Brummit, Polhill & Banda 16080* (K!, holotype; MAL, isotype *non vidi*)

= *Hypoxis sp. A* in Nordal *et al.* (1985) *pro parte quoad specim. Bullock 2045*

= *Hypoxis multiceps sensu* Zimudzi (1996) *quoad specim. Pawek 4142*

= *Hypoxis bampsiana sensu* Nordal & Zimudzi (2001) *pro parte quoad specim. Pawek 4142* et *Brummit, Polhill & Banda 16080*

Robust herb, to 41 cm high; tuber ovoidal, 6.0 cm long and 2.8-5.5 cm wide (when dry), white inside, surmounted by the membranous and fibrous remains of the old leaves growing up to 8.5 cm; roots thick, ribbon-like. Outer leaves 3-4, sheathing at base, thick, ovate, cuspidate, keeled and reflexed, 3.5-20 cm long and (1.2) 2-4 cm wide; lamina tomentose on both sides; nervation parallel, composed of 18-49 veins of different size; inner leaves 3-5, thick, ovate or lanceolate, cuspidate, slightly keeled, erect or slightly reflexed, 13.5-46.0 cm long and (8) 14-57 mm wide; lamina tomentose bifacially; trichomes tufted, 9-13-branched, to 1.6 mm long, golden or red-golden after drying, rather gray in the field, longer on the edges and the midrib; older leaves not so hairy; nervation parallel, composed of 17-67 veins of different size. Scapes 4-8, 11-25 cm long and 2-4 mm wide, compressed, short winged and ciliate in the basal part, wider and tomentose in the apical part above 1/3-1/2 of their length with tufted trichomes to 3.5 mm long. Inflorescences (2-) 4-9-flowered, racemose; bracts subulate, acute, keeled, 0.9-2.5 cm long and 2-4 mm wide, at the lowest, oldest flowers veined with 3 veins, with lamina abaxially covered with tufted trichomes except edges or hairy only on the midrib and veins; pedicelles 3-18 mm long, tomentose; flowers yellow; outer tepals ovate, acute, slightly keeled, 13-15 mm long and 5.0 mm wide, pubescent beneath,

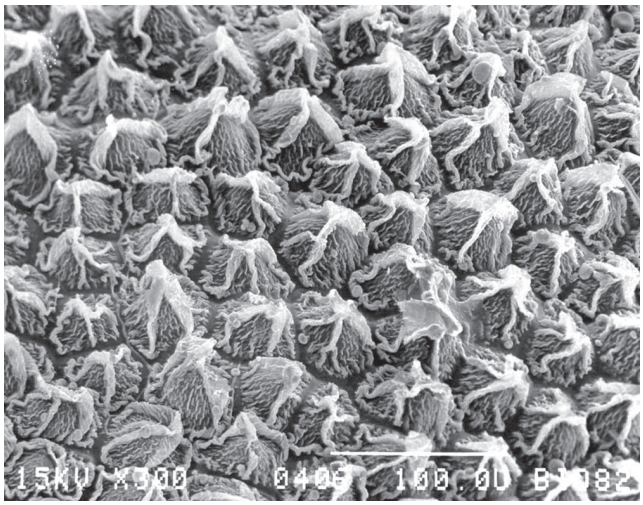


Fig. 28. Seed testa sculpture of *Hypoxis bampsiana* subsp. *tomentosa* (from *Bullock 2045*)

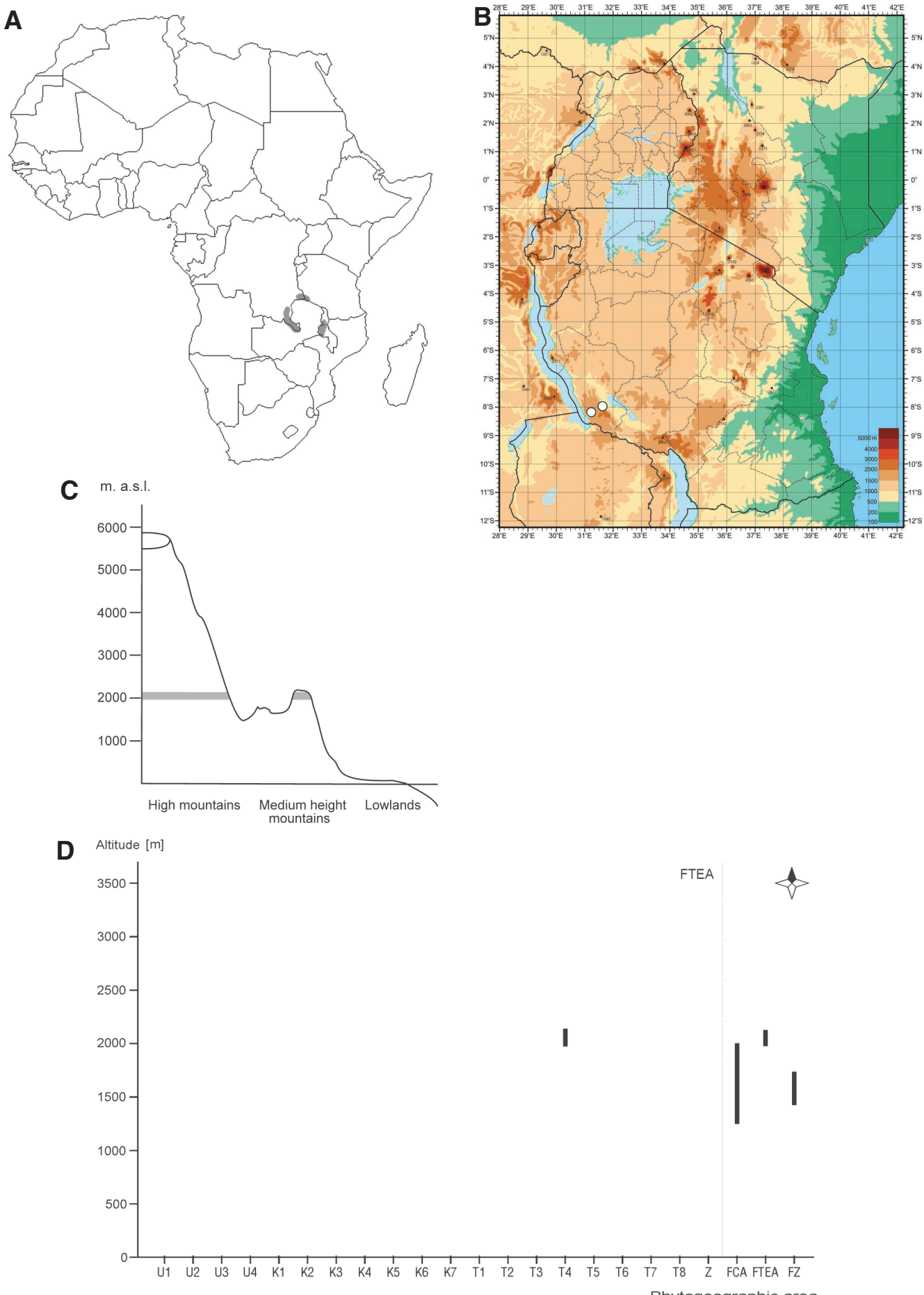
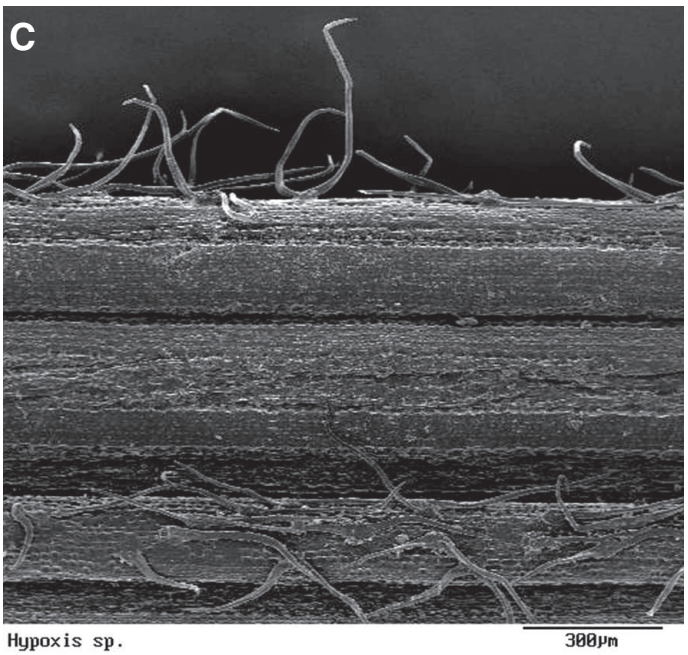
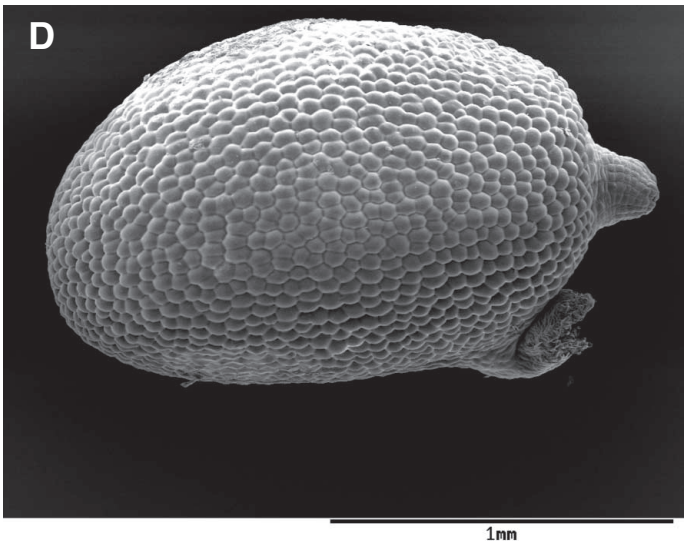
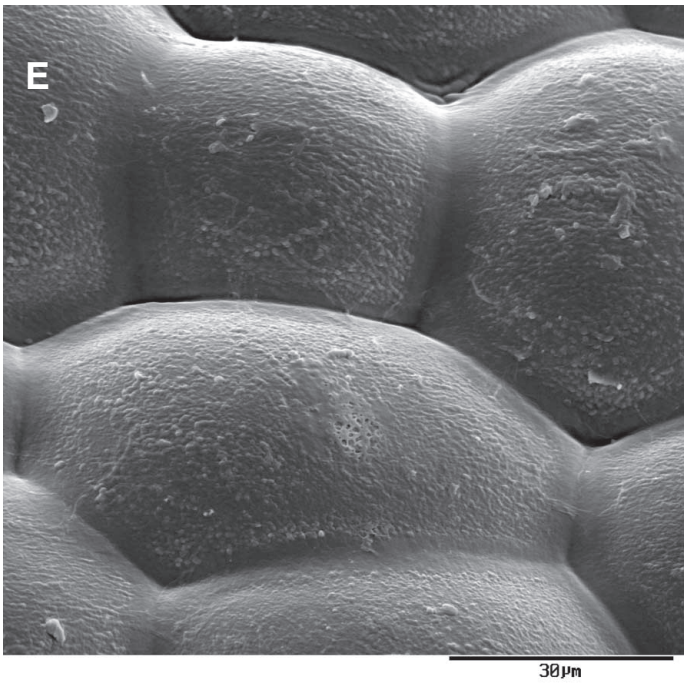


Fig. 29. *Hypoxis bampsiana*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

Fig. 30. *Hypoxis filiformis*
Explanations: A – habit (from *Cooper 462*), B – tubers with cream or yellowish flesh (from *Wiland & Mboya 148*), C – SEM image of two-branched trichomes on a leaf (from *Wiland & Mboya 148*), D – seed (from *Lovett & Thomas 2635*), E – seed testa sculpture (from *Lovett & Thomas 2635*)







provided with a 1 mm long clavate appandage under apex; 7-veined; inner tepals ovate, cuspidate, 12-15 mm long and 7-8 mm wide, 5-6-veined, pubescent along the midrib beneath to 1/3-1/2 of length; stamens 6, equal, 6 mm long; filaments subulate, 2.5 mm long; anthers linear, fused or slightly emarginate at apex, prominently sagittate at base, 4.5-7.0 mm long; ovary obconical, 4-6 mm long and 3-4 mm wide, pubescent; style three-cornered, 2-3 mm long, stigma three lobed with unequal triangular lobes. Capsule obconical, circumscissile, 6-8 mm long and 4-5 mm wide, surmounted by a persistent perigone, pubescent, with numerous seeds. Seeds ovoidal or sphaerical, 1.0-1.5 mm long, with a prominent nipple-shaped appandage at apex, covered with thick cuticula; testa bristly with pointed pyramidal projections, winged with cuticula (Fig. 28).

Distribution. This subspecies occurs in the Democratic Republic of the Congo, Tanzania and Malawi (Fig. 29A), inside the Zambesian Region. In Tanzania it occurs only in the Western Province (T4) (Fig. 29B), between 1981-2134 m a.s.l. in the mountain vegetation zone belt (Fig. 29C). In East Africa this taxon reaches a north-eastern limit of its horizontal range and the uppermost limit of its vertical range. The bottom limit of its vertical range is lowering towards south, reaching 1250 m a.s.l. in the Central Africa (Wiland-Szymańska 2001), and 1300 m a.s.l. (Nordal & Zimudzi 2001) in the Flora Zambesiaca area (Fig. 29D)

Habitat. Montane grassland, upland pasture, in good soil.

Phenology. In November and December in connection with a rainy season. Flowers together with leaves.

Observation. Because of insufficient data, this taxon needs further studies in the field.

Description according to Wiland-Szymańska (2008).

IUCN conservation status. Near Threatened.

Specimens studied. **TANZANIA. Western (T4). Ufipa**. Chapota, 6500 ft (= 1981 m), 04.12.1949, *Bullock 2045* (K); Sumbawanga, 7000 ft (= 2134 m), 27.11.1954, *Richards 3444* pro parte (K).

3. ***Hypoxis filiformis*** Baker in Journ. Linn. Soc. 17: 109 (1878b). TYPE: South Africa, Qeenstown, *Cooper 462* (K! holotype, B! isotype)

Durand & Schinz (1895: 232); Nel (1914b: 305); Bews (1921: 64); De Wildeman (1921a: 34); Jackot Guillarmod (1971: 149); Ross (1972: 132); Compton (1976: 130); Hilliard & Burrtt (1983: 299-300); Heideman (1987: 246, Fig. 90P, Q); Zimudzi (1997: 15); Pooley (1998: 234, photo); Nordal & Zimudzi (2001: 10, Table 12.3.2, Fig. B.);

Wiland-Szymańska (2001: 317, Figs. 6D, 27), Snijman & Singh (2003: 1072); Da Silva *et al*. (2004: 127); Singh (2006: 14); Wiland-Szymańska & Nordal (2006: 8)

= *H. malosana* Baker, Bull. Misc. Inform. 1897: 284 (1897). TYPE: Malawi, Mount Malosa, near Zomba, *Whyte s. N.* (K!, holotype). Baker (1898: 379); Nordal *et al*. (1985: 27, Figs. 1A, 2i-j, 3k, 5C & 16); Wiland-Szymańska (2001: 329, Figs. 15A-C, 16 & 22); Singh (2006: 14)

= *Hypoxis biflora* auct. non. Baker, De Wildeman, Repert. Spec. Nov. Regni Veg. 11: 537 (1913a); De Wildeman (1913b: 18). TYPE: Democratic Republic of the Congo, Upper-Katanga, *Hock s.n.* (BR!, holotype). - *Hypoxis dregei* var. *biflora* (De Wild.) Nel in Bot. Jahrb. 51: 306 (1914b); De Wildeman (1914: 8); Fries (1916: 233); De Wildeman (1921a: 34); Norlindh (1937: 162).

= *Hypoxis münznerii* Nel in Bot. Jahrb. 51: 307 (1914b). TYPE: Tanzania, Mtembwa, *Fromm 127a* (B!, holotype)

= *Hypoxis angustifolia sensu* Geerinck (1971) *pro parte*

Slender herb 20-50 cm high (Fig. 30A); tuber white, cream or yellow inside, smelling like soap, ovoid, 1.0-5 x 1.1-4.0 cm (dried out), often dividing into several smaller; sap not abundant (Fig. 30B); roots white; tunic fibrous stiff black, to 6 cm high. Leaves yellowish green or dark green with white bases, sometimes bases of the outer leaves reddish. Outer leaves 1 to 3, ovate, 3.0-14.5 cm x 4-10 mm, pilose below; trichomes 2-branched; nerves unequal, 7 to13; inner leaves 5 to11, narrow-linear, 2.8-61.0 cm x 1-3 mm wide, hispid on margins and midrib below; trichomes 2-branched, ca. 3 mm long, falling off with age, white in the field, red-brown or golden in the herbarium (Fig. 30C); nerves unequal, 5 to 11. Scapes 2 to 10, 2.5-57.0 cm x 0.5-1.0 mm, often red tinted, in basal half ciliate with 2-branched trichomes, in upper half pubescent with tufted trichomes; trichomes white to red-brown, 0.4-1.3 mm long; cyme 2- to 4-flowered, with pedicels of significantly various lenght, sometimes flowers single; bracts subulate, 2-8 x ca. 1 mm, pubescent along midrib abaxially; pedicels to 23 mm long at the first and third flower, none or very short at the second, lowest flower in the inflorescence, and fourth flower, pubescent. Tepals (5) 6, lemon yellow, orange yellow, to ochre inside; outer tepals with green stripe on reverse, elliptic, 6-12 x 2-3 mm; appendage minute, pubescent abaxially, with 5 to 7 parallel nerves; inner tepals oblong or ovate, acute at apex, 5.0-11.5 x 2-4 mm, almost glabrous with few trichomes at base abaxially, with 3 to 7 parallel nerves; stamens yellow, unequal, longer in outer row, yellow; outer stamens 2.5-5.0 mm long with filaments 2.0-3.5 mm long; inner stamens 1.5-3.0 mm long with filaments 0.5-1.5 mm long; filaments filiform; anthers 1.5-2.5 mm, sagittate, emarginate at apex; ovary obconical, 2.0-3.5 x 1.5-2.5 mm, pubescent; style to 0.5 mm long, or stigma sessile; stigma yellow, oblong or pyramidal, obtuse, composed of three oblong lobes, entirely fused or emarginate at apex, 1.3-2.2 mm long. Capsule obovoid, 3-5 x 2-3 mm, pubescent, opening by transverse slit; seeds numerous, ovoid, ca. 1.5 x 1 mm, black; seed coat prominently colliculate and micropapillate (Fig. 30D-E).

Distribution. A widely dispersed species, collected in the Democratic Republic of the Congo, Burundi, Uganda, Tanzania, Angola, Zambia, Malawi, Mozambique, Zimbabwe, Swaziland, Lesotho and South Africa (Fig. 31A). It is spread in the Zambezian Region, the Zanzibar-Inhambane Regional Mosaic, E part of the Kalahari-Highvel Transition Zone and the Tongoland-Pondoland Regional Mosaic. In the East Africa it is most common in the Southern Highlands (Fig. 31B). *H. filiformis* occurs in the submountain and mountain vegetation zone belts between 960 and 3000 m a.s.l. (Fig. 31C). It is most frequent between 1500-2500 m a.s.l. (Fig. 31D) in the mountain vegetation zone belt. A bottom limit of its vertical range is elevating towards North and West, because in the Southern Africa it grows from the see level (Fig. 31E) (Snijman & Singh 2003; Nordal & Zimudzi 2001), whereas in the Central Africa it is found not below 1000 m a.s.l. (Wiland-Szymańska 2001). This species is reaching the uppermost limit of its vertical distribution in Southern Highlands and not in Uganda, where it also occurs.

Habitat. Natural grassland, especially after burning, disturbed grassland, *Protea* woodland, peat bogs, swampy grassland, grassy glades, pastures, near cultivations; on limestone, clay, sandy soil, black volcanic soil, soil with lots of mica and feldspar.

Phenology. In *H. filiformis*, development of inflorescences may be simultanous with or preceding leaf growth. Flowering from July to May, but especially abundant from October to February (Fig. 32), often after fire. Flowers not scented, open about 11-12 a.m.

Vernacular name. Kivulenzi (dialect not stated; *Bruce 751*, K).

Observations. Locally very abundant, growing in clumps or solitary.

The redescription presented here includes all available measurments of this species.

IUCN conservation status. Least Concern.

Specimens studied. **UGANDA. Western (U2). Kigezi**. Mgatunga, 7000 ft (= 2134 m), 10.1940, *Eggeling 4119* (EA); Virunga Mountains, Ingalinge, Mellom Sabinio, 7000 ft (= 2134 m), *Eggeling 1106* (K). **TANZANIA. Tanzania.** 1918, *Dautrique 101* (BR). **Western (T4)**. **Kigoma**. Mtembwa near Ujiji, 04.02.1909, *Fromm 127 a* (B); 36 miles S of Uvinsa [Uvinza], 5700 ft (= 1737 m), 31.08.1950, *Bullock 3293* (K). **Mpanda.** Kapapa Camp, 1050 m, 28.10.1959, *Richards 11617* (B, BR, K, LISC, S). **Ufipa**. Ufipa Plateau, Tatanda, 03.12.1986, *Moyer 12* (DSM, MO); Mbizi Forest, 7000-8000 ft (= 2134-2438 m), 21.11.1958, *Napper 1104* (EA, K); ibid., Nkonkola hill, 2300 m, 23.11.1987, *Ruffo & Kisena 2760* (K). **Eastern (T6). Kilosa**. Mikumi National Park, E part, 22.02.1971, *Hansen 531* (DSM). **Morogoro.** Kanga Mountain, Northern Nguru, 2000 m, 02.12.1987, *Lovett & Thomas 2635* (MO); Lukwangule Plateau,

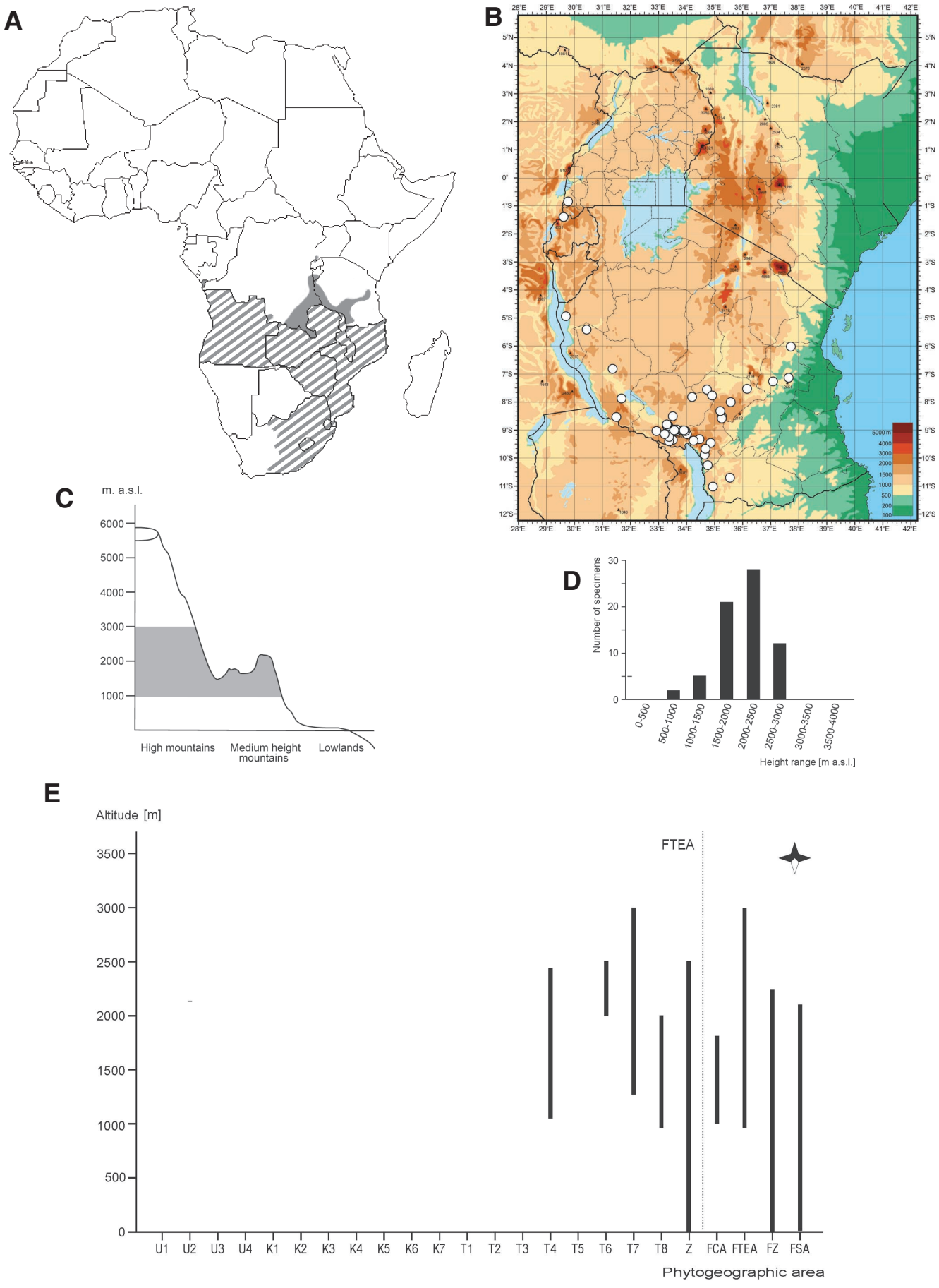


Fig. 31. *Hypoxis filiformis*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

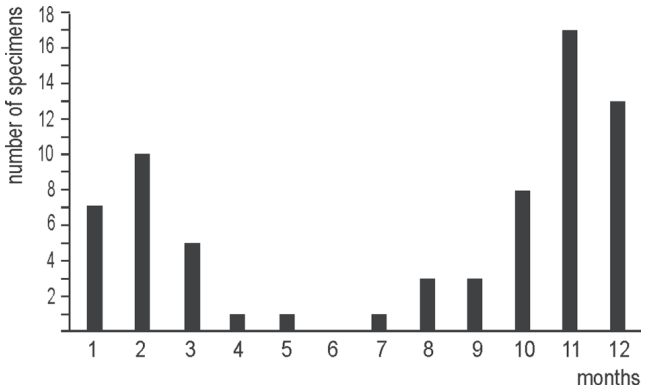


Fig. 32. Flowering periods of *Hypoxis filiformis*

2500 m, 09.02.1934, *Troll 5004* (B); ibid., 30.01.1935, *Bruce 751* (K); ibid., 2385 m, 08.12.1969, *Pócs & Csontos 6081* (DSM); ibid., 2435 m, 01.02.2001, *Jannerup & Mhoro 368* (C, POZG). **Southern Highlands (T7). Mbeya**. Mbeya Peak, 9100 ft (= 2774 m), 07.03.1960, *Kerfoot 1604* (EA); ibid., 9300 ft (= 2835 m), 07.03.1960, *Kerfoot 1610* (EA); Mbeya Mountain, 2600 m, 01.10.1932, *Geilinger B XIX 6* (K); Mbeya Range, 8000 ft (= 2438 m), 01.12.1961, *Kerfoot 3305* (EA); ibid., 4900 ft (= 1494 m), 01.12.1961, *Kerfoot 3306* (EA); Mbeya Range, 2400 m, 11.1972, *Stefanescu 322* (DSM, EA); Mbeya area, *Menries 368* (EA); Mbogo, 8000 ft (= 2438 m), 28.07.1971, *Leedal 661* (EA); Mbosi, 5200-5300 ft (= 1584-1615 m), 15.10.1935, *Horsburgh-Porter s.n.* (BM); Mbozi, near Mission, 5000 ft (= 1524 m), 22.11.1932, *Davies 663* (EA,K); Ilembo, Umalila, 6800 ft (= 2073 m), 20.11.1971, *Leedal 801 b* (EA) & *803* (EA); Songwe, 4200 ft (= 1280 m), *Leedal 524* (EA); Sapanda, 7000 ft (= 2134 m), 03.11.1971, *Leedal 780* (EA); Ruaha National Park, 0,5 km N of Maganwe air strip, 1330 m, 02.01.1973, *Bjørnstad A. 2505* (DSM, EA, K, O); below Mporoto, S slopes, 6200 ft (= 1890 m), 12.03.1932, *St. Clair-Thompson 807* (K); slopes of Matamba Mountains, ca. 2800 m, 22.11.1986, *Goldblatt, Brummit Lovett 8214* (MO); Pungaluma Hills above Msheve Village, Mshokwa Plateau, 1720 m, 26.11.1989, *Lovett & Kayombo 3501* (MO); E of Mouva and Msheve villages, Itangano above Shokva Plateau, 2250 m, 27.10.1990, *Lovett & Kayombo 4861* (MO); 9,3 km from Mbeya-Kyela highway on road between Igoma and Kitulo, S slope of Mporoto Mountains, 2360 m, 27.01.1991, *Gereau, Lovett & Kayombo 3745* (MO, P). **Mbeya/Njombe**. Poroto Mountains, on the road to Kitulo Sane Farm, ca. 10 km W of Kitulo, 2700 m, 01.01.1972, *Bjørnstad I. 605* (O); NW side of Kitulo Plateau, mountain road from Mporo to Kitulo, 06.05.1975, *Hepper, Field & Mhoro 5338* (K); Elton Plateau [Kitulo Plateau], 9000 ft (= 2743 m), 11.11.1931, *Davis E 6* (K); ibid., 2250 m, 11.01.1957, *Richards 7702A* (BR, K); ibid., 2100 m, 24.01.1961, *Richards 14146* (BR, K); ibid., 8500 ft (= 2591 m), 24.02.1966, *Robertson 223* (EA); ibid., 29.02.1967, *Prins-Lampert 307* (WAG); ibid., 9000 ft (= 2743 m), 25.11.1967, *Prins 87* (EA); ibid., 2290 m, 23.09.1968, *Harris 2251* (EA, DSM); ibid., 9000 ft (= 2743 m), 08.02.1970, *Fuller 54* (K); ibid., 3000 m, 11.1972, *Stefanescu 392* (DSM); ibid., 2600 m, 12.12.1989, *Lovett, Sidwell Kayombo 3652A* (MO); ibid., Matamba Pass, 8000 ft (= 2438 m), 21.02.1977, *Leedal 426* (K); ibid., 18 km S of Matamba Village, 2520 m, 27.02.2001, *Wiland & Mboya 148* (POZG). **Mbeya/ Rungwe**. Ngozi forest, 2000 m, 26.09.1932, *Geilinger 2662* (K); Songwe, 1300 m, 29.12.1978, *Leedal 5268* (K). **Iringa**. Iringa, 6000 ft (= 1829 m), *Mabberley 616 c* (K); Sao Hill, 6200 ft (= 1890 m), 02.1959, *Watermeyer 6* (K); ibid., 01.1960, *Watermeyer 249* (K); Maganga, 6000-6500 ft (= 1829-1981 m), 02.08.1969, *Paget-Wilkes 591* (EA, MO) & *Paget-Wikes 592* (MO); Mufindi, Ngwazi road, 6000-6500 ft (= 1981 m), *Paget-Wilkes 984* (EA, MO); Mount Image, 2180-2240 m, 21.12.1973, *Bjørnstad I. 794* (O); Lake Kihanga, 1830 m, 10.02.1987, *Lovett 1499* (DSM, K, MO, NHT). **Rungwe**. Rungwe, 1900 m, 11.09.1932, *Geilinger s.n.* (K); Rungwe Distr., 6000 ft (= 1829 m), 24.02.1932, *Davies D 373* (EA, K); Ngozi to Isongole, 1800 m, 04.11.1993, *Grimshaw 93/035* (K); Kiwira Fishing Camp, 6000 ft (= 1829 m), 05.11.1969, *Batty 801* (K); Upper Kiwira Fishing Camp, 6600-7000 ft (= 2012-2134 m), 29.11.1958, *Napper 1141* (EA, K, UPS); near Kiwira Forest Station, 7500 ft (= 2286 m), 10.1959, *Procter 1488* (EA, K); Ngozi, Poroto Mountains, 2100 m, 17.10.1956, *Richards 6557* (K); Ibaba, Umalila, 10.10.1970, *Leedal 474* (EA); Ivifi, Umalila, Ibaba, 6000 ft (= 1829 m), 28.10.1970, *Leedal 482* (EA). **Njombe**. Njombe, 29.11.1931, *Lynes D5* (K); 20 km SE Njombe along road to Songea, 1750 m, 24.12.1973, *Bjørnstad I. 824* (O); N Livingstone Range, 04.1884, *Johnson & Waller s.n.* (K); Milo, 2300 m, 20.10.1978, *Archbold 2599* (K); Igeri, 7380 ft (= 2249 m), 19.12.1967, *Robertson 820* (EA); ca. 35 km NNW of Lupalilo, 2500 m, 30.12.1973, *Bjørnstad I. 878* (O); Idogo 6 km ESE of Kipengere, 2160 m, 29.12.1973, *Bjørnstad I. 867* (O, UPS); 24 km WSW of Kipengere, 2400 m, 29.12.1973, *Bjørnstad I. 870* (O, UPS); Mnewa, near Luponde Tea Estate, ca. 45 km SSW of Njombe, 2100 m, 27.11.1986, *Brummitt, Goldblatt, Lovett & Mwasumbi 18212* (K). **Southern (T8). Songea**. Matengo Hochland WSW von Songea, Lupembe Berg, 1900-2000 m, 22.11.1935, *Zerny 31* (W); Kimarampaka Stream, about 12 km W of Songea, 960 m, 31.12.1955, *Milne-Redhead & Taylor 8001* (B, BR, EA, LISC).

4. *Hypoxis fischerii* Pax in Bot Jahrb. 15: 143 (1893). TYPE: East Africa, „Seengebiet", *Fischer 611* (B!, holotype, K!, isotype).

Durand & Schinz (1895: 232); Baker (1898: 382); Nel (1914b: 316); Nordal & Iversen (1987: 34-36, Plates 8 & 13C); Singh (2006: 15); Wiland-Szymańska & Nordal (2006: 12).
= *Hypoxis* sp. (cf. *multiflora* Nel) *sensu* Demissew *et al.* (2003: 173, Fig. 39)

Robust or medium herb up to 78 cm tall. Tuber subglobose to cylindrical, 3-9 × 3-6 cm, white or yellowish inside, crowned with fibrous remnants of former leaves. Leaves, tristachous, forming a short pseudostem, ± rigidly erect, becoming lax, usually conduplicate, linear to lanceolate, 10-78 (-102) x 0.8-5.7 cm, always ciliate on margin & midrib with tufted hairs, on the lamina pubescent on the both surfaces or only below, with tufted to 8-armed or bifurcate silvery-strigose hairs; veins unequal, 11-40 (-70). Inflorescences 1-10 (-12), with scapes up to 37 (-50) cm long, overtopped by the mature leaves, 2-5 mm wide, with reducing in steps as pedicels diverge; pedicels 2-25 mm long, decreasing in length upwards; bracts 7.0-2.7 mm long, subulate to linear-lanceolate. Flowers 3-14 (-25) in a raceme-like ± cylindrical arrangement, floral anthesis acropetal; tepals (9-)10-18 × (3-)4-8 mm, inner slightly broader than the outer; stamens equal 6-7 mm long; filaments subulate to almost linear, 1.3-4.0 mm long; anthers

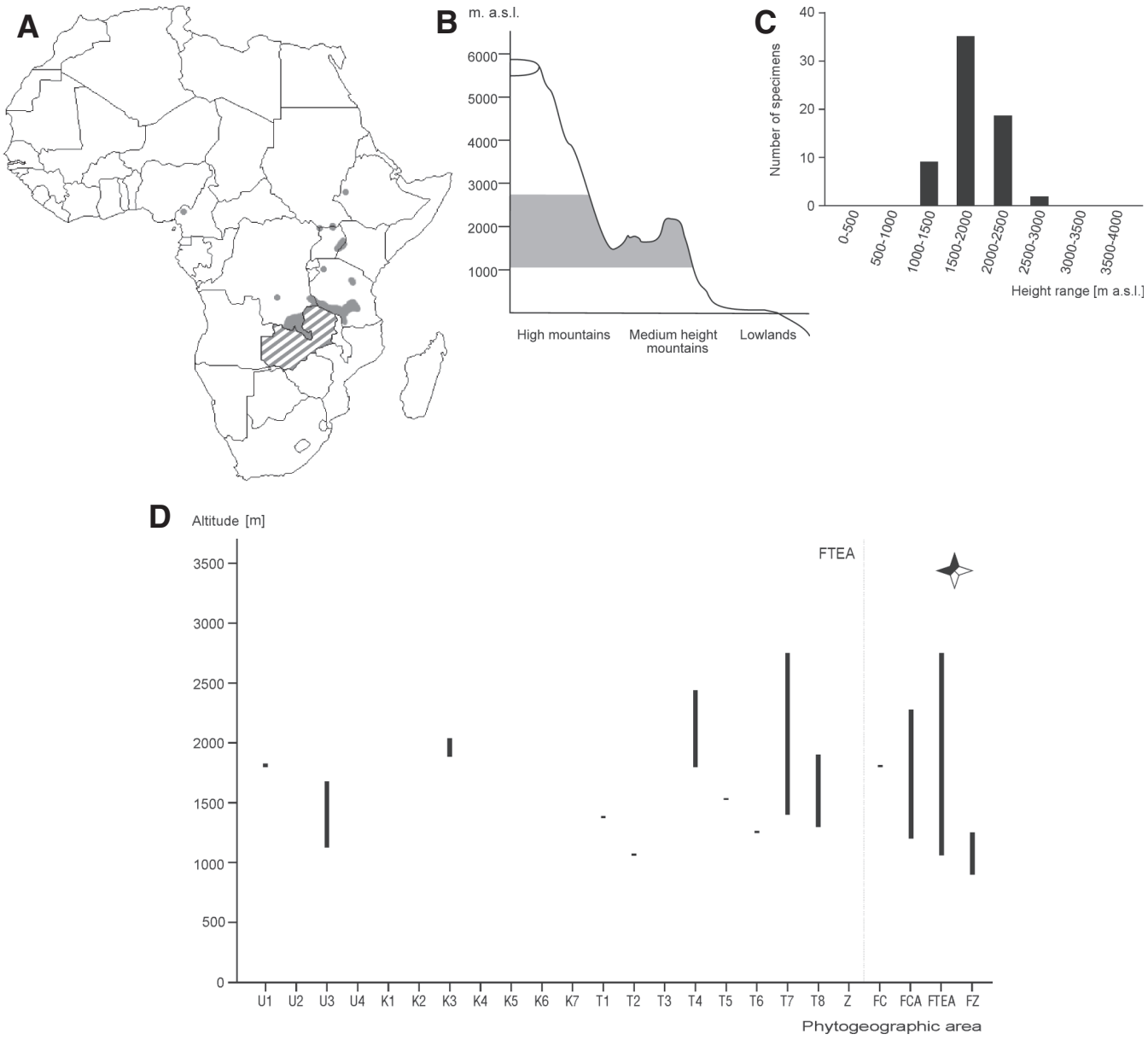


Fig. 33. *Hypoxis fischerii* s.l.
Explanations: A – general distribution, B – vertical range in the East Tropical Africa, C – a histogram of vertical distribution in the East Tropical Africa, D – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

3-8 mm long, entire at apex; style 1-6 mm long; stigma 1-4 mm long composed of 3 linear lobes fused to apex or 3 free triangular lobes. Capsule turbinate, 4-9 × 3-6 mm with opening by transverse slits. Seeds black and most often glossy, (sub-) globose 1.2-2.0 mm in diameter, testa variable, but never with cuticular folding.

Distribution. *Hypoxis fischerii* occurs in: Cameroon, Ethiopia, Democratic Republic of the Congo, Uganda, Kenya, Tanzania, Zambia, Malawi i Mozambique (Fig. 33A). It is found in such White's regions as: Sudanian Region, Guineo-Congolian/Sudania Transition Zone, Somalia-Masai Region, Lake Victoria Regional Mosaic i Zambesian Region. Its centre of an intraspecific diversity is situated in the Zambezian Region. For the East Tropical Africa this species is transitional. Its range is continuous and compact only in the southern part of Tanzania. Other populations are dispersed in isolated insular localities (Fig. 33A). Thought not every specimen examined could be determined into a variety, one can observe, that the varieties differ in their horizontal ranges. Statistical analysis did not show any statistically important differences in vertical distribution between varieties of *H. fischerii* (F=1.691; p=0.16). The species occurs between 1067-2743 m a.s.l (Fig. 33B), in submountain, mountain and a part of subalpine vegetation zone belts. The majority of specimens were collected between 1500-2000 m a.s.l. (Fig. 33C), in submountain and mountain vegetation zone belts. While comparing vertical ranges of *H. fischerii* in the East Africa and other parts of the continent (Nordal & Iversen 1987; Wiland-Szymańska 2001; Nordal & Zimudzi 2001) one can observe an elevetion of the bottom

vertical range limit towards North and West (Fig. 33D).

Vernacular name. Ngilingisi (Wanji) – this name is given to all *Hypoxis* species. Lipipili (dialect not stated) given to three south Tanzanian varieties.

Observations. Because of the large leaves, this species is quite noticable, especially in the southern part of Tanzania.

The description presented here is after Wiland-Szymańska & Nordel (2006).

IUCN conservation status. This species as a whole is Least Concern, but some varieties have a different status.

Specimens not determinable into varieties studied. **KENYA. Rift Valley (K3). Trans-Nzoia.** Mount Elgon, 6700 ft (= 2042 m), 04.03.1931, *Major E. J. & Mrs. Cyril Lugard 550* (K). **Central/ Masai (K4/K6). Machakos/Masai.** Chyulu-North, 19.04.1938, *Bally 735* (EA, K). **TANZANIA. Western (T4). Mpanda.** S Muhambwe, Kigoma, 10.1926, *Grant C.H.B. s.n.* (BM). **Ufipa.** Mbizi Forest, Rukwa, 7500 ft (= 2286 m), 11.11.1963, *Brown 563* (EA); Mbizi Forest, 7000 ft (= 2134 m), 14.11.1970, *Sanane 1388* (K). **Southern Highlands (T7). Mbeya.** Over Mbeya, 09.09.1954, *Smith 1258* (EA); Mbeya Peak, 9000 ft (= 2743 m), 17.03.1960, *Kerfoot 1634* (EA); Mbeya Range, 8000 ft (= 2438 m), 01.12.1961, *Kerfoot 3303* (EA). **Iringa.** Mufindi, 31.12.1968, *Gardiner 667* (EA); Sao Hill, 6000 ft (= 1829 m), 10.1966, *Procter 3354* (EA); near Sao Hill, 1700 m, 22.09.1970, *Thulin & Mhoro 1092* (O); Igawa-Sao Hill Road 7 miles from Sao Hill, 1920 m, 12.12.1962, *Richards 17006* (B, BR, K, UPS); Kisinga, 1540 m, 13.02.2001, *Wiland & Mboya 78* (MO, POZG); Iheme, *McGregor 85* (K); ridge at the border of the Njombe/ Ludewa districts, along the main road from Njombe to Ludewa, 06.11.1987, *Mwasumbi, Magehema, Thomas & Lovett 13433* (MO). **Njombe.** Above Matamba Village on road to Kitulo Plateau, 2500 m, 27.02.2001, *Wiland & Mboya 149* (POZG).

4a. *Hypoxis fischerii* Pax var. *fischerii* Wiland-Szymańska & Nordal (2006: 13, Fig. 1.8)

Nordal & Iversen (1987: 34-36, Plts. 8 & 13C); Singh (2006: 14)
= *Hypoxis multiflora* Nel in Bot. Jahrb. 51: 317 (1914b); Andrews (1956: 306); Blundell (1982: 124). TYPE: Uganda, Elgon-District, *Evan James* (K!, holotype)
= *Hypoxis obtusa* complex *sensu* Nordal *et al*. (1985: 28) *pro parte*.
= *Hypoxis polystachya sensu* Nordal & Zimudzi (2001: 14)

Robust plant, up to 50 cm high; tuber large, yellow, orange or deep ochre; tunic fibrous, black. Leaves pinkish at base, lanceolate, acuminate, coriaceous, 20-25 cm long, 3 cm wide, densely covered with white or grey trichomes, tufted on edges and midrib and 2-branched on the lamina; inner leaves 30-50 cm long, 2-2.5 cm wide, densely covered with silver-grey abaxially, more sparsely adaxially; trichomes on edges and midrib 6-branched and 2-branched on the lamina, up to 6 mm long (Fig. 34B-C); veins unequal, 20-24 veins. Scapes pinkish, 23-30 cm long and 2.5-5 mm wide, covered in upper part with white tufted trichomes (Fig. 34D); inflorescence spicato-racemose, 8-18 cm long, 12-30 flowered; bracts green or brown, subulato-filiform, carinate, 1.5-2.5 cm long, villose along midrib below, with up to 9 veins; pedicells 0.3-1.5 cm long; tepals inside yellow; outer tepals outside green or brown 1.4-1.5 cm long, linear, acute, 4-5 mm wide, villose below; inner tepals ovate, 1.4-1.5 cm long, 6-7 mm wide; stamens equal, 7 mm long; filaments subulate, 3-4 mm long; anthers lanceolate, split at apex, sagittate at base, 5-6 mm long; ovary turbinate, 3-4 mm long, densely covered with adpressed grey trichomes; style columnar 1-6 mm long, stigma with 3 free lobes, 2 mm long. Capsule turbinate; seeds ovoidal, black, with mammiform papillae (Fig. 34A).

Distribution. This variety occurs in Cameroon, Ethiopia, Uganda Kenya and Tanzania (Fig. 35A). It is limited to White's Sudanian Region, Lake Victoria Regional Mosaic and Zambesian Region. Its centre of

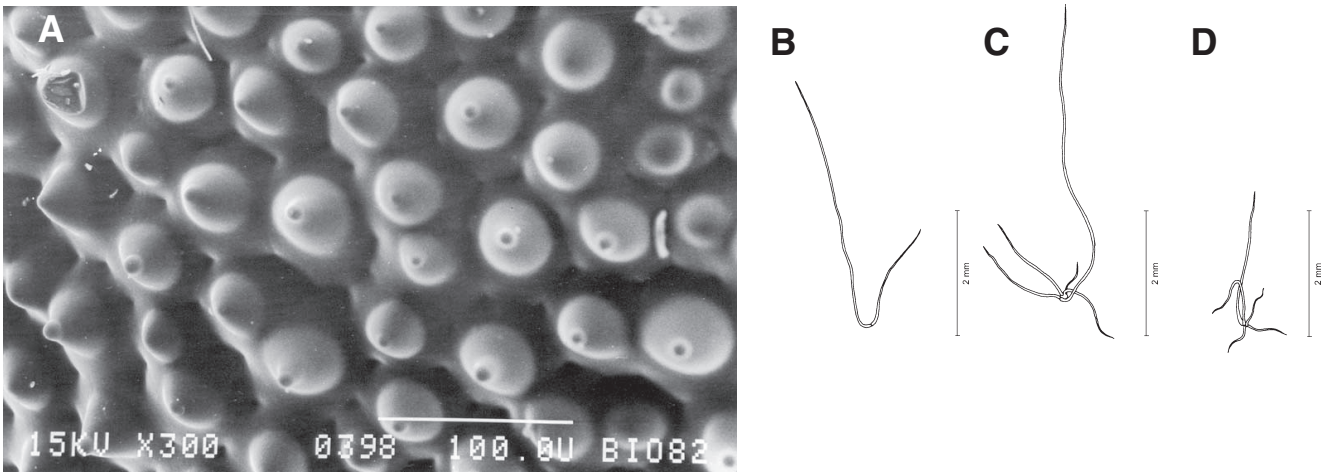


Fig. 34. *Hypoxis fischeri* var. *fischeri*
Explanations: A – SEM of the seed testa sculpture; B – two-branched trichome from leaf lamina, C – tufted trichome from leaf edge, D – tufted trichome from scape (from *Lye 2079*)

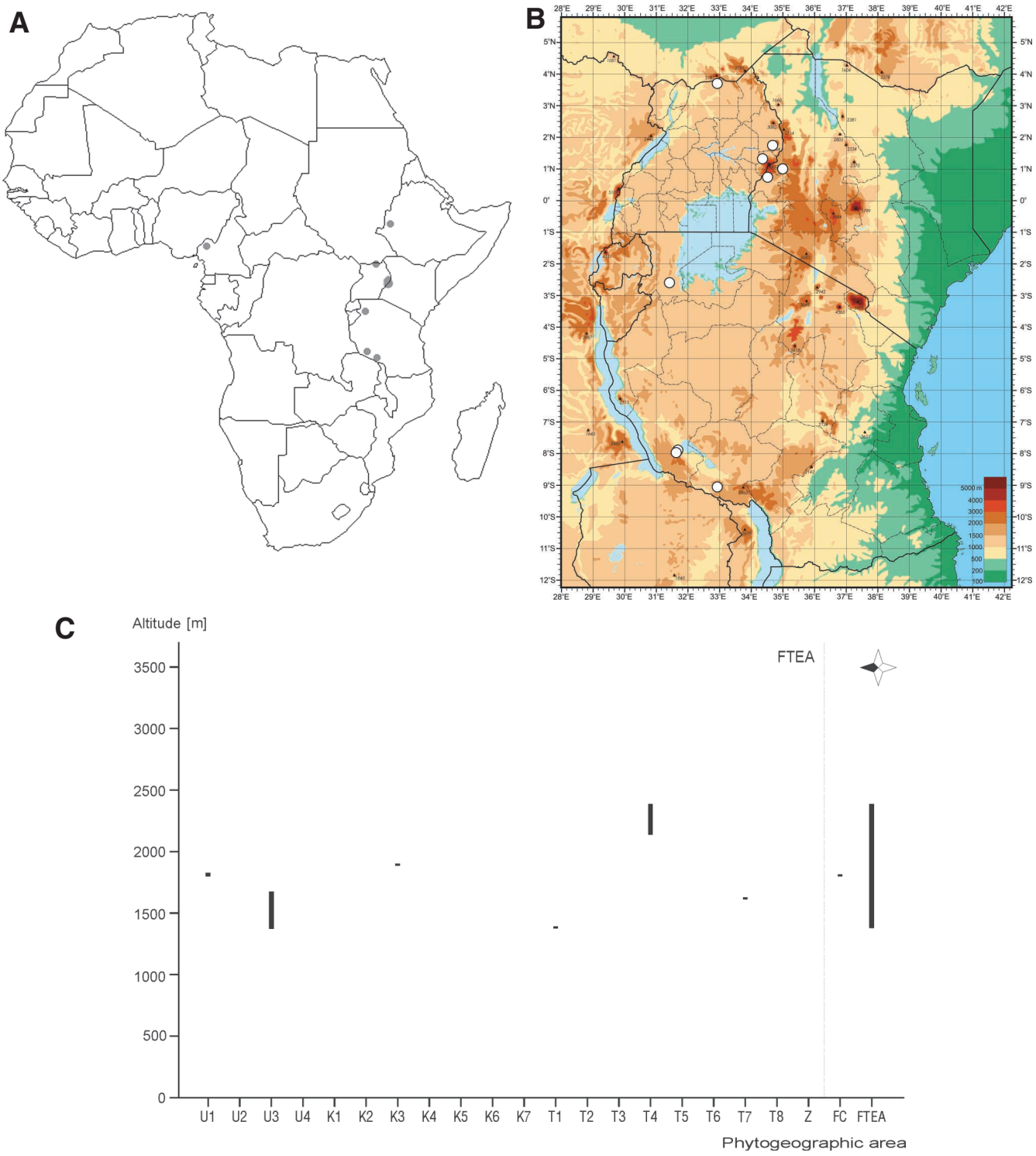


Fig. 35. *Hypoxis fischerii* var. *fischerii*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

abundance is situated in Kenya in the Somalia-Masai Region (Fig. 35B). It was found between 1372-2286 m a.s.l. While comparing its vertical distribution between the East Tropical Africa and Cameroon (Nordal & Iversen 1987) one can notice an elevation of its bottom vertical range limit towards West. Its uppermost vertical limit is found in the Western province in Tanzania (Fig. 35C).

Habitat. Wooded grassland, wet grassland, in short grass, among rocks on fireswept eroded hillside, upland pasture; black clay.

Phenology. Inflorescence develop before inner leaves and persist until the latter are fully grown. Flowers fully open only in the morning. Flowering in August, October, November and from February to April (Fig. 43). At least one resting period from May to July.

Possibly another one from December to January.

Observations. The redescription presented here includes all available data concering this taxon.

IUCN conservation status. Near Threatened.

Specimens studied. **UGANDA. Northern (U1). Acholi.** Lamwo country, 2 km NE for Lotuturu, at end of road, 1800 m, 17.02.1969, *Lye & Lester 2079* (K). **Karamoja.** Namojongotyang, 6000 ft (= 1829 m), *Eggeling 2815* (BR, K). **Eastern (U3). Mbale.** Sipi, Mount Elgon, 4500-5500 ft (= 1372-1676 m), 17.02.1924, *Snowden 822* (BM, K). **Eastern/Rift Valley/ Nyanza (U3/K3/K5). Mbale/Trans-Nzoia/North Kavirondo.** Elgon District, 1905, *Evan James s.n.* (K). **KENYA. Rift Valley (K3). Trans-Nzoia.** Kitale, 6200 ft (= 1890 m), 05.03.1955, *Bogdan 3691* (B, EA, K); ibid., 6200 ft (= 1890 m), 04.1962, *Tweedie 2341* (K) & *Tweedie 2343* (K); ibid., 6200 ft (= 1890 m), 10.1962, *Tweedie 2400* (K). **TANZANIA. Tanzania.** Sine loco, 30.03.1891, *Fischer 611* (B). **Lake (T1). Biharamulo.** Kashasha, 4500 ft (= 1372 m), 10.08.1960, *Tanner 5071* (K). **Western (T4). Ufipa.** Sumbawanga, 7000 ft (= 2134 m), 27.11.1954, *Richards 3444* (K); Mbizi Forest, NE of Sumbawanga, 02.10.1988, *Wiens & Calvin 6998* (K); Mbisi, 7500 ft (= 2286 m), 06.10.1950, *Bullock 3413* (K). **Southern Highlands (T7). Mbeya.** Mbozi, 5300 ft (= 1615 m), 14.11.1932, *Davies 753* (EA, K)

4b. *Hypoxis fischerii* Pax var. *colliculata* (Wiland) Wiland & Nordal in Flora of Tropical East Africa: 13 (2006).

– *Hypoxis hockii* De Wild. var. *colliculata* Wiland in Ann. Missouri Bot. Gard. 88: 321-324, Figs. 9 A-E, 10 C & D, 25 (2001); Singh (2006: 14). TYPE: Democratic Republic of the Congo, Shaba, Plateau des Kundelungu, on the riverside of Lofoi, *Lisowski, Malaisse & Symoens 7682* (POZG!, holo.).
= *Hypoxis subspicata sensu* Geerinck (1971) *pro parte*

Robust herb to 78 cm high; tuber sphaerical or ovoidal, white, cream or yellow, 2.7-3.5 cm wide (when dry); tunic fibrous, 6-25 cm long. Outer leaves 2-3; linear, acute, 5-20 cm long and (1.0-) 1.6-4.0 cm wide, pubescent especially below with tufted trichomes; nerves unequal, 17 to 23 (to 31); inner leaves 15-78 (-102) cm long and 0.8-2.0 cm wide, prominently villous on margins and midrib below and sparsely villous on whole surface with bright tufted trichomes; nerves 11 to 31. Scapes 3 to 7 in number, 17-34 (-50) cm long and ca. 3 mm wide, broadly winged and ciliate in basal part; raceme 6- to 12-flowered; the lowermost bracts 10-17 ca. 2 mm, 3-nerved, bracts in apical part of inflorescence 5-10 mm long and ca. 1 mm wide, abaxially pubescent on midrib; pedicels 4-20 mm long, prominently pubescent. Tepals 6, yellow or orange-yellow; outer tepals elliptic, (9-) 13-16 mm long and (3-) 5-6 mm wide, 5- to 9- nerved; inner tepals ovate, shortly cuspidate at apex, (8-) 11-15 mm long and (5-) 6-8 mm, abaxially pilose on two lower thirds of midrib, 5- to 7- (to 9-) nerved; stamens equal, 5-8 mm long; filaments subulate, 3.5-4.5 mm long; anthers fused or retuse at apex, 4-7 mm long; ovary (3-) 4-6 mm long and (2-) 3-5 mm wide; style subterete or trigonous, 1.0-3.5 mm long; stigma 1-4 mm long, wider than style or equal, obtuse at apex, composed of 3 linear papillate receptive surfaces or of three free triangular lobes with papillae on margins. Capsule (4-) 5-7 mm long and 3-5 mm in diameter; seeds spherical or ovoid, ca. 2 x 1.5 mm, black and matt; seed coat colliculate and micropapillate (Fig. 36).

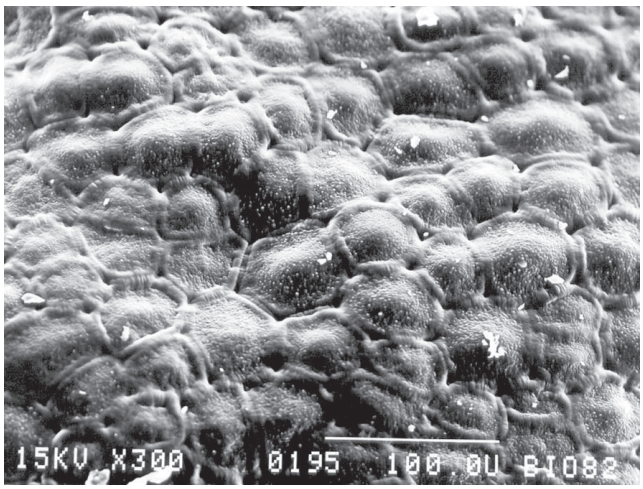


Fig. 36. Seed testa sculpture of *Hypoxis fischeri* var. *colliculata* (from *Richards 2379A*)

Distribution. This variety occurs in the Democratic Republic of the Congo and Tanzania (Fig. 37A) in Zambesian Region. In Tanzania it reaches northern and eastern range limits (Fig. 37B). Taxon collected in the East Tropical Africa between 1829-2286 m a.s.l. Its bottom vertical range limit tends to elevate towards North and East (Fig. 37C). In Tanzania it occurs from 2134 m a.s.l. in T4 and from 1829 m a.s.l. in more eastern situated T7. In the Central Africa it was collected from 1200 m a.s.l. (Wiland-Szymańska 2001).

Habitat. Montane grasslands with clusters of shrubs and trees, upland pasture, among rocks on fireswept eroded hillside; good soil.

Phenology. Flowering from October to December, with a peak in November (Fig. 43). Often after fire. Resting period long. Flowers together with leaves.

Vernacular name. Lipipili (dialect not stated).

Observations. Locally common.

The redescription presented here includes all available data concering this taxon.

IUCN conservation status. Vulnerable.

Specimens studied. **TANZANIA. Western (T4). Ufipa.** Sumbawanga, 7000 ft (= 2134 m), 28.11.1954, *Richards 2379A* (K); Mbisi, 7500 ft (= 2286 m), 06.10.1950, *Bullock 3414* (K); Mbizi Forest Reserve, 2200 m, 18.11.1987, *Ruffo & Kisena 2759* (K). **Southern Highlands (T7). Iringa.** N of escarpment forest & S of Iringa-Mbeya road between James & John's Corner, 6000 ft (= 1829 m), 29.12.1973, *Spjut & Muchai 3467* (EA, K).

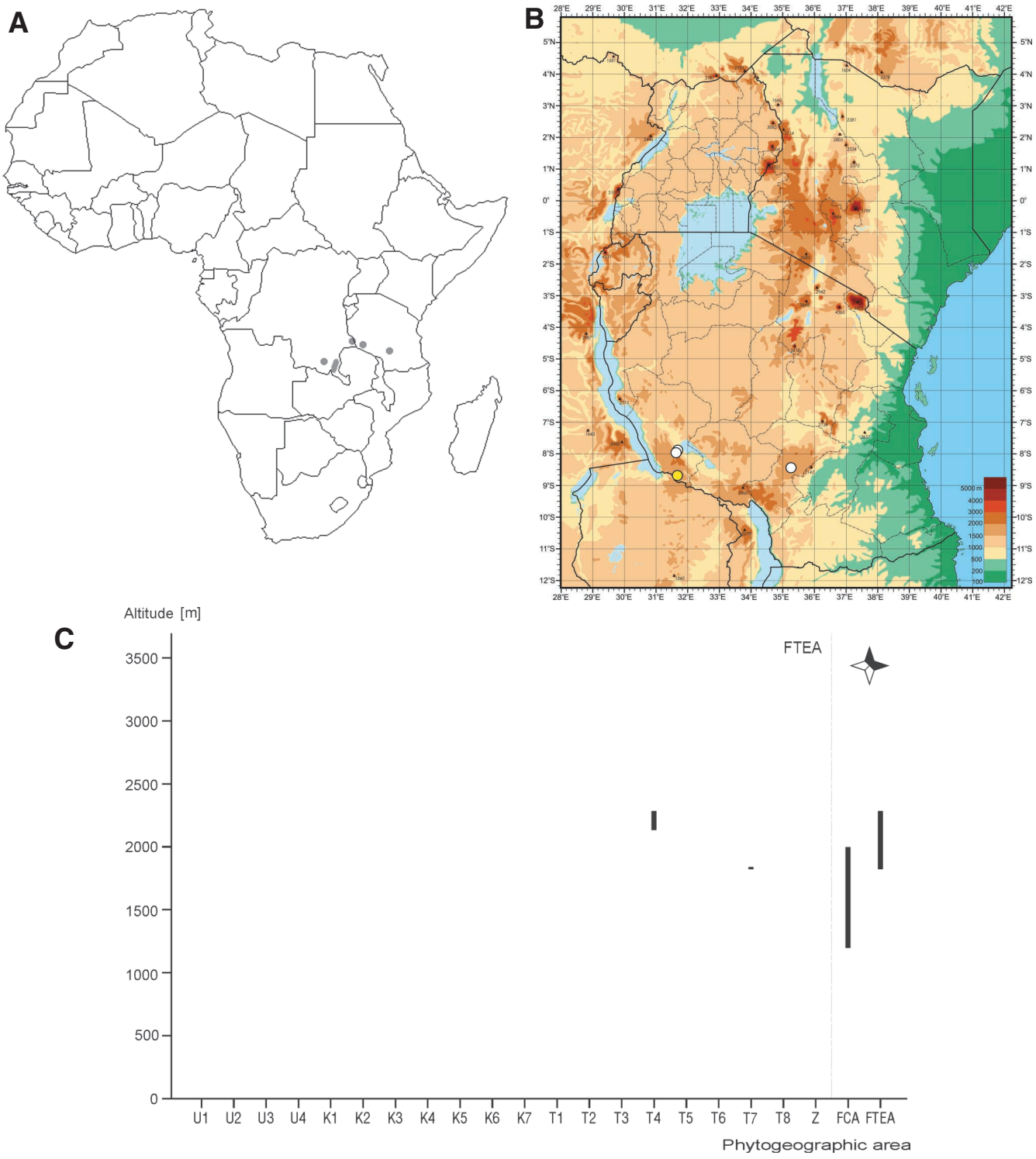


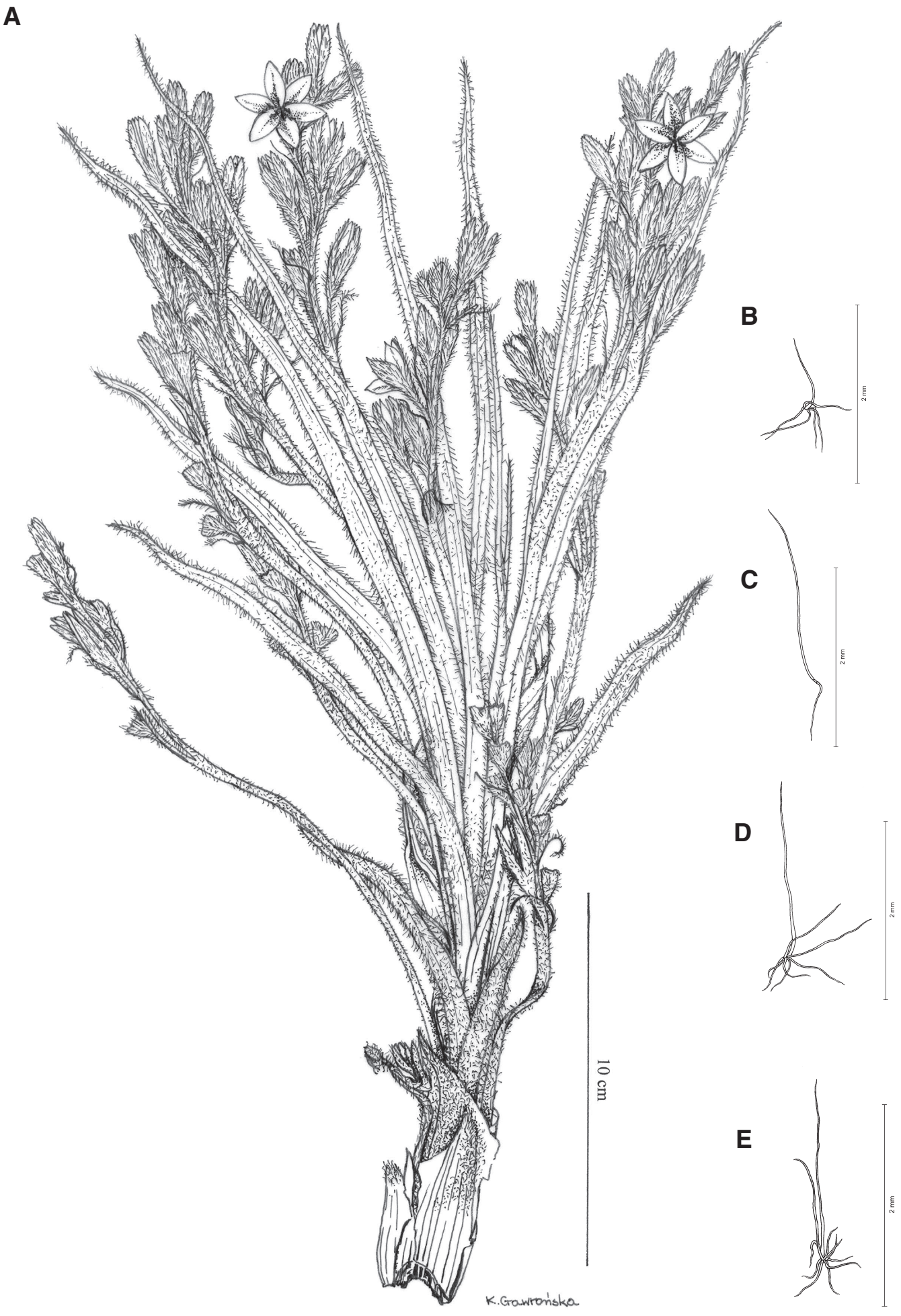
Fig. 37. *Hypoxis fischerii* var. *colliculata*
Explanations: A – general distribution, B – distribution in the East Tropical Africa of *H. fischerii* var. *colliculata* (white dots) and *H. fischeri* var. *katangensis* (yellow dots), C – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

4c. *Hypoxis fischerii* Pax var. *hockii* (Wiland) Wiland & Nordal in Flora of Tropical East Africa: 14 (2006).

– *Hypoxis hockii* De Wild. In Repert. Spec. Nov. Regni Veg. 11: 537 (1913a). TYPE: Democratic Republic of the Congo, Ober-Katanga, *Hock s.n.* (BR!, holotype; B!, isotype). De Wildeman (1913b: 20); Fries (1916: 233); De Wildeman (1921a: 34); Wiland-Szymańska (2001: 320). – *Hypoxis hockii* De Wild. var. *hockii* Wiland in Wiland-Szymańska (2001: 321, Figs. 9F, 10C & D, 25); Singh (2006: 14).

= *Hypoxis pedicellata* Nel in Bot. Jahrb. 51: 315-316 (1914b); De Wildeman (1914: 9); Fries (1916: 233); De Wildeman (1921a: 34). TYPE: Democratic Republic of the Congo, Lualuba, *Deschamps* (BR!, holotype) & Zambia, Mbala Distr., Sisya (Msisi) Forest, *Fries 1261* & *1261a* (UPS!, syntype)

= *Hypoxis polystachya sensu* Nordal & Zimudzi (2001: 14-15) *pro parte*


A
10 cm
K. Gawrońska
B
2 mm
C
2 mm
D
2 mm
E
2 mm

Robust herb, solitary, growing to 90 cm high (Fig. 38A, 38F); tuber white, cream or yellow, getting bluish in apical part after contact with air, conical, turbinate or ovoidal, 4.6-9 cm long and 3.9-6.4 cm wide; tunic fibrous at least to 4.8 cm long. Pseudosteme short; leaves erect, grass or silvery green with light bases; outer leaves ca. 2, oblong, 3-42 cm long and 1-3 cm wide, pubescent, especially on margins, with long, tufted trichomes; nerves ca. 21; inner leaves 4 to 6, linear, narrowing towards the apex, keeled, 12-135 cm long and 0.8- 2.8 cm wide, densely villous with long, white or grey, tufted trichomes (Fig. 38B-D, 38G); nerves unequal 15 to 21, 4 or 6 nerves much larger than others. Scapes ca. 4, 14-30 cm long and 2-4 mm, narrowly winged and ciliate at base, villous apically with long white tufted trichomes (Fig. 38E); raceme 9-11 flowered; bracts subulate, keeled, 7-22 mm long and 1-2 mm wide, the lowermost 3-nerved; pedicels 2-14 mm long, prominently villous. Tepals 6, yellow inside, greenish outside; outer tepals ovate, 14-15 long and ca. 6 mm wide, 7-nerved; inner tepals shortly cuspidate at apex, 13-14 long and ca. 7 mm wide, pilose on lower third of midrib, 5-nerved; stamens equal, 5-7 mm long; filaments subulate ca. 3.5 mm long; anthers fused at apex, 4-5 mm long; ovary 4-9 mm long and ca. 3 mm wide; style terete, 4.5-5.0 mm long; stigma composed of 3 linear lobes fused to apex, 1.5-2.0 mm long. Capsule 5-9 mm long and 3-4 mm wide; seeds ovoid, ca. 2 x 1.5 mm; seed coat with papillae conical, obtuse at apex.

Distribution. This variety occurs in the Democratic Republic of the Congo, Uganda and Tanzania (Fig. 39A) in the Zambesian Region. Its range is continuous and compact only in the southern part of Tanzania. Other of its populations are dispersed in isolated insular localities (Fig. 39B). In the East Tropical Africa it reaches northern and eastern range limits. It was collected between 1250-2200 m a.s.l. In comparison with its vertical range in the Central Africa (Wiland-Szymańska 2001), its bottom vertical range limit is getting elevated towards West and the upper vertical range boundary towards North (Fig. 39C).

Habitat. Miombo woodland, montane grasslands with clusters of shrubs, trees, and/or *Oxytenanthera abyssinica* (A. Rich) Munro, swamp grassland; red soil, gritty or sandy, black loamy soil. In full sun, or in light shade, at tree base.

Phenology. From October to April with peaks in November and February (Fig. 43). In areas of annual fires. The resting period from May to September.

Uses. Medical: Tuber used as medication against swelling of testes.

Vernacular name. Inyeri (Irangi); Lipipili (dialect not stated).

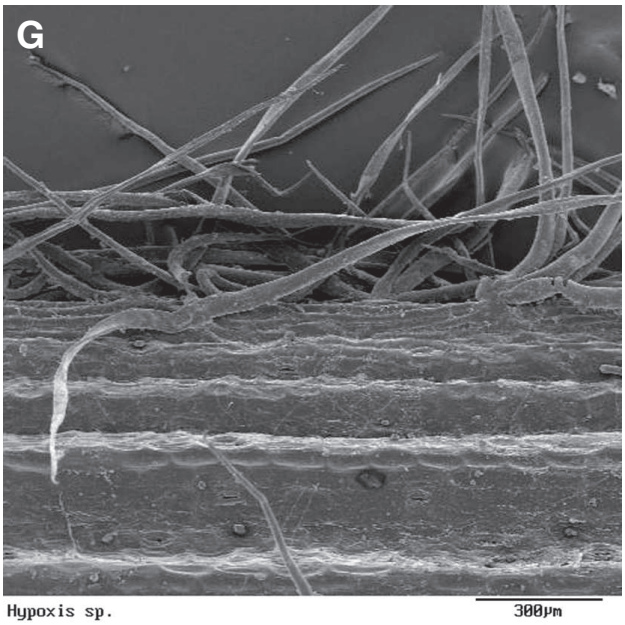


Fig. 38 *Hypoxis fischerii* var. *hockii*
Explanations: A – habit (from *Lisowski, Malaisse & Symoens 11797*), B – tufted trichome from leaf lamina (from *Hazel 441*), C – two-branched trichome from leaf lamina (from *Hazel 441*), D – tufted trichome from leaf edge (from *Hazel 441*), E – tufted trichome from scape (from *Hazel 441*), F – living plant (from *Wiland & Mboya 99*), G – SEM of tufted trichomes on a leaf (from *Wiland & Mboya 99*)

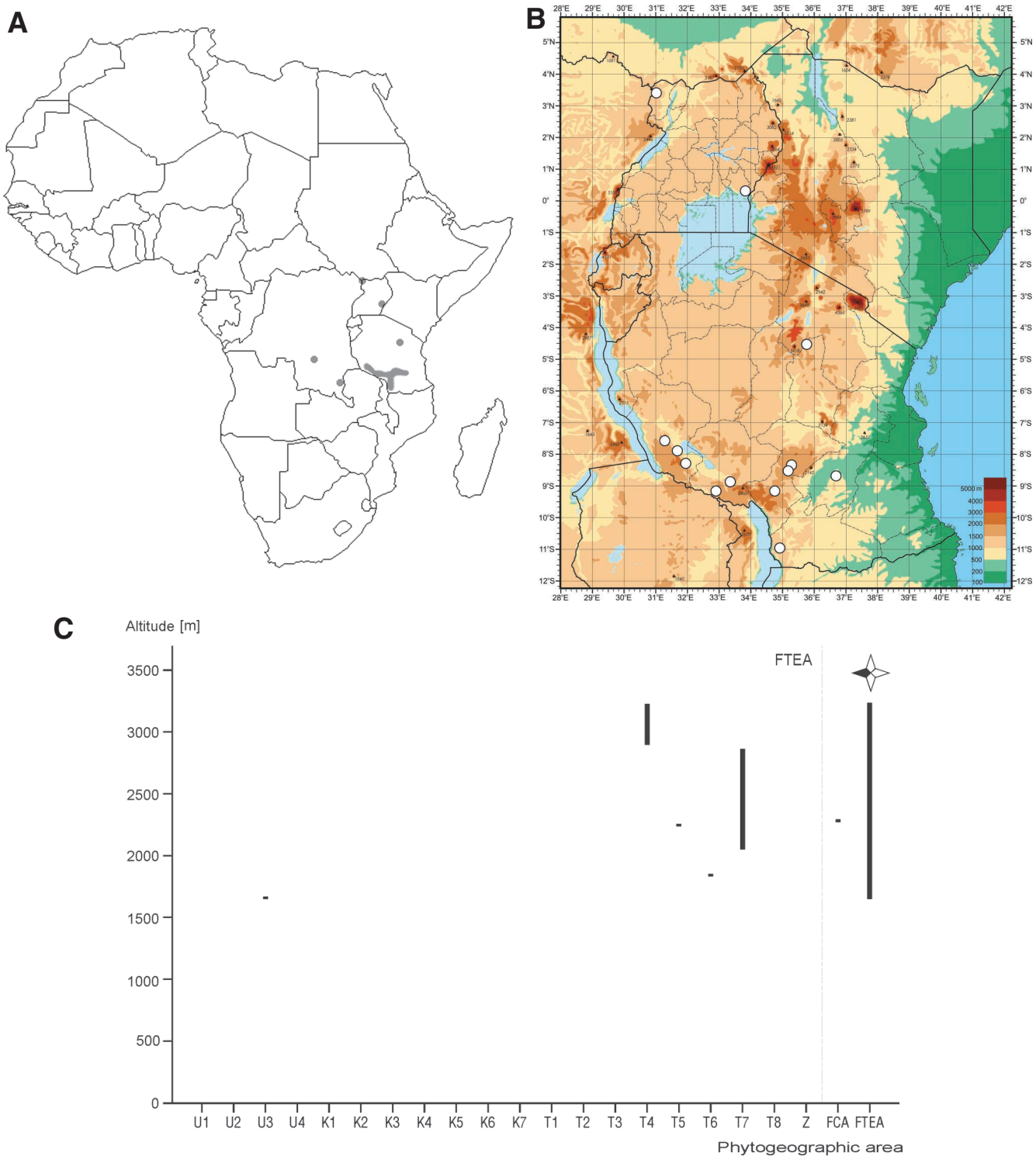


Fig. 39. *Hypoxis fischerii* var. *hockii*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

Observations. The redescription presented here includes all available data concering the morphology of this taxon.

IUCN conservation status. Least Concern.

Specimens studied. **UGANDA. Northern (U1). West Nile.** Kobboko [Koboko], *Eggeling 1840* (K); Koboko, 03.1938, *Hazel 441* (BR, K, S). **Eastern (U3). Busoga.** 1 mile E of Nankoma Hill, 4 miles SSE of Kyemure, 3700 ft (= 1128 m), 16.04.1953, *Wood 992* (B, BR, K, P, PRE, S). **TANZANIA. Western (T4). Ufipa.** Mbizi Forest, 7000 ft (= 2134 m), 14.11.1970, *Sanane 1388* (K); ibid., 2200 m, 18.11.1987, *Benham s.n.* (K); Chala Mountain, 2100 m, 10.12.1956, *Richards 7207* (BR, K); Mmemya highlands, 6500 ft (= 1981 m), 01.12.1954, *Richards 3500* (BR, K). **Central (T5). Kondoa.** Bereku Ridge on Salanga hill, 5000 ft (= 1524 m), 13.01.1928, *Burtt 1064* (K). **Eastern (T6). Ulanga.** Kwiro Mission to Kwiro Forest Reserve, 1250 m, *Cribb, Grey Wilson & Muasumbi 11039* (K). **Southern Highlands (T7). Mbeya.** Pungaluma Hills above Mshewe, 1950 m, 22.11.1989, *Lovett & Kayombo 3421* (MO); Old Vwawa,

1400 m, 02.03.2001, *Wiland & Mboya 157* (NHT, MO, POZG). **Iringa.** Mufindi, N of escarpment forest & S of Iringa-Mbeya road between James & John's Corner, vicinity of Ngwazi Estate, ca. 6000 ft (= 1829 m), 29.10.1973, *Spjut & Muchai 3460* (K); 3 km SW of Mafinga on road to Mbeya, 1800 m, 14.02.2001, *Wiland & Mboya 83* (NHT, POZG); ca. 4 km SW of Mafinga on road to Mbeya, 1800 m, 17.02.2001, *Wiland & Mboya 99* (MO, NHT, POZG); N side of Ngwazi Lake, 1700 m, 15.02.2001, *Wiland & Mboya 89* (MO, POZG). **Njombe.** Igima Village., 1720 m, 23.02.2001, *Wiland & Mboya 109* (NHT, POZG). **Southern (T8). Songea.** Myangayanga Mountains, above Myangayanga, 1450 m, 21.02.2001, *Wiland & Mboya 105* (NHT, POZG).

4d. *Hypoxis fischerii* Pax var. *katangensis* (De Wild.) Wiland & Nordal in Flora of Tropical East Africa: 14 (2006).

– *Hypoxis katangensis* Nel *ex* De Wild. in Bot. Jahrb. 51: 312 (1914b). TYPE: Democratic Republic of the Congo, Katanga, *Verdick s.n.* (BR!, lectotype, here designated). Zambia, zwischen dem Banguelo-See and Tanganyika, *Fries 1148* (UPS!, syntype); De Wildeman (1914: 8); De Wildeman (1921a: 34). – *Hypoxis hockii* De Wild. var. *katangensis* (Nel *ex* De. Wild) Wiland in Ann. Missouri Bot.Gard. 88: 324, Figs. 9 G-J, 10 E, 27 (2001); Singh (2006: 14).
= *Hypoxis aculeata* Nel in Bot. Jahrb. 51: 327-328 (1914b); Singh (2006: 14). TYPE: Tanzania, Msambia, 1800 m, 15.11.1908, *Münzner 59* (B!, holotype)
= *Hypoxis obtusa* complex *sensu* Nordal *et al.* (1985: 28) *pro parte*.
= *Hypoxis polystachya sensu* Nordal & Zimudzi (2001: 14-15) *pro parte*

Medium herb to 36 cm high; tuber not known. Outer leaves 3-4, wide elliptical, 3.6-7.8 cm long, 4-5 mm wide, pubescent on whole surface below with long white two-branched or tufteded trichomes, sparsely pubescent in apical part above; nerves unequal, 27 to 39; inner leaves 5 to 15, linear, 10.5-35.0 cm long, 8-14 mm wide, prominently pubescent on margins and the midrib below with tufteded trichomes, on surface only sparsely pubescent with 2- or 3-branched trichomes, in basal part only ciliate; nerves unequal, 25 to 39. Scapes 5 to 12, 7-34 cm long, 3 mm wide, pubescent with golden tufted trichomes; raceme 8-13-flowered; bracts filiform or subulate, 10-20 mm long, 1-2 mm wide, the lowermost usually 1-nerved, rarely 3-nerved; pedicels 6-15 mm long. Flowers yellow, tepals 6; outer tepals ovate, acute, with a clavate appendage, 10-14 mm long and 3-5 mm wide, 5- to 9-nerved; inner tepals broadly ovate, obtuse at apex, 10-11 mm long and 4-7 mm wide, 7 nerved, pilose abaxially on two lower thirds of midrib; stamens 6-10 mm long; filaments almost linear, 3-3.5 mm long; anthers 4.5-8.0 mm long, slightly or not emarginate at apex; ovary 3.5-5.0 long and 3.5-4.0 mm wide; style 2-4 mm long; stigma ca. 2 mm long, composed of three fused lobes and conical or composed of three free lobes, obtuse at apex. Capsule 6-7 x 4-5 mm; seeds ovoid, ca. 1.5 x 1 mm wide, black and glossy; seed coat with long-acuminate conical papillae.

Distribution. This variety occurs in the Democratic Republic of the Congo, Tanzania and Zambia (Fig. 40A) in the Zambesian Region. It reaches its northern range limit in Tanzania (Fig. 37B), where it grows at 1800 m a.s.l., in lower altitude than in the Democratic Republic of the Congo in the West (Wiland-Szymańska 2001) (Fig. 40B).

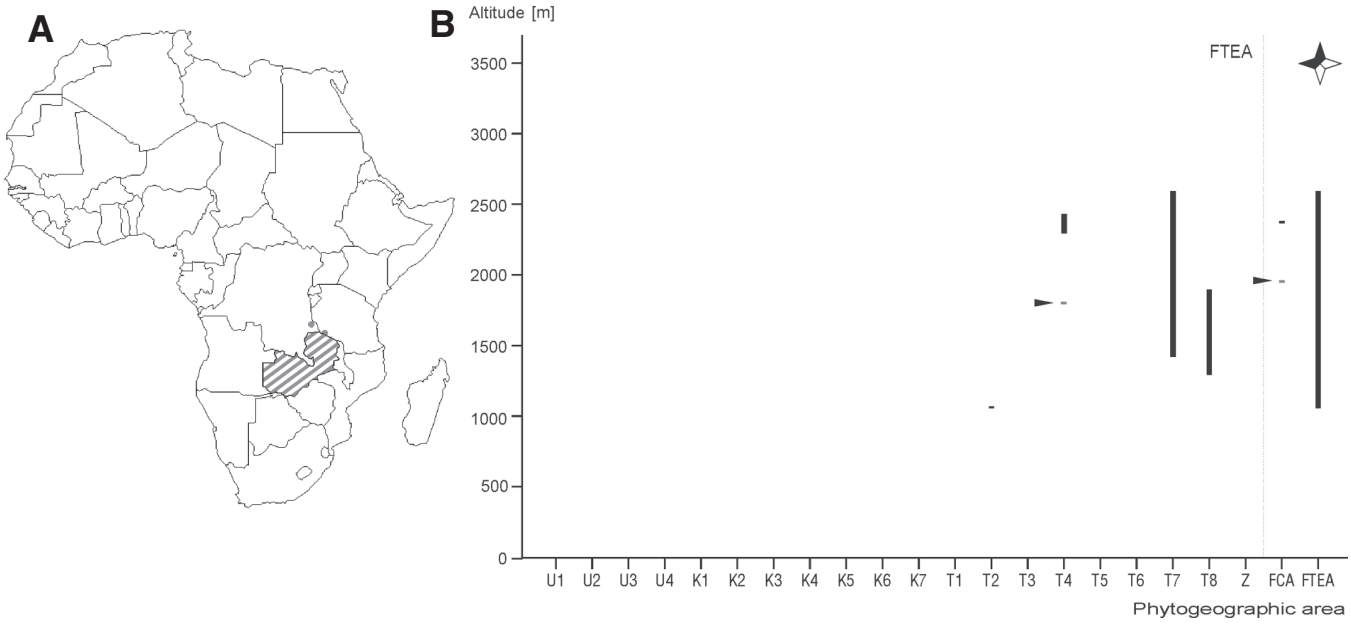


Fig. 40. *Hypoxis fischerii* var. *katangensis*
Explanations: A – general distribution, B – vertical ranges of *H. fischerii* var *katangensis* (arrows) and *H. fischerii* var. *zernyi* in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26


A
10 cm
K.Gawrońska
B
1 mm
C
1 mm
D
1 mm

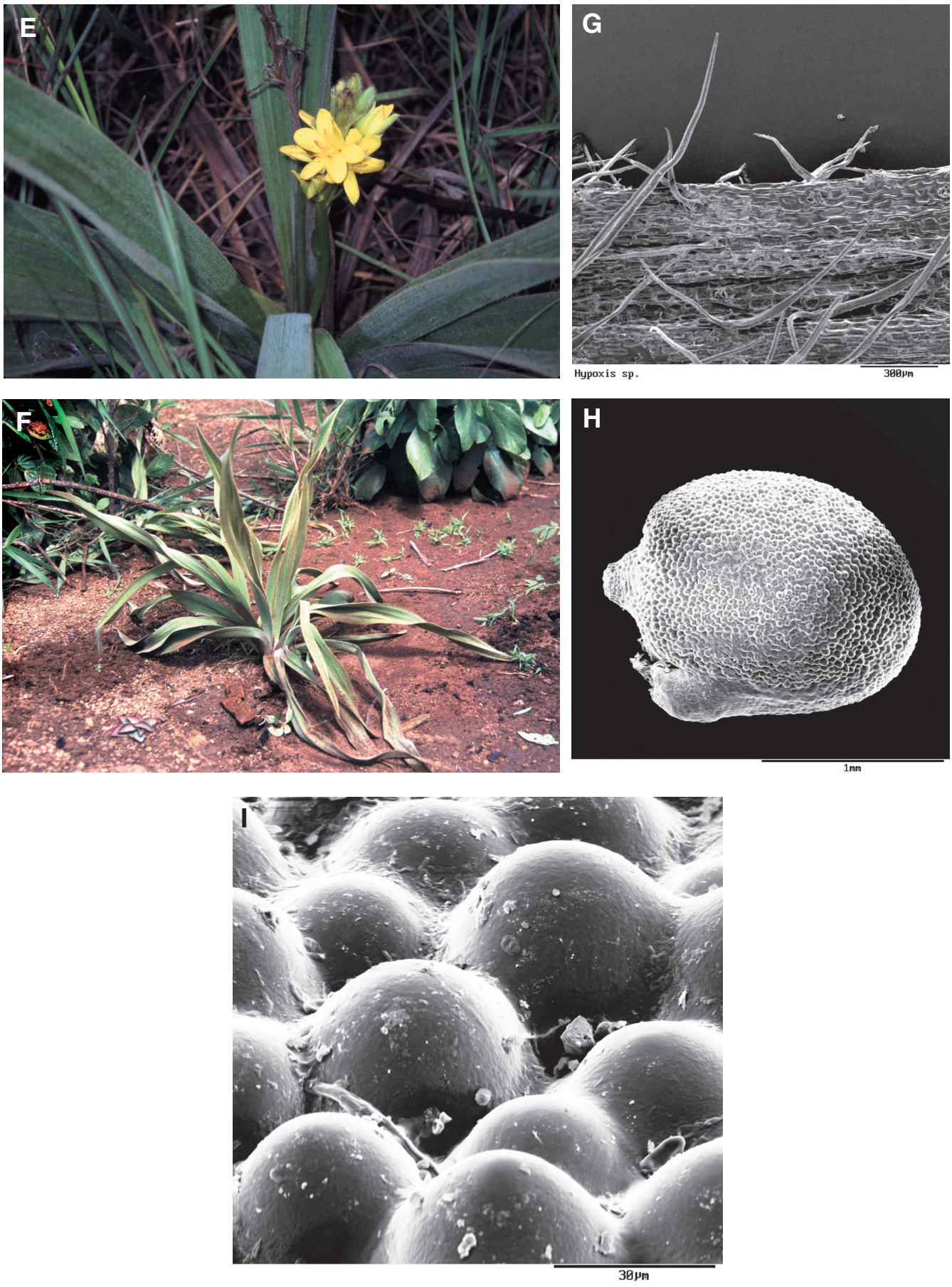


Fig. 41. *Hypoxis fischerii* var. *zernyi*
Explanations: A – habit (from *Wiland & Mboya 93*), B – two-branched trichome from leaf lamina (from *Haarer 95B*), C – tufted trichome from leaf edge (from *Haarer 95B*), D – tufted trichome from scape (from *Haarer 95B*), E-F – living plants (E from *Wiland & Mboya 87*, F from *Wiland & Mboya 86*), G – SEM of tufted trichomes on a leaf (from *Wiland & Mboya 87*), H – seed (after *Wiland & Mboya 80*), I – seed testa sculpture (after *Wiland & Mboya 80*)

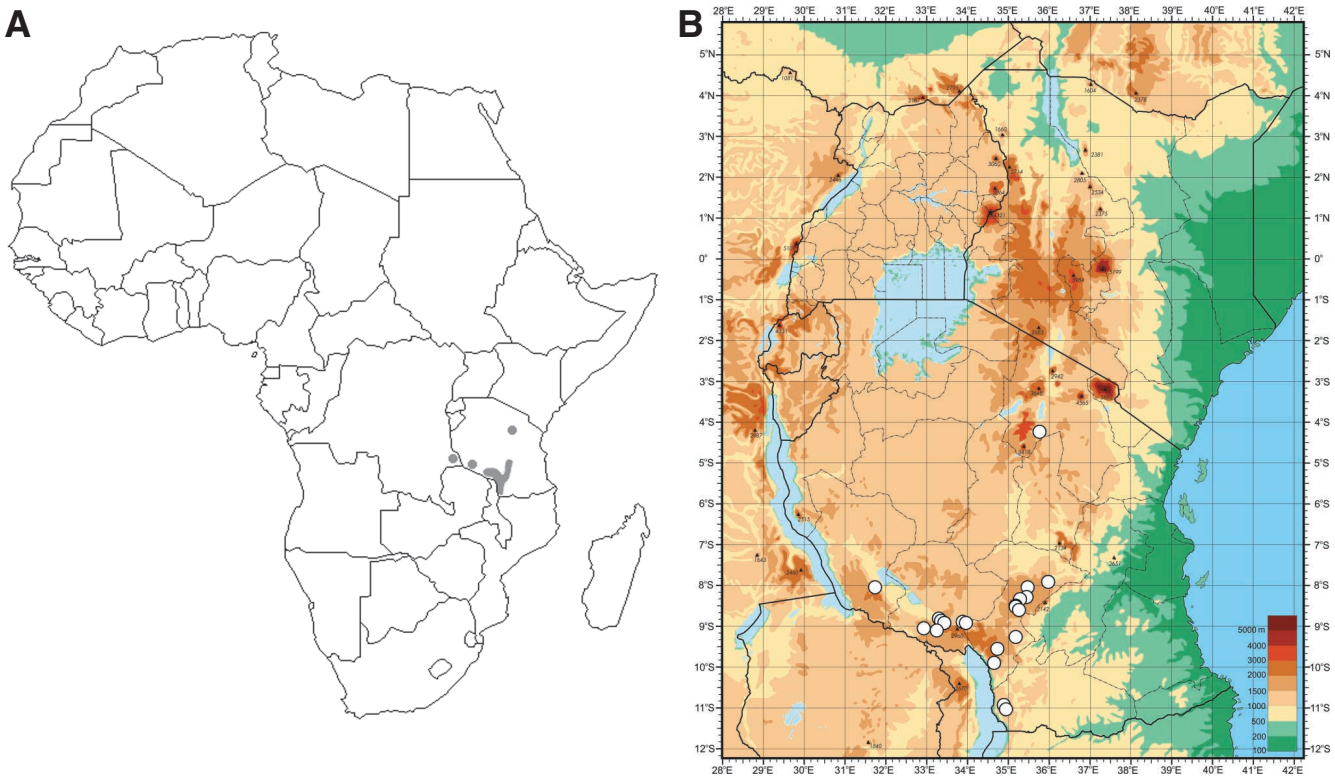


Fig. 42. *Hypoxis fischerii* var. *zernyi*
Explanations: A – general distribution, B – distribution in the East Tropical Africa

Habitat. In short grass and open slightly marshy places.

Phenology. In November already in fruiting stage. Flowers develop before leaves, but persist as infrutescenses, when they are developed (Fig. 43).

IUCN conservation status. Critically Endangered (Extinct?).

Specimen studied. **TANZANIA. Western (T4). Ufipa.** Msamvia [Msambia], 1800 m, 15.11.1908, *Münzner 59* (B).

4e. *Hypoxis fischerii* Pax var. *zernyi* (Schulze) Wiland & Nordal in Flora of Tropical East Africa: 14, Fig. 2 (2006).

– *Hypoxis zernyi* Schulze in Notizbl. Bot. Gart. Berlin 14: 375-376 (1939). TYPE: Tanzania, Matengo-Hochland, WSW von Songea, Berg Lupembe, *Zerny 20* (W!, holotype, B!, isotype); Singh (2006: 15).
= *Hypoxis matangensis* Schulze in Bot. Gart. Berlin 14: 376 (1939). TYPE: Tanzania, Matengo Hochland, WSW von Songea, Wege Linda-Uyangayanga, *Zerny 374* (B!, holotype); Singh (2006: 15)
= *Hypoxis obtusa* complex *sensu* Nordal *et al*. in Nordic J. Bot. 5: 28 (1985) *pro parte*.

Robust herb to 70 cm high; growing separately or in dense clumps (Fig. 41A, 41E-F); tuber ovoidal or oblong, bright yellow to deep orange inside, lighter in the apical part, getting bluish exposed to air, with a light acrid smell, 5.6-10 cm long, 4-8 cm in diameter; often dividing into smaller; sap copious; roots white; tunic fibrous with wide remnants of old leaf blades, black or beige, to 12 cm long. Leaves growing in three rows, grass green or yellowish green, often with white and red bases; outer leaves lanceolate, reflexed, 5-15 cm long, 12-20 mm wide, ciliate with tuft trichomes on the midrib and the edges, 40-42-veined, hirsute on the whole surface of the blade with 2-branched trichomes, more sparsly adaxial; inner leaves wide lanceolate, acute, reflexed, carinate, about 10-60 cm long and (1.0-) 2.4-5.7 cm wide, 32-72-veined, ciliate with tuft trichomes on the midrib and the edges, densely hirsute on both sides of the blade with 2-branched trichomes; trichomes greyish-white or whitish yellow, to 1.5 mm long (Fig. 41B-C, 41G). Scapes 2-10, compressed, reddish at base, 11-34 cm long, 2-4 mm wide, ciliate in basal part, densely covered with tuft trichomes in upper part; inflorescence racemose, 6-7 flowered, often with 2 or 3 flowers at the same node; first three flowers with pedicelles almost equal in length, therefore inflorescence primarily subumbellate, later elongating into raceme; bracts subulate-lanceolate, 10-27 mm long, 2-4 mm wide, 3-5 (-9) veined, hirsute with tuft trichomes on midrib below, sometimes ciliate in apical part (Fig. 41D); pedicells +/- densely hirsute, almost opposite, of varying length, from 2- 20 mm long; flowers usually with a distinctive sweet smell, tepals lemon-yellow or deep yellow above, green with yellow edges below; outer tepals lanceolate, acute, covered with dens indumentum below, 15-20 mm long, 5-6 mm wide, with

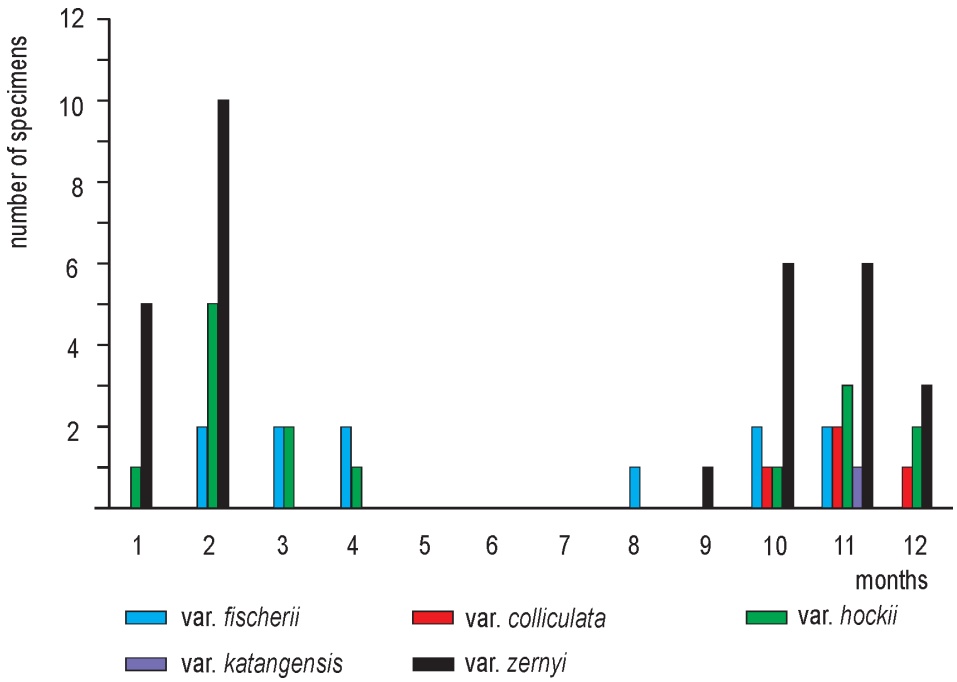


Fig. 43. Flowering periods of varieties of *Hypoxis fischerii*

7 irregular vines; inner tepals ovale, obtuse, 14-18 mm long, 6-8 mm wide, covered with sparse indumentum on the midrib below, 7-veined; stamens almost equal, 6-7 mm long; filaments subulate, about 2.5-4 mm long; anthers linear, basifixe, entire at the apex, sagittate in the basal part, about 5-6 mm long; ovary green, almost obconical, 4-7 mm long, 3-5 mm wide, densely pilose; style 3.5-6.0 mm long; stigma 1-3.5 mm long. Capsule green, obconical, 5-7 mm long, 5-7 mm wide, hirsute; seeds black, polished, flatly colliculate (Fig. 41H-I).

Distribution. This variety occurs in the Democratic Republic of the Congo and Tanzania (Fig. 42A) in the Zambesian Region. Its centre of abundance is situated in the southern Tanzania (Fig. 42B), and can be regarded as an subendemite to this area. It occurs between 1067-2600 m a.s.l. Its bottom limit of vertical range is elevating towards North and West (Fig. 40B). In the Democratic Republic of the Congo it was collected at 2380 m a.s.l. (this study).

Habitat. Open woodland, shrubland, grassland, montane grassland with clusters of shrubs and trees, rocky hillside, rock clefts, in shamba near house; red loam soil, rocky soil. In areas of annual fire. In the sun.

Phenology. From September till February, with peaks in October-November and January-February (Fig. 43). Plants with well developed leaves. Flowers scented. In the field, numerous small ants were seen on inflorescences, one of them collecting pollen. One beetle that ate pollen was observed.

Uses. Medical: Tuber used as medication against swelling of testes.

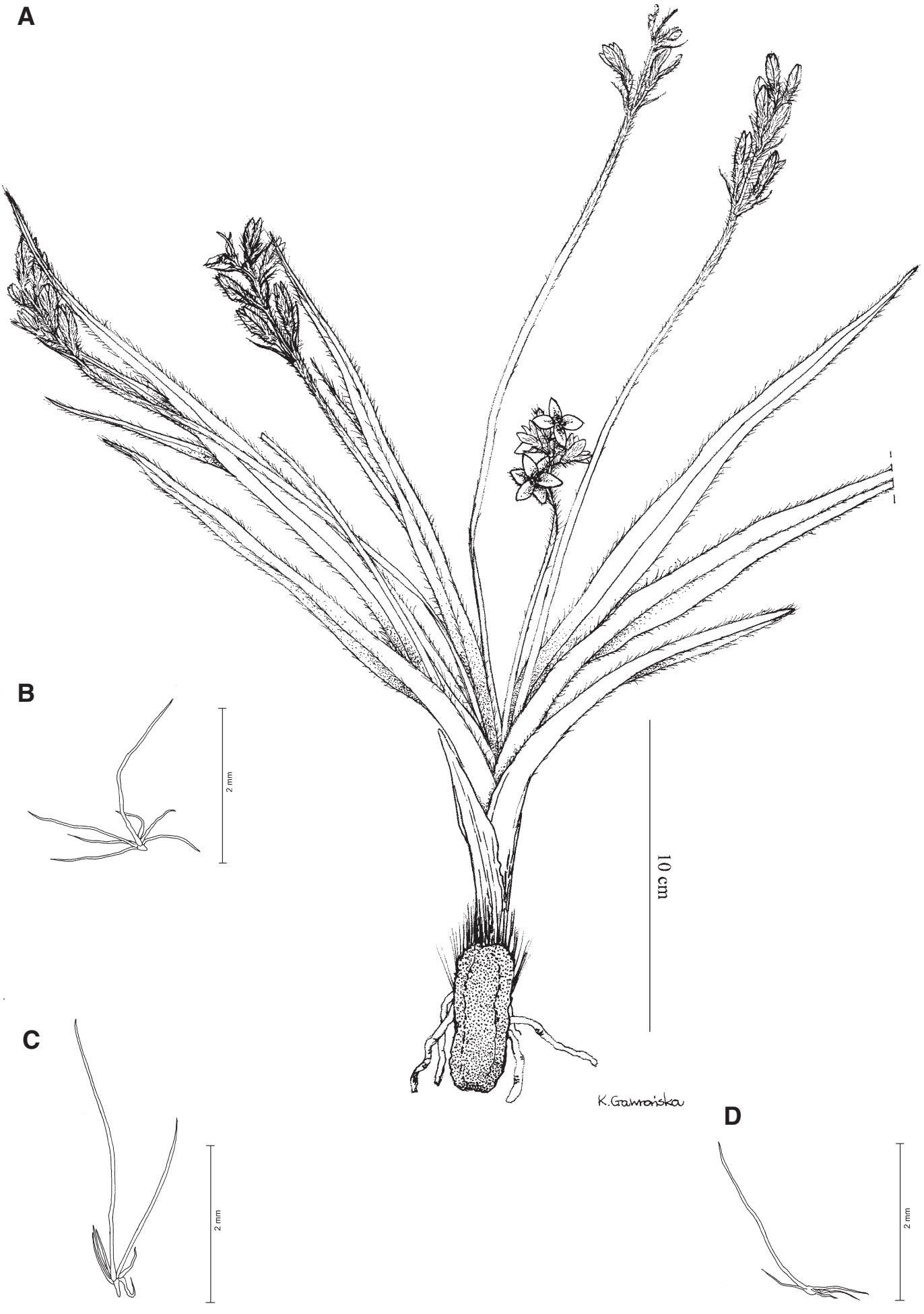
Vernacular name. Lipipili (dialect not stated).

Observations. Locally very common.

The redescription presented here includes all characters characteristic for this taxon.

IUCN conservation status. Least Concern.

Specimens studied. **TANZANIA. Northern (T2). Mbulu.** Babati, Ufiome, approx 3500 ft (= 1067 m), 10.1925, *Haarer 95.B* (K). **Western (T4). Ufipa.** Malonje, 8000 ft (= 2438 m), 12.02.1949, *Bullock 1884* (K); Malonje Montain near Sumbawanga, 2300 m, 01.01.1967, *Schultze 238* (B, EA). **Southern Highlands (T7). Mbeya.** Chimala Escarpment, 1800 m, 06.01.1957, *Richards 7501* (K); ibid., 2100 m, 03.12.1963, *Richards 18530* (K); on the plateau above Chimala Escarpment, 1920 m, 28.02.2001, *Wiland & Mboya 153* (MO, NHT, POZG); Mbeya, 28.09.1932, *Geilinger 2774* (K); Mbeya Peak, 2600 m, 01.10.1932, *Geilinger 2830* (K); 4 miles from Mbeya on Chunya Road, 7000 ft (= 2134 m), 11.01.1970, *Nicholson 125* (EA); Mbosi Circle, Mbeya-Ivuna, 1500 m, 13.01.1961, *Richards 13919* (K); Ivilungu, Umalila, 07.11.1977, *Leedal 4678* (K); Pungaluma Hills above Mshewe on plateau, 1950 m, 22.11.1989, *Lovett & Kayombo 3420* (MO); ibid., 2000 m, 25.11.1989, *Lovett & Kayombo 3473* (MO, P); E of Muvwa and Mshewe villages, Itagano above Shokwa Plateau, 2250 m, 27.10.1990, *Lovett & Kayombo 4860* (MO). **Iringa.** 55 miles from Iringa towards Mbeya, 6000 ft (= 1829 m), 06.11.1969, *Batty 841* (K); at Ifunda, 33 km SW of Iringa along road to Mbeya, 28.12.1971, *Bjørnastad A. 566* (DSM, K); Mufindi, 6000-6500 ft (= 1829-1981 m), 07.10.1968, *Paget-Wilkes 204* (EA, MO); N of escarpment forest & S of Iringa –Mbeya Road between James & John's Corner, 6000 ft (= 1829 m), 29.10.1973, *Spjut & Muchai 3461* (EA, K); Kisinga, 1500 m, 13.02.2001, *Wiland & Mboya 76* (NHT, POZG); near Kisinga village, 1540 m, 13.02.2001, *Wiland & Mboya 80* (MO, NHT, POZG); 3 km from Mafinga on the road to Mbeya, 1800 m, 14.02.2001, *Wiland & Mboya 82* (MO, NHT, POZG); Sao Hill Forest Reserve, 1750 m, 15.02.2001 *Wiland & Mboya 86* (MO, NHT, POZG) & *Wiland & Mboya 87* (NHT,


A
B
2 mm
10 cm
K.Gawrońska
C
2 mm
D
2 mm

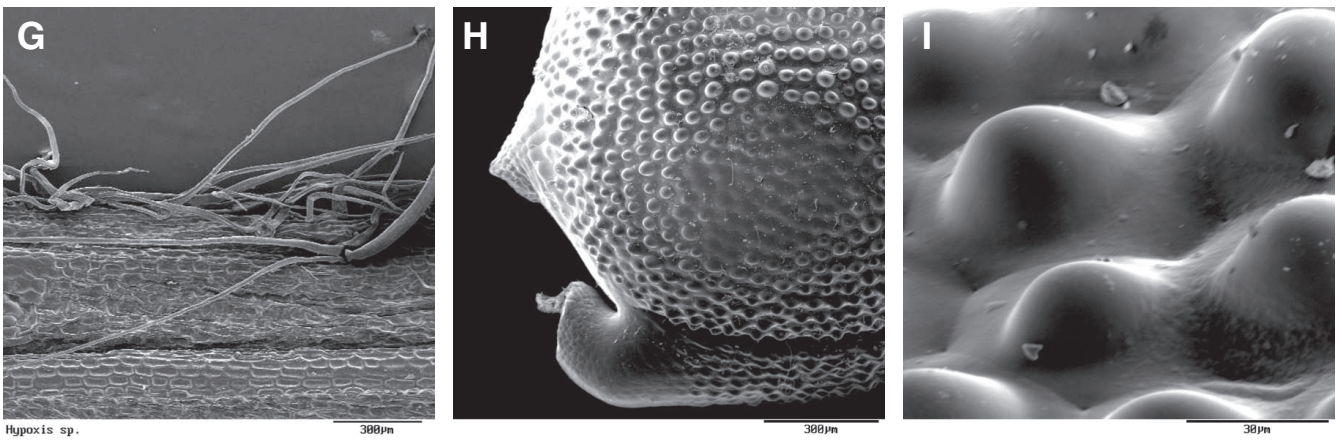


Fig. 44 *Hypoxis galpinii*
Explanations: A – habit, B-C – tufted trichomes from leaf edge, D – tufted trichome from scape, E – living plant, F – tuber, G – SEM image of tufted trichomes on a leaf, H – micropylar part of seed, I – seed testa sculpture (from *Wiland & Mboya 57*)

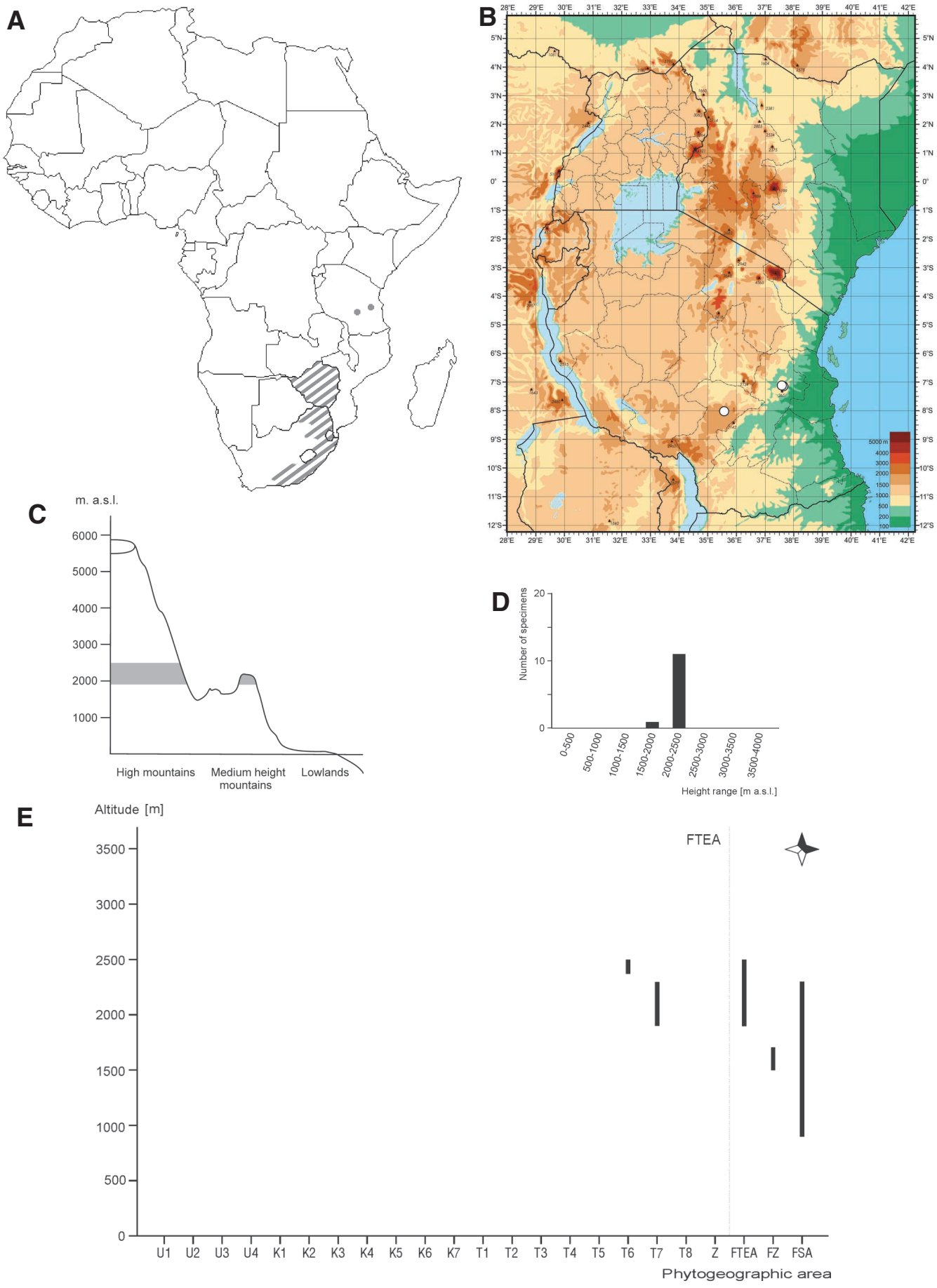


Fig. 45. *Hypoxis galpinii*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

POZG); Itimbo village, 1800 m, 16.02.2001, *Wiland & Mboya 93* (POZG). **Njombe.** Milo, 2300 m, 25.10.1978, *Archbold 2615* (K); Matembwe, Mtakuja Subvillage, 1420 m, 24.02.2001, *Wiland & Mboya 123* (MO, NHT, POZG); Luponde, Mnogwela Street, 2010 m, 25.02.2001, *Wiland & Mboya 132* (POZG). **Southern (T8). Songea.** Matengo-Hochland WSW von Songea, Lupembe Hill, 1900 m, 22.11.1935, *Zerny 20* (B, W); ibid., Linda – Uyangayenga, 1300-1400 m, 25.01.1936, *Zerny 374* (B, W); Lupembe Forest Reserve, 14.11.1956, *Semsei 2593* (EA, K).

5. *Hypoxis galpinii* Baker in Fl. Cap. 6: 188 (1896) as "*Hypoxis galpini*". TYPE: South Africa, Transvaal, *E. E. Galpin 1098* (PRE, holotype; K!, isotype).

Nel (1914b: 320); Compton (1976: 130); Berry (1980: 45); Heideman (1987: 246, Fig. 90I); Zimudzi (1996: 16); Pooley (1998: 234); Nordal & Zimudzi (2001: 11); Snijman & Singh (2003: 1072); Singh (2006: 14); Wiland-Szymańska & Nordal (2006: 11, Figs. 1.2, 1.5)
= *Hypoxis infausta* Nel in Bot. Jahrb. 51: 319-320 (1914b); Singh (2006: 14). TYPE: Tanzania, Morogoro, Uluguru, *Stuhlmann 9161* (B!, holotype).

Medium herb up to 40 cm tall (Fig. 44A, 44E); tuber orange inside, subglobose or elongated, 4.0-5.5 cm long and 1.5-3.7 cm wide, rarely producing two shoots (Fig. 44F); sap not copious; tunic fibrous, brown or black. Leaves yellow green to deep green, sheathing basal part, forming a short white pseudostem, drying dark purple; outer leaves 2-5, lanceolate, acuminate, slightly carinate, recurved, 4.5-25 cm long, 0.8-3 cm wide, covered abaxially with white tufted trichomes on lamina, midrib and edges; trichomes 3-4-branched, up to 3 mm long; veines 10-33; inner leaves 4-10, lanceolate, acuminate, slightly recurved, 14-40 cm long and 1.0-2.2 cm wide, with white hairs on margins and midrib abaxially, glabrous on both surfaces or with sparse indumentum also on the lamina abaxially; trichomes tufted, 3-9(12)-armed, up to 5 mm long (Fig. 44B-C, 44G); veins 13-45. Inflorescences 2-7, spicato-racemose, with scapes 11.5-30 cm long, 1.5-3 mm wide, pubescent in the upper part with tufted trichomes (Fig. 44D); pedicels alternate, 2-8 mm long (upper flowers usually sessile), pubescent; bracts subulate to lanceolate, 10-20 mm long, 2-5 mm wide, 3-5 veined, with trichomes on the midrib abaxially, ciliate in juvenile plants. Flowers 4-10, tepals 4-6; sometimes flowers with different number of tepals occur on this same scape; tepals golden yellow inside; green outside, broadly elliptic, apiculate, 7-11 mm long and 3-5 mm wide, 7-9 veined, covered with trichomes abaxially; inner tepals green along midrib outside, broadly elliptic, obtuse, 6.2-10.5 mm long and 4-6.5 mm wide, 7-9 veined; stamens unequal; outer 3.5-5.2 with filaments 1.7-2.2 mm long, inner 3.5-5 mm long with filaments 1.4-1.7 mm long; filaments subulate; anthers 2.5-4.8 mm long with theca fused; ovary obconical 3-4 mm long and 2-3 mm wide; style 0.8-2.5 mm long; stigma 1.2-2.5 mm long with 3 free or fused erect lobes. Capsule cylindric-turbinate to clavate, 5-10 cm long and 4.5-5 mm wide, circumscissile. Seeds black and glossy, 1.5-1.6 × 1.2-1.4 mm, ovoidal; testa most often papillate, cuticle smooth (Fig. 44H-I).

Distribution. A widely dispersed species occuring in Tanzania, Zimbabwe, Swaziland and South Africa (Fig. 45A). It is spread in the Zambezian Region, the Afromontane Archipelago-like regional centre of endemism, the Zanzibar-Inhambane Regional Mosaic, the Kalahari-Highvel Transition Zone and the Tongoland-Pondoland Regional Mosaic. Its centre of abundance is situated in the South Africa. In Tanzania, where it reaches its northern and eastern limits, its range is disjunct and composed of isolated islands (Fig. 45B). Its vertical range oscilates between 1900-2500 m a.s.l. (Fig. 45C) in the mountain and afrosubalpine vegetation zone belts. The maximum number of collections was made between 2300-2500 m a.s.l. (Fig. 45D) in the Morogoro Mountains, in the afrosubalpine vegetation zone belt (Pócs 1976a, b). The bottom limit of vertical range of this species is elevating towards North (Nordal & Zimudzi 2001, Snijman & Singh 2003) up to its northernmost population on the Lukwangule Plateau (Fig. 45E).

Habitat. Montane grassland with scattered trees, secondary grassland; rocky black mineral soil (pH 6.8), loamy soil.

Phenology. Flowering from November till March (Fig. 46). Flowers appear together with leaves and are open at least in the middle of the day. More than one flower opens on the inflorescence at the same time.

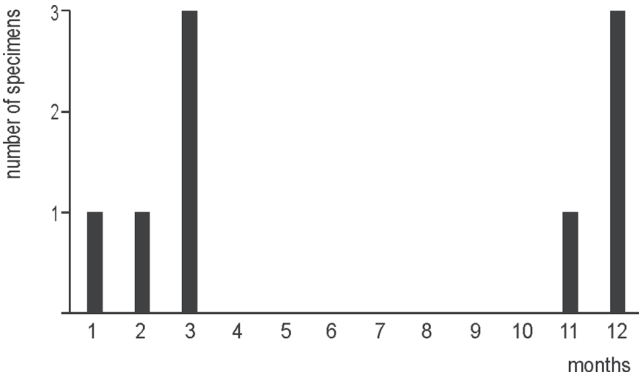


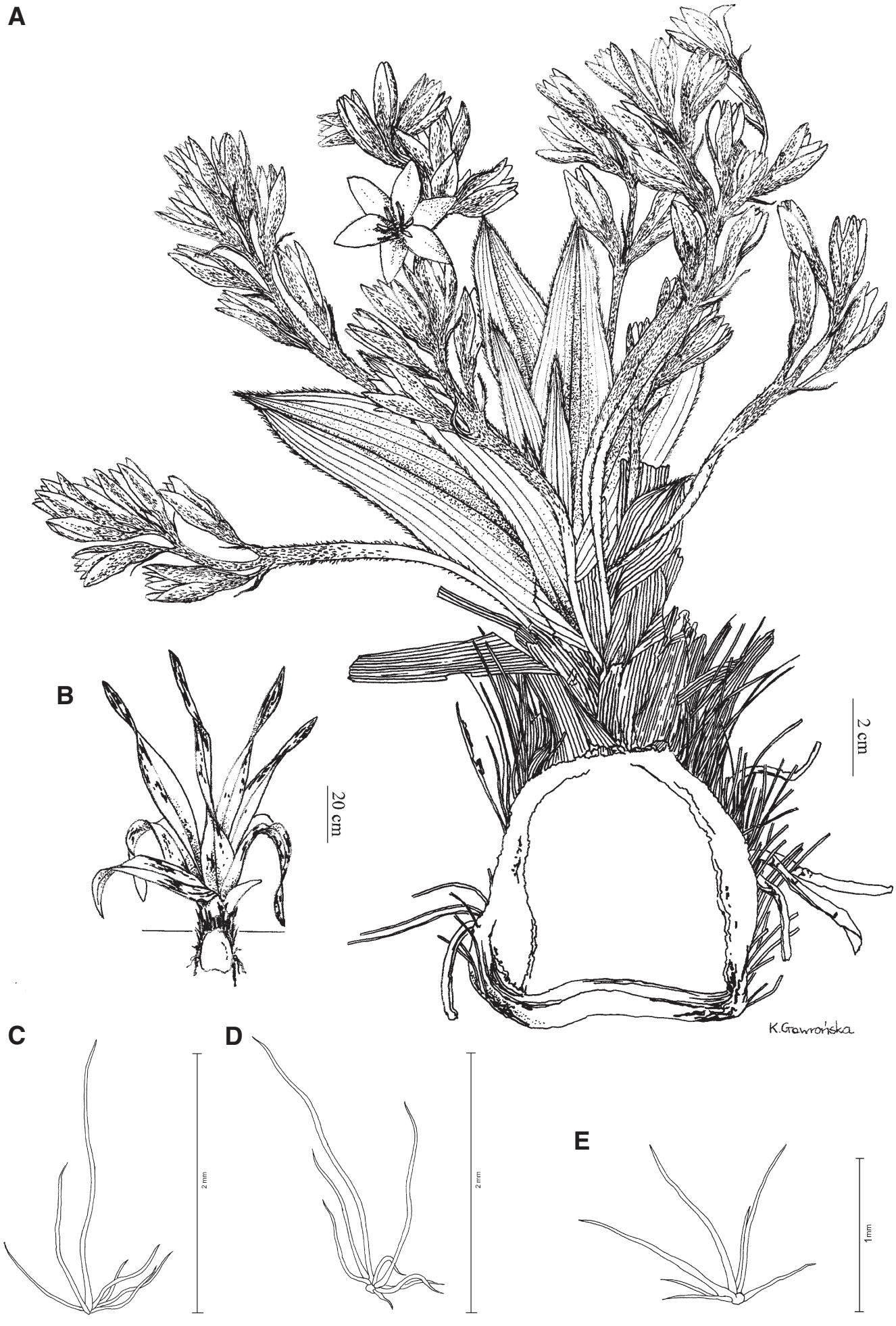
Fig. 46. Flowering periods of *Hypoxis galpinii*

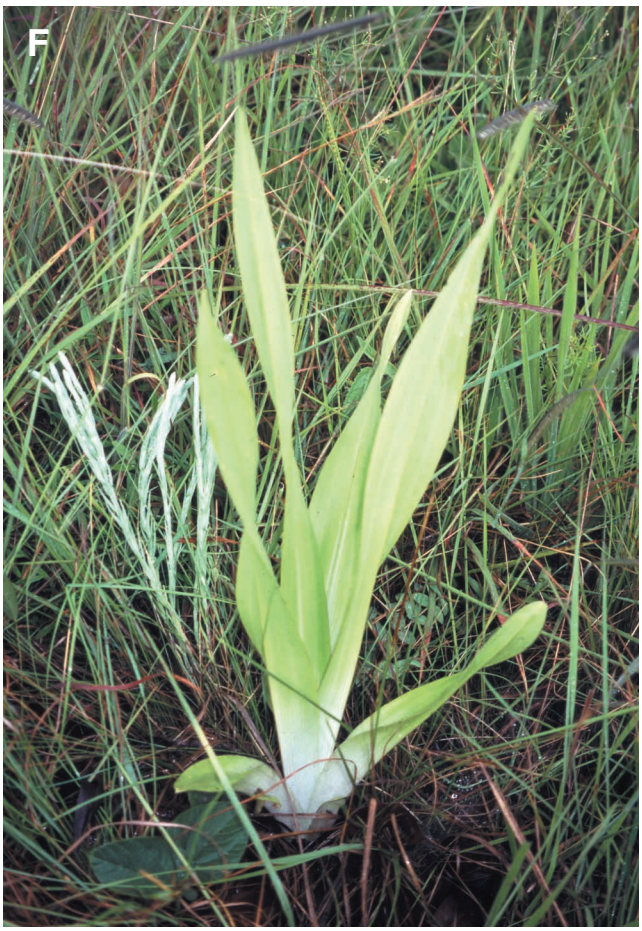
Observations. Plants growing on the Lukwangule Plateau differ morphologically from South African specimens because of thinner and more hairy leaves.

The redescription of this species includes variety of its morphology within its whole range.

IUCN conservation status. Least Concern in Africa but Near Threatened in the East Tropical Africa.

Specimens studied. **TANZANIA. Eastern (T6). Morogoro**. Uluguru Mountains, Lukwangule Plateau, 2400 m, 06.11.1894,


A
B
20 cm
2 cm
K.Gawrońska
C
2 mm
D
2 mm
E
1mm



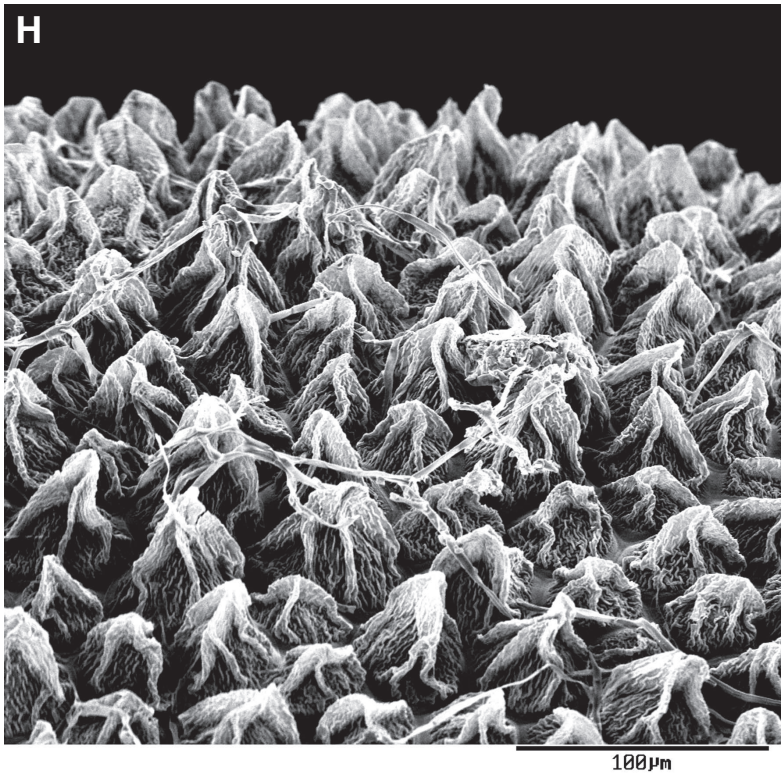


Fig. 47. *Hypoxis goetzei*
Explanations: A – habit during flowering period (from *Goetze 1416*), B – habit after flowering period (from *Wiland & Mboya 162*), C-D – tufted trichomes from scape (from *Wiland & Mboya 97*), E – tufted trichome from leaf edge (from *Wiland & Mboya 97*), F – living plant after anthesis (from *Wiland & Mboya 101*), G – white fleshed tuber just after cutting (from *Wiland & Mboya 81*), H – seed testa sculpture (from *Wiland & Mboya 97*)

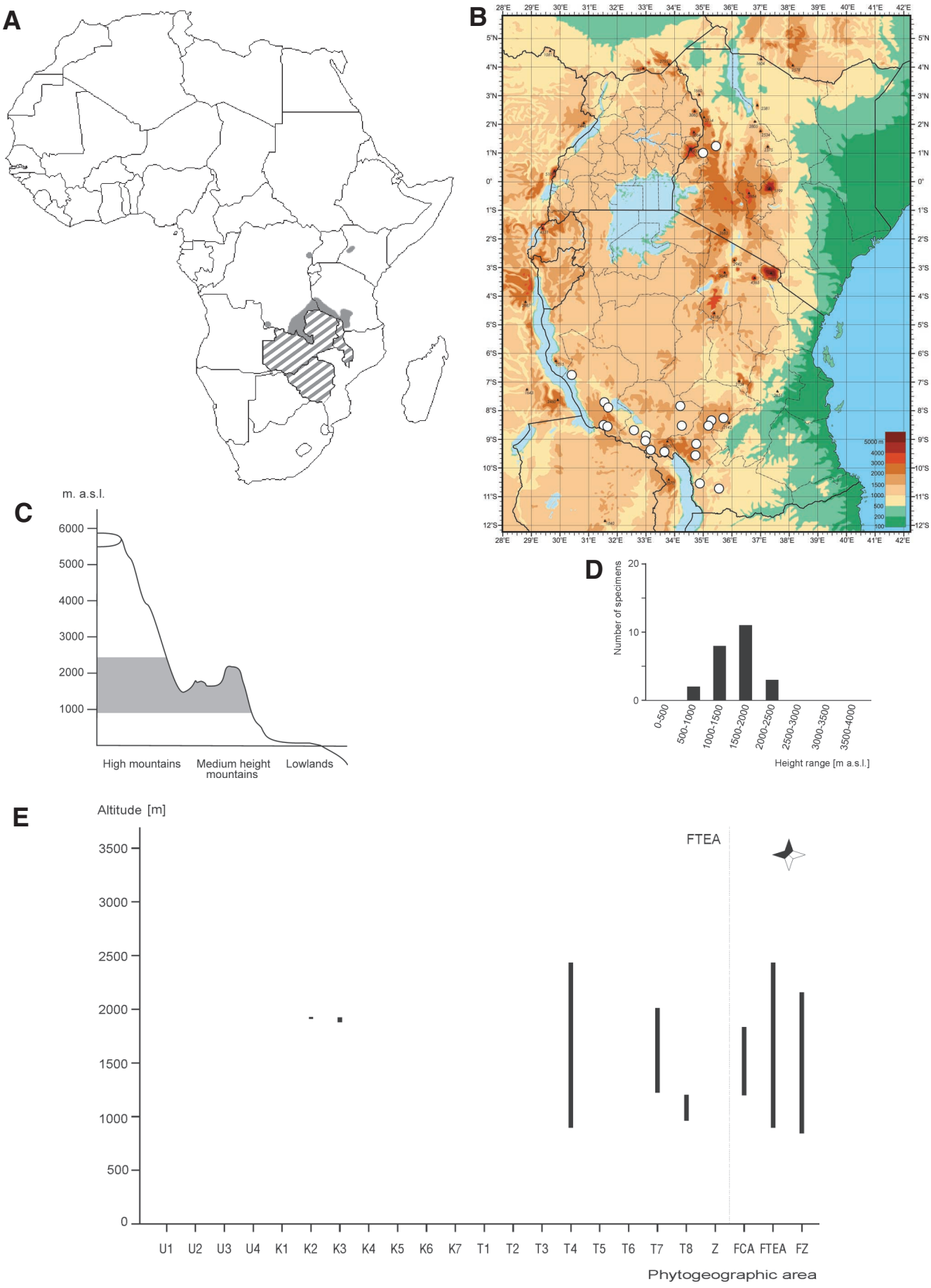


Fig. 48. *Hypoxis goetzei*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

Stuhlmann 9161 (B); ibid., 2400 m, 19.02.1933, *Schlieben 3506* (B, BR, K, MO) & *Schlieben 3506a* (B); ibid., 2400 m, 10.02.1934, *Troll 5002* (B); ibid., 2400-2600 m, 07.12.1969, *Harris, Pócs, Mapunda & Csontos 3719* (DSM, EA, K); ibid., 7800 ft (= 2377 m), 27.01.1976, *Cribb & Grey-Wilson 10451* (K, S); ibid., 2400-2500 m, 14.03.1986, *Bidgood, Lovett, Paul & Pócs 229* (K, S); ibid., 2320 m, 09.02.2001, *Wiland & Mboya 57* (POZG); ibid., over Chenzema Mission, 2500 m, 13.03.1953, *Drummond & Hemsley 1565* (EA, K); ibid., 2430 m, 01.02.2001, *Jannerup & Mhoro 0367* (C, K, POZG). **Southern Highlands (T7). Chunya**. Usafwa, Ntumbi, 2300 m, 21.12.1978, *Leedal 5248* (K); **Iringa.** Ifiga, 1900 m, 11.03.1934, *Troll 5383* (B).

6. *Hypoxis goetzei* Harms in Bot. Jahrb. 30: 276 (1901). TYPE: Tanzania, Mbeya District, Unyiha, Toola, 1300 m, 08.11.1899, *Goetze 1416* (B!, holotype; BM!, BR!, isotypes).

Nel (1914b: 320); Nordal (1985: 25, Figs. 1B, 2d, 9C & E, 13); Agnew & Agnew (1994: 312. Pl. 141); Zimudzi (1996: 14) *pro parte*; Nordal & Zimudzi (2001: 8, Table 12.3.2 A); Wiland-Szymańska (2001: 319, Figs. 5C, D, 8, 13C, 26); Singh (2006: 14); Wiland-Szymańska & Nordal (2006: 9, Fig. 1.3)

= *Hypoxis esculenta* De Wild. in Repert. Spec. Nov. Regni Veg. 11: 537 (1913a); De Wildeman (1913b: 19). TYPE: Democratic Republic of the Congo, Upper-Katanga, *Hock* s.n. (BR!, holotype)

= *Hypoxis rubiginosa* Nel in Bot. Jahrb. 51: 320 (1914b). TYPE: Tanzania, Ngaka [Mgaka] valley, *Busse* 947 (B!, holotype)

= *Hypoxis subspicata sensu* Geerinck (1971) *pro parte*

Robust herb to 80 cm high (Fig. 47A-B, 47F); tuber white inside (Fig. 47G), becoming bluish when exposed to air, conical or obconical, 7-15 cm long and in diameter 4.5-10 cm (when fresh) or 3.2-5.7 cm (when dry), old tubers dividing into e.g. three smaller in apical part; sap very abundant, often also in a leaf rosette; tunic fibrous, black, to 9 cm. Leaves light to vivid green with white bases, sometimes red tinted, between white base and green blade, becoming brown dotted with age, drying brown; outer leaves 3 to 7, ovate, cuspidate, older slightly keeled and reflexed, 5.0-12.2 (-15.0) x 2-5 cm, ciliate on the margins and midrib below, glabrous above; trichomes tufted, brown or dark golden; nerves unequal, 31 to 69; inner leaves erect and tortuous when young, recurved when old, 6 to 8, long elliptic or sword-shaped, acute, entire or sometimes with very small teeth, (7.5-) 11.0-80 cm long and (0.8-) 2.0-7.4 cm wide, ciliate on margins and midrib below, glabrous above; trichomes tufted, ca. 5-branched, brown or dark golden; nerves unequal, 27 to 91 (Fig. 47C-D). Scapes 1 to 8, erect at anthesis, prostarate in fruit, 8.0-25.5 cm long and 2.5-5.0 mm wide, ciliate in lowest $^1/_3$, prominently tomentose in apical $^2/_3$; trichomes tufted, ca. 7-branched with branches 0.6-2.3 mm long, getting darker and falling off with age (Fig. 47E); cyme spiciforme 4- to 14-flowered, floral anthesis basipetal; bracts widly subulate, keeled, (5-) 7-17 x 1-4 mm, the lowermost 5- to 7-nerved, hairy on the midrib abaxially, ciliate on margins in apical part; pedicels 6-10 mm long, at young flowers in the basal part of inflorescence almost none. Tepals 6, yellow inside, pale green outside; outer tepals ovate or lanceolate, keeled, 10.5-18.0 mm long and 4-6 (-7) mm wide, abaxially pubescent; nerves irregular 5 to 9; inner tepals ovate, acute, with margins inflexed below apex, 10-17 mm long and (4-) 5-8 (-9) mm wide; pubescent abaxially along the midrib on lower $^2/_3$; nerves irregular, (5) 7 to 9; stamens yellow, equal, 6-10 mm long; filaments subulate, 3.0-4.5 mm long; anthers prominently sagittate, slightly emarginate or fused at apex, 4-7 (-8) mm long, becoming brown; ovary obconical, (3-) 6-7 (-9) mm long and 3-6 (-7) mm wide, pubescent; style yellow, often tapering towards base, 2.5-4.0 mm long; stigma (1.2-) 2.0-3.0 (-4.0) mm long, composed of three free lobes variously covered with papillae. Capsule green, turbinate, 4-10 x (3-) 4-6 mm, pubescent; seeds ca. 12, globose or almost ovoid, 1.2-1.5 x 1.2-1.5 mm, brown; cuticle thick; seed coat bristly with pointed pyramidal projections winged with cuticle (Fig. 47H).

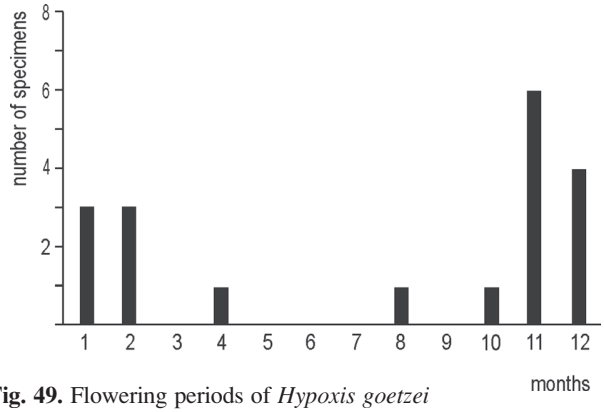


Fig. 49. Flowering periods of *Hypoxis goetzei*

Distribution. Species distributed in the Democratic Republic of the Congo, Kenya, Tanzania, Zambia, Malawi and Zimbabwe (Fig. 48A). Its continuous range is limited to the Zambezian Region, but two isolated populations occur in the Afromontane Archipelago-like regional centre of endemism. In the East Tropical Africa it reaches its northern and eastern limit of range (Fig. 48B). It occurs between 900-2438 m a.s.l. (Fig. 48C), in the submountain and mountain vegetation zone belts, with a maximum of collections made between 1200-2000 m a.s.l. (Fig. 48D), in the lower mountain zone. While comparing data from regions of the East Tropical Africa and other areas (Wiland-Szymańska 2001, Nordal & Zimudzi 2001), a tendency to elevation of the bottom limit of vertical range of this species towards West and North (Fig. 48E) is noticeable.

Habitat. Dembo, wet grassland on the slope of a stream valley, very dry drainage grassland on the edge of ant hill, burnt grassland, grassland with shrubs and trees, miombo woodland; pale brown sandy loam, black loam, light loam, stony soil, ferralite.

Phenology. *Hypoxis goetzei* is unique among other species of *Hypoxis* of the East Tropical Africa in developing

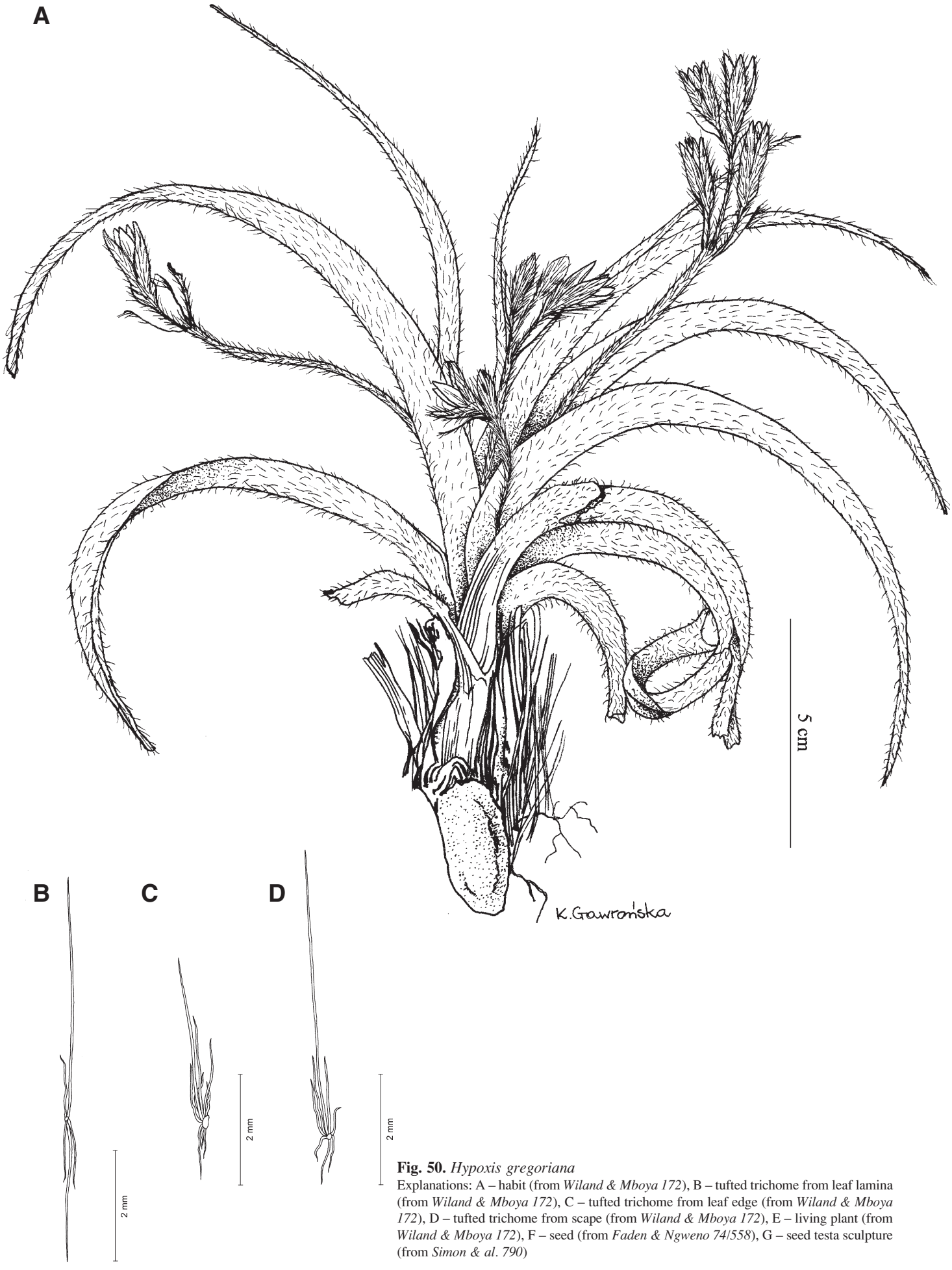


Fig. 50. *Hypoxis gregoriana*
Explanations: A – habit (from *Wiland & Mboya 172*), B – tufted trichome from leaf lamina (from *Wiland & Mboya 172*), C – tufted trichome from leaf edge (from *Wiland & Mboya 172*), D – tufted trichome from scape (from *Wiland & Mboya 172*), E – living plant (from *Wiland & Mboya 172*), F – seed (from *Faden & Ngweno 74/558*), G – seed testa sculpture (from *Simon & al. 790*)

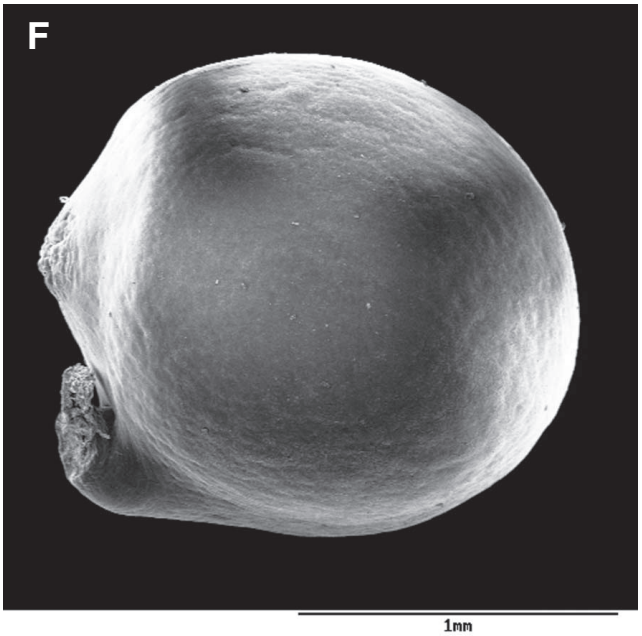
inflorescences long before leaves. Flowering in November and December (Fig. 49), often after fire. Scapes are erect at anthesis and prostrate in fruit. Flowering sequence from the top to bottom. Flowers finely sweet scented.

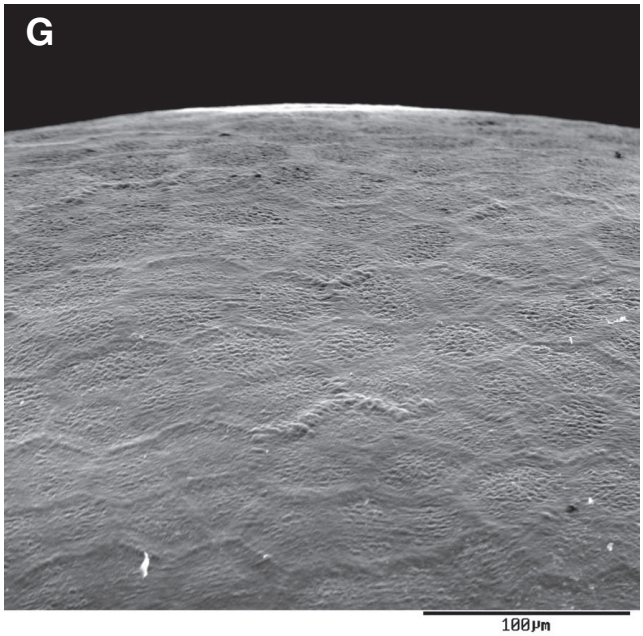
Vernacular name. Msefusefu (Kibena dialect).

Observations. The description presented here is according to Wiland-Szymańska (2001).

IUCN conservation status. Least Concern.

Specimens studied. **KENYA. Turkana/Rift Valley (K2/3). West Suk/Elgeyo.** S Cherangani, 6300 ft (= 1920 m), 15.02.1958, *Symes 285* (EA, K) & *Symes 286* (EA, K). **Rift Valley (K3). Trans-Nzoia.** Kitale, 6200 ft (= 1890 m), 04.1962, *Tweedie 2342* (K) & 08.1962, *Tweedie 2401* (K). **TANZANIA. Western (T4). Mpanda**. Exploration Co. track about 12 miles from Ikola, 900 m, 03.11.1959, *Richards 11701* (BR, EA, K). **Ufipa.** Tatanda, 03.12.1986, *Moyer 25* (DSM, K, MO); Muse to





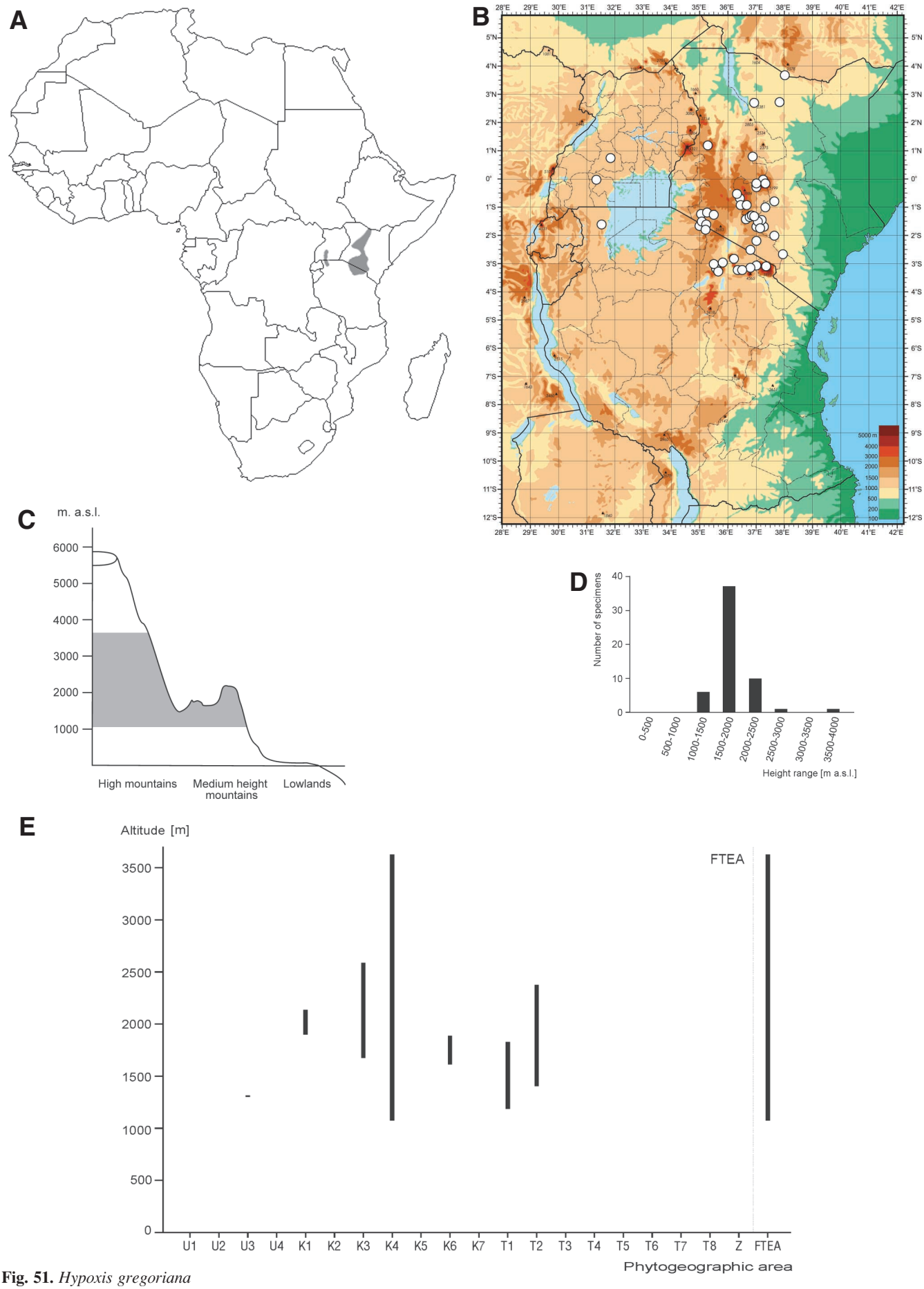


Fig. 51. *Hypoxis gregoriana*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

Sumbawanga Road, 2 miles, Nemwele village, 1650 m, 22.10.1965, *Richards 20570* (K); Mbizi Forest, 7000-8000 ft (= 2134-2438 m), 21-26.02.1958, *Napper 1075* (EA, K); ibid., 7400 ft (= 2256 m), 14.11.1970, *Sanane 1401* (K); Kituria-Lukungu Rivers, 1500 m, 09.12.1958, *Richards 10268* (K). **Southern Highlands (T7)**. **Mbeya**. Unyiha, Hezya, 5000 ft (= 1524 m), 20.11.1970, *Leedal 516* (EA); Magangwe air-strip, 4000 ft (= 1219 m), 10.12.1970, *Greenway & Kanuri 14764* (EA, K, PRE); ibid., 1340 m, 13.12.1972, *Bjørnstad A. 2261* (O); Karashare, 1450 m, 02.03.2001, *Wiland & Mboya 162* (NHT, POZG); Songwe, 4000 ft (= 1219 m), 28.02.1970, *Leedal 533* (EA); Usangu, Sonyanga, 1450 m, 23.11.1978, *Leedal 5196* (K). **Iringa**. 3 km SW of Mafinga on road to Mbeya, 1800 m, 14.02.2001, *Wiland & Mboya 81* (NHT, POZG); N side of Ngwazi lake, 1700 m, 15.02.2001, *Wiland & Mboya 88* (NHT, POZG); Usokami, on road to Kibenga, 1900 m, 16.02.2001, *Wiland & Mboya 97* (NHT, POZG); ca. 4 km SW of Mafinga on road to Mbeya, 1800 m, 17.02.2001, *Wiland & Mboya 101* (NHT, POZG). **Rungwe**. Bulambia [Ulanda Ulambya], 17.11.1970, *Leedal 499* (EA). **Njombe**. Igima Village, 1720 m, 23.02.2001, *Wiland & Mboya 110* (MO, NHT, POZG); Luponde Village, Mnogwela Street, 2010 m, 25.02.2001, *Wiland & Mboya 133* (NHT, POZG). **Southern (T8)**. **Songea**. About 12 km W of Songea by Kimarampaka stream, 960 m, 01.01.1956, *Milne-Redhead & Taylor 8013* (B, BR, EA, K, LISC); Mgaka [Ngaka], 1200 m, 23.01.1901, *Busse 947* (B).

7. *Hypoxis gregoriana* *Rendle* in Journ. Linn. Soc. 30: 408 (1895). TYPE: Kenya, Kikuyu Escarpment, Kedong, *Gregory* (BM!, holotype).

Baker (1898: 380); Singh (2006: 14); Wiland-Szymańska & Nordal (2006: 16, Figs. 1.1, 1.4)
= *Hypoxis araneosa* Nel in Bot. Jahrb. 51: 310 (1914b). TYPE: Tanzania, Ngare-Nairobi, *Endlich* 238 (B!, holotype)
= *Hypoxis obtusa* complex *sensu* Nordal *et al*. in Nordic J. Bot. 5: 28 (1985) *pro parte*.
= *Hypoxis villosa* L. *sensu* Baker (1898) *pro parte*

Medium plant up to 60 cm high (Fig. 50A, 50E); tuber yellow to deep orange, sometimes with a camphor like smell, elongated or globose, 8.5-10.0 cm long and 1.0-3.4 cm, often dividing in apical part into smaller bulbs and producing numerous shoots; sap abundant; tunic fibrous, black. Leaves creating a short pseudostem, yellow-green with white bases; outer leaves, submembranous in basal part, linear, acuminate, to 20 cm long and to 11 mm wide, with about 21 veins, covered with white, adpressed or spreading tuft trichomes, mostly on abaxial side; trichomes 3-5 brancged, sometimes 2-branched; inner leaves, linear, carinate, acuminate, 10-75 cm long and 1.0-2.5 cm wide, recurved, especially if grazed upon, covered with white, adpressed or spreading tuft trichomes, mostly on abaxial side; hairs 3-5 branched, rarely 2-branched, 1.5-4.0 mm long (Fig. 50A-B); veins 9-11, equal, spaced. Scape 1-6, 5-55 cm long and 1-2 mm wide, white villous in apical part with tufted trichomes (Fig. 50D); inflorescence a 2-4 (-6)-flowered cyme; bracts setoso-subulate, 7-12 mm mm long, 1.5 mm wide at base, covered with tuft trichomes on the midrib below, single veined; pedicels 2.0-3.0 cm long; tepals 6, yellow inside; outer tepals yellow green outside, linear or lanceolate, acute, 9-14 mm long, about 2 mm wide, araneoso-villous below, 7-veined; inner tepals oblong, obtuse, 8-12 mm long mm long, 3-4 mm wide, with trichomes along midrib beneath, 7 veined; stamens unequal; outer stamens 4.0-4.3 mm long with filaments ca. 3 mm long; inner stamens 3 mm long with filaments 2 mm long; filaments yellow, subulate; anthers 3-7 mm long, emarginate at apex, yellow, becoming brown; ovary obconical, 3-4 mm long; style cylindrical ca. 0.5 mm long; stigma conical, thick, 1 mm long. Capsule obovoid 5-8 mm long, 4-5 mm wide; seeds 2 mm long, black, seed coat flat, without distinct papillae, but with micropapillation (Figs. 50F-G).

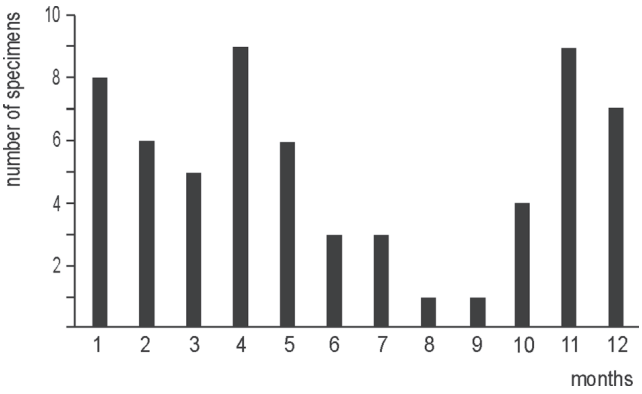


Fig. 52. Flowering periods of *Hypoxis gregoriana*

Distribution. *Hypoxis gregoriana* occurs only in Uganda, Kenya and Tanzania (Fig. 51A-B) and is therefore an endemite of the East Tropical Africa. Its continuous range lies in the Somalia-Masai Region with one isolated island in the Lake Victoria Regional Mosaic. This species is found from submountain to afrosubalpine vegetation zone belts between 1070-3630 m a.s.l. (Fig. 51C), but is most common in the mountain zone between 1500-2000 m a.s.l. (Fig. 51D). Its widest vertical range can be observed in the Central Province in Kenya (Fig. 51E).

Habitat. Open glades, swampy grassland, wooded grassland, semi-deciduous bushland, woodland, open forest, edge of montane forest, the "gianth heath" zone, secondary mountain forest, pasture; black cotton soil, black volcanic soil, dark chocolate loam of volcanic origin, red sandy loam, grey very sandy clay, whitish loamy soil, sandy soil of quartzite, hard gravel soil, among rocks.

Phenology. This species was collected all the year round, however less often during the dry season from June to August (Fig. 52). Often appearing after fire. Inflorescences occur with fully developed leaves.

Uses. Food: Children eat the small tubers attached to the roots. Toy: Children stick sticks into the bulbs to make toy water-like wheels (Kipsigis); cut out the

middle of the bulb to make a miniature gourds which they fill with milk and pretend to drink. Forage: Grazed by domestic stock.

Vernacular name. Chepkimniet (Kipsigis); Engaimalasiyai, Esenyi (Masai).

Observations. Locally common.

The redescription presented here includes new characters in componison with the original protologue.

IUCN conservation status. Least Concern.

Specimens studied. **UGANDA. Buganda (U4). Mengo**. Near Bukomero, Singo, 09.1932, *Eggeling 931* (K). **Masaka**. 17-18 km SE of Ntusi, 1300 m, 19.10.1969, *Lye & Rwaburindore 4517* (EA, K). **KENYA. Northern Frontier (K1). Northern Frontier**. Furroli, 6300 ft (= 1920 m), 15.09.1952, *Gillet 13902* (BR, EA, K); Kulal Mountain, 7000 ft (= 2134 m), 04.1959, *Adamson K5B* (EA, K); ibid., 2050 m, 27.11.1978, *Hepper & Jaeger 7108* (K); ibid., above Gatab, ca. 1900 m, 23.11.1978, *Hepper & Jaeger 7036* (K); Kulal North, 6500 ft (= 1981 m), 23.05.1971, *van Swinderen 125* (EA, K); Lake Rudolf to Gondokoro, 26.11.1899, *Donaldson Smith s.n.* (BM). **Rift Valley (K3). Elgeyo**. Cherangani Hills, Kaibwibich, 2591 m, 17.07.1969, *Mabberley 28* (K). **Laikipia**. 0,5 mile SW Lake Kelole [Kelele] dam, 5500 ft (= 1676 m), 08.04.1969, *Magor 61* (EA, K). **Naivasha**. Naivasha 19 miles, 6500-7000 ft (= 1981-2134 m), 04.1938, *Chandler 2206* (K); Longonot, 8000 ft (= 2438 m), 03.1922, *Dummer 5082* (K); Gilgil area, 6200 ft (= 1890 m), 04.02.1977, *Polhill 487* (K). **Central (K4). North Nyeri**. Daiga near Nanyuki, 6000 ft (= 1829 m), 10.1941, *Bally 1772* (K); Naro Moru River Lodge, 2000 m, 23.01.1970, *Bjørnstad I. 262* (EA, K, O); 5 miles S of Naro Moru, 02.12.1966, *Agnew, Kiniaruh, Ngethe & Wyatt 8865* (MO); 11 km S of Naro Moru, 1900 m, 03.04.1966, *Strid 2386* (EA, K). **North Nyeri/ South Nyeri/ Embu/Meru.** W slopes of Mount Kenya, along the trail from West Kenya Forest Station to summit, ca. 3630 m, 21-27.09.1909, *Mearns 1361* (BR). **Fort Hall/Kiambu**. About 2 miles from Thika on Garissa road, 4880 ft (= 1487 m), 18.04.1970, *Mathew & Hanid 6053* (EA, K); 28 miles from Thika on Garissa road, 4900 ft (= 1494 m), 18.04.1970, *Mathew & Hanid 6057* (EA, K). **Kiambu.** Platform on Kikuyu Escarpment, 30.04.1893, *Gregory s.n.* (BM); Kikuyu grasslands, 6700 ft (= 2042 m), 1930, *Mettam 203* (K); Kikuyu Escarpment Forest, Lari Forest, 1830-2130 m, 05.11.1972, *Hansen 756* (EA, K, UPS). **Nairobi**. Nairobi, 5600 ft (= 1707 m), 18.11.1910, *Battiscombe 465* (EA, K); ibid., 5900 ft (= 1798 m), 03.06.1930, *Napier 169* (EA, K); ibid., 05.01.1950, *Hale 57* (G, K); ibid., Corner of Uhuru Highway & Langata road, 1670 m, 08.05.1975, *Kabuye & Ng'weno 514* (K); ibid., Tchika Road House, 5500 ft (= 1676 m), 05.11.1958, *Verdcourt 372* (EA, K, MO); ibid., St. Austin's road turning to St. Mary's, 17.11.1965, *Agnew & Hanid 7485* (MO); near Nairobi, 08.1903, *Whyte s.n.* (K); round Nairobi, 06.10.1914, *Johnstone (as W. J. Dowson) 157* (EA, K); Nairobi District, 5500 ft (= 1676 m), 14.07.1924, *MacDonald 758* (EA, K); behind Nairobi Golf Range, S of road from Nairobi National Park, ca. 1700 m, 14.05.1974, *Faden R.B. & A.J. & Ngweno 74/558* (K, MO); Archer's Farm, Nairobi district, 06.1933, *Rogers 584* (BM, BR, EA, G, K, P, S, W); Bahati, 05.1933, *Rogers 479* (BR, EA, K, S). **Embu**. 2 miles NW of Kamburu Bridge over Tana River, 1070 m, 09.01.1972, *Robertson 1670* (EA, MO). **Machakos.** Machakos, 1896, *Hinde s.n.* (BM); ca. 32 km from Nairobi on Mombasa Road at the bottom-western side of Lukenya Hill near Lukenya Club, 1560 m, 31.01.1971, *Mwangangi 1581* (BR, EA, K). **Machakos/Kitui.** Mua Hills, 12.1929, *Benson s. n.* (BM); Ukambane, 12.1893, *Scott Elliot 6467* (BM, K). **Machakos/Masai**. Chyulu Hills, 1900 m, 13.12.1993, *Luke & W. R. Q. 3914* (K). **Masai (K6). Masai**. Kapiti Plains, 6200 ft (= 1890 m), 12-01.1914, *Prescott Decie s.n.* (BM); Nairobi-Mombasa road, near turning to Machakos, 5300 ft (= 1615 m), 25.03.1960, *Bally 12163* (G, K); Kapiti Plains, Nairobi-Mombasa Road, just before Machakos turning, 30.03.1970, *Mathew 6004* (EA, K); W upper edge of the Rift Valley, E from Narok, 18.01.1970, *Wendelberger 91/1970* (K); Namanga Hill Forest Reserve, 1800 m, 30.05.2000, *Festo et al. 690* (MO, POZG); Ngong, 6000 ft (= 1829 m), 14.11.1930, *Edwards 1456* (K); Chyulu Hills, 1860 m, 19.10.1969, *Gillet & Kariuki 18835* (BR, EA, K); between Namanga and Kajiado, 65 miles on Nairobi to Namanga road, 5300 ft (= 1615 m), 17.12.1961, *Polhill & Paulo 1016* (B, BR, EA, K, PRE); Ol'legesegonyek on Narok-Kilgoris road near the Mara Bridge on Cis-Mara side, 5600 ft (= 1707 m), 15.04.1961, *Glover, Gwynne & Samuel 614* (BR, EA, K, PRE); Mara Plains, Masai Mara Game Reserve, Fauna Research Unit, 5500 ft (= 1676 m), 15.09.1960, *Stewart 323* (EA, K); Mara Plains, Egalok, 20.10.1958, *Verdcourt & Fraser Darling 2281* (EA, K); 5 miles from Aitong on track to Ngore Ngore, 12.12.1963, *Verdcourt 3828* (C, EA, K); Magadi Junction, 1926, *Prescott Decie s.n.* (BM). **Tanzania.** Between Zanzibar & Uyui, *Taylor W.E. s.n.* (BM). **Lake (T1). Bukoba**. Kiaka to Kikagati Road, 3900 ft (= 1189 m), 11.04.1957, *Gane 106* (EA). **Musoma.** Klein's Camp to Wogakuria Hill, 5300 ft (= 1615 m), 30.12.1964, *Greenway & Myles Turner 12000* (K); 10 miles N of Bologonya River, 6000 ft (= 1829 m), 10.11.1953, *Tanner 1856* (BR, K). **Northern (T2). Masai**. Embagai Mountain, 5800-6500 ft (= 1768-1981 m), 12.07.1931, *St. Clair-Thompson 122* (K); Ngorongro Conservation Area, Mokilal Primary School, 7800 ft (= 2377 m), 14.03.1988, *Chuwa 2620* (K); Ngorongoro, 7000 ft (= 2134 m), 22.11.1956, *Tanner 3293* (K); Ngorongoro crater, 7000 ft (= 2134 m), 15.02.1959, *Heady 1524* (EA, K); ibid., 5900 ft (= 1798 m), 15.02.1959, *Heady 1534* (MO); ibid., E slope, 5600 ft (= 1707 m), 04.1941, *Bally B 2424* (K). **Mbulu**. Mbulumbul, 5900 ft (= 1798 m), 23.06.1944, *Greenway 6941* (EA, K). **Arusha**. Telegraph Station on Songe Hill, 2011 m, 23.02.1969, *Richards 24170* (EA, K, P); Tiang'ong'o Valley, Engalaoni and Emuseresi villages, 1881 m, 29.01.2001, *Simon, Raphael & Loi 753* (MO, POZG) & *Simon, Raphael & Loi 790* (MO, NHT, POZG); Engalaoni village, Lewama subvillage, 1780 m, 17.03.2001, *Wiland, Mboya & Simon 172* (MO, NHT, POZG); Eluai Village, 1800 m, 07.05.2001, *Simon & Mollel 1018* (MO, NHT, POZG); N of Losiwira on a lower slope of Katumbeine Mountain, 2000 m, 17.02.2001, *Simon, Festo & Minde 790* (MO, NHT, POZG); Ketumbeine Forest Reserve, N slope of Ketumbeine Mountain, S of Losiwira, 2260 m, 18.02.2001, *Gereau 6583* (MO, NHT, POZG). **Moshi**. Ngare Nairobi, N and S, 1400-1500 m, 01.1909, *Endlich 238* (B, MO); Kilimanjaro, Enatasia Korongo, W of Lerangwa, 1700 m, 17.11.1993, *Grimshaw 93/058* (K).

8. ***Hypoxis kilimanjarica*** Baker in Fl. Trop. Afr. 7: 378 (1898). TYPE: Tanzania. "Marangu, Lager am Raussibach, Bergwiese oberhalb des Urwaldes, 2440 m, 31.08.1893,,, *Volkens 781* (B!, holotype; K!, BM!, isotype).

Nel (1914b: 303); Nordal *et al*. (1985: 26, Fig. 15); Champluvier (1987: 84, Figs. 28.1A, 1B); Agnew & Agnew (1994: 312);

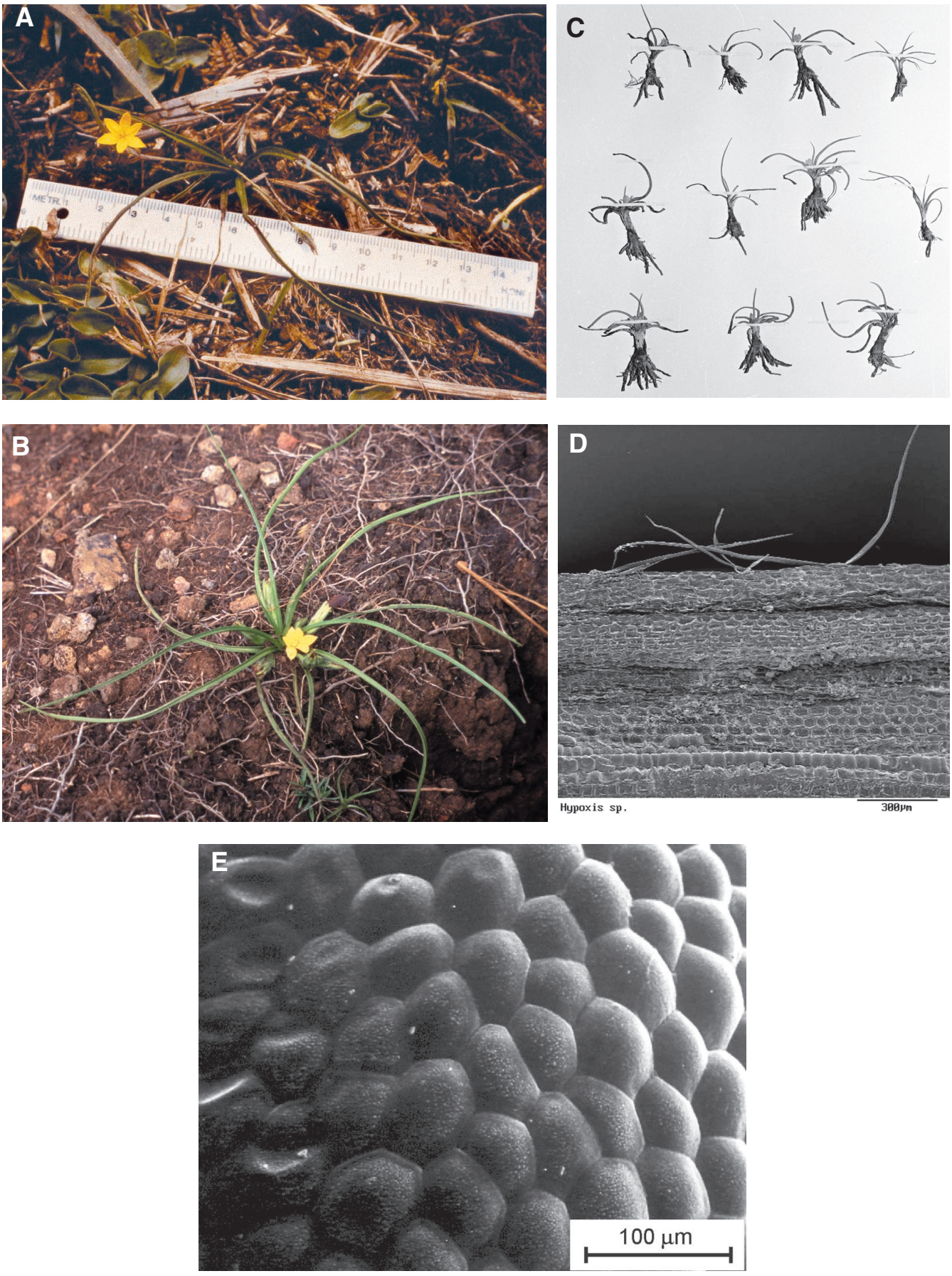


Fig. 53. *Hypoxis kilimanjarica*
Explanations: A – living plant of *H. kilimanjarica* subsp. *kilimanjarica* (from *Staubo 1*), B – living plant of *H. kilimanjarica* subsp. *prostrate* (from *Natural Collections s.n.*), C – herbarium specimens of *H. kilimanjarica* subsp. *prostrata* (from *Thulin & Tidings 201*), D – SEM of two-branched trichomes on a leaf (from *Thulin & Tidings 201*), E – seed testa sculpture (from *Thulin & Tidings 201*)

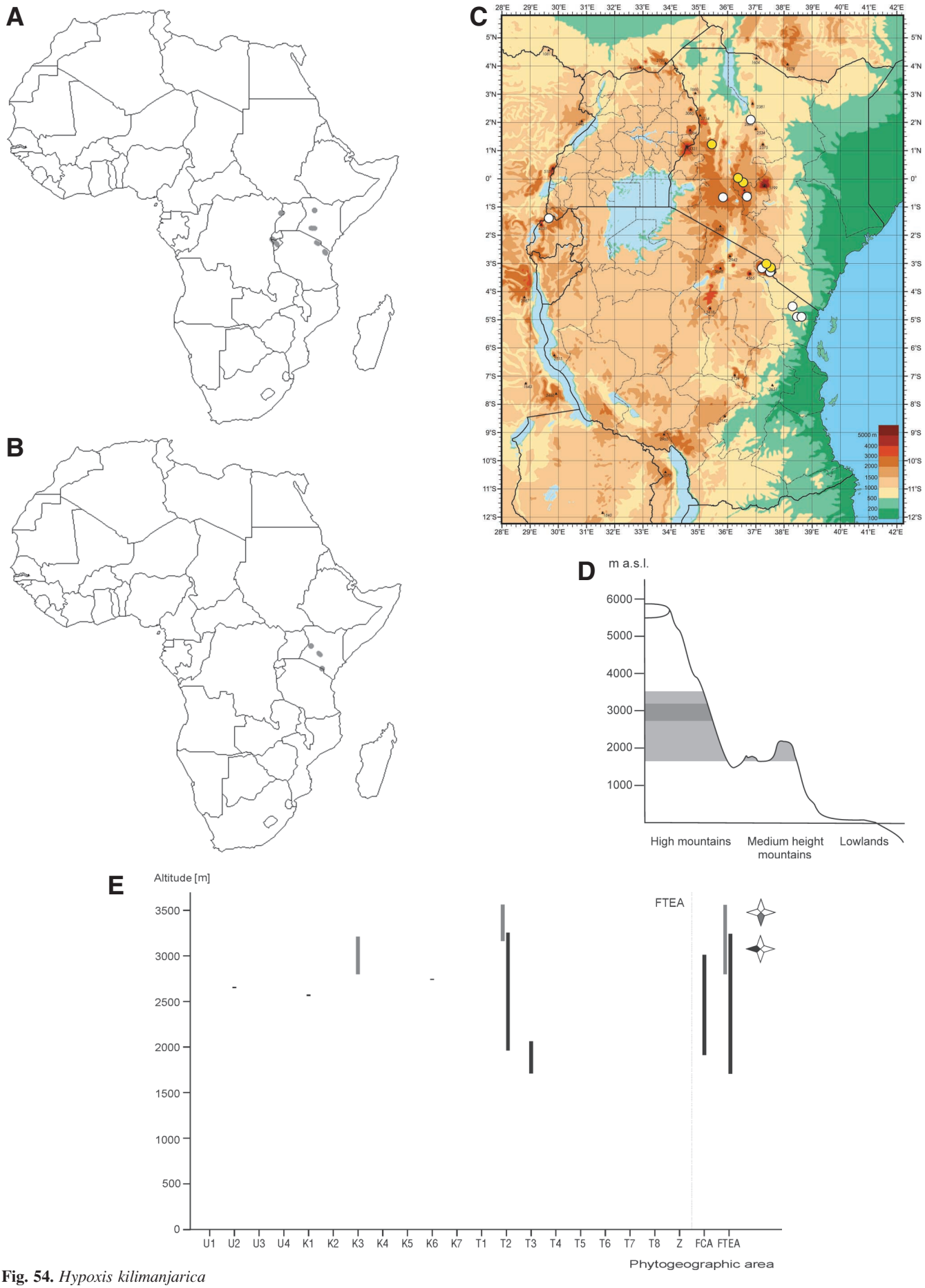


Fig. 54. *Hypoxis kilimanjarica*
Explanations: A – general distribution of *H. kilimanjarica* subsp. *kilimanjarica*, B – general distribution of *H. kilimanjarica* subsp. *prostrata*, C – distribution in the East Tropical Africa, D – vertical range in the East Tropical Africa (darker color shows the altitudes at which the both subspecies are present), E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

Wiland-Szymańska (2001: 324, Figs. 11A, 12A, B, 22), Singh (2006: 14); Wiland-Szymańska & Nordal (2006: 7)

8a. *Hypoxis kilimanjarica* Baker ssp. *kilimanjarica*
Nordal *et al*. (1985: 27); Singh (2006: 14); Wiland-Szymańska & Nordal (2006: 7)

= *Hypoxis incisa* Nel Bot. Jahrb. Syst. 51: 319-320 (1914b). TYPE: Tanzania, West-Usambara, Lutindi, *Liebusch s.n.* (B!, lectotype) & West Usambara, Kiwe-Sabyina-Kathinga-Suttel, *Mildbraed 1678* (?, syntype non vidi); Robyns & Tournay (1955b: 388).
= *Hypoxis alpina* R.E. Fries in K. Svenska Vetensk.-Akad. Handl. Ser. 3, 25 (5): 78 (1948). TYPE: Kenya, Mt. Aberdare, *R.E.& Th.C.E, Fries 2698* (UPS!, holotype)
= *Hypoxis angustifolia sensu* Geerinck (1971: 6) *pro parte*

Small herb to 20 cm high (Fig. 53A); tuber white inside, ovoid or subglobose, 6-14 mm long and 6-13 mm in diameter; sap not abundant; roots not thick; tunic black membranous, to 2.5 cm high, occasionally with some soft fibers. Outer leaves ca. 2, grouped in short pseudostem, oblong, acute, carinate, reflexed, fleshy, ca. 3 cm long and 4 mm wide, ciliate on margins or glabrous; nerves unequal, ca. 7; inner leaves 3 to 8, narrow-linear, carinate, reflexed to prostrate, often spathe-like in basal part, 3.5-22.0 cm long and (1-) 2-4 mm wide, sparsely pilose on margins and midrib below, sometimes also on the blade surface; trichomes 2- to 3-branched; nerves unequal, 9 to 13, some of them very thin. Scapes 1 to 4 in number, 4.5-16 cm and 0.3-1.0 mm, usually bending downwards after flowering, in upper half pubescent; trichomes 2-branched, golden or red-brown; flowers single or two, often the second bud remaining undeveloped; bracts single, rarely two, subulate, very narrow, acute, 3-10 mm long and 0.4-1.0 mm wide, pubescent abaxially with 2-branched trichomes along nerve; pedicels 2.5-6.0 mm long, pubescent with 2- to 5-branched trichomes. Tepals 6, exceptionally 3 or 4, inside rich clear yellow, greenish with yellow margin outside; outer tepals elliptic, acute, 5-7 mm long and 2-3 mm, pubescent abaxially with 2- to 5-branched trichomes, irregularly 7-nerved; inner tepals elliptic or ovate, cuspidate, 4-7 x 1.5-3.0 mm, pubescent along lower ⅓ of midrib abaxially, irregularly 5-nerved; stamens yellow, unequal; outer stamens 3-4 mm long with filaments 2-3 mm long; inner stamens 2.5-3.5 mm long with filaments 1.5-2.0 mm long; filaments subulate; anthers 1.5-2.0 mm long, sagittate, fused and obtuse at apex; ovary obconical, 2-4 x ca. 1.5-2.0 mm, pubescent; style wider in basal part, trigonous, 1-2 mm long; stigma pyramidal, obtuse at apex, with three stripes of papillae, 1-2 mm long; proportion of length of style to length of stigma various. Capsule obovoid, 4-8 x 2.5-3.5 mm, almost glabrous; seeds numerous, ovoid, ca. 1.5 x 1 mm, black; seed coat colliculate.

Distribution. This subspecies is known from the Democratic Republic of the Congo, Ruanda, Burundi, Uganda, Kenya and Tanzania (Fig. 54A). It occurs only in the Afromontane Archipelago-like regional centre of endemism in two Mountain Domains: Imatongs-Usambara and Kivu-Ruwenzori (Fig. 54C). This taxon is subendemic for the East Tropical Africa. *Hypoxis kilimanjarica* subsp. *kilimanjarica* occurs between 1650-3200 m a.s.l., in the mountain and afrosubmountain vegetation zone belts (Fig. 54D). The bottom limit of its vertical range is elevating towards West (Fig. 54E), where in the Central Africa it was collected at 1850 m a.s.l. (Wiland-Szymańska 2001). There is a statistically important difference between vertical distribution of both subspecies of *H. kilimanjarica* (t=-2.866; df=11; p= 0.015342).

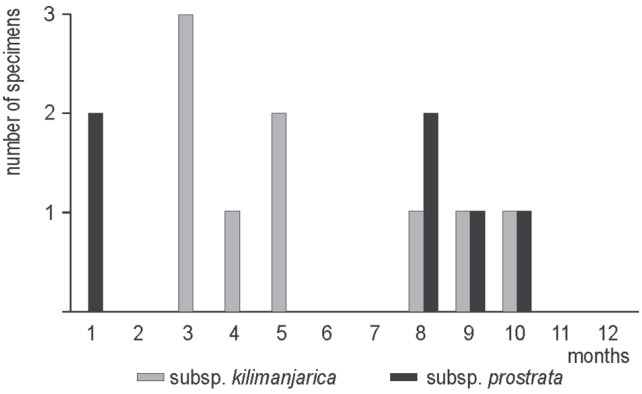


Fig. 55. Flowering periods of *Hypoxis kilimanjarica*

Habitat. Open glades, grassland, heath alternating with rock vegetation and dry elfin forest; shallow, stony soil.

Phenology. From March to May and from August to October (Fig. 55). A scape recurves towards ground after anthesis.

Uses. Forage: Browsed by goats.

Vernacular name. Chepkimniet (Kipsigis), Engaimalasiyai (Masai).

Observations. This subspecies is dissapearing from places which are burned and cultivated.

The presented description is after Wiland-Szymańska (2001).

IUCN conservation status. Vulnerable.

Specimens studied. **UGANDA. Western (U2). Kigezi.** Valley between Mountains Sabinio and Mgahinga, 8500 ft (= 2591 m), 11.1934, *Synge 1229* (BM). **KENYA. Northern Frontier (K1). Northern Frontier.** Mount Nyiru, Mario Forest zone, 2500 m, 30.03.1995, *Bytebier et al. 90* (K). **Rift Valley/Central (K3/K4). Naivasha/South Nyeri/Fort Hall.** Kinangop, 02.04.1922, *Fries R.E. & Th.C.E. 2698* (UPS). **Masai (K6). Masai.** Olokurto, Mau area, 8800 ft (= 2682 m), 13.05.1961, *Glover, Gwynne & Samuel 951* (EA, K). **TANZANIA. Northern (T2). Moshi.** Kilimanjaro, camp at Raussi, middle hight of Mawenzi, Marangu, 2440 m, 31.08.1893, *Volkens 781* (B, BM, G, K); ibid., Marangu, 1900 m, 09.1893, *Volkens 1009* (WRSL); ibid., N side of Kibo, 3200 m, 26.12.1932, *Geilinger 5097* (K); ibid., above Mandara Hut, 2600 m, 27.03.1979, *Staubo 1* (O). **Tanga (T3). Lushoto.** West Usambara Mountains, Lutindi, 1900, *Liebusch s.n.* (B); 1,5 miles NE of Bumbuli Mission on path to Mazumbai,

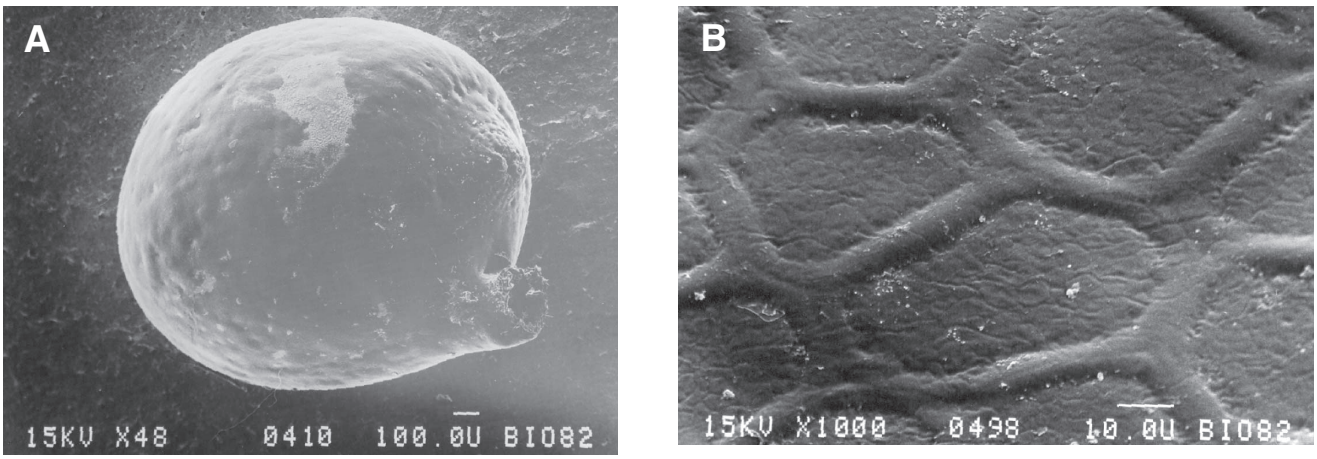


Fig. 56. *Hypoxis malaissei*
Explanations: A – seed, B – seed testa sculpture (from *Bjørnstad 401*)

1650 m, 10.05.1953, *Drummond & Hemsley 2459* (B, BR, EA, K, S); Shagayu Forest Reserve, summit 2,5 km ENE of Shagayu Sawmill, 1950-2000 m, 14.03.1984, *Borhidi, Sebsebe, Hendren, Iversen, Mziray & Pócs 84869* (NHT).

8b. *Hypoxis kilimanjarica* Bake ssp. *prostrata* Holt & Staubo in Nord. J. Bot. 5: 25 (1985). TYPE: Kenya, N. Cherengani, Chepkotet, *Thulin & Tidigs 201* (UPS!, holotype; EA, K!, S, isotypes).

Singh (2006: 14); Wiland-Szymańska & Nordal (2006: 8).

Small herb to 10 cm high (Fig. 53B-C); tuber white inside, subglobose, 0.8-1.5 cm in diameter, sometimes producing several shoots; roots very thick comparing with dimensions of the tuber; tunic membranous. Leaves 6-8, green with yellowish midrib, forming a subterranean white pseudosteme, linear, canaliculate, recurved to almost prostrate on the ground, slightly succulent, not exceeding 12.5 cm and 2 mm wide; veins not visible, submersed in leaf tissue; indumentum very sparse, if present, trichomes 2-branched (Fig. 53D). Scapes 1-8, one-flowered, not exceeding 4 cm; indumentum on scape sparse, trichomes 2-branched; flowers laying on the ground, at leaf base; tepals yellow inside, yellow with a green middle outside; stigma very large. Fruits geotropic; seeds black, colliculate and micropapillate (Fig. 53E).

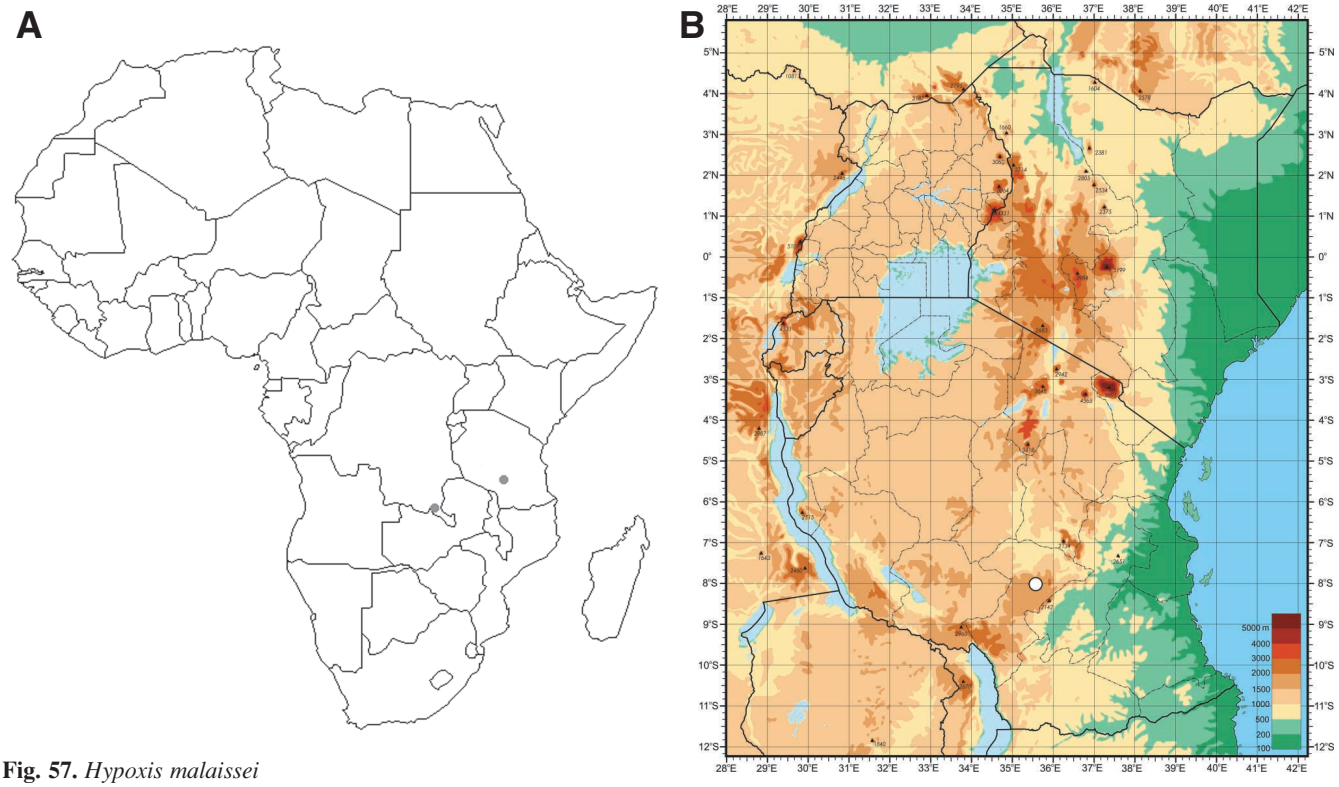


Fig. 57. *Hypoxis malaissei*
Explanations: A – general distribution, B – distribution in the East Tropical Africa

Distribution. An endemic taxon for the Tropical East Africa, known in Kenya and Tanzania only (Fig. 54B) in the Afromontane Archipelago-like regional centre of endemism in the Imatongs-Usambara Domain (Fig. 54C). *H. kilimanjarica* subsp. *prostata* is dispersed in the afrosubalpine vegetation zone belt between 2743-3500 m a.s.l. (Fig. 54D) Its bottom limit of vertical range is elevating towards South (Fig. 54E).

Habitat. Mountain grassland, *Erica, Hypericum, Protea, Alchemilla* bushland, grazed pasture, edge of a track; in peaty, cotton or sandy soil.

Phenology. From August to October and in January (Fig. 55). Flowers at ground level, one opens at a time.

Observations. Succulent leaves and thick roots show adaptation to dry conditions. The taxon is very rare and should be studied in the field.

The presented redescription adds new characters to the protologue.

IUCN conservation status. Vulnerable.

Specimens studied. **KENYA. Rift Valley (K3). Laikipia.** Aberdares range, 3 km SE of Shamata Forest Station, 2950 m, 24.10.1970, *Mabberley 372* (EA, K). **Elgeyo.** N Cherangani Hills, Chepkotet, 3150 m, 12-13.08.1968, *Thulin & Tidigs 201* (EA, K, S, UPS). **Nakuru.** 20 miles S of Thomsons Fals, 9000 ft (= 2743 m), 14.08.1952, *Bogdan 536* (EA). **TANZANIA. Northern (T2). Moshi.** Kilimanjaro, 3200-3500 m, 28.01.1960, *Rauh 129* (EA); ibid., above Mandara Hut, 28.01.1979, *Staubo 3* (O); junction of main trail with track to Maundi Crater, 3100 m, 09.09.1993, *Grimshaw 93693* (K).

9. *Hypoxis malaissei* Wiland in Fragm. Florist. Geobot. 42: 418, Fig. 6 (1997). TYPE: Democratic Republic of the Congo. Shaba: 28 km au N.E. de Lubumbashi, alt. 1208 m, Apr 1971, *Malaisse 7403* (BR!, holotype).

Wiland-Szymańska (2001: 329, Figs. 14A, 14B, 22); Singh (2006: 14); Wiland-Szymańska & Nordal (2006: 7).

Small herb, 15-36 cm; tuber globose, 10 mm in diameter, surrounded by membranous and fibrous black old leaf-bases, for up to 2 cm; roots thick. Outer leaves 7-11 cm long, spathe-like and ovate in the basal part, 10 mm wide blade, above linear, 2.5 cm wide, pubescent beneath with 2-branched and tuft trichomes; inner leaves linear, narrowing towards the apex, acute, 7.5-36.0 cm long and 2.5-4.0 mm wide, hispid on the whole surface, especially in the upper part; trichomes 2-branched, white; nervation parallel, composed of 7-9 veins of different size, two of them as thick as the midrib. Scapes 1-5, shorter than the leaves, 9.5-20.0 cm long and 1.5 mm wide, more intensively hispid apically than basally with long white tuft trichomes; inflorescence 2-5-flowered corymb, sometimes only one flower developing and the other remaining as a degenerated bud; bracts subulate, 5.5-10.0 mm long and 1 mm wide at base, hairy along the midrib beneath; pedicels 7-12 mm long, hispid; perigone composed of 6 tepals, yellow; outer tepals elliptic, acute, keeled, 7.0-7.5 mm long and 2.5-3.0 mm wide, densely hispid beneath, with a clavate appendage near the tip beneath; nervation composed of 5-7 irregular veins; inner tepals obovate, acute at apex, 6.5-7.0 mm long and 2.5-3.0 mm wide, hairy on the lower 1/3 of the midrib beneath; nervation composed of 5 irregular veins; stamens biseriate, equal, about 4 mm; filaments filiform, 2.0-2.5 mm long; anthers 2-3 mm long, sagittate at base, fused and obtuse at apex; ovary obconical, 3.5 mm long, 2.5 mm wide, hispid; style slender, 1.5 mm-2.0; stigma 1 mm, composed of three linear rows of papillae, obtuse at apex. Capsule obovoid, 5 mm long, 3.5 mm in diameter, hispid, surmounted by the persistent perigone, with several seeds. Seeds ovoid, 2 mm long and 1 mm wide, with a large nipple-shaped appendage at the apex; testa honeycombed (Fig. 56).

Distribution. This species occurs in the Democratic Republic of the Congo and Tanzania (Fig. 57A) in the Zambesian Region and is known only from two locations. Thought no data concerning altitude were given on the herbarium sheet, the area in the vicinity of Iringa (Fig. 57B), where it was collected, is situated between 1500-1800 m a.s.l. (East Africa Map, Sheet 215/3) in the submountain vegatation zone.

Habitat. In degraded miombo with *Dichrostachys cinerea* (L.) Wight & Arw, *Euphorbia matabelensis* Pax, *Brachystegia* cf. *wangermeeana* De Wild.

Phenology. The flowering period in January, in connection with the rainy season.

Observations. Because only one location is known, this species needs to be confirmed in the field. The presented redescription adds new data to the protologue.

IUCN conservation status. Critically Endangered (Extinct?).

Specimen studied. **TANZANIA. Southern Highlands (T7). Iringa.** Iringa, 01.01.1971, *Bjørnstad I. 401* (K, O).

10. *Hypoxis nyasica* Baker in Kew Bull. 1897: 284 (1897). TYPE: Malawi, Mount Zomba, *Whyte s.n.* (K!, B!, lectotype, designated here) & Mount Malosa, *Whyte s.n.* (K!, syntype).

Baker (1898: 380); Nel (1914b: 318); Brenan (1954: 86); Nordal & Zimudzi (2001: 16), Da Silva *et al*. (2004: 127); Singh (2006: 15); Wiland-Szymańska & Nordal (2006: 16, Fig. 3).

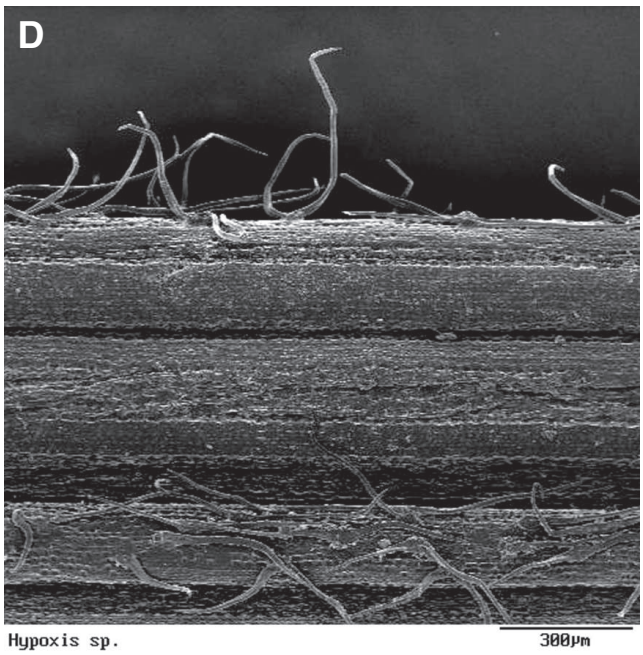
= *Hypoxis campanulata* Nel in Bot Jahrb. 51: 314 (1914b); Singh (2006: 14). TYPE: Lindi District, Tendaguru, *Janensch & Hennig 19* (B!, holotype)

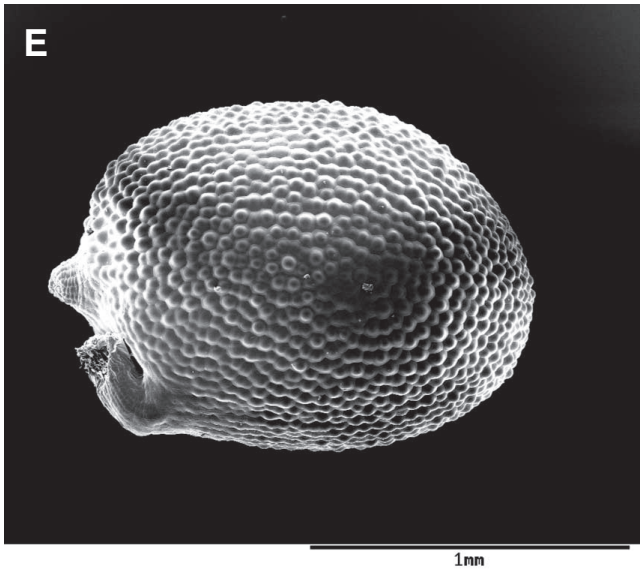
= *Hypoxis engleriana* Nel in Bot. Jahrb. 51: 315 (1914b); not *sensu* Jex-Blake (1948: 130). TYPE: Malawi, Blantyre, Shire Highlands, *Buchanan 26* (K! syntype) & Shire Highlands, Zambesiland, *Geo Adamson 28* (K! syntype) & Blantyre, *Scott s.n.* (K! syntype)

= *Hypoxis engleriana* var. *scottii* Nel in Bot. Jahrb. 51: 315 (1914b). TYPE: Malawi, Shire Highlands, *Scott-Elliot* 8579 (K!, holotype)

= *Hypoxis ingrata* Nel in Bot. Jahrb. 51: 311 (1914b). TYPE: Malawi, lower plateau, north of Lake Malawi (Nyassa), *Rev. Thomson s.n.* (K!, holotype)


A
5 cm
K. Gawrońska
B





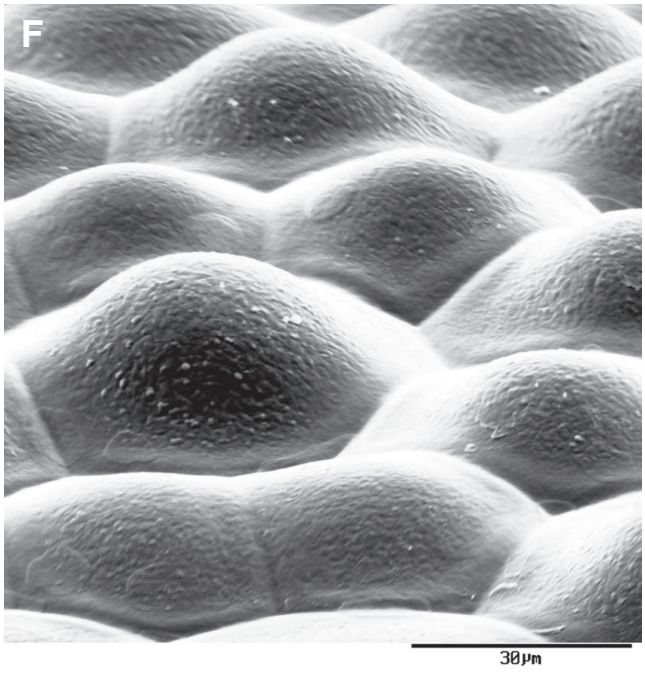


Fig. 58. *Hypoxis nyasica*
Explanations: A – habit (from *Janensch & Hennig 19*), B – living plant (from *Wiland & Mboya 114*), C – tubers connected with stolon-like roots (from *Wiland & Mboya 106*), D – SEM image of two-branched trichomes on a leaf (from *Wiland & Mboya 75*), E – seed (from *Wiland & Mboya 120*), F – seed testa sculpture (from *Wiland & Mboya 120*)

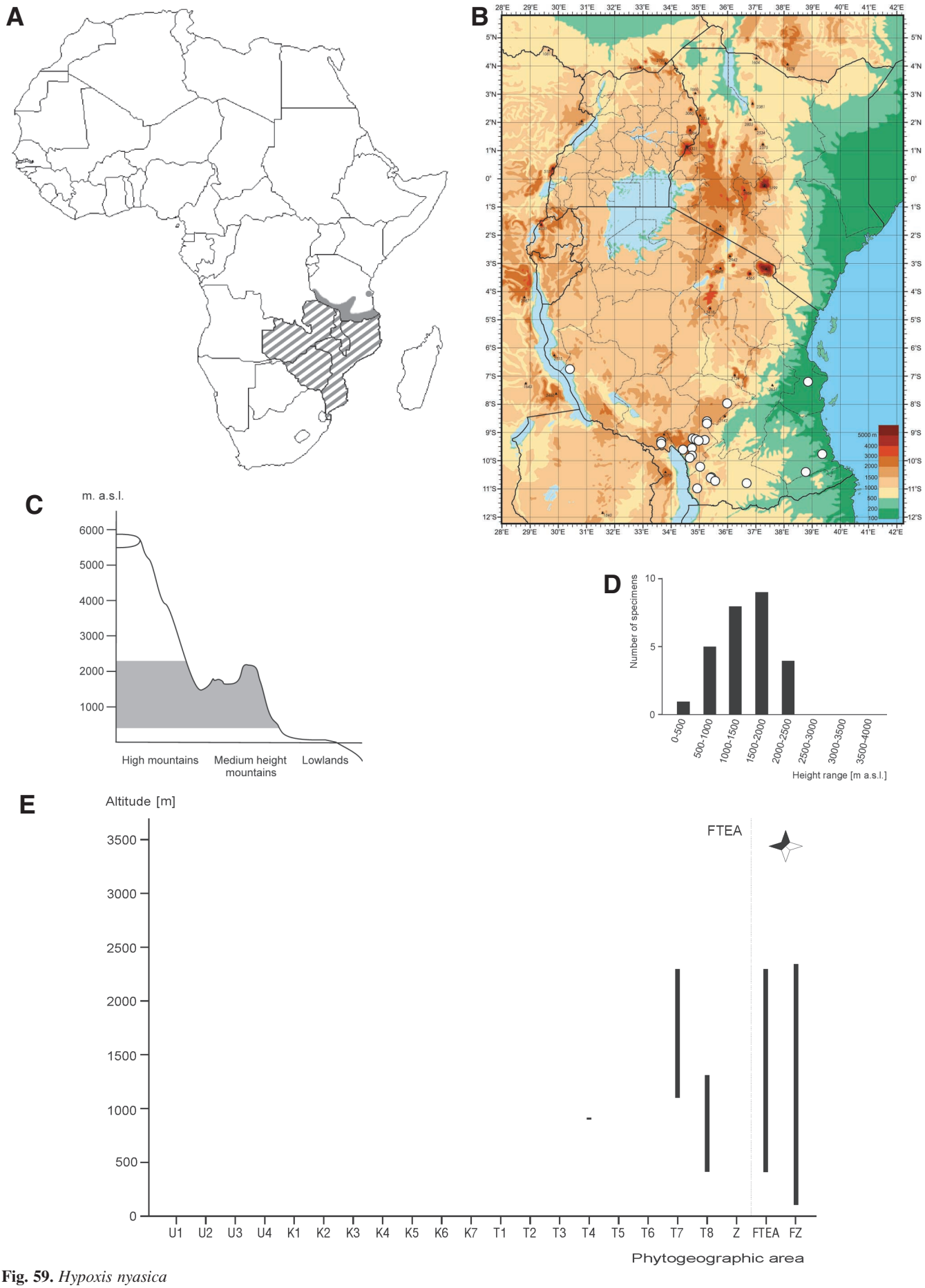


Fig. 59. *Hypoxis nyasica*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

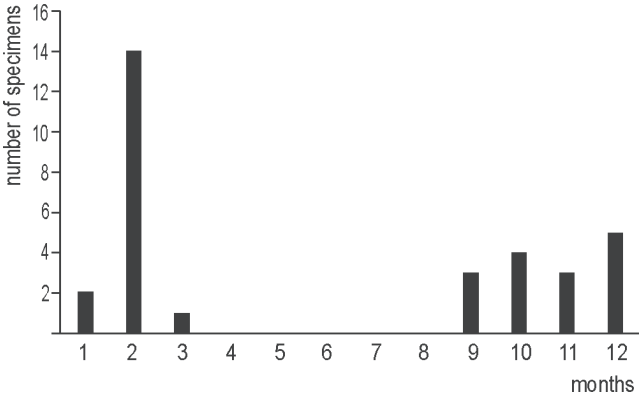


Fig. 60. Flowering periods of *Hypoxis nyasica*

= *Hypoxis probata* Nel in Bot Jahrb. 51: 317 (1914b). TYPE: Tanzania, Rungwe District, Kyimbila, *Stolz 537* (B!,holotype; G, K!, L, M, S, WRSL!, isotypes)
= *Hypoxis retracta* Nel in Bot Jahrb. 51: 312 (1914b). TYPE: Kenya, near Eldama, *Whyte s.n* (B!, lectotype; K!. isotype)
= *Hypoxis canaliculata sensu* Brenan (1954: 86) quoad *Brass 17598*
= *Hypoxis urceolata sensu* Cribb et Leedal (1982: 167, Pl. 46C)
= *Hypoxis obtusa* Burch *sensu* Baker (1898) *pro parte*
= *Hypoxis obtusa* complex *sensu* Nordal *et al*. (1985: 28) *pro parte*
= *Hypoxis villosa sensu* Zimudzi in Kirkia 16: 17 (1996) *pro parte*

Slender herb, 15-90 cm tall (Fig. 58A-B); tuber elongated or ovoid, light yellow to orange inside, becoming bluish near apex when exposed to air; often in large connected groups or divided into many smaller sprouts in apical part, sometimes few tubers connected with stolonlike roots (Fig. 58C), or two tubers one above the other – moniliform, 1.5-3.0 cm long and 1.0-2.5 cm wide (when dry), 3-10 cm long and 3-5 cm wide (when fresh); sap present; tunic fibrous. Pseudostem short, up to 4 cm long; outer leaves shorter than the inner, spathe-like in the basal part, above oblong, 10-14 mm wide, acuminate at apex, pubescent beneath with 2-branched and tuft trichomes; inner leaves linear, grass-like, erect or sometimes straggling, conduplicate at least towards the base, dark green, white or sometimes dark red at the base, 20-90 cm long and 3-22 mm wide, thinly loosely pubescent on the margins and main veins, sometimes with a few hairs on the lamina; trichomes 2-3 branched, whitish in the field, to golden brown in the herbarium, to 1.7 mm long (Fig. 58D); veins 11-13, distinct, different in size and with variable distance between them; margin in dry leaves brownish, darker than the rest of the blade. Inflorescences 1-8, racemose, early overtopped by leaves, with scapes pale green, sometimes tinged with red, up to c. 42 cm long, 1-2(3) mm wide, width reducing in steps as pedicels diverge. Flowers (2-)4-5(-10), at least two lowest opposite; pedicels 3-10 (-20) mm long; bracts subulate to linear-lanceolate, 7-30 mm long, 1-3-veined, sparsely hairy on the midrib below, sometimes ciliate on margins in apical part; tepals all ± similar, green outside, yellow inside, elliptic to lanceolate, 8-11 long and 3-6 mm wide, 5-7-veined; stamens equal; filaments subulate, 1.5-3 mm long; anthers first yellow and later brown, 2.3-5.0 mm long, emarginate at apex; style columnar, 1-3 mm; stigma light yellow, variable, piramidal, with three rows of papillae, or with free, obtuse lobes, 1-2 mm long. Capsule green, mostly 4-6(-8) × 3-4.5 mm, turbinate, opening with a transverse slit near the middle. Seeds black and glossy, 1-1.2 × 1.7 mm, subglobose; testa densely papillate, the papillae dome-shaped, the cuticle smooth (Fig. 58E-F).

Distribution. This species occurs in Tanzania (Fig. 59B), Zambia, Malawi, Mozambique and Zimbabwe (Fig. 59A) in the Zambesian Region. In Tanzania it reaches the northern and eastern limit of its range. It is distributed between 411 and 2300 m a.s.l. (Fig. 59C), but is most abundant between 1000-2000 m a.s.l. (Fig. 59D), in the submountain and lower part of the mountain vegetation zone belts. A bottom limit of its vertical range is elevating towards North and West. For example, it is found in Lindi, under influence of an oceanic climate, on 411 m a.s.l., and in Southern Highlands from 1100 m a.s.l. (Fig. 59E). There is an exception in Western Region of Tanzania, where it occurs at 900 m a.s.l., but it is probably connected with a vicinity of the Lake Tanganika, influencing a continental climate of this area. *Hypoxis nyasica* was collected in the Flora Zambesiaca area between 100-2350 m a.s.l. (Fig. 59E) (Nordal & Zimudzi 2001).

Habitat. Grassland, wet meadow, *Brachystegia* woodland, *Combretum* woodland, disturbed forest, forest edge, floor of pine plantation, pastures, fallows, in full sun or shade; laterite, brown sandy loam, muddy black soil.

Phenology. From September till March, with a peak in February (Fig. 60). Sometimes appearing after fire.

Uses. Gathered in Tanzania and sold in Zambia as a treatment for AIDS.

Observations. Dimensons of leaves and tuber are considerably smaller after drying.

The presented redescription adds new data on the species morphology.

IUCN conservation status. Least Concern.

Specimens studied. **TANZANIA. Western (T4). Mpanda.** Exploration Co. Track about 12 miles from Ikola, 900 m, 03.11.1959, *Richards 11701* (BR). **Eastern (T6). Uzaramo.** E of Coast Range, 11.1860, *Speke & Grant s.n.* (K). **Southern Highlands (T7).** Lower-Plateau, N of Lake Nyassa, 10.1880, *Thomson s.n.* (B). **Iringa.** Mufindi, 6100 ft (= 1859 m), 27.09.1934, *Davies D 951* (K); ibid., 6000 -6500 ft (= 1829-1981 m), 20.10.1968, *Paget-Wilkes 237* (EA, MO); Mufindi West, 6000 -6600 ft (= 1829-2012 m), 24.02.1932, *St. Clair Thompson 645* (EA, K); Kigogo, near the old forester's house, 1800 m, 09.03.1987, *Lovett, Keeley & Niblett 1672* (DSM, K, MO, NHT); Isele, 1620 m, 13.02.2001, *Wiland & Mboya 74* (NHT, MO, POZG) & *Wiland*


A
B
C

& Mboya 75 (NHT, POZG). **Rungwe.** Station Kyimbila, 1350 m, 09.01.1911, *Stolz 537* (B, UWR, WRSL); Mwankinja, 01.1954, *Semsei 1562* (BR, EA, K); Chivanjee, 1100 m, 04.12.1978, *Leedal 5202* (K). **Njombe.** Njombe, 06.12.1931, *Lynes D91* (K); ibid., 08.12.1931, *Lynes D87* (K); Milo, 2300 m, 05.10.1978, *Archbold 2442* (K); ibid., 2300 m, 25.10.1978, *Archbold 2616* (K); Mellom, Lizitu & Lugalawa, 2000 m, 23.09.1970, *Thulin & Mhoro 1109* (K, O); Ludewa, 06.11.1987, *Mwasubi, Magehema, Thomas & Lovett 13432* (MO); Igima, Lihogossa Swamp, 1720 m, 23.02.2001, *Wiland & Mboya 108* (NHT, MO, POZG); Nyombo, 1700 m, 24.02.2001, *Wiland & Mboya 111* (NHT, POZG); near Nyombo, Mkoo Stream, 1500 m, 24.02.2001, *Wiland & Mboya 114* (NHT, POZG); ibid., 1480 m, *Wiland & Mboya 119* (NHT, POZG); Matembwe, 1480 m, 24.02.2001, *Wiland & Mboya 120* (NHT, POZG) & *Wiland & Mboya 121 a* (POZG); ibid., Mtakuja Subvillage, 1420 m, 24.02.2001, *Wiland & Mboya 122* (NHT, MO, POZG); Luponde, on road to Lusitu, 2100 m, 25.02.2001, *Wiland & Mboya 131* (NHT, MO, POZG); ibid., Mnogwela Street, 2010 m, 25.02.2001, *Wiland & Mboya 134* (NHT, MO, POZG). **Southern (T8). Songea.** Kimarampaka river, 12 km vest for Songea, 960 m, 31.12.1955, *Milne-Redhead & Taylor 8002* (B, BR, EA, K, LISC); Peramiho Village, 860 m, 20.02.2001, *Wiland & Mboya 102* (MO, NHT, POZG); ibid., on edge of Liguambi Stream,

Fig. 61. *Hypoxis obtusa*
Explanations: A – scape (from *Jaeger 243*), B – inner leaves (from *Jaeger 243*), C – outer leaf (from *Jaeger 243*), D – freshly cut tuber with bluish tint and drops of sap in apical part (after *Wiland & Mboya 85*), E – seed testa sculpture (from *Perdue & Kibuwa 114369*)

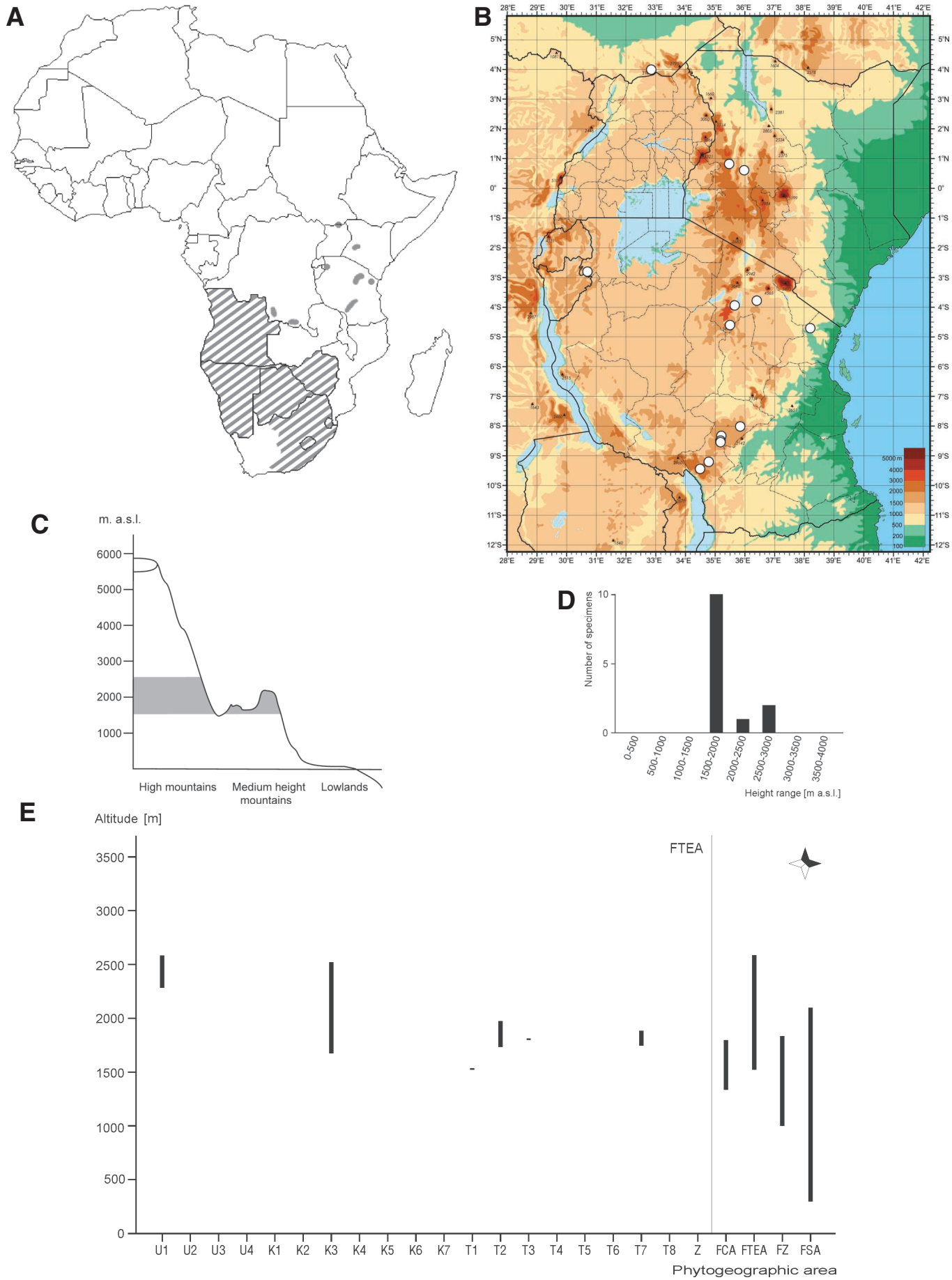


Fig. 62. *Hypoxis obtusa*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

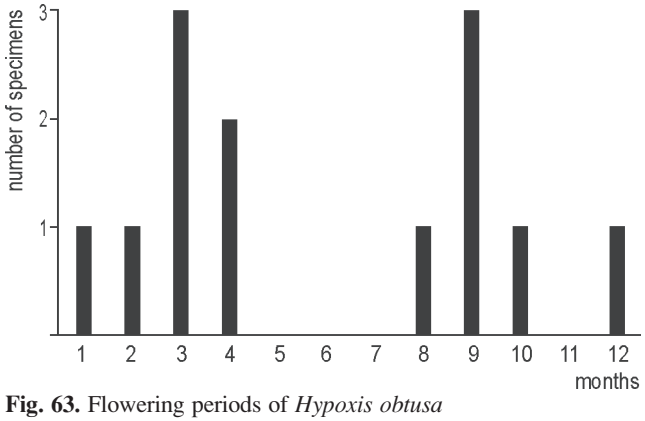


Fig. 63. Flowering periods of *Hypoxis obtusa*

820 m, 20.02.2001, *Wiland & Mboya 104* (MO, NHT, POZG); Matengo Highlands, Myangayanga, 1310 m, 21.02.2001, *Wiland & Mboya 106* (MO, NHT, POZG). **Tunduru.** Near Libobi village, 870 m, 21.12.1955, *Milne-Redhead & Taylor 7733* (B, K). **Lindi.** Tendaguru, 1910, *Janensch & Hennig 19* (B); Nachingwea, 1350 ft (= 411 m), 21.09.1952, *Anderson 792* (EA, K, NHT)

11. ***Hypoxis obtusa*** Burch *ex* Ker Gawl. in Bot. Reg.: Table 159 (1816). TYPE: South Africa, Bot. Reg. Table 159 (Iconotype!).

Durand & Schinz (1895: 233); Baker (1878: 114, *pro parte* quoad type; 1898: 381); Nel (1914b: 334); Bews (1921: 64); Norlindh & Weimarck (1937: 167) *pro parte*; Martineau (1953: 16, Pl. XXII); Sölch (1969: 1-2); Trauseld (1969: 31, phot.); Jackot Guillarmod (1971: 149); Ross (1972: 132); Pearse (1978: 64, phot.); Hilliard & Burtt (1986: 205); Heideman (1987: 247, Figs. 90M, N, O); Nordal & Zimudzi (2001: 13); Snijman & Singh (2003: 1072); Singh (2006: 15); Wiland & Nordal (2006: 11); Singh (2007: 363-364).

= *Hypoxis angolensis* Baker in Trans. Linn. Soc. Ser. 2, Bot. 1: 266 (1878). TYPE: Angola. Huilla, in collinis dumetosis prope Lopollo, *Welwitsch 4059* (BM!, holo.). Durand & Schinz (1895: 231); Baker (1898: 380-381); Wiland-Szymańska (2001: 306-309, Figs. 1, 2A & B, 22); Singh (2006: 14).

= *Hypoxis demissa* Nel in Bot. Jahrb. 51: 328 (1914b); Singh (2006: 14). TYPE: Tanzania. Reise nach Uluguru, Uhehe, Usangu, *Prittwitz & Gaffron 171* (B!, holo.)

= *Hypoxis protrusa* Nel in Bot. Jahrb. 51: 336 (1914b); Singh (2006: 15). TYPE: Tanzania, Kilimandscharo: Rand des Ostafrikanischen Grabens, Umbugwe und Iraku, *Merker 18* (B!, lectotype) & Wanege-Hochland, Buschgrassteppe zwischen Akida Maussa und Mangati, *Jaeger 243* (B!, syntype)

= *Hypoxis subspicata sensu* Geerinck (1971) *pro parte*

= *Hypoxis obtusa* complex *sensu* Nordal *et al*. In Nordic J. Bot. 5: 28 (1985) *pro parte*.

= *Hypoxis villosa* complex Zimudzi in Kirkia 16: 14 (1996) *pro parte*

= *Hypoxis villosa* L. f. *sensu* Friis & Vollesen in Biologiske Skrifter 51: 506-507 (2005) *pro parte*.

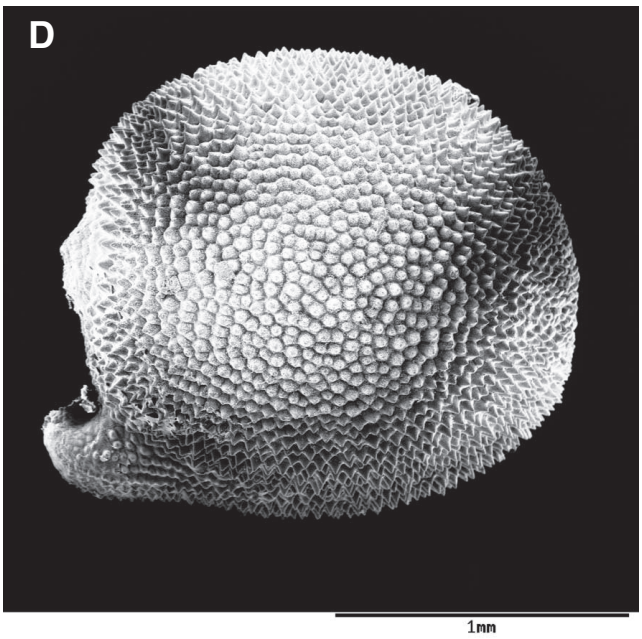
Robust herb to 1 m high; rhizome ovoid or cylindrical, yellow-orange, getting bluish in upper part, with a smell of old potatoes, 6.4-11.0 x 3.9-6.6 cm (Fig. 61D); sap copious; tunic to 8 cm, usually large, matted and fibrous, rather easily detached, brown-red. Outer leaves 3 to 5, ovate (Fig. 61C), dull maroon-brown at the base, 6-14 x 0.8-1.4 cm, ciliate on the margins and midrib below, glabrous above; trichomes tufted, white; nerves of unequal size, (29 to) 39 to 67; inner leaves 8 to 27, linear, grass green except whitish basal parts, (12-) 21-48 (-66) x 0.6-1.6 cm wide, in basal part wider and with membranous margins, prominently keeled, ciliate on the margins and midrib below, glabrous above (Fig. 61B); trichomes tufted, adpressed, ca. 4-branched with branches 0.5-2.7 mm long, white or grey; thin nerves of equal size, very densely arranged (when dry), (29 to) 33 to 67. Scapes 3 to 13, 13-27 cm x 3-4 (-5) mm, basally tapering, shortly winged and ciliate, in upper half prominently hispid with tufted trichomes; raceme 6- to 12-flowered, floral anthesis acropetal (Fig. 61A); bracts subulate, lowermost 11-25 x 1.5-2.0 mm, 7-nerved, pubescent on midrib and nerves abaxially; upper bracts much smaller, almost filiform; pedicels 4-23 mm long, hispid. Tepals 6, clear yellow inside, green outside with pale yellow margins; outer tepals oval, 9-16 x 3-5 mm, 5- to 9-nerved with irregular nerves, abaxially hispid; appendage clavate; inner tepals ovate, obtuse, 9-14 x 4.5-10.0 mm, 5- to 7- (10-) nerved with irregular nerves, pubescent abaxially along the midrib; stamens subequal or inner shorter than outer, greenish yellow; outer stamens 5-9 mm long with filaments 3.5-4.5 mm long; inner stamens 4.5-7.5 mm long with filaments 2.5-3.5 mm long; anthers linear, prominently sagittate, slightly emarginate or fused at apex, 3.5-5.0 mm long; ovary 4.5-13.0 x 3.5-6.0 mm, hispid; style 1-2 mm long; stigma pyramidal, greenish yellow, 1.5-3.0 mm long. Capsule obconical, 6-10 x 4-5 mm, hispid; seeds 6 to 9, ovoid, 1.2-1.5 x ca. 1 mm, black and glossy; seed coat colliculate (Fig. 61E).

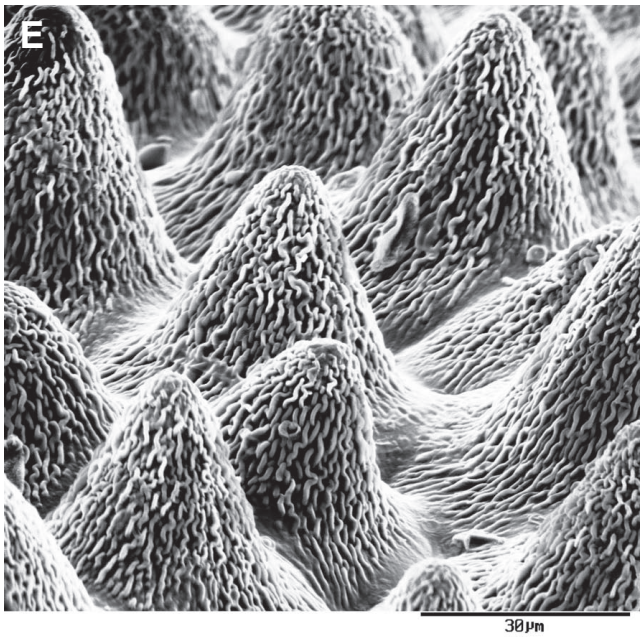
Distribution. A species with a wide range from the Democratic Republic of the Congo, Uganda, Kenya, Tanzania, Angola, Zimbabwe, Namibia, Botswana, Republic of South Africa, Swaziland to Lesotho (Fig. 62A). It occurs in the Zambezian Region, the Kalahari-Highveld Transition zone, the Sudanian Region and the Somalia-Masai Region. Its centre of abundance is situated in the eastern part of the South Africa. In the Central and East Africa (Fig. 62B) the range of this species is disjunctive and insular. It occurs in this area between 1524 and 2591 m a.s.l. (Fig. 62C), but most frequently from 1600-2000 m a.s.l. (Fig. 62D), in the submountain and lower part of the mountain vegatation zone belts. A species bottom limit of the vertical range is elevating towards North and East (Nordal & Zimudzi 2001; Wiland-Szymańska 2001; Snijman & Singh 2003) (Fig. 62E).

Habitat. Grassland, scattered tree und shrub grassland, swamp edge, damp valley; dark grey sandy and stony loam.

Phenology. From August to April (Fig. 63). Sometimes flowers imidiately after burning.

Fig. 64. *Hypoxis polystachya*
Explanations: A – living plant during anthesis (from *Wiland & Mboya 161 A*), B – living plant in the field (from *Wiland & Mboya 156*), C – paniculate inflorescence with undetermined flowering sequence (from *Duvigneaud & Timperman 2528*, BR), D – seed (from *Wiland & Mboya 159*), E – seed testa sculpture (from *Wiland & Mboya 159*)





Observations. The presented redescription includes data on the species morphology within its whole range.

IUCN conservation status. Near threatened in the East Tropical Africa but least concern in Africa.

Specimens studied. **UGANDA. Northern (U1). Acholi.** Imatongs, 7500 ft (= 2286 m), 04.1938, *Eggeling 3597* (K); Lomwaga Mountain, 8500 ft (= 2591 m), 05.04.1945, *Greenway & Hummel 7279* (EA, K, PRE). **KENYA. Rift Valley (K3). Elgeyo.** Kapsiliat, 8300 ft (= 2530 m), 22.12.1943, *Starzeński s.n.* (BR). **Uasin Gishu.** Kipkarren district, 5500 ft (= 1676 m), 03.1932, *Brodhurst-Hill 745* (K). **TANZANIA Lake Province (T1). Ngara.** Keza, Bushubi, 5000 ft (= 1524 m), 20.09.1960, *Tanner 5164* (K, WAG). **Northern (T2). Masai.** Lolkisale, Ol Donyo Mountain, 5700-6500 ft (= 1737-1981 m), 02.1967, *Beesley 230* (K). **Mbulu.** Umbugwe & Iraku, 1902-1903, *Merker 18* (B); between Akida Maussa and Mangati, 19.09.1906, *Jaeger 243* (B). **Tanga (T3). Lushoto**. Worlds View, 1 mile W of Gologolo, W scarp of West Usambaras, 1800 m, 01.03.1953, *Drummond & Hemsley 1373* p.p. (K). **Southern Highlands (T7). Iringa.** Between Ngwazi and Igolowe, 1845 m, 07.03.1989, *Kayombo & Kayombo 80* (MO); near the Iringa-Mbeya road, N of Lake Ngwazi, 16.09.1971, *Perdue & Kibuwa 11469* (EA, K); between James & John's Corner, vicinity of Ngwazi Estate, 6000 ft (= 1829 m), 29.10.1973, *Spjut & Muchai 3462* (EA, MO); Sao Hill Forest Res., 1750 m, 15.02.2001, *Wiland & Mboya 85* (MO, POZG); Sao Hill, 6200 ft (= 1890 m), *Watermayer 155* (K); Dabaga highlands, Kilolo, 24 miles SE of Iringa, 6200 ft (= 1890 m), 08.02.1962, *Polhill & Paulo 1394* (B, BR, EA, K, LISC, P, PRE). **Njombe.** Kidoko [Kitogo], 28/29.08.1901, *von Prittwitz & Gaffron 171* (B); Lihogossa Swamp near Njombe, 1800 m, 18.01.1957, *Richards 7892* (B, BR).

12. *Hypoxis polystachya* Welw. *ex* Baker in Trans. Linn. Soc., Bot 1: 206 (1878). TYPE: Angola, Huilla, inter Lopollo et Catumba, *Welwitsch 4060* (BM!, holotype).

Baker (1878: 115; 1898: 382); Durand & Schinz (1895: 233); Singh (2006: 15); Wiland & Nordal (2006: 10, Fig. 1.9)

= *Hypoxis subspicata* Pax in Bot. Jahrb 15: 143 (1893). TYPE: Angola, Quango, *Pogge 424* (B!, lectotype, designated here) & Malandsche, *Teuscz in von Mechow 249* (B!, syntype). Durand & Schinz (1896: 260); Baker (1898: 381); Nel (1914b: 328); De Wildeman (1914: 9); De Wildeman (1921a: 34); Geerinck (1971: 6) *pro parte*; Nordal & Zimudzi (2001: 7); Wiland-Szymańska (2001: 341, Figs. 10A, B, 25).
= *Hypoxis* sp. A of Nordal *et al*. in Nord. J. Bot. 5: 29 (1985), *pro parte* quoad *Davies 742*.

Robust herb up to 1 m tall (Fig. 64A-B); tuber subglobose, elongated or conical, 5-18 cm long and 4-7 cm wide, white or light orange inside, getting bluish when exposed to air, smelling like ginger; sap abundant, sometimes present in a leaf rosette; tunic fibrous, stiff. Leaves tristichous, arching when mature, dark green with bases whitish, or sometimes red tinted. Outer leaves ca. 7, linear, acute, 3.0-6.5 cm long and 1.6-2.0 cm wide, glabrous basally and above, pubescent below with long, tufted trichomes; nerves unequal ca. 23; inner leaves ca. 9, lanceolate to broadly linear, acute, prominently keeled, 40-100 cm long and 2.0-5.8 cm wide, lamina white pilose-pubescent abaxially (outside), becoming glabrescent with age, glabrous adaxially (inside, sometimes with a few hairs), margins and abaxial (outside) midrib densely white lanate; hairs silvery-white, up to 3 mm long, tufted, 3-10-armed with arms subequal ascending-spreading; veins of subequal size 31-41 closely spaced when dry, but not so when fresh. Inflorescences 1-7, 18-25 cm lond and ca. 4 mm wide, width reducing in steps as pedicels diverge, narrowly winged and ciliate at base, villous apically with long white tufted trichomes; raceme dense, cylindrical, 8-26-flowered, sometimes branched in apical part and panicle-like (Fig. 64C); flowering sequence often undetermined; the lowermost bracts 20-30 mm long and 4 mm wide, 5-nerved,

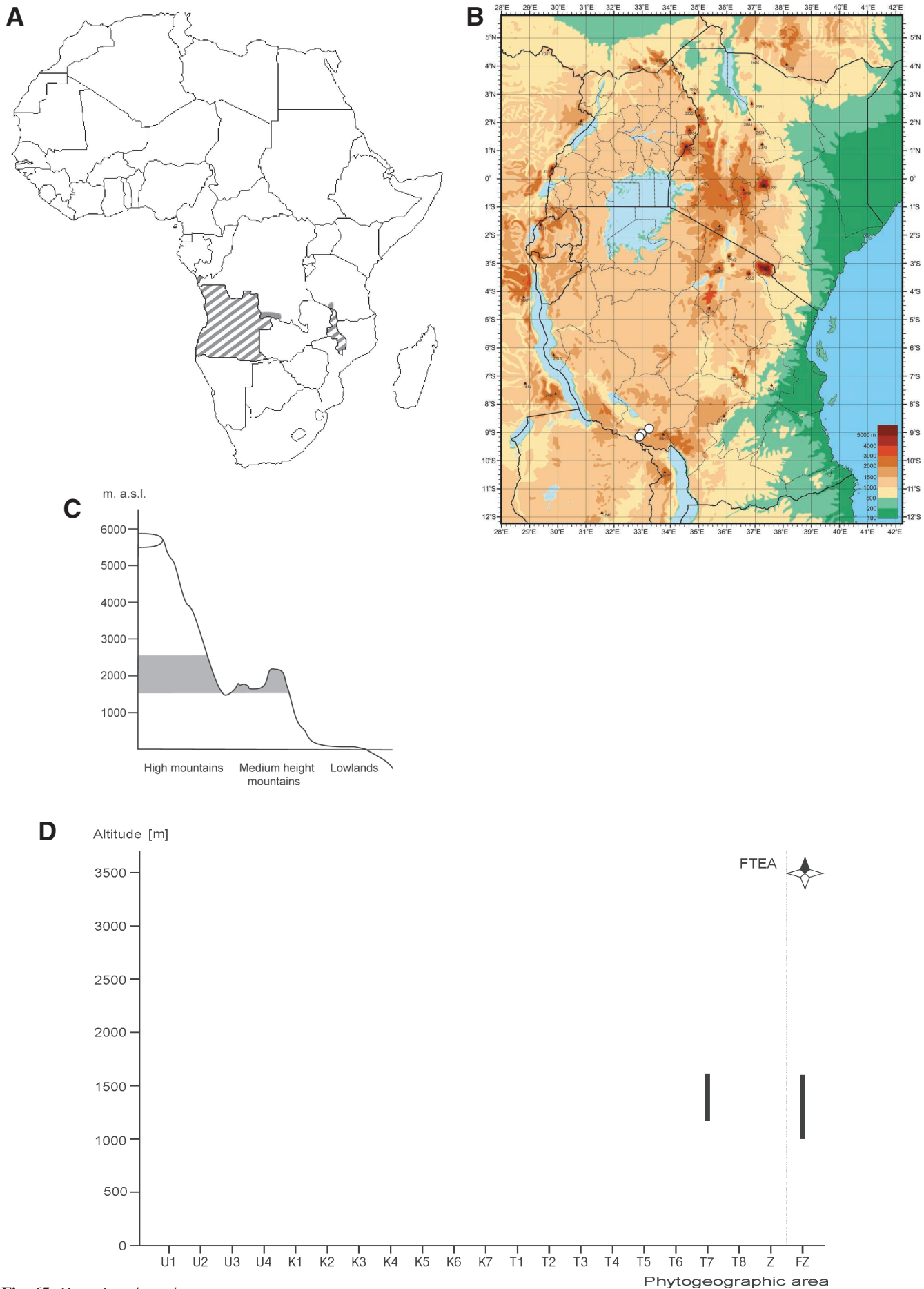


Fig. 65. *Hypoxis polystachya*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

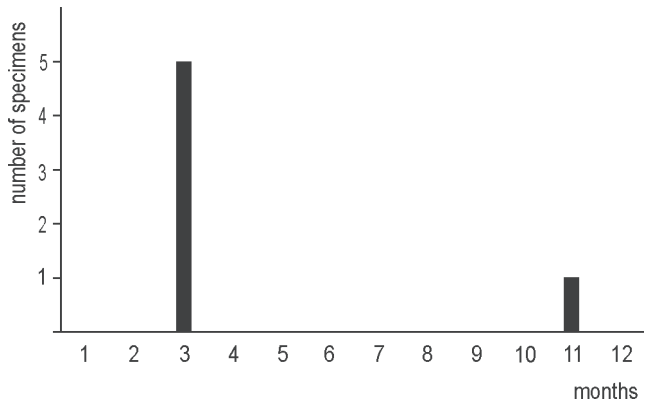


Fig. 66. Flowering periods of *Hypoxis polystachya*

pubescent with long trichomes along midrib and on lamina surface in basal and apical parts below, sometimes ciliate; pedicels 2-10 mm long, prominently pubescent. Flowers yellow, tepals 6; outer tepals ovate or oblong, 14-17 mm long and 4-5 mm wide, densely hispid abaxially, 7- to 9-nerved; inner tepals ovate, obtuse 12-15 mm long and 7-8 mm, pilose on lower half of midrib abaxially, 7- to 9-nerved; stamens equal; filaments subulate, 2.2-3. 5 mm long; anthers linear, sagittate, fused at apex, 4.5-7 mm long; ovary obconical, 7 mm long and 4 mm wide, densely pilose; style terete, (1.5) 2-6 mm long; stigma narrowly pyramidal, composed of 3 linear fused lobes, 1.5-4 mm long. Capsule turbinate-obconical, 6-8 × 3.5-5.0 mm, circumscissile, sparsely white pubescent. Seeds brownish-black, almost globular, 1.6-1.8 mm in diameter, seed coat tuberculate, with conical papillae covered closely with a minutely wrinkled cuticle and 3-4 longitudinal narrow wing-like ribs or with wrinkled cuticula without wings (Fig. 64D-E).

Distribution. This species is distributed in the Democratic Republic of the Congo, Tanzania, Angola and Malawi (Fig. 65A) in the Zambesian Region. It occurs in the East Tropical Africa in the Southern Highlands Province (Fig. 65B) between 1180-1615 m a.s.l. (Fig. 65C), in the submountain vegetation zone belt. Its bottom limit of the vertical range is elevating towards North (Fig. 65D) (Nordal & Zimudzi 2001), but its upper limit does not change much thorughout its range.

Habitat. Primary and disturbed miombo woodland; black loamy soil, laterite.

Phenology. Flowering in March and November (Fig. 66).

Observations. The presented redescription adds new data to the protologue.

Uses. Medical: The only species in the East Tropical Africa observed to be cultivated on purpose for medical uses. Tubers are used as medication against swelling of testicles or ovaries. A tuber sap is a treatment against skin moles.

IUCN conservation status. Vulnerable.

Specimens studied. **TANZANIA. Southern Highlands (T7). Mbeya.** Mbozi Zambi, 5300 ft (= 1615 m), 19.11.1930, *Davies 742* (K); Mbosi, 5200-5300 ft (= 1585-1615 m), 1935, *Horsbrugh-Porter s.n.* (BM) & *Horsbrugh-Porter s.n.* (BM); Old Vwawa, 1400 m, 02.03.2001, *Wiland & Mboya 156* (POZG) & *Wiland & Mboya 159* (POZG); Karasha, 1450 m, 02.03.2001, *Wiland & Mboya 161* (POZG) & *Wiland & Mboya 161a* (POZG); Mshewe, 1180 m, 01.03.2001, *Wiland & Mboya 154* (POZG).

13. *Hypoxis rigidula* Baker in Journ. Linn. Soc. 17: 116-117 (1878). TYPE: South Africa, *Cooper 883* (K, syntype non vidi) & *3239* (K, syntype non vidi) & *1763* (?, syntype non vidi) & *3241* (?, syntype non vidi); *Burchell 3694* (K, syntype non vidi) *Zeyher 1670* (K, P!, syntype non vidi); *Drčge 2194* (K, P!, syntype non vidi); *Hort. Kew. Anno 1863* (K, syntype non vidi).

Durand & Schinz (1895: 233); Baker (1896: 186); Nel (1914b: 331); Bews (1921: 64); Norlindh & Weimarck (1937: 166); Verdoorn (1947: Pl. 1021); Sölch (1969: 2); Trauseld (1969: 31, phot.); Jackot Guillarmod (1971: 149); Compton (1976: 129); Pearse (1978: 64); Berry (1980: 45); Heideman (1987: 247); Zimudzi (1996: 16) *pro parte*; Pooley (1998: 234, photo); Craven (1999: 54); Nordal & Zimudzi (2001: 12); Da Silva *et al.* (2004: 127); Singh (2006: 15); Wiland-Szymańska & Nordal (2006: 19); Singh (2007: 364).

var. *rigidula* Baker in Journ. Linn. Soc. 17: 116 (1878)
Ross (1972: 132); Heideman (1987: 247, Fig. 90K); Snijman & Singh (2003: 1073); Singh (2006: 15);
= *Hypoxis elliptica* Nel. in Bot. Jahrb. 51: 332 (1914b). TYPE: South Africa. Alexandra Distr., Friedenau, *Rudatis 688* (B!, syntype); auf dem Berge bei Maritzburg, *Schlechter 2303* (?, syntype non vidi); zwischen maritzxburg and Greytown, *Wilms 2317* (K, syntype non vidi); Fields Hill bei Pinetown, *Woood 734*, (?, syntype non vidi)
= *Hypoxis laikipiensis* Rendle in Journ. Linn. Soc. 21: 407 (1895); TYPE: Kenya. Laikipia, W of Alng'aria, *J.W. Gregory* (BM, holotype non vidi; B, isotype non vidi; K!, photoisotype). Baker (1898: 381); Singh (2006: 15).
= *Hypoxis robusta* Nel *sensu* Wiland-Szymańska (2001) *pro parte quod specim. Lisowski, Malaisee & Symoens 12984*
= *Hypoxis obtusa* complex *sensu* Nordal *et al.* in Nordic J. Bot. 5: 28 (1985) *pro parte*.
= *Hypoxis villosa* complex *sensu* Zimudzi in Kirkia 16: 17 (1997) *pro parte*.

Robust herb to 1 m tall (Fig. 67A, 67E); tuber turbinate to hemisphaeric with flat base, vertical or horizontal with yellow or orange flesh, sometimes getting bluish exposed to air, 2.5-10.2 cm long and 1.5-7 cm wide, sometimes dividing in upper part (Fig. 67F-G); sap abundant; tunic fibrous, black. Outer leaves shorter than the inner, the most outer up to 20 cm long, spathe like at base, oblong in the upper part, acuminate at apex, about 2 cm wide; densely covered with tufted and 2-branched trichomes; inner leaves 5-9, dark green, lighter at base, creating a distinctive pseudostem 6-15 cm long, linear, rigidly coriaceous, erect, conduplicate, 30-130 x 0.5-2.2 cm, pilose with tufted whitish to silvery

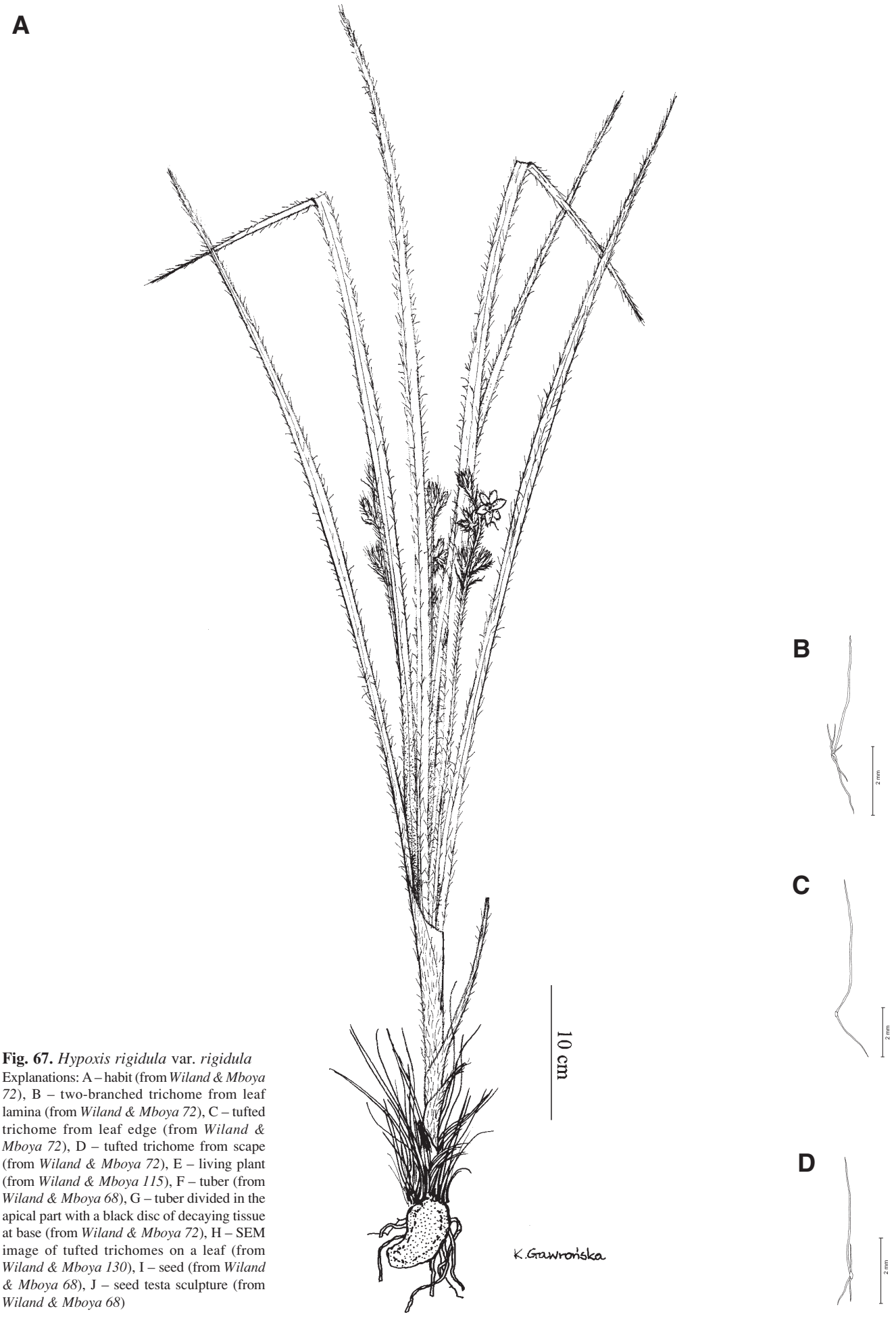
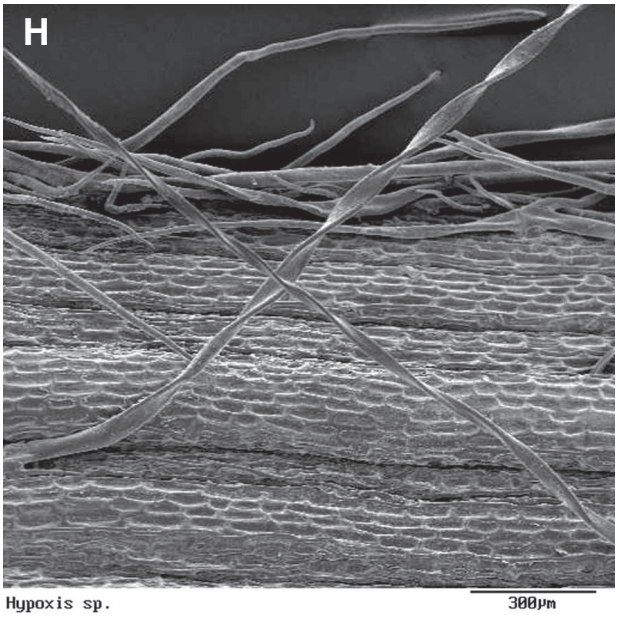


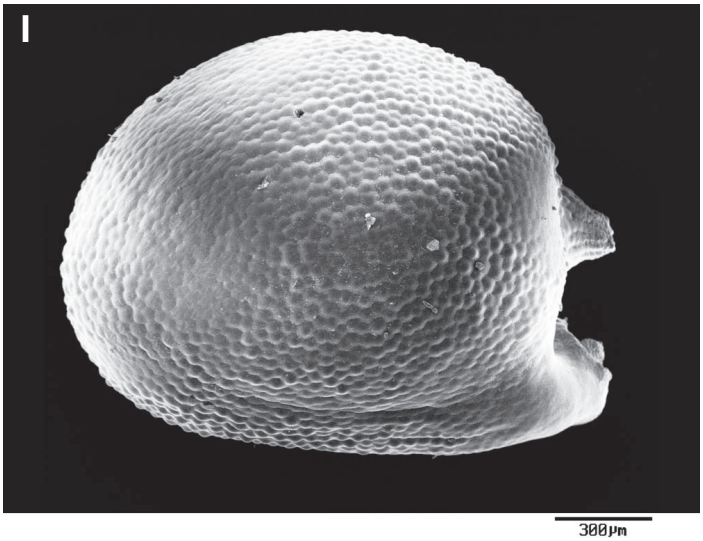
Fig. 67. *Hypoxis rigidula* var. *rigidula*
Explanations: A – habit (from *Wiland & Mboya 72*), B – two-branched trichome from leaf lamina (from *Wiland & Mboya 72*), C – tufted trichome from leaf edge (from *Wiland & Mboya 72*), D – tufted trichome from scape (from *Wiland & Mboya 72*), E – living plant (from *Wiland & Mboya 115*), F – tuber (from *Wiland & Mboya 68*), G – tuber divided in the apical part with a black disc of decaying tissue at base (from *Wiland & Mboya 72*), H – SEM image of tufted trichomes on a leaf (from *Wiland & Mboya 130*), I – seed (from *Wiland & Mboya 68*), J – seed testa sculpture (from *Wiland & Mboya 68*)


E


F


G


H
Hypoxis sp.
300µm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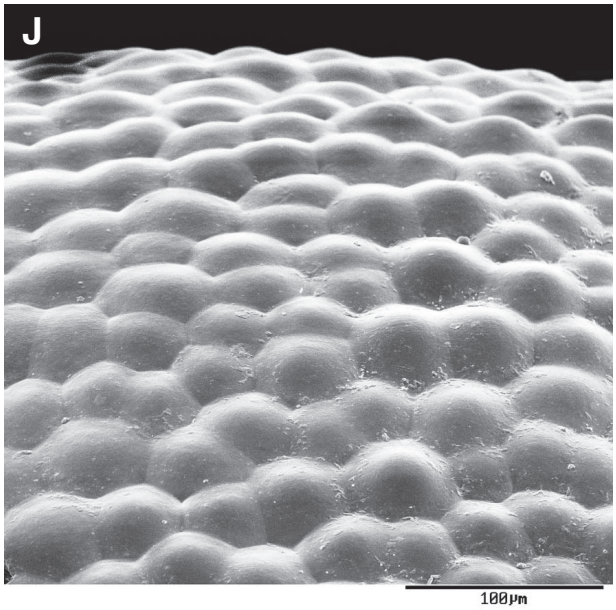
J
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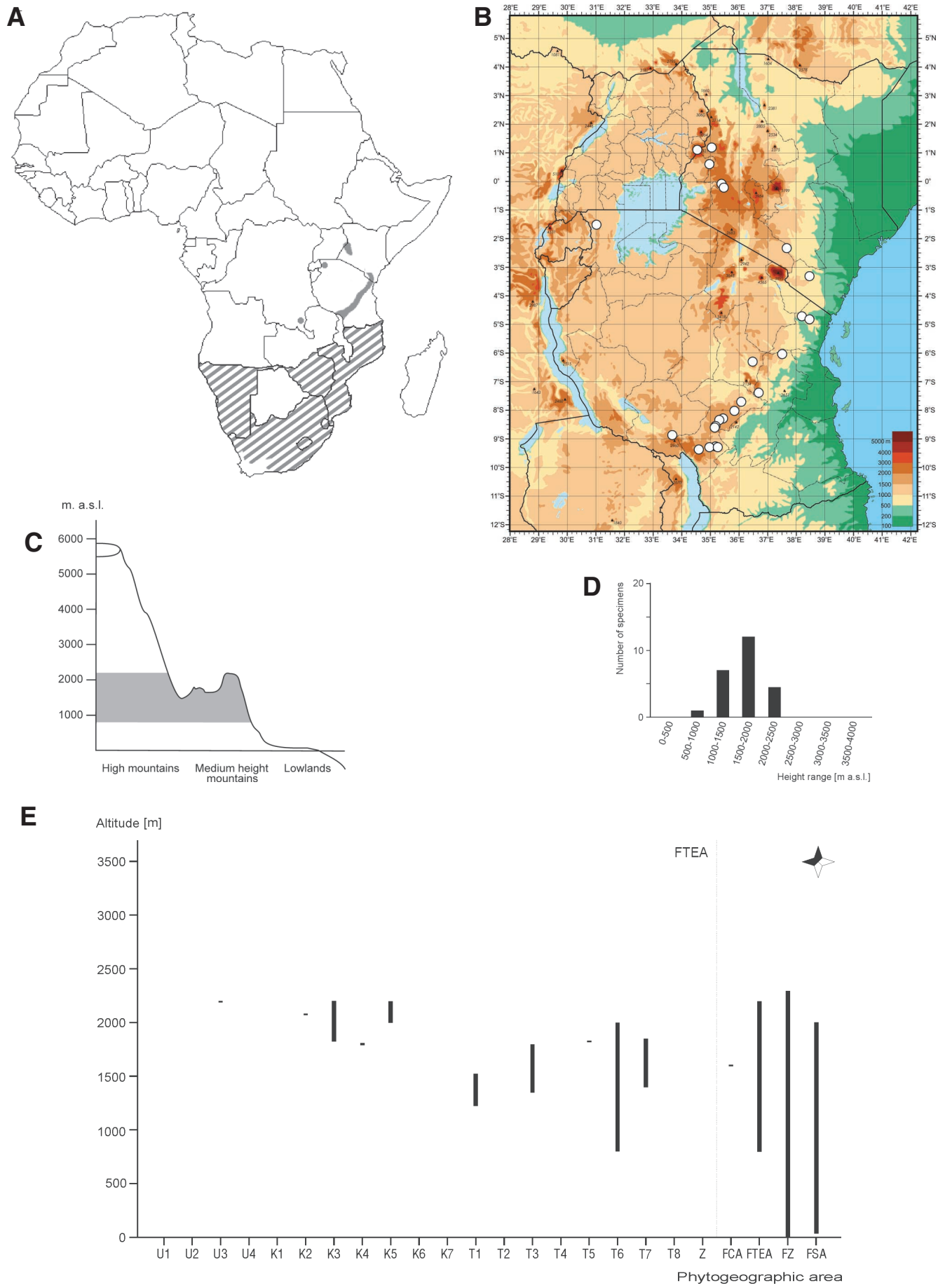


Fig. 68. *Hypoxis rigidula* var. *rigidula*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

greyish hairs along margins and midrib and with 2-3-branched hairs on the lamina (Fig. 67B-C, 67H); veins 11-17, distinctive. Inflorescences 1-5, with scapes 30-70 cm long and 1.5-2.0 mm wide, slender, covered with long ascending greyish-white tufted hairs (Fig. 67D), overtopped by the mature leaves. Flowers 3-14 (-23), alternate, in an up to 15 cm long spicate raceme; lower pedicels 0.6- 1.0 (-1.9) cm long, shorter towards the apex; bracts linear subulate, 12-26 mm long; tepals light yellow inside and green outside, outer tepals sometimes with red stripe, (5-) 12-18 long and 5-7 mm wide; outer tepals lanceolate, acute; inner tepals suboval and subacute; stamens equal, yellow or brown; filaments- subulate, 1.3-2.5 mm long; anthers sagittate, fused apically, 3-6 mm long; ovary turbinate, green, 4-8 mm long and 3-5 mm wide; style 0.5-1 (-2.3) mm; stigma yellow, piramidal, 1-2 (-3.5) mm long. Capsule turbinate, 8 mm long, circumscissile, densely villose. Seeds glossy, black, globose, 1.2-1.7 mm in diameter with papillate testa, cuticle smooth (Fig. 67I-J).

Distribution. H. rigidula var. *rigidula* is widely dispersed in the Democratic Republic of the Congo, Uganda, Kenya, Tanzania, Angola, Zimbabwe, Mozambique, Republic of South Africa, Swaziland and Lesotho (Fig. 68A). It occurs in the Zambezian Region, the Kalahari-Highveld Transition zone, the Sudanian Region and the Somalia-Masai Region. Its centre of abundance is situated in the eastern part of the South Africa. In the East Tropical Africa it has one area of continuous range and two island locations (Fig. 68B). It reaches here North and East limits of its range. It is distributed between 800-2200 m a.s.l. (Fig. 68C), especially often from 1400-2200 m a.s.l. (Fig. 68D), in a lower part of the mountain vegetation zone belt. In the south-eastern part of Africa this taxon occurs almost from the see level (Fig. 68E) (Snijman & Singh 2003, Nordal & Zimudzi 2001), but its bottom limit of the vertical range is elevating rapidly in the North. In the Democratic Republic of Congo the most western location is situated 1600 m a.s.l. (this study).

Habitat. Grassland dry or wet, bushland, open woodland, seepage bog, fallow maize field, in full sun; laterite or black soil (pH 6-6.8) rich in humus.

Phenology. Flowering from September till June (Fig. 69), often after recent burn. Inflorescences are developing simultaneously with leaves.

Uses. Medical**:** Tubers are given to chickens as a cure. Magical: A cut tuber is used in a charm against extensive rain. Forage: Leaves nibbled by animals. The tubers are eaten by monkeys.

Vernacular name. Lipipili (dialect not stated).

Observations. In the area studied, flowers are usually pedicellate, at least in fruiting state. It distinguishes them from South African populations, where flowers are always sitting.

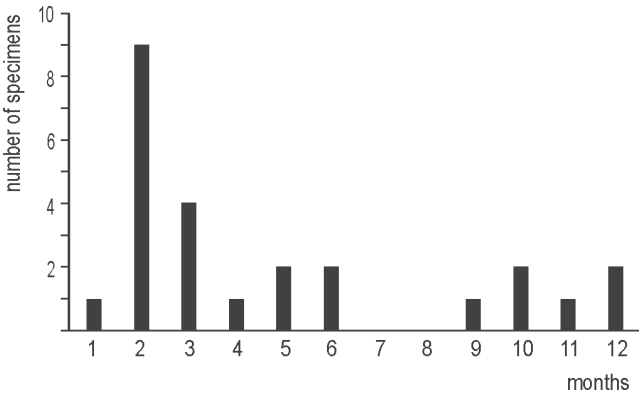


Fig. 69. Flowering periods of *Hypoxis rigidula* var. *rigidula*

The presented redescription includes a morphological variability within the whole range of this species.

IUCN conservation status. Least Concern.

Specimens studied. **UGANDA/KENYA. Eastern/Rift Valley/ Nyanza (U3/K3/K5). Mbale/TransNzoia/North Kavirondo.** Mount Elgon, 2200 m, 20.03.1938, *Ake Holm 19* (S). **KENYA. Turkana (K2). West Suk.** Keringet, 6800 ft (= 2073 m), 05.1969, *Tweedie 3643* (K); ibid., 06.1969, *Tweedie 3657* (K). **Rift Valley (K3). Uasin Gishu.** Near Kipkarren, 6000 ft (= 1829 m), 28.03.1952, *Cooke 19A* (K). **Laikipia.** W of Alrigaria, Laikipia, from camp # 67 to camp # 68, 1893, *Gregory s.n.* (BM). **Central/Masai (K4/K6). Machakos/Masai.** Chyulu Hills, first lookout to Saddle, 1800 m, 11.12.1993, *Luke P.A. & W.R.Q. 3859* (K). **Nyanza (K5). Kisumu-Londiani.** Gwongogween, near Lumbwa, ok. 2000 m, 21.04.1922, *Fries R.E. & Th.C.E. 2827* (UPS, WAG); Tinderet Forest Reserve, 2200 m, 26.06.1949, *Maas Geesteranus 5193* (BR, G, K, L, MO, PRE, S). **Coast (K7). Teita.** Mbololo, 09-10.1938, *Boy Joanna s.n. (Coryndon Mas. 9023)* (EA, K). **TANZANIA. Lake (T1). Bukoba.** Karagwe, 4000 ft (= 1219 m)-5000 ft (= 1524 m), 1893-1894, *Scott Elliot 8206* (B, BM, K). **Tanga (T3). Lushoto.** World's view, 1 miles W Gologolo, W Scarp of W Usambaras, 1800 m, 01.03.1953, *Drummond & Hemsley 1373* p.p. (K); West Usambara Mountains, below Baga II Forest Reserve between Mgwashi and Mtai above Mzinga village, 1350-1600 m, 31.01.1985, *Borhidi, Iversen & Mziray 85425* (K, MO). **Central (T5). Mpwapwa.** Kiboriani mountains, 6000 ft (= 1829 m), 09.12.1938, *Hornby Mr.& Mrs. 2097* (EA, K). **Eastern (T6). Kilosa.** Rubeho Mountains, Kisanga, hill above Elphon's Pass pump station, 800 m, 11.02.2001, *Wiland & Mboya 68* (POZG). **Morogoro.** Nguru Mountains, summit of Kwasenjuga, facing E, 2000 m, 01.02.1991, *Manktelow, Pócs & Swenson 91090* (K, UPS). **Southern Highlands (T7). Iringa.** N of escarpment forest & S for Iringa-Mbeya Road, between James & John's Corner, 6000 ft (= 1829 m), 29.10.1973, *Spjut & Muchai 3458* (K); ibid., vicinity of Ngwazi Estate, 6000 ft (= 1829 m), 29.10.1973, *Spjut & Muchai 3466* (EA, K); Igowole, 1850 m, 10.03.1989, *Kayombo & Kayombo 245* (MO); Itungi, 1680 m, 12.02.2001, *Wiland & Mboya 70* (POZG); Lulanzi, near Kilolo Village, 1800 m, 13.02.2001, *Wiland & Mboya 72* (POZG); Itimbo, 1800 m, 16.02.2001, *Wiland & Mboya 94* (MO, POZG). **Njombe.** Njombe, 29.11.1931, *Lynes 39* (K); near Nyombo, Mkoo Stream, 1500 m, 24.02.2001, *Wiland & Mboya 115* (POZG) & *Wiland & Mboya 117* (POZG); Matembwe, 1480 m, 24.02.2001, *Wiland & Mboya 121* (POZG); ibid., Mtakuja subvillage, 1420 m, 24.02.2001, *Wiland & Mboya 124* (POZG); Igombole, 1400 m, 24.02.2001, *Wiland & Mboya 130* (POZG).

14. *Hypoxis schimperii* Baker in Journ. Linn. Soc. 17: 110 (1878). TYPE: Ethiopia, Gonder (Begemder), *Schimper 1118* (K!, holo.).

Durand & Schinz (1895: 234); Baker (1898: 378); Nel (1914b: 305); Cufodontis (1971: 1578); Nordal (1997: 89); Demissew *et al*. (2003: 170, Fig. 144), Singh (2006: 15); Wiland-Szymańska & Nordal (2006: 6).

= *Hypoxis macrocarpa* Holt & Staubo in Nordal *et al*., Nord. J. Bot. 5: 25, Figs. 5F, 14 (1985). TYPE: Tanzania, Ufipa District, Sumbawanga, near Mpui, *Richards 8768* (K!, holotype)

= *H. cuanzensis sensu* Nordal & Zimudzi (2001: 7).

Slender herb up to 45 cm tall (Fig. 70A); corm white or greenish-yellow inside, dull honey to dull hazel exteriorly, cylindrical, 2-4.5 cm long, 1.5-3 cm in diameter; tunic fibrous and brown. Leaves 4-14, forming a whitish pseudostem up to 5 cm long, narrowly lanceolate, +/- erect, up to c. 45 cm long and 1.5-12 mm wide, glabrous or thinly pilose, mostly on the margins and midrib abaxially (outside) with hairs 2-armed, the arms fine, appressed, ± unequal; only 2 visible veins except the midrib. Scapes 1-6, slender, bend over with the weight of the flowers and fruits, up to 21 cm long, appressed-pilose. Flowers usually solitary, but sometimes 2-4 in a lax corymb; pedicels 2-6 mm long, appressed-pilose; bracts 5-15 mm long, filiform to linear-lanceolate. Tepals 6, 5 or 4, bright yellow inside, green with a yellow margin outside, sometimes with a reddish-brown band outside; tepals narrowly elliptic, up to 12 mm long and 3-4 mm wide, thinly pilose abaxially; stamens equal, yellow; filaments subulate, 1.3-4.0 mm long; anthers 2.6-3.2 mm long, fused at apex; ovary obconical, 3 mm long, pale green; style 0.5-1.6 mm long; stigma 1.5-2.3 mm long, yellow. Capsule 5-10 mm long and 4-5 mm wide, turbinate-cylindric, circumscissile, thinly pilose. Seeds dark brown, 0.8-1.2 mm in diameter, globose; testa papillose, each papilla with a minutely wrinkled cuticle and 3-4 longitudinal narrow wing-like ribs (Fig. 70B).

Distribution. A species of wide distribution in Ethiopia, Kenya, Tanzania, Zambia and Zimbabwe (Fig. 71A). It occurs in the Afromontane Archipelago-like

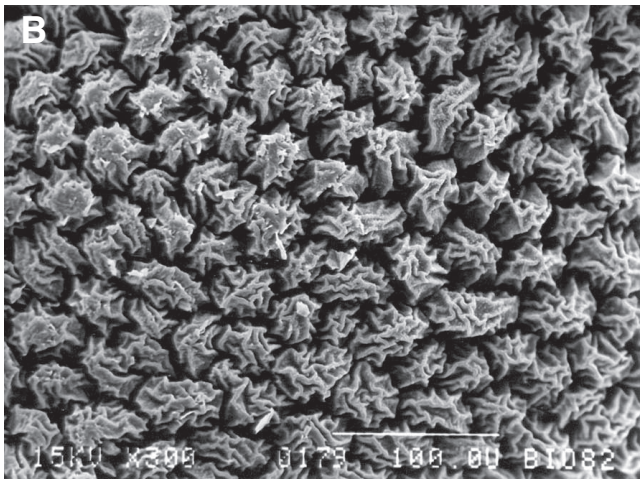


Fig. 70. *Hypoxis schimperii*
Explanations: A – habit (from *Schimper 1118*), B – seed testa sculpture (from *Gillet 17261*)

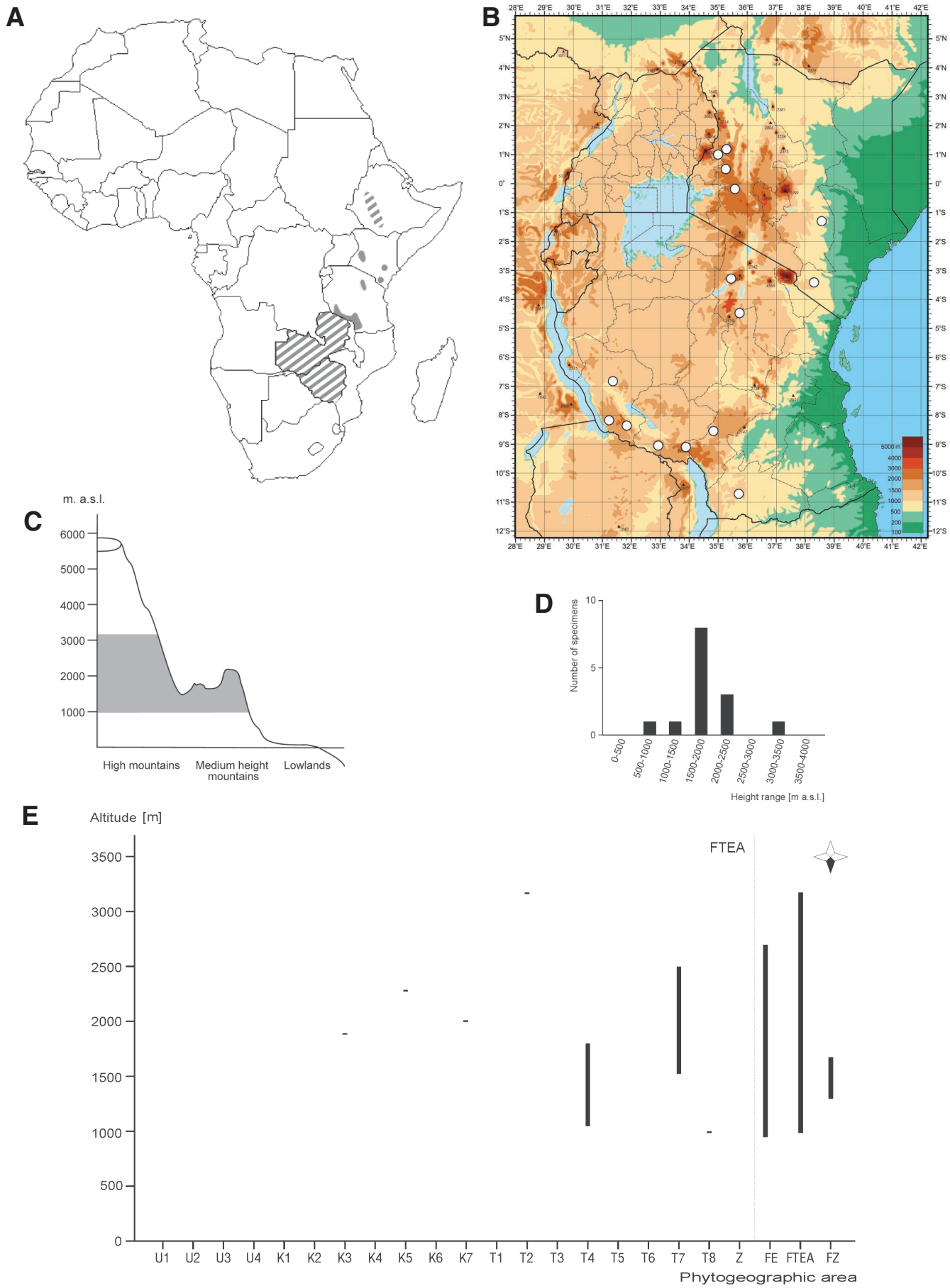


Fig. 71. *Hypoxis schimperii*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

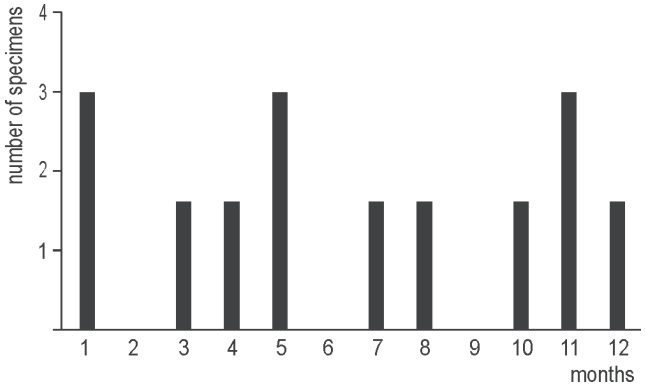


Fig. 72. Flowering periods of *Hypoxis schimperi*

regional centre of endemism in three Mountain Domains: Ethiopian, Imatongs-Usambara i Uluguru-Mlanje (Fig. 71B). It was collected between 990-3170 m a.s.l. (Fig. 71C), especially often from 1500 to 2000 m a.s.l. (Fig. 71D), in the submountain and mountain vegetatione zone belts. Its bottm limit of the vertical range is elevating towards South (Fig. 71E) (Demissew *et al*. 2003; Nordal & Zimudzi 2001. The upper limit is situated higher in the East Africa then in Ethiopia, but is positioned much lower in the South.

Habitat. Swampy grassland, wet dambo, stream bank, *Philippia* thickets on basement complex, pasture; black or sandy soil.

Phenology. Flowering through most of the year (Fig. 72).

Observations. This species needs a further study, because in a few specimens testa differs from the state described above: *Moreau 80* – seeds lacking cuticula folding, unripe seeds, flat; *Mabberly & Mccall 106* & *Davis 81* – papillose seeds with small papilla. Other characters are very similar. In the herbarium the underground organs look like a true corm, but it must be confirmed in the field.

The presented redescription includes new data on morphology of this species.

IUCN conservation status. Near threatened.

Specimens studied. **KENYA. Rift Valley (K3). Trans-Nzoia.** Near Kapenguria road 2-3 miles from Kitale, 6200 ft (= 1890 m), early 05.1954, *Rayner 541* (K); Kitale, swamp by side of Kitale-Hempstedt's bridge road, about 1 mile from where it turns off from the Kitale-Kapenguria road, 6200 ft (= 1890 m), 07.05.1954, *Rayner 551* (K); swamp 4 miles on road to Hempstead Bridge, 6200 ft (= 1890 m), 06.08.1968, *Agnew, Kibe & Mathenge 10588* (EA). **Uasin Gishu**. Near Eldoret, 6200 ft (= 1890 m), 08.07.1950, *Wiltshire 24* (K). **Central (K4). Kitui.** Endau Hill, 19.11.1979, *Gatheri, Mungai & Kibui 79/84* (K). **Nyanza (K5). Kisumu-Londiani.** Londiani, 7500 ft (= 2286 m), 10.05.1953, *Davis 81* (BM, K). **Coast (K7). Teita.** NE slope of MountYale, 2000 m, 10.04.1966, *Gillet 17261* (K). **TANZANIA. Northern (T2). Masai/Mbulu.** N side of Oldeani, 10400 ft (= 3170 m), 01.1935, *Moreau Mr. & Mrs. 80* (EA, K). **Western (T4). Mpanda.** Kapapa Camp, 1050 m, 28.10.1959, *Richards 11621* (K). **Ufipa.** Chapota, 5500 ft (= 1676 m), 05.12.1949, *Bullock 2057* (K); Sumbawanga near Mpui, 1800 m, 16.03.1957, *Richards 8768* (K). **Central (T5). Kondoa.** Bereku, 17.01.1974, *Arazululu M.R. & S. 28737* (EA). **Southern Highlands (T7). Iringa.** About 12 km W of Sao Hill on road to Mbeya, 2100 m, *Brummitt & Polhill 13642* (K, O). **Mbeya.** Kitulo Plateau near Ndumbi River, 2500 m, 22.11.1986, *Brummitt & Goldblatt 18094* (K); Mbozi near mission, 5000 ft (= 1524 m), 22.11.1932, *Davies 663* (EA, K). **Southern (T8). Songea.** Ca. 6,5 km W for Songea, 990 m, 06.01.1956, *Milne-Redhead & Taylor 8058* (B, BR, EA, K, LISC).

15. *Hypoxis urceolata* Nel in Bot. Jahrb. 51: 336 (1914b). TYPE: Kenya, near Nairobi (K!, lectotype); Tanzania, sine loc., *Obst s.n.* (B!, syntype); Uganda, Ohagwe, *Dawe 103* (K!, syntype); Uganda, Buddu, Dawe 231 (K!, syntype).

Troupin (1971: VI.277, Fig. P. VI.276); Vollesen *et al*. (1999: 112); Wiland-Szymańska (2001: 345-348, Figs. 18A-G, 19, 23), Singh (2006: 15); Wiland-Szymańska & Nordal (2006: 18, Fig. 1.7)
= *Hypoxis apiculata* Nel in Bot. Jahrb. 51: 327 (1914b). TYPE: Tanzania, Kilimandscharo, auf dem Gipfel, N'di (Taita) Berg, *Hildebrandt 2542* (B!, holo.)
= *Hypoxis arenosa* Nel in Bot. Jahrb. 51: 310 (1914b); Singh (2006: 14). TYPE: Tanzania, Ost Usambara, *Holst* 93 (B!, holo)
= *Hypoxis bequaertii* De Wild. in Pl. Bequaert. 1: 49 (1921b). TYPE: Democratic Republic of the Congo, Haut-Zaďre, entre Irumu et Bogoro, *Bequaert 4919* (BR!, lectotype, designated here) & Kivu, entre Beni et Kasindi, *Bequaert 5198* (BR!, syntype). Robyns & Tournay (1955: 390).
= *Hypoxis crispa* Nel in Bot. Jahrb. 51: 334 (1914b). TYPE: Tanzania, Kilimandscharo, Landschaft des Ngowe (Muengue), *Volkens 360* (B!, holo.)
= *Hypoxis cryptophylla* Nel in Bot. Jahrb. 51: 316 (1914b); Singh (2006: 15). TYPE: Unterprovinz der Wimbere, Uyogo und Ussangu, Tal und Hochsteppe von Süd-Kavagwe, Westufer des Nyansa bis zum Kagera, *von Trotha 140* (B!, holo.)
= *Hypoxis textilis* Nel in Bot. Jahrb 51: 326 (1914b). TYPE: Tanzania, Umpeke (Bumpeke) *Stuhlmann 858 a* (B!, holo.)
= *Hypoxis obtusa* Burch *sensu* Baker (1898) *pro parte*
= *Hypoxis obtusa* complex *sensu* Nordal *et al*. In Nordic J. Bot. 5: 28 (1985) *pro parte*.
= *Hypoxis obtusa* auct. Non Ker-Gawl.; Champluvier (1987: 84, Figs. 28.2A, 2B)
= *Hypoxis subspicata sensu* Geerinck (1971) *pro parte*
= *Hypoxis villosa* L. *sensu* Baker (1898) *pro parte*
= *Hypoxis villosa sensu* Rendle in Baker *et al*. (1905) as *Bagshawe 177*
= *Hypoxis villosa* L. f. *sensu* Friis & Vollesen in Biologiske Skrifter 51: 506-507 (2005) *pro parte*

Robust herb up to 60 cm tall (Fig. 73A, 73E); tuber bright yellow to saffron yellow (rarely whitish) inside, getting bluish when exposed to air, ovoid, 3.3-6.5 cm long and 2.3-3.0 (4.3) cm wide, sometimes producing more than one shoot; tunic fibrous. Leaves yellowish green with lighter bases; outer leaves 1 to 5, oblongo-ovate, (4.5-) 6-13 cm long and 0.8-2.0 (-2.4) cm wide, sometimes reflexed, sparcely pubescent or glasbrescent; trichomes on margins and midrib abaxially tufted, on

lamina surface 2-branched or rarely tufted, golden brown to whitish; veins unequal, 17 to 28 (to 33); inner leaves 5 to 15, linear, (11-) 17-60 (-95) cm long and 0.8-2.0 cm wide, sometimes reflexed; indumentum like above, with trichomes falling off with age (Fig. 73B-C); veins unequal, (12-) 19 to 45. Scapes 4 to 9, 8-45 cm long and 2-3 mm wide, width reducing in steps as pedicels diverge, ciliate in lower half, pubescent above; trichomes tufted, ca. 5-branched, golden (Fig. 73D); raceme (2-) 4-7-flowered; at least two lowest flowers opposite; bracts subulate, keeled, (5-) 9-24 mm long and 1-2 mm wide, 3-nerved at the lowest flowers, pubescent on midrib abaxially, ciliate on margins; pedicels 0-35 mm long, tomentose; tepals 6, yellow or orange inside, green outside; outer tepals ovate, 8-15 x 4-5 (-6) mm, keeled, pubescent abaxially, irregularly 5- to 7-nerved; inner tepals ovate, obtuse, 8-14 x ca. 5 mm, irregularly 5- to 7-nerved, pubescent abaxially along the midrib; stamens unequal; outer stamens 4-8 mm, inner 4-7 mm long; filaments subulate, 1.5-4.0 mm long; anthers 3-6 mm long, fused apically, yellow; ovary obconical 4-10 mm long and 3-4 mm wide; style 3-4 mm long; stigma pyramidal, 2-3 mm long, with three stripes of papillae, yellow. Capsule turbinate, 4-10 x 3-5 mm, circumscissile. Seeds ovoid, ca. 1.5 mm long 1 mm wide, black; seed coat colliculate with more or less flat papillae (Fig. 73F-G).

Distribution. The range of *H. urceolata* is continuous in Rwanda, the Democratic Republik of the Congo, Uganda, Kenya and Tanzania (Fig 74A), except one location in the southern Tanzania (Fig. 74B). This species occurs in the Somalia-Masai Region, Sudanian Region and Lake Victoria Regional Mosaic. It can be regarded as a subendemite for the East Africa. It is distributed between 305-2835 m a.s.l. (Fig. 74C), but especially often from 1000-2000 m a.s.l. (Fig. 74D), in the submountain and mountain vegetation zone belt. Its bottom limit of the vertical range is elevating towards West (Fig. 74E) (Wiland-Szymańska 2001).

Habitat. Grassland, *Brachystegia* woodlands, *Combretum* woodlands, disturbed bushland, pastures, wet or dry, after annual burns, often on slopes; sandy soil over quartzite, gravel soil, dark grey sandy clay loam, red brown clay loam, cotton soil.

Phenology. Flowering during a whole year but especially often from September to October and from January to May (Fig. 75), what is connected with rainy seasons.

Uses. Technical: Roots used for gum (*Jarret 337*, EA, K).

Vernacular name. Ekimanza (Ankole).

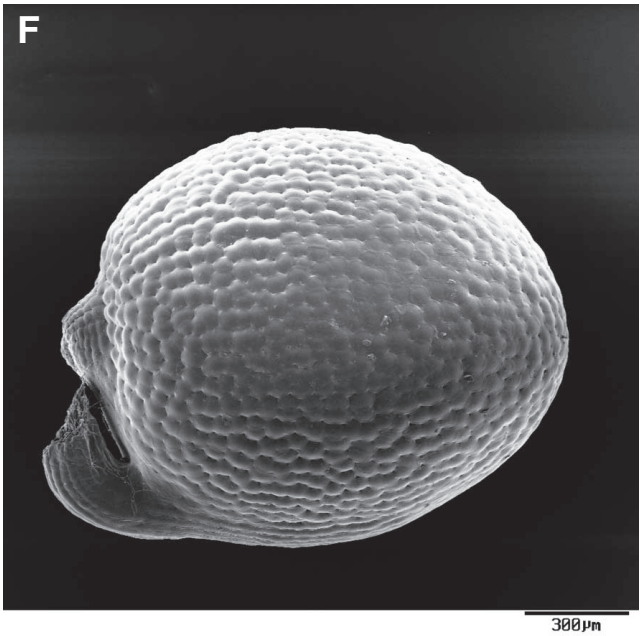
Observation. This species was also reported from the West Africa (Morton, 1968: 31, Plate IX, Fig. 35; Hutchinson & Dalziel, 1936: 394; Hepper, 1968: 172), Sudan (Andrews, 1956: 306) and Ethiopia (Cufodontis, 1939: 328, as *H. apiculata*) but these determinations are doubtful. Similar citations in the works of Heriz-Smith (1962) and Jex-Blake (1948) are probably not correct.

The presented redescription includes the morphological variability of this species within its whole range.

IUCN conservation status. Least concern.

Specimens studied. UGANDA. 23.09.1903, *Warre E. s. n.* (K); Ohagwe, 3900 ft (= 1189 m), 1904, *Dawe 103* (K). Northern (U1). West Nile. Kobboto [Koboko], *Eggeling 1840* (K); Lendu, 04.1940, *Eggeling 3893* (K). Acholi. Imatong Mountains, Langia, 5000 ft (= 1524 m), 04.1943, *Purseglove 1383* (EA, K); ibid., 9300 ft (= 2835 m), 04.1943, *Purseglove 1428* (EA, K); ca. 4 km SE of Lomwaga, 18.07.1974, *Katende K2126* (MO). Karamoja. Mout Debasien [Kadam], 5800 ft (= 1768 m), 08.01.1937, *Thomas 2211* (K); ibid., Namojongtyang, 5800 ft (= 1768 m), *Eggeling 2850* (BR, K); ibid., Karamoja, near Moruita, 05.1948, *Eggeling 5796* (K); Morongole Mountain, 6000-8000 ft (= 1829-2438 m), 04.1960, *Wilson 997* (EA, K); Moroto Mountain, 7800 ft (= 2377 m), 03.01.1937, *Thomas 2154* (K). Western (U2). Toro. Kitakwenda, 400 ft (= 122 m), 15.09.1906, *Bagshawe & Camb 1221* (BM); Central Kibale, 10.1940, *Sangster 683* (K). Ankole. At Muko Range Experimental Station ca. 15 km NW of Mbarara, 1400 m, 23.09.1970, *Bjørnstad A. AB 554* (K); Ruizi River, 4300 ft (= 1311 m), 12.01.1950, *Jarret 144* (EA, K); ibid., 4300 ft (= 1311 m), 28.09.1950, *Jarret 337* (EA, K); ca. 3 km E from Makatarisi, 1300 m, 25.09.1969, *Lye, Faden & Evans 4328* (EA, K); Mbarara, 4800 ft (= 1463 m), 03.1939, *Pursglove 605* (K); Muchuchukye, 05.08.1920, *Roscoe s.n.* (K); Unworo to Ankole, 1907, *Tufnell s.n.* (BM). Kigezi. Kigezi District, 5600 ft (= 1707 m), 25.08.1938, *Thomas 2504* (K). Eastern (U3). Mbale. North Bugisu, Muyembe Escarpment, 4000 ft (= 1219 m), 24.04.1955, *Norman 254* (K); Bukedi, Mbale, 4000 ft (= 1219 m), *Snowden 193* (BM, K). Eastern/Rift Valley/Nyanza(U3/K3/K5). Mbale/TransNzoia/North Kavirondo. Mount Elgon, 1920, *Benham s.n.* (BM); ibid., 6800 ft (= 2073 m), 04.1931, *Major E.J. & Cyril Lugard 597* (K); ibid., near River Suam, 03.05.1951, *Wiltshire 71* (K). Buganda (U4). Masaka. Buddu, 3900 ft (= 1189 m), 1905, *Dawe 231* (K); near Kikobe ferry on the River Kagera, 03.1904, *Bagshawe 177* (BM). Mengo. Bukomero, Singo, mile 53 on Kampala-Hoima road, 09.1932, *Eggeling 556* (K); Wakyato-Luwero, 3600 ft (= 1097 m), 21.04.1956, *Langdale-Brown 2065* (EA, K). KENYA. Two day march from Eldama Ravine, 7000-8000 ft (= 2134-2438 m), 1898, *Whyte s.n.* (K); 2000 m, 11.1908, *Alluaud 216* (P); 1926, *Prescott Decie s.n.* (BM). Northern Frontier (K1). Northern Frontier. Ol Doinyo Lengio [Mathews Peak], 7500 ft (= 2286 m), 20.12.1958, *Newbould 3291* (K); Ol Doinyo, 1900 m, 17.02.1979, *Bamps 6552* (BR, EA). Turkana (K2). West Suk. Sekerr Mountain, 7700 ft (= 2347 m), 03.08.1968, *Agnew, Kibe & Mathenge 10484* (MO); Kapenguria, 1000 ft (= 305 m), 05.1932, *Napier 1942* (EA, K); Keringet, 6800 ft (= 2073 m), 05.1969, *Tweedie 3639* (K). Turkana/Rift Valley (K2/3). West Suk/Elgeyo. S Cherangani, 6300 ft (= 1920 m), 18.02.1958, *Symes 288* (EA, K) & *Symes 289* (EA, K); SE Cherangani, 6300 ft (= 1920 m), 12.05.1959, *Symes 51* (EA, K). Rift Valley (K3). Trans-Nzoia. Kitale, 6300 ft (= 1920 m), 02.1935, *Thorold 2751* (EA, K); SW Elgon, Saboti Hill, 6500 ft (= 1981 m), 11.05.58, *Symes 374* (EA, K). Nandi. Nandi (Nile), 6000-7000 ft (= 1829-2134 m), 01.1894, *Scott Elliot 6983* (BM). Elgeyo. Cherangani Hills, Kaibwibich, 8000 ft (= 2438 m), 06.09.1969, *Mabberley & McCall 106* (K). Baringo/Laikipia. Leikipia [Laikipia] Plateau and Aberdare Range, 1908, *Routledge Scoroby s.n.* (K). Nakuru.


A
10 cm
K. Gawrońska
B
2 mm
C
2 mm
D
2 mm



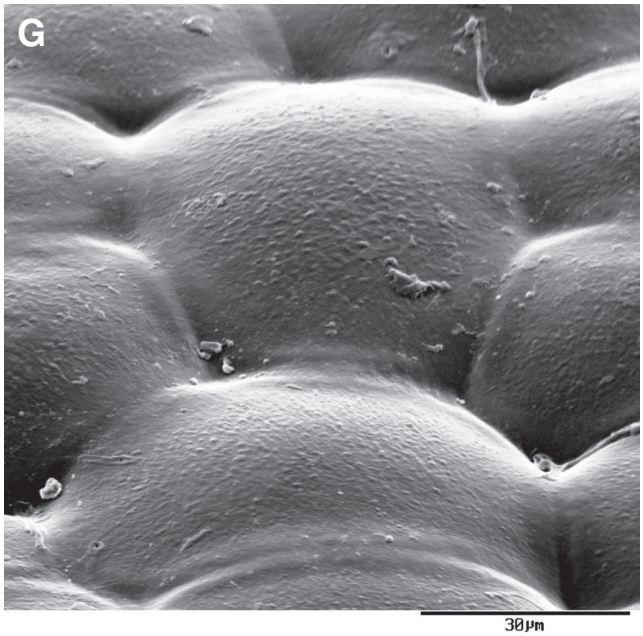


Fig. 73. *Hypoxis urceolata*
Explanations: A – habit (A from *Hildebrandt 2542*), B – two-branched trichome from leaf lamina (from *Haarer 64B*), C – two-branched from leaf edge (from *Haarer 64B*), D – tufted trichome from scape (from *Haarer 64B*), E – living plant (from *Bjřrnstad AB 554*), F – seed (from *Katende K2126*), G – seed testa sculpture (from *Katende K2126*)

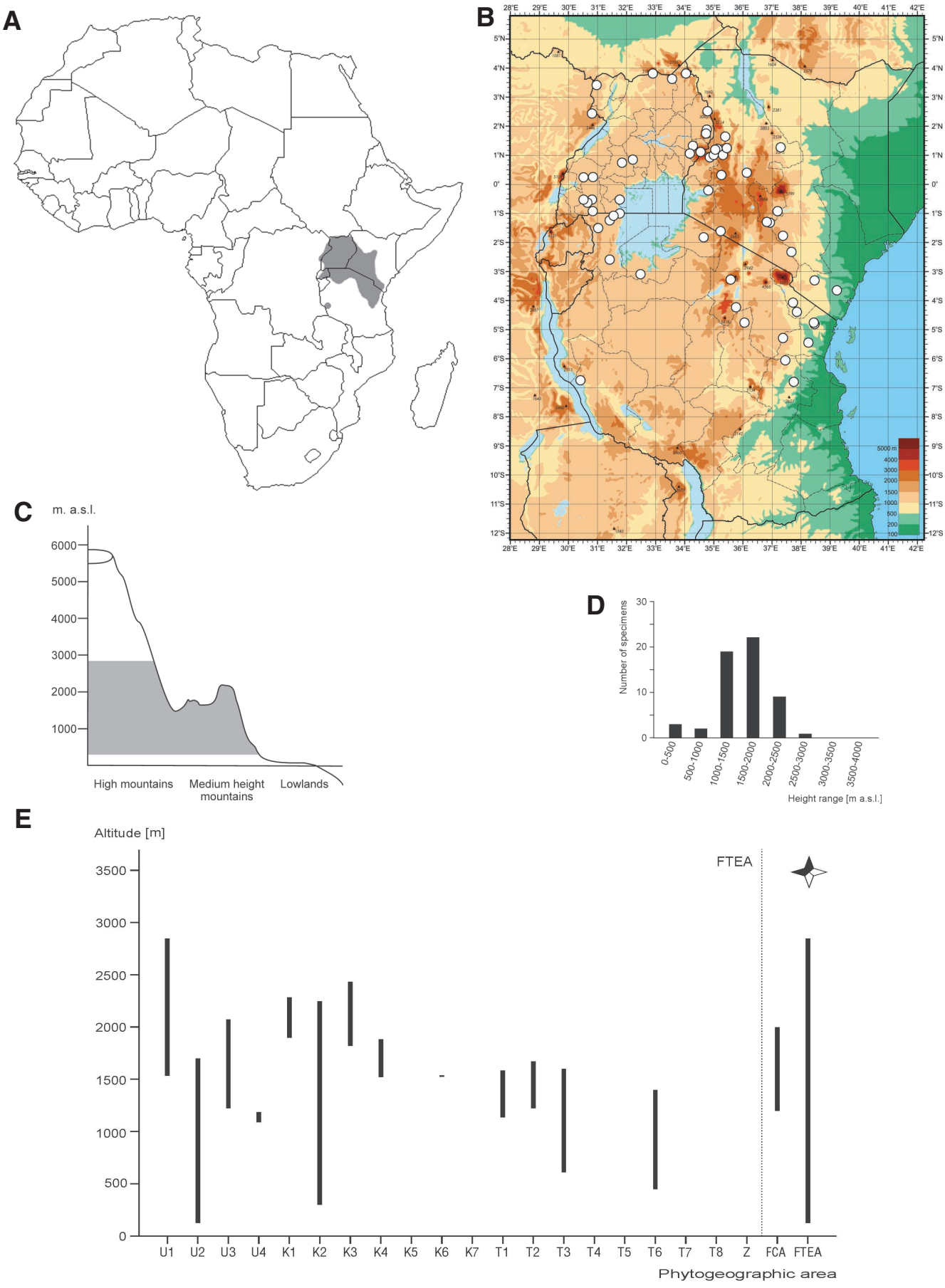


Fig. 74. *Hypoxis urceolata*
Explanations: A – general distribution, B – distribution in the East Tropical Africa, C – vertical range in the East Tropical Africa, D – a histogram of vertical distribution in the East Tropical Africa, E – vertical ranges in phytogeographic provinces of the East Tropical Africa and in other floristic regions; other explanations: see Fig. 26

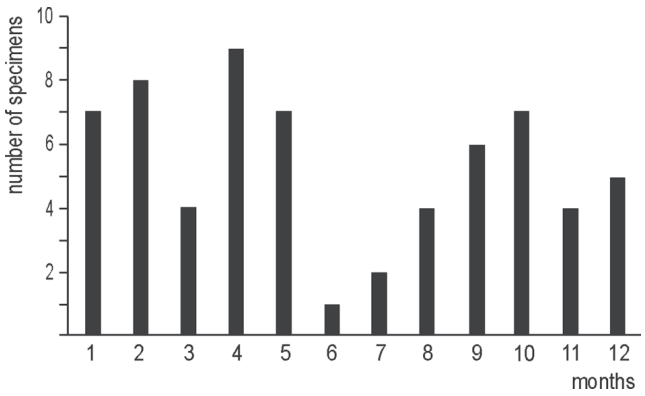


Fig. 75. Flowering periods of *Hypoxis urceolata*

Deloraine, 6400 ft (= 1951 m), 15.10.1944, *Starzeński s.n.* (BR). Rift Valley/Nyanza (K3/K5). Trans-Nzoia/North Kavirondo. NE Elgon, 7600 ft (= 2316 m), 04.1953, *Tweedie 1128* (K). Central (K4). Fort Hall. Near Makuyu on Thika-Sagana Road, 02.12.1966, *Agnew, Kiniaruh, Ngethe & Wyatt 8821* (MO). Nairobi. Near Nairobi, 08.1903, *Whyte s.n.* (K); Nairobi, 1600 m, 1910, *Winkler 4232* (WRSL); ibid., 5700 ft (= 1737 m), 29.01.1932, *Napier 1777* (EA, K); near Lenana High School entrance, 1650 m, 13.01.1972, *Msafiri 15* (EA, K). Machakos. 3,5 miles N of Nunguni in Kithembe village, 1890 m, 13.05.1968, *Mwangangi 961* (MO). Central/ Masai (K4/K6). Machakos/ Masai. Chyulu North, 5000 ft (= 1524 m),19.04.1938, *Bally 735* (EA, K). Masai (K6). Masai. Mara Game Reserve near Keekorok Lodge, 15.07.1968, *Agnew & Braun 10187* (BM). Coast (K7). Teita. Ndi Mountain, 02.1877, *Hildebrandt 2542* (B, BM, K). TANZANIA. 1911, *Obst s.n.* (B); cult. Kew 021-75-00280, 12.1974, *Hale 153* (K). Lake (T1). Bukoba. Karagwe, Nyansa, 08.1896, *von Trotha 140* (B); Bunazi, 4000 ft (= 1219 m), 10.1931, *Haarer 2334* (EA, K); Minziro Forest Reserve, Kalagala village, S of Kamyinanbuzi Hill, 1130 m, 29.11.1999, *Sitoni, Kayombo, Bayona & Simon 1026* (MO, POZG). Biharamulo. Biharamulo teritorium, 1300 m, 06.12.1954, *Christiaensen 771* (BR, EA, K). Mwanza. Umpeke [Bumpeke], 24.10.1899, *Stuhlmann 858 a* (B). Musoma. Tabora River, 5200 ft (= 1585 m), 22.08.1962, *Greenway 10780* (EA, PRE). Northern (T2). Masai. Loskitu Mountain [Loskitok], N of Mgera, 4000 ft (= 1219 m), 18.09.1933, *Burtt 4892* (EA, K, S). Masai/Mbulu. Oldeani, 5500 ft (= 1676 m), 01.1935, *Moreau Mr. & Mrs. 81* (K). Mbulu. Babati, Ufiome, ca. 4000 ft (= 1219 m), 10.1925, *Haarer 64* (B, K). Moshi. Kilimanjaro, Ngowe (Muengue), 1550 m, 11.06.1893, *Volkens 360* (B). Tanga (T3). Pare. Near Same, 3000 ft (= 914 m), 10.1927, *Haarer 884* (EA, K); S Pare Mountains, Suji Malindi Village, Heitanga, Magunga, 1510 m, 02.02.1999, *Mlangwa 78* (MO, POZG). Lushoto. Korogwe-Handeni Road, 2000 ft (= 610 m), 22.04.1954, *Faulkner 1420* (B, BR, LISC, S); West Usambara Mts., below Baga II Forest Reserve between Mgwashi and Mtai above Mzinga village, 1350-1600 m, 31.01.1985, *Borhidi, Iversen & Mziray 85425* (K); road from Baga I Forest Reserve to Baga II F. R., 1380 m, 10.03.2001, *Wiland & Mboya 171* (MO, POZG). Lushoto/Tanga. Usambara Mountains, 10.1891, *Holst 93* (B). Western (T4). Mpanda. Ikola-Mpanda road, 20 miles from Ikola, 1050 m, 08.11.1959, *Richards 11750* (K). Central (T5). Kondoa. Iringe at Kinjassi, 27.02.1925, *Burtt 284* (K). Eastern (T6). Morogoro. 10 miles NE of Kingolwira Station, 1500 ft (= 457 m), 11.11.1957, *Welch 418* (K); Nguru Mountains, Maskati, 1400 m, 13.02.1993, *Manktelow 93188* (K).

Species not included in this treatment and additional nomenclatural notes

Several authors mention additional species (Engler 1894, Rendle 1895, Baker 1898, Nel 1914, Jex-Blake 1948, Heriz-Smith 1962, Blundell 1982, Agnew & Agnew 1994, Singh 2007), which have not been confirmed during the current study. A popular name is *Hypoxis villosa*, reported several times from the East Tropical Africa (Engler 1894; Rendle 1895; Baker 1898; Heriz-Smith 1962; Blundell 1982; Agnew & Agnew 1994). However a type specimen stored in a herbarium in Paris does not resemble any plant found in this region. The plant material, which was cited by Baker (1898) belongs to three different species: *H. angustifolia*, *H. gregoriana* and *H. urceolata*. It was unfortunately impossible to verify the understanding of this taxon by other authors, because the data on the material was missing or it was not available. Currently, one has to assume, that the status of this species is unknown. Such view was also supported by Singh (2006).

Other questionable species names are *H. cameroniana* Bak. from the East Usambara Mountains (Nel 1914b) and *H. engleriana* from Mount Elgon (Jex-Blake 1948). Unfortunately, it was impossible to determine the taxonomical identity of these two species in the area of the East Tropical Africa. The detailed descriptions are lacking in both papers mentioned above. In the work of Jex-Blake (1948) no specimens are cited. The herbarium specimen cited in the treatment of Nel (1914b) was *Braun 2732* (herbarium not stated), not available for the current study.

Hypoxis obtusa, cited and illustrated in a paper by Moriarty (1975) and Plowes & Drummond (1975), is certainly not this species *sensu stricto*, but rather a general account of *Hypoxis* with larger leaves in the Flora Zambesiaca area. The same situation, concerning plants from Kenya, applies to works of Blundell (1982), Sapieha (1990) and Agnew & Agnew (1994). The specimens of *H. obtusa* cited by Baker (1898) belong in fact to *H. nyasica* and *H. urceolata*.

Hypoxis obtusa complex described by Nordal *et al.* (1985) was a conglomerate of species based on a single feature of "seed testa colliculate, black and covered with a thin cuticle". Currently, 21 species names included as synonyms of the *Hypoxis obtusa* complex are recognized as seven separate species.

Hypoxis sp. A. (Nordal *et al.* 1985) is found to be artificial, because the two specimens on which it was based *Davies 742* and *Bullock 2045* belong to *H. polystachya* (Wiland-Szymańska & Nordal 2006) and *H. bampsiana* subsp. *tomentosa* (Wiland-Szymańska 2008), respectively.

Singh (2007) mentions two herbarium specimens from the FTEA region that were classified as *H. argentea* var. *sericea* (Baker) Baker. However, the herbarium

number: *Robertson 374A* (EA) represents *H. angustifolia* var. *luzuloides*. This, again, shows the problems in the classification and differentiation between species, as well as lack of unified nomenclature for the genus *Hypoxis* in Africa.

5. Conclusions

This monograph gives for the first time a complete key with full descriptions and distributions of all known *Hypoxis* taxa found in the East Tropical Africa. Not only the species, but also subspecies and varieties were carefully studied as to their morphology. It has occurred, that characters, which were not taken into consideration before, like tuber flesh color and tunic, can be useful in distinguishing the East Tropical African taxa of this genus.

The study of distribution of the species occurring in the East Tropical Africa was conducted for this area, but also for their whole range. The general ranges for most of the species were presented for the first time. Their study, as well as a revision of literature data, led to a new conclusion as to the number of all *Hypoxis* species in Africa, which is now 55. The revision demonstrates that distribution of many of the *Hypoxis* species is connected with White's phytochoria. It also shows that not only South Africa, but also the Zambesian Region is a very important center of diversity of this species. This knowledge gives evidence for the fact, that the number of endemic species of *Hypoxis* for the East Tropical Africa is very low, including only one species and one subspecies. For the first time, a study of vertical ranges of *Hypoxis* was conducted. It has revealed that most of the species in the East Tropical Africa grow in the mountains and they show preferences for dispersal in particular altitudinal levels. The analysis of the vertical range on the whole area of different taxa has showed that there are differences in altitudinal distribution depending on the geographic location.

The studies of the *Hypoxis* leaf anatomy confirm in many cases the previous knowledge on the subject. They add however new data concerning anatomical differentiation of the cataphylls and the inner leaves. Also differentiated mesophyll and simultaneous presence of different types of stomata on one leaf were never before described for this genus. Mucilage canals, believed so far to be confined only to the tuber or cataphylls, are reported here to be present also in inner leaves of some species. Additionally their existence is not constant in one species, as they were found in half of the samples examined. For the first time wax crystals, supposed before to be confined to only one *Hypoxis* species, were described for many of them. A succulent leaf, depicted here for *H. kilimanjarica* var. *prostrata* was never before mentioned for this genus.

For the first time for this genus, anatomical studies were conducted as a part of taxonomical analysis. Anatomical differences are certainly found in *Hypoxis* leaves, and in some cases they are species specific. For example, a special leaf anatomy of *H. kilimanjarica* subsp. *prostrata* enables to distinguish this taxon from all other from the East Tropical Africa, solely on the basis of a leaf cross-section. Large bulliform epidermal cells of *H. angustifolia* are also very characteristic for this species in the East Tropical Africa. The number of vascular bundles can be however established only after a section of a leaf and is useful only in species with a small number of bundles, not changing with plant age. Another useful taxonomic characters might be observed after a study of epidermis: occurrence of bulliform cells beside the keel zone and, especially, types and distribution of trichomes. Because of variation in distribution, the mucilage canals could not have been by now taxonomically evaluated.

Never before anatomical characters of scapes (except indumentum) were studied in a taxonomic context for this genus. The scapes show some differences, as to sclerenchyma distribution, as well as the number of vascular bundles. These characters might be of use in taxonomy. Moreover, this anatomical study has showed, why peduncles of species, lacking well developed sclerenchyma ring, tend to bend down after anthesis.

Phenology of flowering was for the first time studied for this genus. It has revealed, that there are two groups of taxa, one with a resting period and the other without it. It is connected with a climate in which the species occurs.

The human influence on *Hypoxis* species was studied in terms of their use. These plants are not often utilized as food or medicine in the East Tropical Africa. Some of them however are used in folk medicine, and are believed to possess magical properties. Because of their indifference to occasional fire, most of the species of *Hypoxis* survive quite well in the East Tropical Africa, being a visible component of various types of grasslands. Some species however are under threat of extinction. This is due to their incapability of surviving in changed habitats, especially in shade of cultivated plants. Another threat is a large-scale collection of species believed to cure the HIV, or sold as a substitute of a similar taxon, recognized to possess such qualities. The IUCN categories were for the first time proposed for the East Tropical African taxa of *Hypoxis*.

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Index to the scientific names of the East Tropical African taxa of *Hypoxis*

Curculigo baguirmiensis A. Chev. = ***Hypoxis angustifolia*** Lam. **var.** ***luzuloides*** (Robyns & Tournay) Wiland
Hypoxis aculeata Nel = ***Hypoxis fischerii*** Pax **var.** ***katangensis*** (De Wild.) Wiland & Nordal
Hypoxis alpina R. E. Fries = ***Hypoxis kilimanjarica*** Baker **ssp.** ***kilimanjarica***
Hypoxis angolensis Baker = ***Hypoxis obtusa*** Burch *ex* Ker Gawl.
Hypoxis angustifolia Lam.
Hypoxis angustifolia Lam. **var.** ***luzuloides*** (Robyns & Tournay) Wiland
Hypoxis apiculata Nel = ***Hypoxis urceolata*** Nel
Hypoxis araneosa Nel = ***Hypoxis gregoriana*** Rendle
Hypoxis arenosa Nel = ***Hypoxis urceolata*** Nel
Hypoxis bampsiana Wiland
Hypoxis bampsiana Wiland **ssp.** ***tomentosa*** Wiland
Hypoxis bequaertii De Wild. = ***Hypoxis urceolata*** Nel
Hypoxis biflora De Wildeman = ***Hypoxis filiformis*** Baker
Hypoxis campanulata Nel = ***Hypoxis nyasica*** Baker
Hypoxis crispa Nel = ***Hypoxis urceolata*** Nel
Hypoxis cryptophylla Nel = ***Hypoxis urceolata*** Nel
Hypoxis demissa Nel = ***Hypoxis obtusa*** Burch *ex* Ker Gawl.
Hypoxis dregei var. *biflora* (De Wild.) Nel = ***Hypoxis filiformis*** Baker
Hypoxis elliptica Nel. = ***Hypoxis rigidula*** Baker **var.** ***rigidula***
Hypoxis engleriana Nel = ***Hypoxis nyasica*** Baker
Hypoxis engleriana var. *scottii* Nel = ***Hypoxis nyasica*** Baker
Hypoxis esculenta De Wild. = ***Hypoxis goetzei*** Harms
Hypoxis filiformis Baker
Hypoxis fischerii Pax
Hypoxis fischerii Pax **var.** ***colliculata*** (Wiland) Wiland & Nordal
Hypoxis fischerii Pax **var.** ***fischerii***
Hypoxis fischerii Pax **var.** ***hockii*** (Wiland) Wiland & Nordal
Hypoxis fischerii Pax **var.** ***katangensis*** (De Wild.) Wiland & Nordal
Hypoxis fischerii Pax **var.** ***zernyi*** (Schulze) Wiland & Nordal
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Hypoxis infausta Nel = ***Hypoxis galpinii*** Baker
Hypoxis ingrata Nel = ***Hypoxis nyasica*** Baker
Hypoxis katangensis Nel *ex* De Wild. = ***Hypoxis fischerii*** Pax **var.** ***katangensis*** (De Wild.) Wiland & Nordal
Hypoxis kilimanjarica Baker
Hypoxis kilimanjarica Baker **ssp.** ***kilimanjarica***
Hypoxis kilimanjarica Baker **ssp.** ***prostrata*** Holt & Staubo
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Hypoxis luzuloides Robyns & Tournay = ***Hypoxis angustifolia*** Lam. **var.** ***luzuloides*** (Robyns
Hypoxis macrocarpa Holt & Staubo = ***Hypoxis schimperii*** Baker
Hypoxis malaissei Wiland
Hypoxis matangensis Schulze = ***Hypoxis fischerii*** Pax **var.** ***zernyi*** (Schulze) Wiland & Nordal
Hypoxis malosana Baker = ***Hypoxis filiformis*** Baker
Hypoxis multiflora Nel = ***Hypoxis fischerii*** Pax **var.** ***fischerii***
Hypoxis münznerii Nel = ***Hypoxis filiformis*** Baker
Hypoxis nyasica Baker
Hypoxis obtusa Burch *ex* Ker Gawl.
Hypoxis pedicellata Nel = ***Hypoxis fischerii*** Pax **var.** ***hockii*** (Wiland) Wiland & Nordal
Hypoxis polystachya Welw.
Hypoxis probata Nel = ***Hypoxis nyasica*** Baker

Hypoxis protrusa Nel = ***Hypoxis obtusa*** Burch *ex* Ker Gawl.
Hypoxis retracta Nel = ***Hypoxis nyasica*** Baker
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Hypoxis rigidula Baker **var. *rigidula***
Hypoxis rubiginosa Nel = ***Hypoxis goetzei*** Harms
Hypoxis schimperii Baker
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Hypoxis textilis Nel = ***Hypoxis urceolata*** Nel
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Akanyasiswa – *Hypoxis angustifolia* Lam. var. *luzuloides* (Robyns & Tournay) Wiland (Ankole)
Chepkimiet – *Hypoxis angustifolia* Lam. var. *luzuloides* (Robyns & Tournay) Wiland (Kipsigis)
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Ekimanza – *Hypoxis urceolata* Nel (Ankole).
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Engaimalasiyai – *Hypoxis kilimanjarica* Baker ssp. *kilimanjarica* (Masai)
Esenyi – *Hypoxis gregoriana* Rendle (Masai)
Esoteh – *Hypoxis angustifolia* Lam. var. *luzuloides* (Robyns & Tournay) Wiland (Turkana)
Fireambuzi – *Hypoxis angustifolia* Lam. var. *luzuloides* (Robyns & Tournay) Wiland (Swahili)
Inyeri – *Hypoxis fischerii* Pax var. *hockii* (Wiland) Wiland & Nordal (Irangi)
Kikoninga – *Hypoxis angustifolia* Lam. var. *luzuloides* (Robyns & Tournay) Wiland (Swahili)
Kivulenze – *Hypoxis angustifolia* Lam. var. *luzuloides* (Robyns & Tournay) Wiland (dialect not stated)
Kivulenzi – *Hypoxis filiformis* Baker (dialect not stated)
Lipipili – *Hypoxis fischerii Pax* var. *colliculata* (Wiland) Wiland & Nordal; *Hypoxis fischerii* Pax var. *hockii* (Wiland) Wiland & Nordal; *Hypoxis rigidula Baker* var. *rigidula* (dialect not stated)
Mdago – *Hypoxis angustifolia* Lam. var. *luzuloides* (Robyns & Tournay) Wiland (dialect not stated).
Msefusefu – *Hypoxis goetzei* Harms (Kibena)
Ndiko – *Hypoxis angustifolia* Lam. var. *luzuloides* (Robyns & Tournay) Wiland (Digo)
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