

## Diversity and endemism of the western Ethiopian escarpment – a preliminary comparison with other areas of the Horn of Africa

SEBSEBE DEMISSEW, INGER NORDAL, CHRISTOF HERRMANN, IB FRIIS,  
TESFAYE AWAS AND ODD STABBETORP

SEBSEBE DEMISSEW, NORDAL, I., HERRMANN, C., FRIIS, I., TEFAYE AWAS & STABBETORP, O. 2005. Diversity and endemism of the western Ethiopian escarpment – a preliminary comparison with other areas of the Horn of Africa. *Biol. Skr.* **55**: 315-330. ISSN 0366-3612. ISBN 87-7304-304-4.

The vegetation on the western Ethiopian escarpment is still fairly intact, but imperfectly known. The escarpment-area agrees with the area of White's *Undifferentiated woodlands (Ethiopian type)*. It has characteristic vegetation, which consists mainly of deciduous woodland, with combretaceous trees, e.g. *Anogeissus leiocarpus*, *Combretum hartmannianum*, or the frankincense tree, *Boswellia papyrifera*, and dense thickets of the lowland bamboo *Oxytenanthera abyssinica*. Other vegetation types are wooded grassland, riverine forest and swamps. Potential threats to the vegetation and flora of the western escarpment are mentioned. The flora of the western escarpment consists of at least 950 species, of which at least 27 are endemic or near-endemic. Most of these occur in the Benshangul Gumuz National Regional State, a core area of the western Ethiopian escarpment. A number of new endemic species have been discovered in Benshangul Gumuz in recent years, especially petaloid monocots. Genera with western escarpment endemics include *Ceropegia* (Asclepiadaceae), *Vernonia*, *Bidens* and *Laggera* (Asteraceae), *Combretum* (Combretaceae), *Crinum* (Amaryllidaceae), *Chlorophytum* (Anthericaceae) and *Aloe* (Aloaceae). With regard to diversity the western escarpment ranks at a low position when compared with Ethiopian and Eritrean Flora regions, while with regard to number of local endemics it ranks higher than most Ethiopian and Eritrean Flora regions, but lower than Flora regions in Somalia. With regard to the relative number of local endemics the western escarpment ranks lower than nearly all Flora regions in Somalia, but higher than nearly all Ethiopian and Eritrean Flora regions. Possible reasons for the development of the endemism in a transition zone between the Nile Valley and the Ethiopian highlands are discussed. The new endemic species *Chlorophytum herrmannii* Nordal & Sebsebe and *Chlorophytum serpens* Sebsebe & Nordal from the region are described in an appendix, and the new combination *Drimiopsis spicata* (Baker) Sebsebe & Stedje for an endemic species is made.

*Sebsebe Demissew, National Herbarium of Ethiopia, Addis Ababa University, P.O. Box 3434, Addis Ababa, Ethiopia. E-mail: nat.heb@telecom.net.et or sebsebed@bio.aau.edu.et*

*Inger Nordal, Department of Biology, University of Oslo, P.O. Box 1045, Blindern, N-0316 Oslo, Norway. E-mail: inger.nordal@bio.uio.no*

*Christof Herrmann, Av. Industrial 2, Satipo, Peru. E-mail: c\_herrmann62@hotmail.com*

*Ib Friis, Botanical Garden and Museum, Natural History Museum of Denmark, University of Copenhagen, Gothersgade 130, DK-1123 Copenhagen K, Denmark. E-mail: ibf@snm.ku.dk*

Tesfaye Awas, Institute of Biodiversity Conservation and Research, P.O. Box 30728, Addis Ababa, Ethiopia

Odd Stabbetorp, Norwegian Institute for Nature Research, P.O. Box 736, Sentrum, N-0105 Oslo, Norway. E-mail: odd.stabbetorp@nina.no

## Introduction

The study of the Ethiopian flora of vascular plants has intensified since the beginning of the Ethiopian Flora project in 1980 and much new herbarium material has accumulated (Friis 2001). Yet, the gathering of information and the scientific investigations in the different parts of Ethiopia have not been evenly distributed. Accessible regions with passable roads and other infrastructure have been better investigated than those without these facilities. The construction of new roads, particularly in the southern regions of Ethiopia, has resulted in records of species that are either new to science or new for the Ethiopian flora. However, many other areas remain poorly collected (Friis 2001).

The western escarpment of the Ethiopian highlands is one of the areas that have had little attention before 1980. The flora around the twin towns of Gallabat and Metemma on the Sudan-Ethiopian border was studied in 1865 (Fig. 1 and the section *Exploration of the flora* in this paper) and this and a few other areas of the western escarpment, especially in the Gambella National Regional State (Fig. 1), have been visited by a number of botanists since.

The vegetation of the western Ethiopian escarpment has been characterised as a separate vegetation unit by White (1983) on his vegetation map of Africa, where it is mapped as unit no. 29b (Fig. 1) and named *Undifferentiated woodlands (Ethiopian type)*. To the east, this particular vegetation type is bordered by the extremely mixed and complex vegetation mosaic of the Ethiopian highlands, to the west

with the grassland, wooded grassland and bushland of the Nile Valley. This area has also appeared, and has been somewhat differently treated, in other recent attempts at mapping the Ethiopian vegetation (Friis & Sebsebe Demissew 2001), but White's concept seems to us to be the most appropriate.

Our preliminary analyses of what we know so far about this little explored region, including data which we have extracted from the *Flora of Ethiopia and Eritrea* (Hedberg & Edwards 1989, 1995; Edwards *et al.* 1995, 1997, 2000), show that this region has an interesting and partly unique flora.

There is very little detailed information about the environment of this area, but what is said in the following, based primarily on government reports and a project survey of the Benshangul Gumuz National Regional State (Population and Housing Census of Ethiopia 1994; Bureau of Planning and Economic Development 1998; Feasibility Study 2001), may be approximately true for large parts of the western Ethiopian escarpment. The central position of the Benshangul Gumuz National Regional State is indicated in Fig. 1.

The aim of this paper is to demonstrate the endemism of the western Ethiopian escarpment and to illustrate the general interest of the flora of that area, where comparatively much of the natural vegetation is still nearly intact. By doing so, we hope to encourage further studies as the area becomes more generally accessible. We also sincerely hope that an increasing knowledge of this area might contribute to the conservation of the vegetation and flora of this interesting area.

### ***Physical environment***

The topography of the western Ethiopian escarpment is characterised by a rolling terrain, sloping sometimes comparatively gently, sometimes dropping steeply from an average of ca. 1800 m (sometimes considerably higher) on the Ethiopian highlands to the east to 500-700 m in the lowlands of the Sudan. In the lowland there are a number of isolated hills and outcrops rising several hundred meters above the prevailing elevation.

The exact area of the western Ethiopian escarpment is not known, but the area of White's *Undifferentiated woodlands (Ethiopian type)* is approximately 145,000 km<sup>2</sup>, when estimated from the vegetation map accompanying White (1983).

The average rainfall (more or less unimodal from April to October, sometimes with small peaks in January to February) is 1200 mm in the area around the town of Assosa, capital of the Benshangul Gumuz National Regional State, and this figure is reduced towards north and west to about 800 mm. There are heavy showers associated with thunderstorms over the escarpment (oreographic rain). The mean annual temperature varies from 20° C to 35° C, and the variation is, as elsewhere, strongly correlated with altitude.

The geology of the area comprises predominantly outcrops of very old Precambrian rocks. Deep clayish red soils (dystric nitosols) predominate in most of the zone south of the Blue Nile (Abay) river. These have good physical property with general agricultural potential. North of the Abay, the predominant soils (orthic acrisols) are chemically poorer and have a more limited agricultural potential, although big farms with good potential have been established at the base of the western escarpment near the border between Ethiopia and Eritrea. The soils in many places south of the Benshangul Gumuz National Regional State seem also to have more limited agricul-

tural potential. Particularly in the Benshangul Gumuz National Regional State the western Precambrian formation holds rich mineral deposits, mainly gold, but also copper, lead, and zinc. In addition there are important occurrences of marble, which to some extent are utilised.

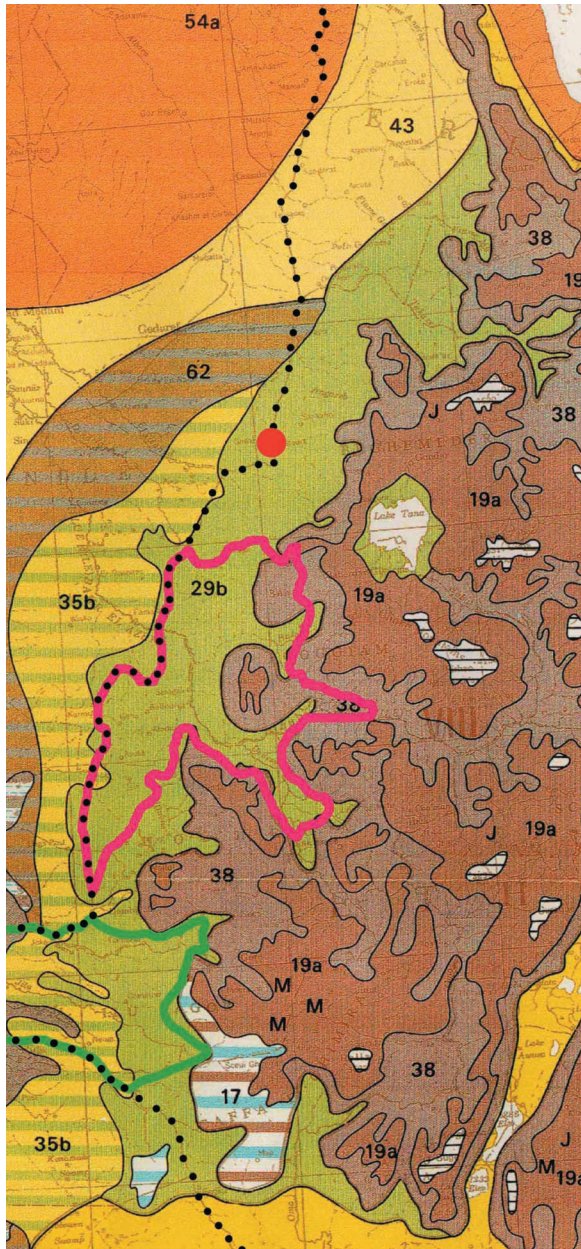
### ***Vegetation; species richness***

On the western escarpment of Ethiopia the destruction of forest and woodland resources has been less than in other parts of Ethiopia. This is due to the low population density and the general inaccessibility of the region. Most of the region is covered with different types of forests, woodlands and bamboo tickets.

The common woodland type is dominated by small to moderately sized trees with fairly large deciduous leaves. The woodland has a number of floristic characteristics, that have partly been listed by White (1983, p. 107) in his description of the *Undifferentiated woodlands (Ethiopian type)*. Later, but mainly unpublished studies (described in more detail below under *Exploration of the Flora*), have supplemented this information. Species of *Terminalia*, *Combretum*, and *Lannea* are common, as well as *Entada abyssinica*, *Erythrina abyssinica*, *Strychnos innocula*, *Anogeissus leiocarpus*, and *Stereospermum kunthianum*. Particularly interesting is the common occurrence of the solid-stemmed lowland bamboo (*Oxytenanthera abyssinica*). The ground cover is a tall stratum of perennial grasses, including species of *Cymbopogon*, *Hyparrhenia*, *Echinochloa*, *Sorghum* and *Pennisetum*. This vegetation type, which occurs at most altitudes of the escarpment, is burnt regularly, and is part of a zone of high fire frequency, which occurs across Africa from Senegal to the western Ethiopian escarpment, where it penetrates into the highlands along the deep river valleys (Jensen & Friis 2001: Fig. 3). This vegetation has been burning annually for such a long time that the plants show many adaptations to fire,



and the vegetation must be assumed not to be adversely affected by controlled annual fires. Such adaptations in the flora of the region have been dealt with by Jensen & Friis (2001) and Menassie Gashaw *et al.* (2002).



The riparian and swamp vegetation consists of two physiognomically different types, riverine forests and open almost treeless swamps. Typical trees in the riverine forests are *Celtis africana*, *Ficus sycomorus*, *Tamarindus indica*, *Syzygium guinense*, *Kigelia aethiopicum*, *Lepisanthes senegalensis*, *Nuxia oppositifolia*, *Salix mucronata*, *Trichilia emetica*, *Diospyros mespiliformis*, *Mimusops kummel*, *Breonadia salicifolia*, *Phoenix reclinata*, and species of *Acacia* and *Ficus*. There is often a shrub layer, and lianas and vascular epiphytes occur. The ground cover includes grasses ferns, and a few herbaceous dicotyledons.

The swamps are dominated by species of Cyperaceae, grasses, and many herbs, of which many are not found elsewhere in Ethiopia. Volume 2(1) of the *Flora of Ethiopia and Eritrea* (Edwards *et al.* 2000) contains an appendix with recently recorded species for the Flora area, and many of these new records have recently been made in the Benshangul Gumuz National Regional State. The flora of ground orchids in the Benshangul Gumuz National Regional State is very diverse for Ethiopia, as is indicated by Cribb *et al.* (2002).

### *Exploration of the flora*

The flora of the western escarpment of Ethiopia has been rather sporadically explored (Cufodontis 1962; Friis 2001). During his trav-

**Fig. 1.** Section of White's Vegetation map of Africa from 1983, showing the total extent of the mapping unit 29b, "Undifferentiated woodlands (Ethiopian type)." The border between Eritrea/Ethiopia (to the right) and the Sudan (to the left) has been marked with a dotted line. The Benshangul Gumuz National Regional State, which is frequently referred to in the text, and which covers a large and topographically very diverse part of White's mapping unit 29b, is marked with red outline. The eastern part of the Gambella National Regional State is marked with green outline. The twin towns of Gallabat and Metemma are marked with a red dot. Reproduced with permission (UPO/D/A/2000-088).

els in the Sudan in 1865-1871 G. Schweinfurth made a detour into Ethiopia and studied the flora in western Amhara region around Gallabat and Metemma (Schweinfurth 1865). R.E.G. Pichi-Sermolli explored in 1937 the western Ethiopian escarpment in the region to the west of Lake Tana (Pichi-Sermolli 1951). The lowlands and the western Ethiopian escarpment in the Gambella National Regional State has been studied fairly frequently in the years just before and during the Ethiopian Flora Project (1980-2004), but modern studies of the flora to the north of the Gambella have been rather few. M.G. Gilbert, J.J.F.E. de Wilde, W.J.J.O. de Wilde and B.E. de Wilde-Dufjes and M. Thulin visited the western Ethiopian escarpment in the 1960es and 1970es, Mesfin Tadesse, Sebsebe Demissew and others studied the area several times in the 1970es and 1980es. I. Friis, Menassie Gashaw, S. Bidgood, Sebsebe Demissew and Tesfaye Awas and others paid visits to the Benshangul Gumuz National Regional State the 1990es and in 2000-2001. However, a special contribution to the knowledge of the flora of the Benshangul Gumuz National Regional State has been made by C. Hermann, who spent two years' of work for the Ethiopian Department of Agriculture in Benshangul Gumuz National Regional State during 1999-2001. He has particularly enriched our knowledge of the area because he has stayed there and collected during the rainy season.

Together, these studies have indicated that the western Ethiopian escarpment hosts an interesting and partly unique, but as yet poorly known flora, as is demonstrated by the examples later in this paper.

#### ***Socio-economic conditions, development and possible threats to the biodiversity***

According to the most recent population census (Population and Housing Census of Ethiopia 1994), the population of the Ben-

shangul Gumuz National Regional State, a core area in this study, is ca. 460.000 people, of which 92% are settled in rural areas. This gives a density of 10.9 individuals pr km<sup>2</sup>, while the overall number for Ethiopia is 57.7. Ten years earlier the population was much less dense and the impact on vegetation accordingly only slight. During the famine in Welo and Tigray around 1984 100.000 persons were moved from the areas in north and north-east and settled in the Benshangul Gumuz National Regional State (National Atlas of Ethiopia 1988). The area used for agricultural production in the Benshangul Gumuz National Regional State amounts to 142.223 ha, only about 2.84% of the region's area, or 0.36 ha pr. inhabitant (Bureau of Planning and Economic Development 1998). In many parts of the western Escarpment income is created by collection of gum arabic from *Acacia seyal* and frankincense from *Boswellia papyrifera*. The local tradition of gold mining in the western lowlands, especially in the Benshangul Gumuz National Regional State, goes back to the Axumite Empire, and currently (Bureau of Planning and Economic Development 1998) an average of 180 kg gold/month is produced in the mining season (February to April).

The population on the western escarpment is growing. The population of the Benshangul Gumuz National Regional State is expected to be double within 2030 (Bureau of Planning and Economic Development 1998), and elsewhere a similar or slightly lower increase seems likely.

These changes may present a number of threats to the biodiversity.

(1) Loss of wetlands by draining, which would mean loss of habitat for the many rare orchids and other wetland species, including endemics.

(2) Unsustainable development of the woodlands and bamboo-thickets by uncritical fuelwood cutting, charcoal-burning and mining,

which may harm future sustainable exploitation of the woody vegetation by the local people and might threaten some of the woody endemics.

(3) Unsustainable development of agriculture and mining in the wooded grasslands, which might threaten some of the rare grassland and woodland species.

(4) Change from traditional slash and burn agriculture to large scale cultivation.

It is therefore important that the flora becomes better known so that the threats can be assessed and proper management plans drafted and implemented.

### Diversity of the western Ethiopian escarpment

The flora of the area covered by this vegetation is not well known, and it is only possible to present a rough estimate of the diversity. Two of us (Sebebe Demissew and Tesfaye Awas) have compiled a list of 956 species of vascular plants that are reported to occur in the Benshangul Gumuz National Regional State, a core area in the area under study here. The list has been compiled from published *Flora of Ethiopia and Eritrea* accounts and unpublished sources.

It would currently be very difficult to give a precise count of the species, which occur on the entire western Ethiopian escarpment, or the area of White's *Undifferentiated woodlands (Ethiopian type)*, but a reasonable guess would seem to be the number of species in the Benshangul Gumuz National Regional State plus 10-25%, or a total between 1040 and 1180 species. Together, the authors of this paper have visited many small sectors of the western Ethiopian escarpment, and it is our impression that many of the species are widespread in a north-south direction, even some of the species, which are endemic to the escarpment. It is therefore our impression that a list for the

Benshangul Gumuz National Regional State will represent a comparatively large proportion of the entire diversity.

### Endemism of the western Ethiopian escarpment

In spite of the imperfect knowledge of the flora of the western Ethiopian escarpment, there are a notable number of interesting local endemics or near-endemics which are restricted to or mainly distributed in White's *Undifferentiated woodlands (Ethiopian type)*. The highest concentration seems to be in the Benshangul Gumuz National Regional State, but our knowledge about the distribution of the plant species of the western Ethiopian escarpment is still incomplete. The examples we are aware of from our own studies have been supplemented by examples found through searches through the *Flora of Ethiopia and Eritrea*, but we are sure that many more examples will be found through further studies. These 27 examples are discussed below. We do not know the exact number, but a reasonable guess would probably be to add 10-25%, so the number may increase to 30-40.

### Dicotyledones

#### *Asclepiadaceae*

*Ceropegia recurvata* M.G. Gilbert. This a newly described endemic species discovered in the *Oxytenanthera* woodland around Assosa in the Benshangul Gumuz National Regional State at altitudes between 1300 and 2200 m (Gilbert 2002). It is related to *Ceropegia melanops* H. Huber and *C. nigra* N.E. Br. from Central and West Africa. This species occurs in other localities in western Ethiopia, where western taxa reach into the Ethiopian highlands in the deep river valleys; the southernmost example of this is from the Omo Valley in the *Flora of Ethiopia and Eritrea* region GG, a locality which seems to



be inside the southernmost extension of White's *Undifferentiated woodlands (Ethiopian type)*.

### **Asteraceae**

*Ochrocephala imatongensis* (Philipson) Dittrich. This is a species which is fairly widespread in White's *Undifferentiated woodlands (Ethiopian type)*, but transgresses slightly the borders of this area in southern Sudan and northern Uganda. It occurs in areas of fierce annual grass fires in woodlands along the western escarpment of Ethiopia from Gallabat and Metemma to Gambella, and has outlying localities on the Imatong Mountains, both on the Sudanese and the Ugandan side. A rather similar distribution is shown by the climber *Peponium cienkowskii* (Schweinf.) Engl. (Cucurbitaceae, see below). The relationship of this monotypic genus is not yet known.

*Vernonia cylindrica* Sch. Bip. ex Walp. This species often occurs in undergrowth of *Oxytenanthera* thickets at altitudes between 1200 and 1600 m. It seems to be distributed from western part of the *Flora of Ethiopia and Eritrea* region TU throughout the bamboo thickets of Benshangul Gumuz National Regional State. It is not known elsewhere, and the relationship of it is not yet known.

*Vernonia thulinii* Mesfin. This is a fairly recently described species (Mesfin Tadesse 1997) that probably should be included here. It is restricted to the woodlands of the Didessa Valley, but it is well known that species from the western Ethiopian escarpment may penetrate into the highlands along the major river valleys. The species is not known elsewhere, and the relationship of it is not yet known.

*Vernonia gilbertii* Mesfin. This is another fairly recently described species (Mesfin Tadesse 1997) with a similar, but slightly wider known

distribution than *V. thulinii*. It occurs in very open *Combretum-Terminalia-Stereospermum* woodland at 1200-1700 m a.s.l., with a concentration in the Benshangul Gumuz National Regional State, but it penetrates further into the highlands along the big river valleys, and it has its southern limit just inside the woodlands of Gambella. It is not known elsewhere, and the relationship of it is not yet known.

*Vernonia didessana* Mesfin. This is yet another fairly recently described species (Mesfin Tadesse 1997) with a distribution that only just exceeds the Benshangul Gumuz National Regional State, where it occurs in woodland with *Piliostigma*, *Combretum*, *Schefflera*, *Entada*, etc., on sandy soil at altitudes between 1220 and 1700 m. a.s.l. It is not known elsewhere, and the relationship of it is not yet known.

*Lagera braunii* Vatke. This species occurs in open *Annona senegalensis* woodland and *Oxytenanthera abyssinica* thickets at altitudes between 1300 and 1800 m on the western escarpment of the Ethiopian highlands. In spite of its distribution in White's *Undifferentiated woodlands (Ethiopian type)* it will have to be classified as a near-endemic, because it is also known from the Jebel Marra in western Sudan, but not elsewhere. The relationship of it is not yet known.

*Bidens borianiana* (Sch. Bip. ex Schweinf.) Cufod. This species occurs in regularly burning woodlands from ca. 300 to 1200 m a.s.l. from south-western Eritrea along the western Ethiopian escarpment to the northern Benshangul Gumuz National Regional State; it also occurs in the immediately adjacent parts of the Sudan. The relationship of it is not yet known.

### **Combretaceae**

*Combretum hartmannianum* Schweinf. This species is a characteristic small tree in the woodlands along the western border of

Ethiopia from the extreme south-western part of Eritrea to the Benshangul Gumuz National Regional State and the adjacent parts of the Sudan at altitudes between 500 and 1200 m. The remarkable drooping and extremely long drawn-out leaf-tip makes *C. hartmannianum* easy to recognise, and the feature is not found in any other species. It is not known elsewhere, and the relationship of it is not yet known.

*Combretum rochetianum* A. Rich. ex A. Juss. This species has almost the same distribution area as the previous one. The relationship of this species is not yet known. It is not known elsewhere, and the relationship of it is not yet known.

#### **Cucurbitaceae**

*Peponium cienkowskii* (Schweinf.) Engl. This species has been recorded from rocky outcrops on the border between the Benshangul Gumuz National Regional State and the adjacent part of the Sudan, but is also known from similar habitats in the Imatong Mountains, both on the Sudanese and the Ugandan side, so it is slightly transgressing the limits of White's *Undifferentiated woodlands (Ethiopian type)*. A rather similar distribution is shown by the tall, shrubby Asteraceae *Ochrocephala imatongensis* (Philipson) Dittrich. The relationship of this species is not yet known.

#### **Euphorbiaceae**

*Phyllanthus dewildiorum* M.G. Gilbert. This species occurs in woodlands in the deep river valleys of the western part of the *Flora of Ethiopia and Eritrea* regions WG and KF, and it seems to be restricted to the area of White's *Undifferentiated woodlands (Ethiopian type)*. According to the *Flora of Ethiopia and Eritrea*, it is closely related to *Phyllanthus trichotepalus* Brenan, known from western Uganda, Rwanda, Burundi and Congo DR.

*Euphorbia veneifica* Kotschy. This species occurs in the *Combretum* woodlands of the Sudan and western Ethiopia, just entering northern Uganda, and it does thus transgress the borders of White's *Undifferentiated woodlands (Ethiopian type)*. The distribution thus resembles that of *Peponium cienkowskii* (Schweinf.) Engl. and *Ochrocephala imatongensis* (Philipson) Dittrich. The relationship of this species is not yet known.

#### **Fabaceae subfam. Papilionoideae**

*Mucuna melanocarpa* Hochst. ex A. Rich. This species is endemic to Ethiopia and occurs mainly on the western escarpment and in the deep river valleys. It is common in the western *Combretum* woodland, but it spreads into suitable habitats elsewhere in Ethiopia, reaching the *Flora of Ethiopia and Eritrea* regions GG and SD, and it may therefore slightly transgress the borders of White's *Undifferentiated woodlands (Ethiopian type)*. The relationship of this species is not yet known.

*Rhynchosia stipulosa* A. Rich. This species is apparently endemic to the western Ethiopian deciduous woodlands. It was described from the dry woodlands of Shire in Tigray and has also been recorded from similar habitats in western parts of the *Flora of Ethiopia and Eritrea* regions WG and GG, which are all within White's *Undifferentiated woodlands (Ethiopian type)*. However, in the *Flora of Ethiopia and Eritrea* it is suggested that this species may be conspecific with the widespread African species *Rhynchosia luteola* (Hiern) K. Schum.

*Vigna frutescens* A. Rich. subsp. *kotschyi* (Schweinf.) Verdc. This subspecies is an Ethiopian near-endemic described from *Combretum* woodlands in western Ethiopia and the adjacent parts of the Sudan. It is only known from very few collections, which have been collected inside White's *Undifferentiated woodlands*



(*Ethiopian type*). However, it may be identical with *Vigna neumannii* Harms, described from woodlands in the Ethiopian Rift Valley, but the type of the later is now lost, and the taxon has apparently not been recollected. Even if the two taxa are united, the resulting taxon would be an endemic or a near-endemic of White's *Undifferentiated woodlands (Ethiopian type)*.

### **Lamiaceae**

*Pycnostachys* sp. = Mesfin & Kagnew 2249. This apparently undescribed and narrowly restricted species has been collected in wetlands near Assosa, capital of the Benshangul Gumuz National Regional State, by Mesfin & Kagnew 2249 and Friis *et al.* 7919. It would seem to be narrowly restricted inside White's *Undifferentiated woodlands (Ethiopian type)*. It may be related to *P. niarniamensis* Gürke from the Sudan, Uganda and Kenya.

*Scutellaria schweinfurthii* Briq. Subsp. *schweinfurthii*. This subspecies occurs in wooded grassland subject to regular burning and in rocky places with woodland. From Ethiopia it is only known with certainty from the western part of the *Flora of Ethiopia and Eritrea* region WG. It is doubtfully recorded from the lowlands of IL (Gambella). Outside Ethiopia, it is known from similar habitats in southern Sudan and the adjacent parts of Uganda, and it does therefore, like a few other species, slightly transgress the borders of White's *Undifferentiated woodlands (Ethiopian type)*. The other subspecies, *Scutellaria schweinfurthii* Briq. subsp. *paucifolia* (Baker) A.J. Paton, is widespread in tropical Africa.

### **Vitaceae**

*Cyphostemma pannosum* Vollesen. This Ethiopian endemic species was described from a specimen collected by Friis *et al.* (as no. 2409) in *Combretum* woodland on the western Ethiopian escarpment above Gambella (in the

*Flora of Ethiopia and Eritrea* region IL), but it has also been found from woodlands of the Benshangul Gumuz National Regional State and in one similar locality in the *Flora of Ethiopia and Eritrea* region GG, at the south-eastern border of White's *Undifferentiated woodlands (Ethiopian type)*. It is most closely related to the West African species *Cyphostemma flavicans* (Bak.) Descoings.

### **Monocotyledons.**

In this group, particularly the petaloid monocots appear to have speciated in the region.

### **Amaryllidaceae**

*Crinum bambusetum* Nordal & Sebsebe. This is a newly described species, which is distributed near Assosa in the Benshangul Gumuz National Regional State and in adjacent areas of the Sudan (Nordal & Sebsebe 2002). All localities are inside White's *Undifferentiated woodlands (Ethiopian type)*. It belongs among the *Crinum* species with star-shaped rather than bell-shaped flowers, a group with few and rare species in Tropical Africa. It is the only *Crinum* known to grow in bamboo ticket. The sister species appears to be *Crinum subcernuum* Baker, distributed disjunctly in southern Africa.

### **Anthericaceae**

*Chlorophytum herrmannii* Nordal & Sebsebe sp. nov. This endemic new species will be formally described below. It is only known from open rocky outcrops in the bamboo forest close to Assosa in the Benshangul Gumuz National Regional State. It belongs among the species with prostrate inflorescence, but differs from the others by its much branched inflorescence and pubescent leaf undersides. The sister species appears to be *Chlorophytum neghellense* Cufod., another Ethiopian endemic only found in Bale and Sidamo regions in *Acacia-Commiphora* woodland and bushland.

*Chlorophytum serpens* Sebsebe & Nordal sp. nov. This new species is endemic to Ethiopia and will be formally described below. It has only been found in open patches in *Combretum-Terminalia* woodland and only in an area north of Assosa in the Benshangul Gumuz National Regional State. Also this species belongs among the taxa with prostrate inflorescence, and it connects to the widely distributed *Chlorophytum comosum* (Thunb.) Jacq. complex, otherwise including rainforest taxa. Superficially it resembles the Cameroonian *C. petrophilum* K. Krause, growing in moss mats in lowland rain forest. The species share the trait of rather short, broadly lanceolate leaves and very long trailing inflorescences producing plantlets (pseudovivipary) and very few flowers.

#### ***Hyacinthaceae***

*Drimiopsis spicata* (Baker) Sebsebe & Stedje comb. nov. (formalised below). This species grows in grassland at the margin of *Combretum-Terminalia* woodland and in annually flooded meadows near river banks. It has been recorded from a small area in the *Flora of Ethiopia and Eritrea* region WG, in the lowland part of IL and the adjacent parts of the Sudan. This species is unique in having blue flowers, apparently bridging the morphological gap between the genus *Ledebouria* (with which it shares the flower colour) and the genus *Drimiopsis* (with which it shares the reduced bracts, the closed flowers and the sessile ovary). It might have originated as an inter-generic hybrid, which has overcome sterility and constituted a distinct species. The case is under study by Sebsebe & Stedje (in prep.).

#### ***Aloaceae***

*Aloe* sp. = Friis *et al.* 9130. This is an apparently undescribed Ethiopian endemic species from rocky outcrops in the south western part of the Benshangul Gumuz National Regional State. It will be described as a new taxon when ade-

quate material has been obtained. It is unique within the genus in having traits making it resistant to fires.

#### ***Commelinaceae***

*Cyanotis* sp. = Gilbert & Thulin 707. This apparently endemic and undescribed species is so far only known from one collection from rock crevices the deep river valleys in the western part of the *Flora of Ethiopia and Eritrea* region WG. The relationship of this species is not yet known.

#### ***Cyperaceae***

*Ascolepis eriocauloides* (Steud.) Steud. This western Ethiopian endemic occurs in seasonally wet grassland and seepage areas with shallow soil over rocks, presumably in deciduous woodland. It was described from the *Flora of Ethiopia and Eritrea* region TU and is now also known from western part of the regions WG and KF. It seems to be restricted to White's *Undifferentiated woodlands (Ethiopian type)*. The relationship of this species is not yet known.

### **Discussion and conclusion**

It seems fairly clear that biogeographically, the flora of the western Ethiopian escarpment (White's *Undifferentiated woodlands (Ethiopian type)*) is linked most closely to the flora of the West-African Sudanian region (White 1983), as can be seen from *e.g.* the distribution of dominant tree species such as *Anogeissus leiocarpus* (see Wickens 1976: Map. 55), and in has mostly been included with the Sudanian regional centre of endemism of White (1983).

The western Ethiopian escarpment could perhaps be considered a transition zone between the Afromontane region in Ethiopia and the Sudanian region in the Sudan. In several of his phytogeographical maps, White has indicated the existence of such a transition zone, *e.g.* on a map of the Sudanian region

(White 1983: Fig. 7), but this transition zone is indicated at higher altitudes and above his mapping unit 29b, *Undifferentiated woodlands (Ethiopian type)*. It is as yet too early to draw any firm conclusions about the precise phytogeographical position of the western Ethiopian escarpment as a separate phytochorion at some rank. Yet, it is tempting to compare some of our preliminary observations on diversity and endemism of the area with the results of Friis *et al.* (in this publication) and see how the area studied in this paper ranks in comparison with other parts of the Horn of Africa.

#### **Rank in comparison with diversity of other areas of the Horn of Africa**

In this paper, it has been established that the entire western Ethiopian escarpment, or the area of White's *Undifferentiated woodlands (Ethiopian type)*, has a flora of more than 950 species, and perhaps 1040-1180 species.

Compared to the figures found for the various Flora regions of the Horn of Africa by Friis *et al.* (in this publication: Fig. 3), such a diversity seems to be comparable to a range of Flora regions of the *Flora of Ethiopia and Eritrea*, where there is both highland and lowland, e.g. EW, TU, GD, GJ and BA. The Flora regions of *Flora of Ethiopia and Eritrea* are indicated on a map reproduced in all the published volumes, and in Friis *et al.* (in this publication: Fig. 2).

We can calculate the expected diversity of the western Ethiopian escarpment, based on the empirical formula found by Friis *et al.* (in this publication), where  $T_{exp}$  is the number of expected taxa in the Flora region and A is the area in square degrees of the region:

$$T_{exp} = 587 + 96.57 * A$$

The area of the western Ethiopian escarpment is, as mentioned in the introduction, approximately 145,000 km<sup>2</sup>, or, as we consider the latitudinal decline in longitude degree insignifi-

cant so close to the equator, 12.0 square degrees, for which area the expected diversity according to the formula is 1746. Hence, the estimated minus the expected value is between -566 and -706. When compared with Friis *et al.* (in this publication: Fig. 4), and if our estimate is correct, this will place the diversity of the western escarpment at approximately the same rank as the *Flora of Ethiopia and Eritrea* region HA and a number of Flora regions in Somalia. However, we must emphasise that so far, this is only based on very limited evidence.

#### **Rank in comparison with local endemism of other areas of the Horn of Africa**

In the list of examples, which we have so far been able to put together, there are 27 cases that can be considered endemics or near endemics on the western Ethiopian escarpment (the area covered by White's *Undifferentiated woodlands (Ethiopian type)*), and our estimate is that future studies may add to this figure, so that the number of endemics may increase to 30-40, which – even with conservative estimates – will rank the area analysed here at a higher position than nearly all the Ethiopian and Eritrean Flora regions analysed for single-region endemics in Friis *et al.* (in this publication: Fig. 12), with the exception of HA and SD, but lower than a number of the Flora regions in Somalia.

This means that the endemism (number of endemics/number of species) of the western Ethiopian escarpment (White's *Undifferentiated woodlands (Ethiopian type)*) is approximately 0.03 (3%). A comparison with Friis *et al.* (in this publication: Fig. 13) shows that only the values from the *Flora of Ethiopia and Eritrea* Flora regions of HA and SD are comparable with this, and only among the Flora regions of north-eastern Somalia there are values consistently higher than 0.03.

The diversity and endemism of the western Ethiopian escarpment is not likely to be clearly

reflected in the analyses made in the paper by Friis *et al.* (2005) as these analyses use the *Flora of Ethiopia and Eritrea* and the *Flora of Somalia* regions as units. The western escarpment and White's *Undifferentiated woodlands (Ethiopian type)* cut across nine Flora regions (EW, TU, GD, GJ, WG, IL, KF, GG, SD), which is nearly one third of the units. Endemism in a comparatively narrow zone that cuts across so many units would tend to blur the results of the analysis.

#### **Possible reasons for the endemism**

The local endemism in White's *Undifferentiated woodlands (Ethiopian type)* has developed in a region where the distance between the mountains and the dry lowlands is relatively small, and the climatic shift may have been very dramatic in relation to Pleistocene fluctuations between wetter and drier periods (cf. White 1993). The flora of such areas would be expected to have suffered from severe extinction, but it has been shown that elsewhere such areas in fact can be rich in species and particularly in endemism, as is *e.g.* shown by the discussion of the transitional zone between the Afromontane and the Somalia-Masai region in 'the *Flora of Ethiopia and Eritrea* regions BA and SD by Sebsebe Demissew *et al.* (2001, p. 245), and of the transition zone with *Juniperus-Buxus-Acokanthera* between the Afromontane region and the Somalia-Masai region by Friis (1992).

The mechanisms that support the evolution of an endemic flora in such places are as yet undocumented, but a possible explanation of the endemics and near endemics in White's *Undifferentiated woodlands (Ethiopian type)* might be the complex topography and the relatively reliable oreographic rain on the western Ethiopian escarpment, which, with the deep hinterland of deep river valleys, would seem to provide small refugia during time of adverse climatic conditions. This may have secured niches of very restricted range where species

could survive unfavourable periods. The best conditions for such niches are likely to have been in the most topographically and geologically complex area in the lower reach and at the mouth of the biggest river system in western Ethiopia, the gorges of the Abay river and its tributaries, an area that approximately agrees with the extension of the Benshangul Gumuz National Regional State, the area apparently most rich in local endemics.

Two new endemic species of *Chlorophytum* (Anthericaceae) and a new combination for an endemic species of *Drimiopsis* (Hyacinthaceae)

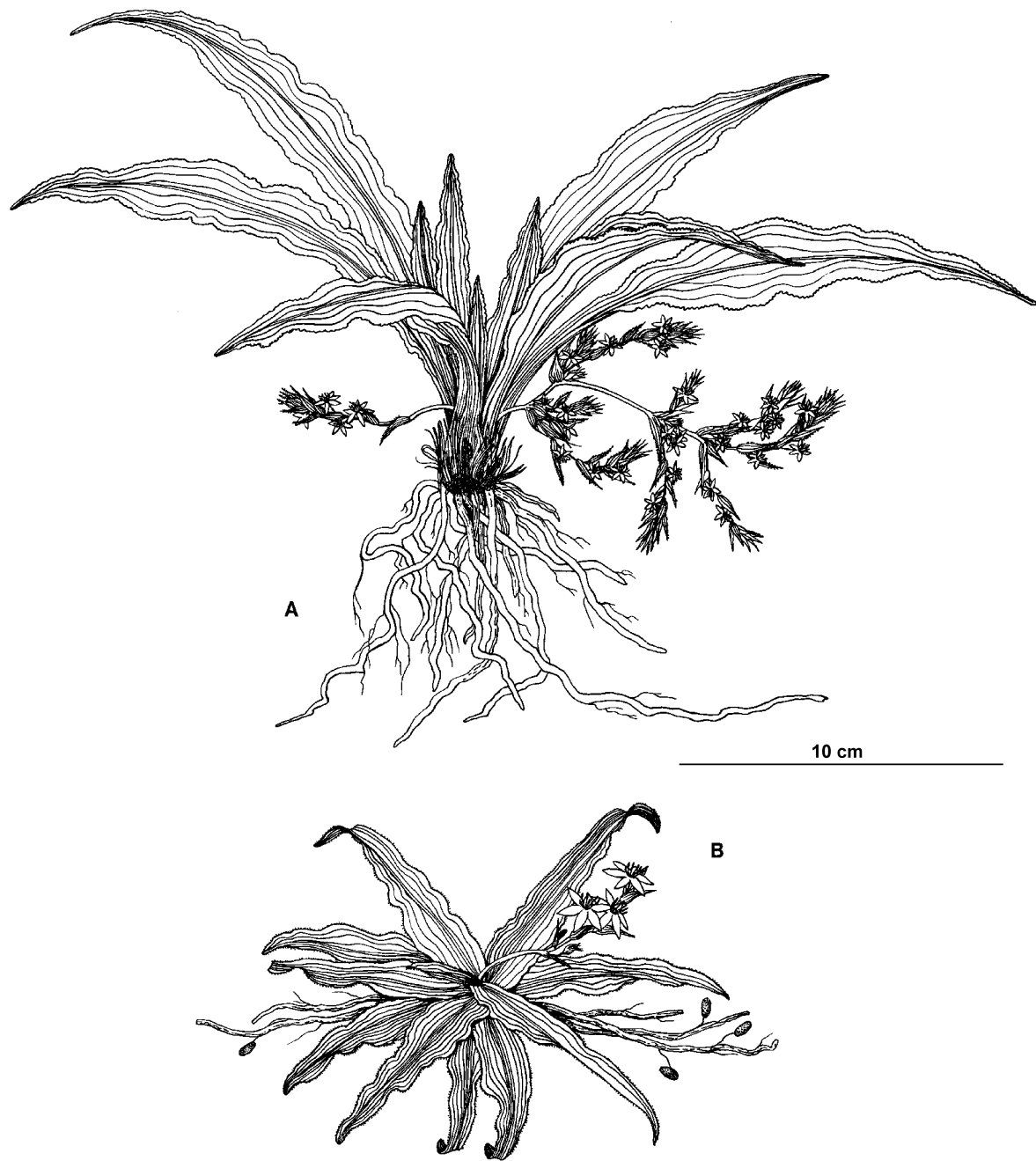
*Chlorophytum herrmannii* Nordal & Sebsebe, sp. nov.

Type: Benshangul Gumuz National Regional State, Anbessa Chaka, ca. 24 km SE of Assosa, 9° 54' 41" N 34° 39' 35" E, 1590 m, 27.05.2001, Herrmann 220 (ETH holotype, K isotype, Fig. 2A).

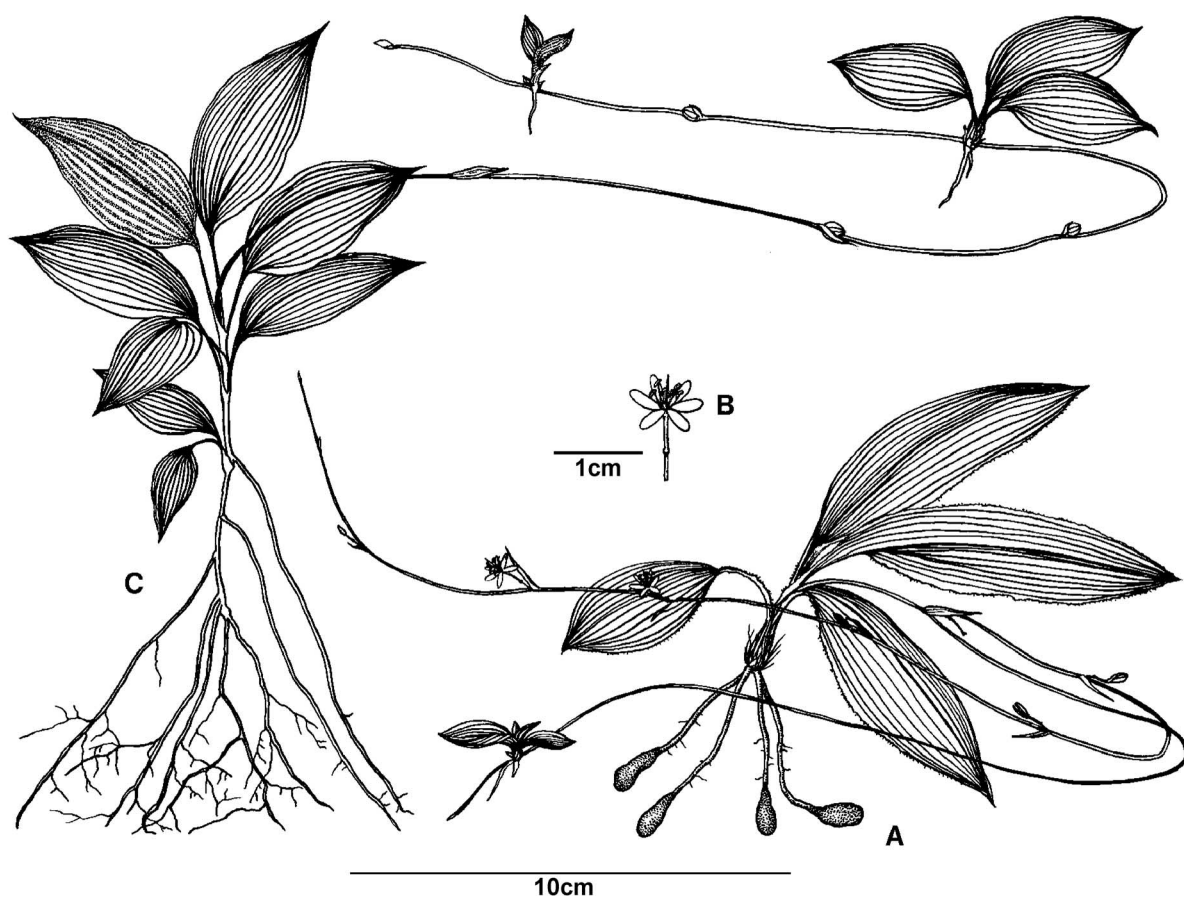
*Haec species nova habitu prostrato foliorum et inflorescentiarum C. neghellensi Cufod. similis, sed differt radicibus carnosis (non tenuibus tubera lateralia habentibus), foliis nec secus marginem et in nervis; inflorescentia valde ramosa, pedicello articulado, non curvato. Inflorescentia prostrata ut in C. humifuso, sed foliis brevioribus, prostratis (non erectis), rosulatis, (non distichis), ciliatis (non glabris) et inflorescentia ramosa differt.*

Perennial herbs with short horizontal rhizomes carrying fleshy roots. Leaves rosulate, slightly petiolate, lanceolate, up to 20 x 3.5 cm, acute with hyaline, crispy undulate margin, ciliate on margin and the veins abaxially. Peduncles 2-2.5 cm long, prostrate with short hairs. Inflorescence a much branched panicle, 4-12 cm long, also flat on the ground. Bracts large and leaf-like, up to 20 x 5 mm, ciliate along margin and veins. Pedicels straight, 2-4 at each node, 5-6 mm long at anthesis, articulated in the lower half. Flowers white with brownish





**Fig. 2.** (A). The new species *Chlorophytum herrmannii* Nordal & Sebsebe, based on the holotype from Benshangul Gumuz National Regional State (Herrmann 220). (B). For comparison, *Chlorophytum neghellense* Cufod., based on plant from Sidamo in southern Ethiopia (Nordal 2218).



**Fig 3.** A-B. The new species *Chlorophytum serpens* Sebsebe & Nordal, based on the holotype from Benshangul-Gumuz National Regional State (Sebsebe Demissew et al. 6080). Drawn by Svetlana Voronkova. A. complete plant. B. Detail of flower. C. For comparison, *Chlorophytum petrophilum* Krause, based on the holotype from Cameroon (Zenker 4846).

tips, tepals 5-6 x 2 mm with 3-5 veins. Stamens shorter than the tepals, filaments 3-4 mm long, anthers 2 mm. Styles straight. Fruits and seeds not known.

The species epithet honours the collector, Christof Herrmann, who, during his work for the Benshangul Gumuz National Regional State, extended the knowledge of the region's biodiversity considerably.

The species grows on open rocky outcrops in bamboo forest, around 1600 m. It is only known from the Assosa area in the Benshangul Gumuz National Regional State (*Flora of*

*Ethiopia and Eritrea* region WG). The main flowering period is in June.

Based on morphology, *C. herrmannii* might well be the sister species of another fairly narrow Ethiopian endemic, *C. neghellense* (Fig. 2B), growing in *Acacia-Combretum-Commiphora* dominated woodland, often heavily grazed, on red sandy soils between 1000 and 1700 m, in *Flora of Ethiopia and Eritrea* regions SD and BA.

*Chlorophytum serpens* Sebsebe & Nordal, sp. nov.

Type: Benshangul Gumuz National Regional State, 71 km from Chagni towards Guba

(Mankush), 11° 12' N 36° 07' E, 1100 m, 23.07.2001, *Sebsebe Demissew, Tesfaye Awas, Melaku Wandafrash & Kagneu H. Sillasie* 6080 (ETH holotype, K isotype, Fig. 3A, B).

*Haec species nova C. petrophilo Krause similis, brevissima folia et longissimas inflorescentias habens, praecipue viviparia multiplicans, differt radicibus brevibus, in tuber distinctum terminantibus, rosula foliorum sine internodiis, foliis distincte ciliatis et firmis non membranaceis.*

Perennial herbs with short rhizomes carrying short roots ending in distinct tubers. Leaves rosulate, petiolate, broadly lanceolate, 7-10 x 2-3 cm, with ciliate margins. Peduncles lax arcuate to trailing, glabrous. Inflorescence up to 50 cm long, simple or with one branch. Bracts 5 – 15 mm, acute to acuminate. Pedicels, single or paired at the nodes, 4-8 mm long at anthesis, articulated near or below the middle. Flowers white, tepals patent, 3-5 x 1.5-2 mm with 3-veins. Stamens shorter than the tepals, filaments 2-3 mm long, anthers ca. 1.5 mm. Styles straight. Fruits and seeds not known.

The species name refers to the trailing, thus serpent-like habit, of the inflorescence.

The species grows in *Combretum-Terminalia* woodland with tall *Sorghum* and *Pennisetum* species, around 1100 m. It is only known from the type locality in the *Flora of Ethiopia and Eritrea* region GJ. It flowers in July.

Both *C. serpens* and *C. petrophilum* belong in the widespread, heterogeneous *C. comosum* (Thunb.) Jacq. complex, a complex where pseudovivipary is common. *C. petrophilum* is a rainforest taxon, only found in the wettest coastal forests of Cameroon. The particular traits of the relatively short broadly lanceolate leaves and the very long trailing inflorescences might have evolved independently in the two species.

*Drimiopsis spicata* (Baker) Sebsebe & Stedje, comb. nov.

Basionym: *Scilla spicata* Baker in *Journ. Bot.* 1878: 323 (1878).

Types: The Sudan, Jur, east of the river Wau, Schweinfurth 1641 (K syntype); by the River Wau, Schweinfurth 1652 (K syntype)

[next person in K should lectotypify]

Synonym: *Drimiopsis barteri* sensu Stedje, non Baker, in *Flora of Ethiopia and Eritrea* 6: 139 (1997).

The species is referred to the genus *Drimiopsis* due to its reduced bracts, the closed flower and the sessile ovary. It is, however, easily recognised from other species in the genus by its purplish to bluish flowers, all others have whitish to greenish. The particular flower colour reminds of traits found in the closely related genus, *Ledebouria*.

The species grows in grassland at the margin of *Combretum-Terminalia* woodland, in annually flooded meadows near river banks. It is recorded from the *Flora of Ethiopia and Eritrea* regions WG and IL and from adjacent parts of the Sudan. The flowering period is from April to May.

## Acknowledgements

We wish to thank Dr. P.H. Wagner, Botanical Library, University of Copenhagen, for translating the diagnoses in the Appendix into Latin. Two of us (Sebsebe Demissew and Inger Nordal) would like to acknowledge Financial support from NUFU to work on the Biodiversity of Eastern Africa (Lilies, Orchids and Sedges) – Taxonomy, Conservation and Use.

## Literature cited

- Bureau of Planning and Economic Development. 1998. *Population Projection for Benishangul Gumuz National Regional State 1994-2003*. Unpublished.
- Cribb, P., Herrmann, C., & Sebsebe Demissew. 2002. New records of orchids from Ethiopia. *Lindleyana* 17: 178-188.
- Cufodontis, G. 1962. The botanical exploration of North-east Tropical Africa. In: Fernandes, A. (ed.), *Comptes Rendus de la IVe Réunion plénière de l'Association pour l'Étude taxonomique de la Flore d'Afrique tropicale*. Lisbonne et Coïmbre, 16-23 septembre, 1960. Lisboa. Pp. 233-248.

- Edwards, S., Mesfin Tadesse & Hedberg, I. (eds.), 1995. *Flora of Ethiopia and Eritrea. Vol. 2,2. Canellaceae to Euphorbiaceae*. Addis Ababa, Ethiopia & Uppsala, Sweden.
- Edwards, S., Mesfin Tadesse, Sebsebe Demissew & Hedberg, I. (eds.), 2000. *Flora of Ethiopia and Eritrea. Vol. 2,1. Magnoliaceae to Flacourtiaceae*. Addis Ababa, Ethiopia & Uppsala, Sweden.
- Edwards, S., Sebsebe Demissew & Hedberg, I. (eds.), 1997. *Flora of Ethiopia and Eritrea Vol. 6. Hydrocharitaceae to Areaceae*. Addis Ababa, Ethiopia & Uppsala, Sweden.
- Feasibility Study. 2001. *Feasibility Study and Environmental Impact Assessment for: Assosa-Guba Road project. NDF Credit No. 207-TD1. November 2001*. Carl Bro a/s Transport Department, in association with DANA Consult Plc Engineering Consultants.
- Friis, I. 1992. Forest and Forest Trees of Northeast Tropical Africa. Their Natural Habitats and Distribution Patterns in Ethiopia, Djibouti and Somalia. *Kew Bull., Addit. Ser.* **15**.
- Friis, I. 2001. Progress with the botanical exploration of Ethiopia and Eritrea during the last forty years. *Systematics and Geography of Plants* **71**: 165-186.
- Friis, I. & Sebsebe Demissew. 2001. Vegetation maps of Ethiopia and Eritrea. A review of the existing maps and the need for a new map for the Flora of Ethiopia and Eritrea. *Biol. Skr.* **54**: 399-439.
- Friis, I., Thulin, M., Adersen, H. & Bürger, A.-M. 2005. Patterns of plant diversity and endemism in the Horn of Africa. *Biol. Skr.* **55**: 289-314.
- Gilbert, M.G. 2002. Notes on the Ceropogonaceae (Asclepiadaceae) of Ethiopia. *Nord. J. Bot.* **22**: 205-210.
- Hedberg, I. & Edwards, S. (eds.), 1989. *Flora of Ethiopia. Vol. 3. Pittosporaceae to Araliaceae*. Addis Ababa and Asmara, Ethiopia & Uppsala, Sweden.
- Hedberg, I. & Edwards, S. (eds.), 1995. *Flora of Ethiopia and Eritrea. Vol. 7. Poaceae*. By Sylvia Phillips. Addis Ababa, Ethiopia & Uppsala, Sweden.
- Jensen, M. & Friis, I. 2001. Fire regimes, floristics, diversity, life forms and biomass in wooded grassland, woodland and dry forest at Gambella, western Ethiopia. *Biol. Skr.* **54**: 349-387.
- Menassie Gashaw, Michelsen, A., Friis, I., Jensen, M., Sebsebe Demissew & Zerihun Woldu. 2002. Post-fire regeneration strategies and tree bark resistance to heating in frequently burning tropical savanna woodlands and grasslands in Ethiopia. *Nord. J. Bot.* **22**: 19-33.
- Mesfin Tadesse. 1997. New species of Vernonia (Compositae-Vernonieae) from northeast Africa. *Kew Bull.* **52**: 575-592.
- National Atlas of Ethiopia. 1988. *National Atlas of Ethiopia. 1. edition*. Ethiopian Mapping Authority, Addis Ababa.
- Nordal, I. & Sebsebe Demissew. 2002. Crinum bambusetum, a new species of Amaryllidaceae from North East Africa. *Kew Bull.* **57**: 465-469.
- Pichi-Sermolli, R.E.G. 1951. *Missione di Studio al Lago Tana. Vol. 7. Recherche Botanique. Parte I. Fanerogame raccolte nel Bacino Idrografico del Lago Tana, nel Semien, nella Regione di Tucùr-Dinghià ed in Eritrea*. Accademia nazionale dei Lincei, Roma.
- Population and Housing Census of Ethiopia. 1994. *Results for Benshangul Gumz R.S. Vol. I, Statistical Report & Vol. II, Analytical Report*. Addis Ababa.
- Schweinfurth, G. 1865. Vier Briefe an Dr. H. Barth. *Z. Allg. Erdk.* **19**: 305-324, 385-427.
- Sebsebe Demissew, Nordal, I. & Stabbetorp, O.E. 2001. Patterns of endemism of the genus Aloe in the Flora of Ethiopia and Eritrea. *Biol. Skr.* **54**: 233-246.
- White, F. 1983. *The vegetation of Africa: A descriptive memoir to accompany the UNESCO/AETFAT/UNSO vegetation map of Africa*. UNESCO, Paris.
- White, F. 1993. Refuge theory, ice-age aridity and the history of tropical biotas: an essay in plant geography. *Fragm. Florist. Geobot. Suppl.* **2(2)**: 385-409.
- Wickens, G.E. 1976. The Flora of Jebel Marra (Sudan Republic) and its geographical affinities. *Kew Bull., Addit. Ser.* **5**.