

Euphorbia venefica Trémaux ex Kotschy (Euphorbiaceae) and other shrub-like cylindrically stemmed *Euphorbia* with spirally arranged single spines

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Abstract. On two independent field trips in 2015 and 2018, the authors collected a tall shrub-like succulent species of *Euphorbia* (Euphorbiaceae) in *Combretum-Terminalia* woodland of the Omo Valley in south-western Ethiopia. These collections represent the easternmost records of *E. venefica* Trémaux ex Kotschy and are the first records from inside the borders of Ethiopia. *Euphorbia venefica* belongs to a group of large succulent species with single spines borne on a spine-shield and arranged on the cylindrical stem in a spiral. The species in this group are reviewed here, based on material in herbaria and the literature. The East African *E. venefica* and the West African *E. unispina* share potential distribution, have overlapping variation in stem- and leaf-morphology and cannot be separated by the characters mentioned in the literature. We consider these two taxa to be one species, to be called *E. venefica* and distributed from Burkina Faso to Ethiopia. *E. poissonii* presents characters that may justify it being a separate species restricted to Africa west of Cameroon. *Euphorbia darbandensis* N.E. Br. and *E. sapinii* De Wild. are too poorly known and could not be placed. Conservation assessments suggest that neither *E. venefica*, nor *E. poissonii* are threatened.

Key words. Environmental modelling, nomenclature, Sudanian zone, taxonomy woodland.

1. Introduction

In August 2015, Tesfaye Awas explored the northern slopes of the Omo Valley in the Konta special woreda, in south-western Ethiopia. This remote area could previously only be reached on foot or horseback but had become accessible by car because of the work beginning on the new Omo/Gibe IV dam. Near the Omo River and above the projected dam, he collected and photographed a sterile, shrubby and succulent plant which could not be identified at the time (Fig. 1). In October 2018, Weber, Ergua Atinafe and Friis went on a field trip to the same general area to record the floristic composition of the Sudanian woodlands and wooded grass-

lands in south-western Ethiopia, not knowing of Tesfaye Awas' find. Here, near the work site of the Omo/Gibe IV dam, Weber observed and collected a shrubby and succulent c. 2 m tall plant (Fig. 2, 3), which was profusely flowering and clearly belonged to the genus *Euphorbia*. Using the *Flora of Ethiopia and Eritrea* (Gilbert 1995), it was possible to assign the plant to subgenus *Euphorbia*, which counts 45 species out of the total of 106 species in the Flora account. It was tentatively identified as *E. venenifika* (for the correct name of this species, see 3.2), though the geographical information in the Flora did not support that idea (see 3.1). The identification was subsequently confirmed



Fig. 1. Detail (above) and general habit (below) of the sterile record of *Euphorbia venefica*, collected as Tesfaye Awas 2627 (ETH). These plants were observed in rather dense woodland in the valley of a small tributary to the Omo River. (Tefaye Awas phot.)

as *E. venefica* Kotschy at the Royal Botanic Gardens, Kew (K). In the most recent phylogenetic study and classification of subgenus *Euphorbia*, the species is included in the

sampling and falls under section *Euphorbia* (as '*E. venenifica*') (Dorsey et al. 2013).

The field-work by Weber, Ergua Atinafe and Friis was part of a project started by



Fig. 2. Detail and general habit of the flowering and fruiting record of *Euphorbia venefica*, collected as Friis, Weber, Ergua Atinafe & Ermias Getachew 15889 (ETH). These plants were observed in relatively open *Combretum-Terminalia* woodlands just north of the Omo River in Ethiopia. Note the clusters of fruits at the end of several branches in the lower images. (Odile Weber phot.)

Friis in 2014 to study the little known floristic patterns in the woodlands of Ethiopia along the borders with Sudan and South Sudan (Pichi Sermolli 1957; Harrison & Jackson 1958; White 1983; Friis et al. 2010; Breugel et al. 2016). *Euphorbia venefica* has not been observed in any of the 152 sites studied for this woodland project (for the study sites between Jimma and the Omo River, see Fig. 4).

In August 2019, Prof. Sebsebe Demissew, Addis Ababa, told Weber and Friis about Tesfaye Awas' unidentified plant, which they immediately realised was the same as the flowering succulent plant they had found and identified. The present paper contains a joint report on the discoveries, and a critical review of the earlier eastern African collections of *E. venefica* and of the nomenclature, taxonomy and phytogeographical status of this and related species. The new record is of particular interest because the plant has not previously been found so far to the east in Africa.

2. Materials and Methods

All material collected on the field trips in August 2015 and October 2018 is deposited at the National Herbarium of Ethiopia at Addis Ababa University (ETH). As the collections from 2018 could not be satisfactorily identified there, it was sent on loan to the Herbarium at the Royal Botanic Gardens, Kew (K). Additional material at K and the Natural History Museum, London (BM), including material in alcohol, has been seen for this study, both material of the species with cylindrical stems and spirally arranged single spines and material of potentially related species. Herbarium material from other European herbaria has been consulted by correspondence with curators (W and B) and on digital images traced via the Global Biodiversity Information Facility (GBIF.org 2019), Global Plants on Jstor (<https://plants.jstor.org/>), the Naturalis collections database (<http://biportal.naturalis.nl/>), the database of the Musée national d'histoire naturelle, Paris (P; <https://science.mnhn.fr/institution/mnhn/collection/p/item/search>) and the virtual herbarium of the Meise Botanic

Garden (BR; <http://www.botanicalcollections.be/#/en/search>). Tropicos (<https://www.tropicos.org/>) of the Missouri Botanical Garden, St. Louis, Missouri, USA (MO) was consulted for supplementary material. Material of the relevant species seen and identified is listed in 3.4 and mapped in Fig. 5, 7 and 9; imperfect specimens that could not be satisfactorily identified have been omitted.

Standard methods were used for collecting botanical material on our field trips, including the use of GPS. Our post facto georeferencing of the 19th century material from the Sudan and South Sudan is based on the relevant old literature with localities traced on the digitised set of maps of Sudan in 1:250.000 kept at Library of Congress, Washington, DC (<https://www.loc.gov/resource/g8310m.gct00289/?sp=32>), Russeger's *Karte von Ost Sudan*, 1843 (<https://www.oldmapsonline.org/map/cuni/1084712>) and the information in Wickens (1972) and Friis & Vollesen (2005). Material from other countries was georeferenced for Cameroon with the use of Letouzey (1968), for the area of the *Flore d'Afrique Centrale* with the use of Bamps (1982), for the area of the *Flora of Tropical East Africa* with the use of Polhill (1988) and for specimens from elsewhere with the Fuzzy Gazetteer (<http://dma.jrc.it/fuzzyg/query/>) and Google Earth Pro (2019). When a collection was indicated to have been made between two georeferenced points, our input in the process of mapping and modelling is the coordinates of the topographically most likely site between the two points, estimated in relation to features identifiable in Google Earth Pro (2019). Doubtfully georeferenced collecting localities cited in 3.4 are marked with '[?]' and not mapped. The topographical data was converted to shapefiles with the software DIVA-GIS 7.5 (<http://www.diva-gis.org/>). Modelling of the potential distribution has been done with two different methods to secure reliable results: DIVA-GIS, using the BioClim option, to determine the environmental envelopes, and MaxEnt 3.4.1 (http://biodiversityinformatics.amnh.org/open_source/maxent/) to model a probability distribution based on grid cells, where the predicted suitability of conditions for the species is deter-

mined for each grid cell. For both methods, we used the full set of variables from WorldClim v. 1.4 (Current conditions) with a 30 seconds resolution (1960-1990; <http://www.worldclim.org/current>).

External shapefiles used for the map in Fig. 4 and 5 were obtained from the following sources: The digital elevation model from <https://cgiarcsi.community/data/srtm-90m-digital-elevation-database-v4-1>. The alignment of country borders and rivers from <https://www.naturalearthdata.com/downloads/50m-cultural-vectors/50m-admin-0-countries-2/> and <https://www.naturalearthdata.com/downloads/10m-physical-vectors/10m-rivers-lake-centerlines/> (the latter was also used in Fig. 9).

In Fig. 9, the distribution of our records was compared to the main vegetation types of Africa using a shapefile of UNESCO's vegetation map of Africa (White 1983) produced by World Agroforestry Centre (ICRAF), Nairobi. Photographs and the digital maps were finalised with Adobe Photoshop CS6.

3. Results

3.1. The new record of *Euphorbia venefica* and a critical review of previous records

The shrubby and succulent species of *Euphorbia* (Euphorbiaceae) which the authors discovered during their field trips in 2015 and 2018 (photographs of the species *in situ*, Fig. 1, 2; herbarium material of leaves and apical part of stem, showing spines, Fig. 3) were observed between the two southernmost plots studied for the woodland analysis mentioned in the introduction (map in Fig. 4). The habitat contained, apart from *Combretum molle* G. Don and *Terminalia schimperiana* Hochst. (both Combretaceae), the following species of trees, which according to our studies of 148 sites are all typical woodland trees in large parts of western Ethiopia: *Lannea fruticosa* Engler (Anacardiaceae), *Vitex doniana* Sweet (Lamiaceae), *Pseudocedrela kotschyi* (Schweinf.) Harms (Meliaceae), *Bridelia scleroneura* Müll. Arg. (formerly Euphorbiaceae, now Phyllanthaceae), *Piliostigma thonningii* (Schu-

macher) Milne-Redh. (Fabaceae) and *Ficus sycomorus* L. (Moraceae).

Euphorbia venefica is included in the account of the Euphorbiaceae in the *Flora of Ethiopia and Eritrea* (Gilbert 1995: 334) with the geographical information: "Known from within the Flora area by only a single old collection from the Benishangul (Beni Sciangul), probably to the west of Asosa." The record referred to was made in May 1848 by the Polish traveller and microbiologist Leon Cienkowski at Mt. Fazugli (with the spelling variants Fazughli and Fesoghlu), the highest peak of which (1460 m) is at 11° 01' N and 34° 54' E. Cienkowski's collection of *E. venefica* can no longer be found, but it is cited by Schweinfurth (1867: 36) as "In den Gebirgen von Benischangol, Fesoghlu, Mai 1848, ohne Blüten." According to the current administrative divisions, Mt. Fazugli is in the Geissan district of the Blue Nile state of the Republic of the Sudan, just 7.5 km west of the border with the present, more restricted Benishangul-Gumuz Regional State in Ethiopia and southwest of where the Blue Nile crosses from Ethiopia into the Sudan (Google Earth Pro 2019; see map in Fig. 5).

The French traveller, photographer and architect Pierre Trémaux, who according to Schweinfurth (1867: VI) took part in Cienkowski's expedition, studied sterile specimens of the same species in the same general area of the Sudan on Mt. Kaçane, a moderately sized inselberg near Dar Foq and southwest of Mt. Fazugli. His collecting localities are shown on the *Carte détaillée d'une partie du Soudan Oriental N° 4* in Trémaux (1853) and are among the eastern localities on our map in Fig. 5, locality-cluster A. He also published a description with two excellent lithographs of sterile plants in leafless condition (Trémaux 1853: Tab. 12, 13; see our Fig. 6) and named his plant *Euphorbia mamillaris* (see discussion in 3.2).

The species had been collected already in 1837 on several hills of the Nuba Mountains in Kordofan in central Sudan (about 450 km west of where Cienkowski and Trémaux recorded it; localities shown on map in Fig. 5, locality-cluster B) by the Austrian traveller and naturalist Theodor Kotschy, who



Fig. 3. Leaves (A-C) and apical part of stem (D) of Friis, Weber, Ergua Atinafe & Ermias Getachew 15889 (ETH). Leaves and stem were sliced and treated with alcohol to facilitate drying. A. Leaf with truncate-apiculate leaf-apex. B. Leaf with acute leaf-apex. C. Leaf with acuminate leaf-apex. D. Apical part of stem, showing the position of spines immediately below the leaf-scars. A-D reproduced at the same scale; scale bar at A 10 cm long. (Ib Friis phot.)

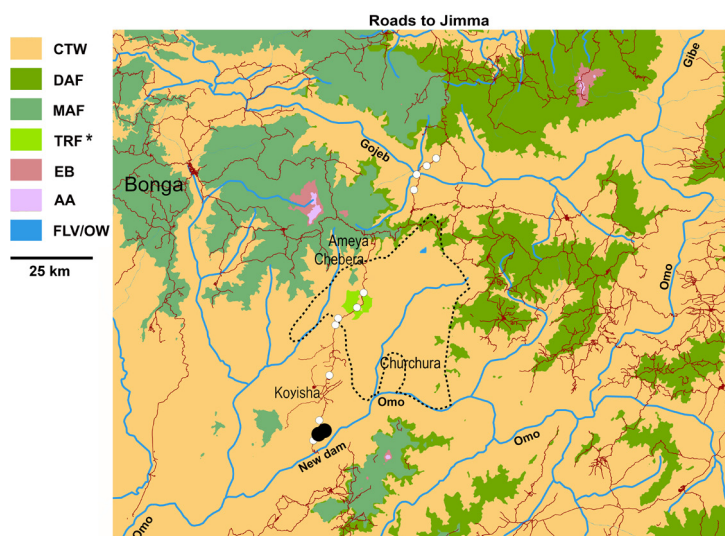


Fig. 4. Map of part of south-western Ethiopia, showing vegetation and collecting localities of *Euphorbia venefica* (black dots). The white dots indicate sites where floristic inventories were made during the October 2018 field trip; the black dotted line indicates the border of the Chebera-Churchura National Park. Based on Friis et al. (2010), the vegetation is indicated like this: CTW. *Combretum-Terminalia* woodland. DAF. Dry Afromontane forest. MAF. Moist Afromontane forest. TRF*. Forest with species from both TRF (Transitional Rain Forest) and MAF. EB. Ericaceous belt. AA. Afroalpine vegetation. FLV/OW. Fresh-water lakes with open water.

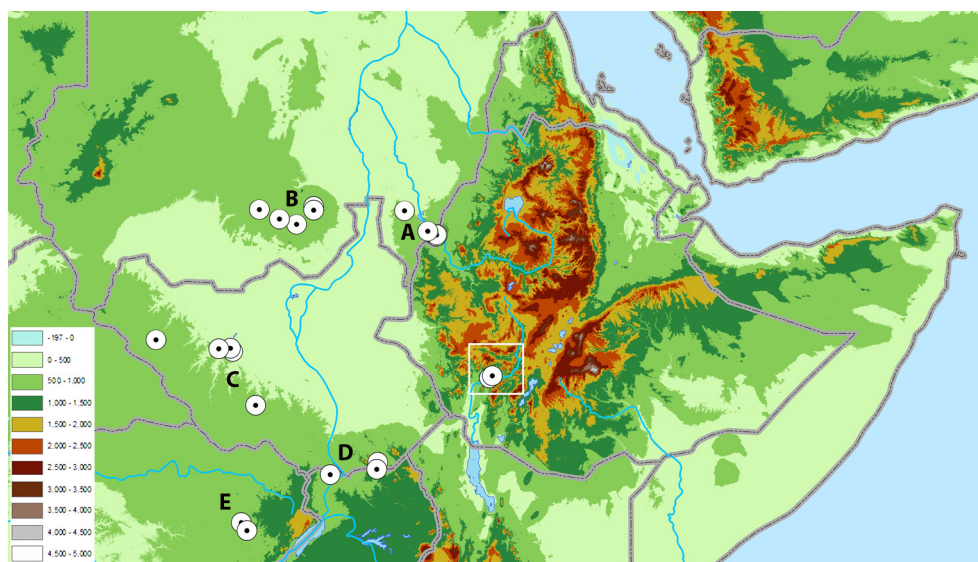


Fig. 5. Map showing the distribution of *E. venefica* in and near Ethiopia (white bird-eye dots) against elevation (legend units in meters above sea level). The white square indicates the area shown in Figure 4 with the new Ethiopian records. The letters A-E indicate the clusters of records of what has traditionally been named *Euphorbia venefica* or *E. venenifica*. Cluster marked A. Cienkowski's, Trémaux's, Hartmann's and Mano's records from around Mt. Fazugli and Roseires. Cluster marked B. Kotschy's collections from the Nuba Mountains and two newer collections. Cluster marked C. Schweinfurth's collections from south-western Sudan. Cluster marked D. Collections from the border between South Sudan and Uganda. Cluster marked E. Collections from north-eastern Democratic Republic of Congo.

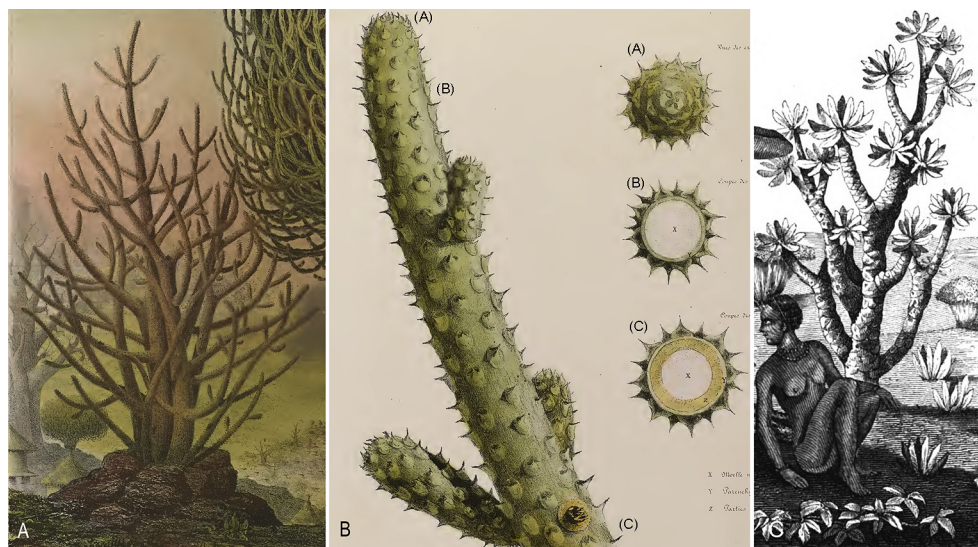


Fig. 6. Details from early illustrations of *E. venefica* from eastern Sudan. A. Detail of Trémaux (1854: Tab. 13, left part), showing a group of plants in leafless condition. B. Detail of Trémaux (1854: Tab. 14, left part), showing tip of branch, where (A) is the view of the apex of the branch, (B) the level where a cross section of the still herbaceous part of the branch has been made and (C) the level where a cross section of a partly lignified part of the branch has been made. In the figures to the right, (X) indicates soft pith, (Z) lignified tissue and (Y) a parenchymatic layer below the grey, corky bark. C. Detail of Hartmann (1863: 517, right part of Fig. 25), showing plant in leaf; the drawing does not show spines (thus resembling plants that we refer to *E. poissonii*), but Hartmann (1863: 560) states that he collected a specimen with spines. The works by Trémaux (1854) and Hartmann (1863) are in the public domain.

took part as zoologist and botanist in an expedition led by the geologist Joseph von Russeger. The first observations of this species and the use of its milky sap as an arrow poison were published in a general travel account by Russeger (1844: 182-183), but no scientific name was proposed for the plant. Kotschy published his observations and named the plant four years later than the publication by Trémaux (Kotschy 1857: 173; see about the nomenclature in 3.2).

In June 1860, the German medical doctor and naturalist Robert Hartmann observed the same species and published a rough illustration of a sterile plant with leaves, which had not been observed before (Hartmann 1863: 483, Fig. 25 on p. 517, 560; reproduced in our Fig. 6C, western locality in Fig. 5, locality-cluster A). The observations were made on inselbergs in Upper Sennaar between Jebel Ghule [J. Guli] and Jebel Seneh and at Dull Roro [J. Roru], etc. Upper Sennaar is largely equivalent to the Blue Nile state of the present day Republic of the Sudan; Hartmann's localities are west of the present Roseires Dam on the Blue Nile.

In a range of works on the flora of the Sudan and South Sudan, the German botanist and traveller Georg Schweinfurth (1862, 1867, 1868, 1873a, 1873b) provided new information about this species and renamed it *Euphorbia venefica*. Schweinfurth observed and collected the plant in a number of localities to the west of the Nile inside what is now South Sudan (localities indicated on map in Fig. 5, locality-cluster C). The Austrian traveller Ernst Marno (1874: 253, 275) reported having seen the plant on inselbergs in Upper Sennaar, near where it was first studied by Cienkowski, Trémaux and Hartmann.

In his general review of the arrow poisons of the world, Lewin (1894) mentioned the use of the milky sap of this plant, which he called *E. venefica*, as a strong arrow poison, in particular used by members of the Burum ethnic group, now living in the northeastern part of South Sudan, and by the people of the Fung or Sennaar sultanate along the Blue Nile.

The above-mentioned records are all from scattered localities in the Sudan and South Sudan, none from inside the present Ethio-

pian borders. More recently, records from East Africa have been made from parts of Uganda and the Democratic Republic of Congo, all from near the borders of the Sudan and South Sudan (Fig. 5, locality-clusters D and E). Our two records of the plant from the Omo Valley extend the distribution of the species 180 km further to the east of the previously known localities, which corresponds to about 500 km south-east of the previously known localities in the Nuba Mountains and Sennaar.

The Sudanese localities of *E. venefica* belong to the scattered vegetation type which Harrison & Jackson (1958) call the 'Hill catenas', which include mountain slopes and inselbergs with vegetation generally dominated by species that are more moisture-loving than plants in the surrounding plains, but also able to stand periods of drought. The lower slopes of the Imatong Mountains and the hills in northern Uganda, where *E. venefica* has also been collected, have similar vegetation to that of the inselbergs. The collections made by Schweinfurth in South Sudan to the west of the Nile seem all to be from the *Anogeissus-Khaya-Isobertinia* woodland of Harrison & Jackson (1958), and this is also the vegetation of the inselberg-localities inside the forest in the north-eastern Democratic Republic of Congo. The climate and vegetation at the locality of our record from the Omo Valley in Ethiopia seems to agree with the conditions on the lower slopes of the Imatong Mountains (Friis & Vollesen 2005: 713). Apart from the localities in the Imatong Mountains, there seems to be a zone in the eastern South Sudan from which *E. venefica* is absent; this area includes the swamps of the Sudd along the Nile and the generally dry grasslands between the Nile and the western escarpment of Ethiopia, which are sometimes flooded by heavy rain (Harrison & Jackson 1958).

Using both MaxEnt and environmental envelopes, we modelled the potentially suitable areas for *E. venefica* based on the East African collections. The models show suitable areas of habitat for the species in West Africa, particularly in Nigeria, Togo, Benin and Ivory Coast (see our Fig. 7A). We therefore decided to include studies of similar

West African species and have drawn taxonomic consequences from this. This is further developed in 3.3.

3.2. *Euphorbia venefica* vs. *E. venenifica* – the correct original material, name and authority for our plant

The repeated scientific discoveries of this plant as described in 3.1, sometimes given no name, sometimes given an illegitimate name, has confused its nomenclature and typification. In the heading of Trémaux's description of this species, he wrote "Euphorbia mamillaris (espèce nouvelle)". However, *E. mamillaris* Trémaux is an illegitimate later homonym of *E. mamillaris* L. (Linnaeus 1753: 451), as the two names are so similar that they are likely to be confused (Turland et al. 2018, Art. 53.2 and Ex. 11). In his general description of the vegetation of the Nile Valley, Kotschy (1857: 173) provided new information on the species and a short description: "Die giftigste Pflanze der Neger hat hier ihre Heimat, es ist die gefürchtete *Euphorbia venefica* Trem-eau [sic!], ein Wolfsmilchstrauch, 0–8 Fuss hoch, mit zylindrischen nackten, gegen die Spitze mit kurzen starken Stacheln besetzten Ästen, an deren Scheitel kleine gelbgrüne Blumen sitzen. Sobald ein Teil der Äste verletzt wird, fließt eine dicke Milch hervor, welche den Neger als Hauptbestandteil zur Vergiftung von Lanzen und Wurfspießen, zumal jenen von Eisenholz, nötig ist." This German text by Kotschy includes diagnostic characters of the plants and the name *E. venefica*, and it fulfils the requirements for an effectively and validly published and legitimate name for a new taxon (Turland et al. 2018, Art. 6, 51, 52). A reference to Trémaux appears on a label of Kotschy's collection W0078596, as the specimen is named "*Euphorbia venefica* Trémaux", a name never published by Trémaux, but perhaps mentioned in notes or correspondence between Trémaux and Kotschy. According to the International Code of Nomenclature for Algae, Fungi, and Plants (Turland et al. 2018, Art. 6.13), "*Euphorbia venefica* Trémaux" cannot be a replacement name for the illegitimate *E. mamillaris* Trémaux, as no potential replaced synonym is cited in

Kotschy's protologue and Kotschy does not refer to any of Trémaux's published works. Kotschy's original material for that publication must therefore be the material collected and studied by him in Kordofan and not any of Trémaux's illustrations. It is therefore not correct when Carter (in Carter & Radcliffe-Smith 1988: 494) suggests that Trémaux's illustrations are part of the original material of "*E. venenifica* Kotschy." However, both on the label of W0078596 and in his publication, Kotschy ascribed the name *E. venefica* to Trémaux, and in agreement with Turland et al. (2018, Art. 46.3 and Ex. 15), the rightful authority of the name *E. venefica* is 'Trémaux ex Kotschy'. Boissier (1862: 178) also cited the name as '*E. venefica* Trémaux mss. ex Kotschy'.

In his three publications mentioning this plant, Schweinfurth (1862 & 1867: 36, 1873b: 351) consistently changed the name to "*E. venenifica* Trém. ex Kotschy". Brown (1911: 562) and almost all subsequent authors (listed in the synonymy in the taxonomic part of this paper) have used that altered name. However, the International Plant Name Index (IPNI; <https://www.ipni.org/>) states about *E. venenifica* "a sphalm.; use *E. venefica*" and "Brown (...) cited the name as '*Euphorbia venenifica* Trémaux ex Kotschy' (an error)." This situation has caused confusion, and we will attempt a clarification here. Turland et al. (2018, Art. 60.1) state that "The original spelling of a name or epithet is to be retained, except for the correction of typographical or orthographical errors (...)". It is therefore necessary to ascertain if Schweinfurth's change from *E. venefica* to *E. venenifica* is a correction of such a typographical or orthographical error. Both *E. venefica* and *E. venenifica* are clearly based on the Latin word for poison, 'venenum', and 'venefica' is a contraction of 'venenifica' (Ernout & Meillet 1959), but the contracted form 'venefica' is the only one documented from classical Latin as written before AD 200 (Glare 1982); only later Latin sources document the longer form 'venenifica' (Lewis & Short 1879). Schweinfurth's change of *E. venefica* to *E. venenifica* is thus not a correction of a typographical or orthographical error made by Kotschy or Boissier and hence not admissible under the Code of Nomenclature.

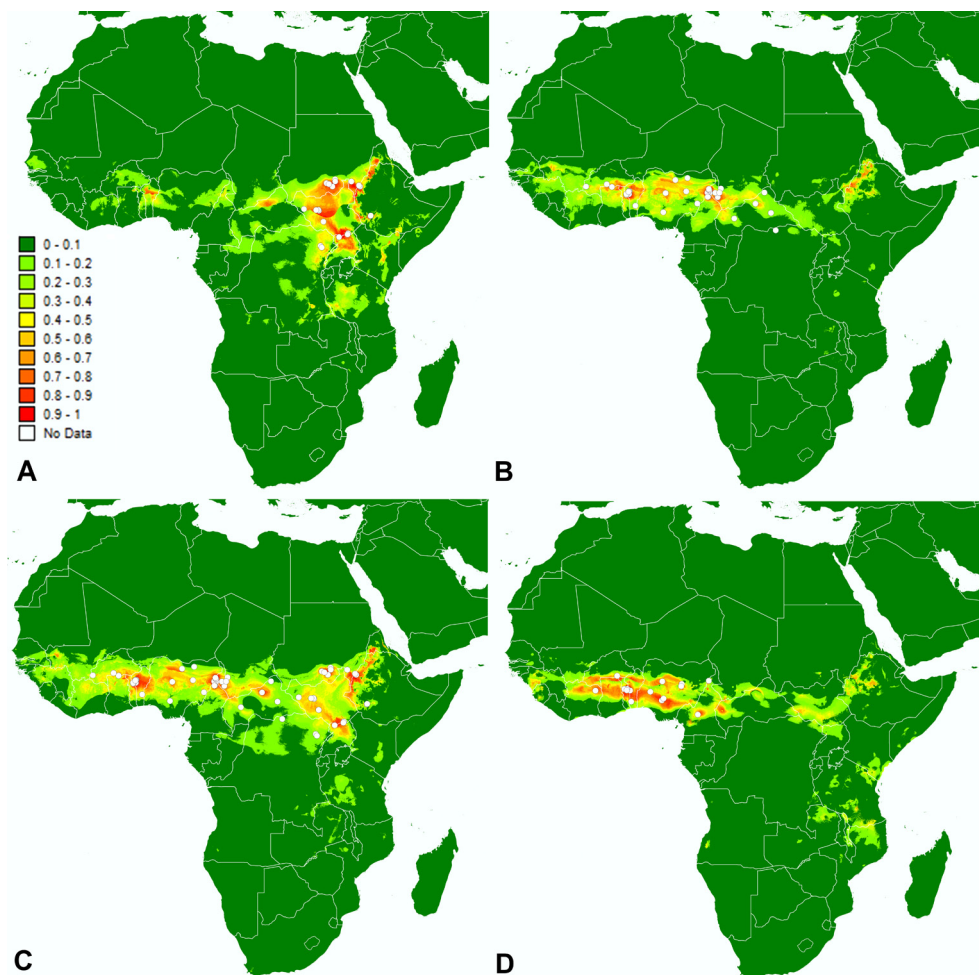


Fig. 7. Observed and modelled potential distributions of *Euphorbia venefica* and *E. poissonii*. A. *E. venefica*, as traditionally circumscribed (specimens exclusively from East Africa), with suitable areas in the west where the species is expected to occur. B. West and Central African records traditionally referred to *E. unispina*, with suitable areas in the east. C. *E. venefica* as circumscribed in this paper. D. *E. poissonii* as circumscribed in this paper. *E. darbandensis* and *E. sapinii* are only known by collections cited in the protologue (for distribution, see Fig. 9) and have not been modelled. The habitat-suitability calculated by MaxEnt is indicated on a scale from 0.0 to 1.0 shown on A, where 0.0 means that the area is unsuitable for the species and 1.0 means that the species is expected to be present in the area.

3.3. Potential distributions and taxonomic discussion

The following is a geographical and taxonomic discussion of the succulent spine-shield species of *Euphorbia* in Africa with single spines arranged on a cylindrical stem in a spiral, *E. venefica*, *E. unispina* and *E. poissonii*. Two poorly known African species also with spirally arranged single spines on cylindrical stems are omitted from the

detailed discussions in 3.3.1 and 3.3.2, *E. sapinii* De Wild. (Wildeman 1908: 290) and *E. darbandensis* N.E. Br. (Brown 1913: 1040). *Euphorbia sapinii* was described from the Kasai region in the north-western part of the Democratic Republic of Congo. The type of this name is a plant with almost linear leaves, a character found scattered through the distribution area of *E. venefica* / *E. unispina* and seems to represent the leaves formed early

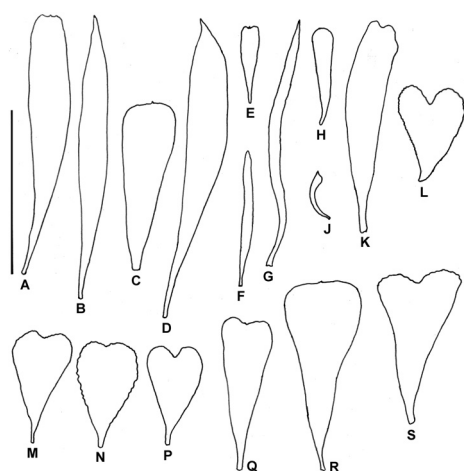


Fig. 8. Range of variation in outline of leaves of *Euphorbia venefica* (A-L) and *Euphorbia poissonii* (M-S) drawn from herbarium specimens: A. Friis et al. 15889 (Ethiopia), truncate and apiculate leaf. B. From same plant as A, lanceolate and acuminate leaf. C. Schweinfurth 1827 (South Sudan), truncate and apiculate leaf. D. From same collection as C, truncate and apiculate leaf. E. Wickens 3090 (Sudan), young truncate and apiculate leaf. F. Schweinfurth 1375 (South Sudan), young narrowly lanceolate, acuminate leaf. G. Hepper 1386 (Nigeria), young narrowly lanceolate, acuminate leaf. H. Dalziel 329 (Nigeria), young leaf with rounded apical part. J. Greenway & Eggeling 7245 (Uganda), young apiculate leaf (folded leaf in side view). K. Eggeling 1209 (Uganda), emarginate leaf. L. Hakki et al. 855 (Togo), emarginate leaf. M. Barter 1491 (Nigeria), obtriangular, emarginate and slightly apiculate leaf. N. Kitson 543 (Ghana), obtriangular, emarginate leaf. P. Hakki et al. 383 (Togo), obtriangular, emarginate leaf. Q. Hakki et al. 296 (Togo), truncate and slightly apiculate leaf. R. Boudouresque 5527 (Niger), obtriangular and apiculate leaf. S. Bally 5192 (Ghana), obtriangular, emarginate leaf. All drawn to same scale from specimens at K (10 cm long scale bar at A).

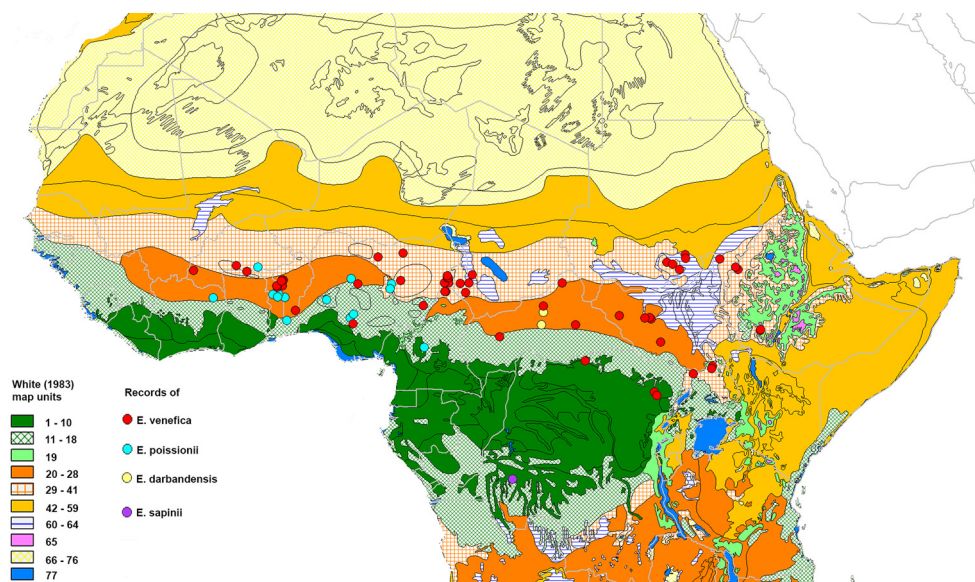


Fig. 9. Distribution of all taxa on major African habitats (habitat types simplified from White 1983). The species are most frequent in the Sudanian woodlands, but occur also in the mosaic of lowland rain forest and woodlands and on inselbergs in the areas with closed lowland forest. 1-10. Lowland rain forest, Guineo-Congolean forests, swamp forests and Transitional forest. 11-18. Mosaics of lowland forests and woodlands and secondary grasslands. 19. Undifferentiated Afromontane vegetation. 20-28. Dense types of woodlands, including Sudanian *Isomerlinia* woodlands. 29-41. Open types of woodlands, including the open Sudanian and Ethiopian woodlands. 42-59. Somalia-Masai *Acacia-Commiphora* deciduous bushlands, Sahel *Acacia* wooded grassland and deciduous bushland and (northernmost zone) semidesert grassland and bushland. 60-64. Moist edaphic grasslands of the Nile Valley and elsewhere. 65. Altimontane (Afroalpine) vegetation. 66-76. Deserts and halophytic vegetation of various types (the southernmost zone rich in regs, hamadas and wadis). 77. Mangroves along the coasts and inland lakes with open water.

during the rains. *Euphorbia darbandensis* was described from the Central African Republic as being not more than c. 40 cm tall and with spines much more slender than those of *E. venefica* / *E. unispina*. Insufficient material makes it impossible for us to form conclusions about these two taxa, and we have just listed the type material as species imperfectly known.

When using the records in 3.4, we found that the predicted distributions produced by DIVA-GIS and MaxEnt were very similar though slightly narrower when using DIVA-GIS. We have therefore only shown the predicted distributions produced using MaxEnt in Fig. 7A-D, with the actual records superimposed as white dots. Both the DIVA-GIS and MaxEnt models based on specimens belonging to *E. venefica* as this taxon is traditionally circumscribed (Fig. 7A) shows potential area in West Africa, particularly in Central African Republic, Nigeria, Togo, Benin and Ivory Coast. Conversely, models based on west African material (*E. unispina*) show potential area in north-eastern Congo, Uganda, South Sudan and small areas in Sudan and Ethiopia (Fig. 7B). A model based on specimens belonging to *E. venefica* and *E. unispina* combined (Fig. 7C) shows suitable areas that cover largely the same areas as found in Fig. 7A and B combined, but some of the area south of the Equator deemed suitable in Fig. 7A is no longer indicated as such. A model based on specimens here referred to *E. poissonii*, shows areas of high suitability in West Africa, but with an extension to the Central African Republic and South Sudan and again with small areas in Sudan and Ethiopia (Fig. 7D). Table 2 shows data from the climatic envelopes modelled with DIVA-GIS. The climatic ranges, including the differences between the rainfall in driest and wettest quarters, are very similar for *E. venefica* and *E. poissonii*.

3.3.1. Does *E. venefica* extend into West Africa, and are *E. venefica* and *E. unispina* conspecific?

According to Carter & Radcliffe-Smith (1988), Gilbert (1995), Lebrun & Stork (2006) and Darbyshire et al. (2015), *E. venefica* (as '*E. venenifca*') is restricted to

eastern tropical Africa (Ethiopia, Sudan, South Sudan and Uganda). However, our distributional model of *E. venefica* based on East African material shows potential distribution in West Africa (see Fig. 7A). From West Africa, Hutchinson et al. (1954: 419, 422) and Newton (1992) mention two shrubby or tree-like, succulent species of *Euphorbia* with cylindrical branches, spirally arranged spines and one spine per spine-shield like *E. venefica*: *E. unispina*, N.E. Br. and *E. poissonii* Pax. Other succulent species with rounded, but in the apical part not completely cylindrical stems and spirally arranged spines (*E. paganorum* A. Chev. and *E. sudanica* A. Chev.) can, apart from the shape of the apical part of the stems, be distinguished by having two spines on the spine-shields, leaves with spine-like lobes in the apical part and by not developing the corky bark seen in *E. venefica*, *E. unispina* and *E. poissonii*. In the phylogenetic analysis by Dorsey et al. (2013), '*E. venenifca*' forms a nested clade with *E. unispina* and *E. sapinii* (*E. poissonii* was not included in the study), but also with three samples of *E. sudanica*. Our morphological observations indicate that *E. sudanica* is distinct in several characters and does not seem to belong within a clade of the closely related *E. venefica*, *E. unispina* and *E. sapinii*. Yet other shrubby or tree-like succulent species of *Euphorbia* in West Africa have longitudinally angled or winged branches with the spine-shields restricted to the angles or wings (*E. desmondii* Keay & Milne-Redhead, *E. deightonii* Croizat and *E. kamerunica* Pax).

The modelled distributions of both *E. venefica* s.str. (Fig. 7A) and *E. unispina* (Fig. 7B) also suggest suitable areas for *E. venefica* and *E. unispina* in woodland habitats south of the Guineo-Congolian rainforest. According to Lebrun & Stork (2006) and Carter & Leach (2001) however, there are no species similar to *E. venefica* in areas south of the rain forest belt, apart from *E. sapinii*, which is at the southern limit of the rain forest (type locality). For the sake of completion we also looked at the literature for Southern Africa (White et al. 1941) and Madagascar (Rauh 1985, 1987; Haevermans et al. 2004) and found no similar species.

In her account of the genus *Euphorbia* for the *Flora of Tropical East Africa*, Carter (in Carter & Radcliffe-Smith 1988: 495) points out that a number of species similar to *E. venefica* exist outside Africa (*Euphorbia quarad* Defl. in Yemen, and *E. nivalia* Buch.-Ham. and *E. neriifolia* L. in India). However, they are easily distinguished from *E. venefica*, *E. unispina* and *E. poissonii* by consistently possessing two spines on the spine-shields. *Euphorbia poissonii* and *E. unispina* are the only species truly similar to *E. venefica* in most characters.

When describing *E. unispina* using West African material from Togo (Kersting 569 and 573) and from Northern Nigeria (Dalziel 329), Brown (1911: 561) remarked how, in his opinion, the new species differed from *E. venefica*: “Closely related to *E. venefica* [= *E. venefica*] Trém. [sic!], but the spines are not flattened at the base, the leaves are different in form, more crisped on the margins and the styles longer, less united and more slender.” Brown must refer to flattening of the spine in the direction along the branches, as we have never observed any lateral flattening. However, we do not see any distinction between *E. venefica* and *E. unispina* in this character; the leaves appear above the spines, flattened spines are associated with well-developed leaves and the spines on parts of the stem with no leaves are not flattened. Concerning a difference in leaf form, it is true that throughout the range of *E. unispina* the leaves vary significantly in shape, from lanceolate with an acuminate apex to obtriangular with an emarginate and apiculate apex, but this variation also occurs in the East African material traditionally referred to *E. venefica* (see our Fig. 8). Our Ethiopian collection had both leaves with an acuminate apex and leaves with a truncate or emarginate-apiculate apex (Fig. 3). Another collection (Wickens 3090, K; Fig. 8C) from near the Nuba Mountains has emarginate-apiculate leaves. Narrowly lanceolate leaves have also been seen from Nigeria, for example in Hepper 1386 (Fig. 8G). In the apical part of lanceolate and acuminate leaves, the margin of the whole leaf is entire or only minutely crisped; while in apically truncate or obtriangular leaves nearly the entire length of the lamina may be finely crisped.

The obtriangular leaves with crisped margins are more frequently seen in West African material, but can also occur in East African specimens. Young leaves in South Sudan and Uganda may be linear and acuminate (Fig. 8F) or beginning to develop lobes at either side of the tip (Fig. 8J). Although the group consisting of *E. venefica* and *E. unispina* looks as if it has clinal variation in leaf-shape, with lanceolate leaves with entire margin in East Africa and obtriangular, truncate or emarginate-apiculate leaves with finely crisped margin in West Africa, we have noted young lanceolate leaves throughout the potential area of *E. venefica* and *E. unispina*. There is no clear discontinuity in this variation. Concerning the differences in the style, we have examined all available spirit material of this group at K, and do not see a distinction in the degree of fusion of the styles, given by N.E. Brown as a character differentiating *E. venefica* from *E. unispina*. None of these characters have a distribution that agrees with a distinction between a species in Sudan, South Sudan, Ethiopia, Uganda and northeastern Congo (*E. venefica*, Fig. 7A) and another species in West Africa with an eastern boundary in Chad, the Central African Republic and north-western Congo (*E. unispina*, Fig. 7B). In conclusion, we find that a distinction at species level between *E. venefica* and *E. unispina*, based on the characters proposed by Brown, is not tenable. The variation does not suggest a clear-cut infraspecific distinction either. We are not the first to suggest that *E. venefica* and *E. unispina* are conspecific. P.R.O. Bally suggested in 1959 on a determinavit slip attached to type-material of *E. unispina* at K (Kersting 573) that *E. unispina* was a synonym of ‘*E. venefica*’ [= *E. venefica*], but we cannot see that he ever published this conclusion.

Woodland species that reach from the Atlantic Ocean to the western escarpment of Ethiopia are not rare. A few examples are: *Terminalia schimperiana* Hochst. (syn.: *T. glaucescens* Benth.) and *T. leiocarpa* (DC.) Baill. (syn.: *Anogeissus leiocarpa* (DC.) Guill. & Perr.). See further examples in Friis & Sebsebe Demissew (2020). Yet, in very few cases the belt of woodland species is taken up not by one, but by a pair of closely related

species, which together form a continuous distribution from western Ethiopia to near the Atlantic Ocean. A division between two sister-species in northern Cameroon would agree with the barrier that has been formed by the extended Lake Chad during moist periods of the past (Bouchette et al. 2010). An example of a species pair split at Lake Chad is *Boswellia dalzielii* Hutch. (white flowers), reaching from Senegal and Mali to Cameroon, and *Boswellia papyrifera* (Caill. ex Delile) Hochst. (pink flowers) which reaches from eastern Nigeria and Cameroon to western Ethiopia, with a distribution in Sudan and South Sudan very similar to that of *Euphorbia venefica* (Lebrun & Stork 2011). However, no discontinuity in the morphological variation of *E. venefica* is seen in the areas on either side of northern Cameroon and Lake Chad.

J.-P. Essou (in Akoègninou et al. 2006: 565) listed *E. venefica* as a synonym of *E. unispina* and stated that *E. unispina* is a conserved species name. While searching the online edition of the International Code of Nomenclature for algae, fungi, and plants: Appendices I–VII (<https://naturalhistory2.si.edu/botany/codes-proposals/>) we did not find any proposal, let alone a decision, to conserve the name *E. unispina* over *E. venefica* when, as done here, the two taxa are considered conspecific.

3.3.2. Are the combined *E. venefica* - *E. unispina* and *E. poissonii* conspecific?

Pax's protologue of *E. poissonii* (Poisson & Pax 1902: 62), based on a now apparently lost collection from near the coast of Dahomey (now Benin), described the plant as an up to 2 m tall shrub with cylindrical stems up to 4 cm in diameter, with rhomboid podaria (swellings on the stems from which the leaves develop) without stipular spines and with dimorphic fleshy leaves; the terminal leaves are obtriangular with an emarginate-apiculate apex, the leaves lower on the stems are obovate-lanceolate with an obtuse apex; the cyathia develop among the terminal podaria on dichasia with short and fleshy branches. *Euphorbia poissonii* is not mentioned in the monograph of the African species of *Euphorbia* sect. *Diacanthium* by

Pax (1905). Brown (1911: 560), who based his opinion on additional collections from Ghana, Togo and Nigeria and on a living plant cultivated at Kew, accepts *E. poissonii*, pointing out that it is spineless and that the podaria (which he called tubercles) were scarcely visible on a live plant, but seemed more prominent on herbarium material. Chevalier (1933: 548-549), who had seen the plant in situ, also accepted *E. poissonii* as a species distinct from *E. venefica* and *E. unispina*; he found that the most distinctive feature was the absence of spines and he agreed with Brown that podaria or tubercles were hardly distinguishable on the branches of live plants, but visible on dried material. Keay (1958: 418-419) also maintained *E. poissonii* as a distinct species mostly without spines, but sometimes with solitary spines rudimentary or present only on young plants.

In his review of West African succulent species of *Euphorbia*, Newton (1992: 120) took up the discussion of distinguishing between *E. poissonii* and *E. unispina*. He rejected characters derived from the presence or absence of spines on the plants, pointing out that while observing the species in the field he had observed both spineless and spiny plants in any one population, and that young plants always had spines, which the present authors can confirm from notes on specimen labels. Apart from vague differences in the leaves, he decided to identify specimens with large and green cyathia as *E. poissonii* and specimens with small and red cyathia as *E. unispina*. Unfortunately, cyathia are rarely preserved in herbarium material (if present, then usually with faded colours), and in spirit material the colours are completely lost, so for colours we have to rely on the collectors' field notes, as quoted in section 3.4 on the taxonomy). On labels, it is often pointed out that the male flowers (i.e. filaments) are strikingly red, but no collector has mentioned that the cup-shaped cyathia are anything but green and the glands yellowish-green. Ralf Biechele photographed *E. poissonii* in Nigeria with cyathia and vegetative characters agreeing with our definition of that species (http://www.africanplants.senckenberg.de/root/index.php?page_id=78&id=692#image=26364).

Table 1. Diagnostic morphological features differentiating the spine-shield *Euphorbia* with cylindrical stems and spirally arranged single spines *E. venefica* and *E. poissonii*.

	<i>E. venefica</i>	<i>E. poissonii</i>
Spines	well developed and up to 8 mm long in adult plants, protruding from a rounded spine-shield, round or dorsal-ventrally flattened by a petiole above the spine	rudimentary or lacking on adult plants, but developed on young plants
Branching	with mostly spreading branches, which are up to c. 3.5 cm thick	candelabra-shaped, with soon upright branches, almost parallel with the main stem, branches 2.5-4.5 cm thick
Flowering branches	normally without a clearly distinguishable zone below the current flowering	mostly with clearly marked zones from previous flowering below current flowering
Leaves	with long-cuneate base, but very variable in the upper part, from lanceolate and long-acuminate to spatulate or inversed triangular, and then with truncate to deeply emarginate and apiculate apex	obovate, with long-cuneate base and widely emarginate, sometimes even bilobed, mucronate apex
Fruiting pedicel	usually less than 5 mm long	usually more than 5 mm long

The photograph shows green cyathia with yellow to orange glands and reddish female flowers. We can see no consistent differences in colour, size and shape between the cyathia of *E. poissonii* and *E. unispina*, nor can we see any difference in these characters between the West and East African material. Similarly, the inflorescences in both West and East African material are repeatedly forked dichasia with short branches and three to seven cyathia, rarely more.

Rauh et al. (1969: 218) concluded like this, after developmental morphological studies in the botanical garden in Heidelberg, Germany. “Although the different species [*E. poissonii*, *E. unispina*, *E. venefica* and the little known species *E. sapinii* and *E. darbandensis*] show a considerable variability in leaf shape and formation of spines, we cannot state any valid differences in structure and organization of the cymes and the cyathia. Furthermore, all the plants show similar growth forms. We propose, therefore, to consider the described species as varieties of one true species, *Euphorbia venenifica* [= *E. venefica*], which was first described by Trémaux. To finalise this, further investigations on living material will be necessary.”

In agreement with the conclusion of Rauh et al. (1969), Arbonnier (2004: 296) united all

three taxa under discussion here, but erroneously listed *E. venefica* and *E. unispina* as synonyms of *E. poissonii*, which is a later name than *E. venefica*.

In spite of the careful observations by Rauh et al., we find that there is morphological evidence for some kind of distinction between *E. poissonii* on one hand and *E. venefica* and *E. unispina* on the other, but we cannot decide with certainty if the differences are based on genetic factors or induced by variation in age, habitats and seasonality. With our present knowledge, we think that maintaining *E. poissonii* as a distinct species is the best solution, rather than reducing it to an infraspecific taxon as suggested by Rauh et al. The most workable characters are stated in Table 1 and shown by illustrations posted as stable images on the internet, which we refer to after the descriptions in the taxonomic review (section 3.4.).

3.4. Formal taxonomic review and identification of records

The two widespread species of spine-shield *Euphorbia* with spirally arranged single spines on cylindrical stems, *E. venefica* and *E. poissonii*, can be distinguished as shown in Table 1, although some characters do

sometimes overlap, and imperfect material consisting only of leaves or part of the stem may be impossible to identify. The nomenclature and typification of *E. venefica* follows the conclusions in 3.2. (*Euphorbia venefica* vs. *E. venenifca* – the correct original material, name and authority for our plant). The protologues and original material of two poorly known species, *E. darbandensis* and *E. sapi-nii*, are referred to at the end of this review.

***Euphorbia venefica* Trémaux ex Kotschy (1857: 173)**

Boissier (1862: 178). - Types: Sudan, Kordofan. “Frutex candelabrifomis, 4–5 pedes altus, aphyllus, in montibus Nubanorum Tira dictis frequens, rarior in planitie septentrionali montium Kodro [= Hedra] et Debatna, 5.1837,” Kotschy s.n. (W [W0078596], syntype). “Frequens in montibus Tira ubi lacte gummosa sagittae invenenatur. Inter Hedra et Debatna in savannis Nubanorum, 5.1837,” Kotschy s.n. (W [W0078599], syntype). The two collections are very similar and a lectotypification seems unnecessary.

E. mamillaris Trémaux (1853: Tab. 13-14), nom. Illeg., non L. (1753: 451, as ‘*E. mammillaris*’)

Types: Sudan, Upper Sennaar, Dar Foq [Fung], Jebel Kaçane, published lithographs in Trémaux (1853: Plate 13 [left plant] & 14 [left plant]), syntypes. A part of a sterile branch at P (P00540288) is in a later note on the specimen claimed to be an isotype (supposed to be part of Trémaux’s original material), but we have seen no further evidence for that claim.

Euphorbia venenifca ‘Trémaux ex Kotschy’, Schweinfurth (1862 & 1867: 36, 1873b: 351), orth. mut. (see 3.2).

Marno (1874: 253, 275); Lewin (1894: 125); Pax (1905: 64); Brown (1911: 562); Chevalier (1913: 267); Lewin (1923: 296, 298); Chevalier (1933: 549); Aubréville (1950: 178); Eggeling & Dale (1952: 128, Photo 20); Andrews (1952: 67); Cufodontis (1958: 461); Carter in Carter & Radcliffe-Smith (1988: 494); El Amin (1990: 132); Gilbert (1995: 334); Friis & Vollesen (1998: 167); Govaerts et al. (2000: 856); Lebrun & Stork (2006: 150, 151 [map]); Kalema & Beentje (2012: 55); Darbyshire et al. (2015: 221). - Types as for *E. venefica* Trémaux ex Kotschy.

E. unispina N.E. Br. (Brown 1911: 561).

Lewin (1923: 241); Chevalier (1933: 550); Holland (1922: 578); Aubréville (1950: 178); Keay (1958: 422); Brunel et al. (1984: 197); Newton (1992: 120); Akoëgninou (2006: 565); Lebrun

& Stork (2006: 150, 151 [map]); Thiombiano et al. (2012: 208); César & Chatelain (2019: 425). - Types: Togo, Loso, Kersting 569 (B, syntype, destroyed; K [K000252780], isosyntype); Nigeria, North Nigeria, Katagum District, Dalziel 329 (K, syntype).

Shrub or small tree, usually 2–5 m high. Normally with one, occasionally with a few stems from the base, sparsely branched, mostly with three branches at each point of branching, and sometimes branching again. The branches spreading to ascending, cylindrical, up to c. 3.5 cm thick on first or second years’ growth (base of branches, older branches and main stem thicker), whitish to pale green when fresh, grey to dark grey or brown when dried, soon developing a thin corky mantle around assimilating, succulent tissue, inside of which a cylinder of lignified tissue around a spongy pith. Branches that have flowered appear uniform, without clearly marked zones from previous flowering below the current flowering at the end of the branches. Spine-shields c. 1 cm apart, evenly distributed or sometimes in c. 8 spiral series, ovoid and longest in the direction of the growth of the branches to almost circular, 6–8 mm in diameter, with a single spine centrally on the shield. Spines robust, with the wide spine-base taking up almost the entire shield, abruptly or gradually tapering, c. 8(–14) mm long; spines deteriorate or fall off on older branches. Smaller prickles absent or very rare (we have not observed any, but according to Carter & Radcliffe-Smith (1988: 495) the spine-shields may occasionally have rudimentary prickles). Leaves only present at the tip of the branches, each leaf immediately above a spine-shield, and fall off by the end of the rainy season, lamina sessile or narrowing to a very short and hardly distinguishable pedicel, more or less fleshy when fresh, very variable in size and shape, from lanceolate to obovate or narrowly to widely obtriangular, 4–22 × 1–4 cm; base cuneate, apex long acute, truncate or (mainly in material from West Africa) broadly emarginate and apiculate, margin entire, straight, or often minutely crisped, particularly in young plants (this seems to be particularly prominent in material from West Africa). Cymes appearing near the tip of the branches before or at the beginning

of the rainy season, solitary, each immediately above an insertion of a leaf, unbranched, producing one cyathium, or normally forking once, producing three cyathia, according to the collection Bally E313 and to Carter & Radcliffe-Smith (1988: 495) sometimes twice, producing seven cyathia, and according to Rauh et al. (1969: 218) a third forking has been observed, producing 15 cyathia. Peduncles and cyme-branches very short or up to 5(–7) mm long; bracts lanceolate to broadly ovate or obovate, with rounded apex, c. $2.5 \times 2\text{--}4$ mm. Cyathia green, broadly campanulate, c. $2.5 \times 4\text{--}5$ mm, lobes c. 1 mm long, c. 1.5 mm wide, fimbriate; glands five, transversely oblong, rarely slightly widened at both ends (only seen in Hepper 3917), c. $1 \times 2\text{--}2.5$ mm, not concave, almost contiguous, yellow or yellowish green; lobes subcircular, 1–1.5 mm diameter. Male flowers with stamens up to 3.5 mm long, red, but colour not often recorded. Female flower with styles joined for 1–1.5 mm at the base, thickened and bilobed towards apex. Fruits on reflexed pedicels which elongate during ripening up to a length of c. 5 mm; capsule distinctly 3-lobed, c. 4 mm wide, c. 6 mm long, smooth and glabrous, greyish-green to greyish at maturity. Seeds subglobose, c. 2.5 mm in diameter, mottled, smooth.

Stable internet images: http://www.africanplants.senckenberg.de/root/index.php?page_id=78&id=699#image=7628, [image=65587](http://www.africanplants.senckenberg.de/root/index.php?page_id=78&id=699#image=65587), and [image=7629](http://www.africanplants.senckenberg.de/root/index.php?page_id=78&id=699#image=7629).

Mali / Burkina Faso: dans les rochers entre Sikasso [in Mali; $5^{\circ} 40' \text{ W}$, $11^{\circ} 19' \text{ N}$] et Bobo Dioulasso [in Burkina Faso; $4^{\circ} 18' \text{ W}$, $11^{\circ} 12' \text{ N}$], [mapped as $5^{\circ} 00' \text{ W}$, $11^{\circ} 00' \text{ N}$], 6.1899, Chevalier s.n. (P [P00535573]).

Burkina Faso: Arbuste à 3 m, ancienne jachère, entre Sourou [$1^{\circ} 53' \text{ W}$, $11^{\circ} 24' \text{ N}$] et Nébou [$1^{\circ} 53' \text{ W}$, $11^{\circ} 19' \text{ N}$], [mapped as $1^{\circ} 53' \text{ W}$, $11^{\circ} 21' \text{ N}$], 29.11.1973, Toutain 316 (P [P00535572]).

Niger/Chad [most likely in Niger]: Médictk [?, probably not a locality]. 1.1908, Guillard, du Rocha & Joubert [Mission Tilho] s.n. (P [P00576854]).

Ivory Coast: Plante 1–2 m très rameuse dès la base, entre les fentes des rochers, Touradougou, Hte Sassandra entre Soucouraba [$7^{\circ} 04' \text{ W}$, $10^{\circ} 07' \text{ N}$] et Samou [$7^{\circ} 00' \text{ W}$, $9^{\circ} 30' \text{ N}$], [mapped as $7^{\circ} 02' \text{ W}$, $10^{\circ} 00' \text{ N}$], 20.5.1909, Chevalier 21583 (P [P00576855, P00576856]).

Ghana: North Territory, near Navrongo [mapped as coordinates for hills north of town; $1^{\circ} 06' \text{ W}$, $10^{\circ} 56' \text{ N}$], 10.1938, Vigne FH 4616 (K).

Togo: Loso [$1^{\circ} 06' \text{ E}$, $9^{\circ} 46' \text{ N}$], 2.1902, Kersting 569 [cited from Keay 1958: 422]. 8 km north of Niamtougou [$1^{\circ} 05' \text{ E}$, $9^{\circ} 50' \text{ N}$], pass south of Défalé [mapped as $1^{\circ} 05' \text{ E}$, $9^{\circ} 52' \text{ N}$], 9.5.1978, Hakki, Leuenberger & Schiers 855 (B, K, P [P00576859]). Difale [$1^{\circ} 05' \text{ E}$, $9^{\circ} 52' \text{ N}$], 1907, Kersting 573 (B, destroyed; K [K000252779, K000252780], P [P00576858]). Mt. Kerkefua [?], 1–2 km from Kyehe [?], 3.1987, Brunel 10829 (TOGO [TOGO03252]).

Bénin: Savane arbustive, Atakora, Natttingou, Yarpao, $1^{\circ} 28' \text{ E}$, $10^{\circ} 18' \text{ N}$, 530 m, 17.1.2002, Akoègninou et al. 6138 (BENIN, WAG [WAG.1798874]). Arbuste 2 m, fleur rose, Atakora, Natttingou, Kota, galerie, $1^{\circ} 27' \text{ E}$, $10^{\circ} 13' \text{ N}$, 380 m, 24.2.2001, Akoègninou et al. 4354 (BENIN, WAG [WAG.1798875]). Kota [$1^{\circ} 27' \text{ E}$, $10^{\circ} 13' \text{ N}$], Sokpon 410 [cited from Akoègninou 2006: 565]. Atakora, Kopargo, Tanéka, c. $1^{\circ} 30' \text{ E}$, $9^{\circ} 52' \text{ N}$, 31.8.1999, Sinsin et al. 3257 (BENIN, WAG [WAG.1798876]). Arbuste, 1.5 m, $\varnothing$ 5 cm, rocher nu, granite, Sou, Save, Mt. Tané, sur granite, $2^{\circ} 28' \text{ E}$, $8^{\circ} 05' \text{ N}$, 30.3.2001, van der Zon 492 (WAG [WAG.1798878]). Succulent shrub, 2–3 m high, flowers greenish, Atakora, Natttingou, Tanéka to Koko, gallery forest on stony slopes, $1^{\circ} 31' \text{ E}$, $9^{\circ} 53' \text{ N}$, 460 m, 14.4.2001, van der Maesen et al. 7576 (BENIN, WAG [WAG.1798877]). Arbuste à 3 m, fleur jaunâtre, savane boisée saxicole, Atakora, Natttingou, Kotopounga, $1^{\circ} 34' \text{ E}$, $10^{\circ} 18' \text{ N}$, 27.4.2000, Houngron 7780 (BENIN, WAG [WAG.1798879]).

Nigeria: North Nigeria, Katagum [$10^{\circ} 21' \text{ E}$, $12^{\circ} 17' \text{ N}$], received 1908, Dalziel 329 (K). Kano [$8^{\circ} 31' \text{ E}$, $11^{\circ} 59' \text{ N}$], 28.3.1947, Bally E313 (K spirit 2616). Approximately one m tall, erect, succulent shrub with 2–3 ascending branches, 3–4 cm in diam., leaves linear-lanceolate, up to 20 cm long, 3–4 cm wide, cyathea green, male flowers red, Adamawa Division, Vogel Peak Area, River Kirimi (= Jiri) Valley, grassy hillside above River Kirimi, $11^{\circ} 50' \text{ E}$, $8^{\circ} 25' \text{ N}$, 1580 m, 16.11.1957, Hepper 1386 (K, K spirit 18938). Based on fieldwork, Rauh et al. (1969: 219) has recorded the species on dry sandstone outcrops surrounded by forest at Agnabode [$6^{\circ} 42' \text{ E}$, $7^{\circ} 06' \text{ N}$] near the River Niger.

Cameroon: Diaclases d'un mamelon rocheux, forme presque inerme, mêlée à d'autres individus épineux (plus jeunes ?), Gourya, 32 km SW du Mokolo, [$13^{\circ} 35' \text{ E}$, $10^{\circ} 37' \text{ N}$], 9.1.1965, Raynal 12907 (P [P05512781, P00576844], WAG [WAG.1798873]). Garoua [$13^{\circ} 24' \text{ E}$, $9^{\circ} 18' \text{ N}$], au pied du Mt. Tinguelin [$13^{\circ} 26' \text{ E}$, $9^{\circ} 26' \text{ N}$, mapped as this], 11 km nord de la ville,

12.12.1964, Raynal 12431 (P [P05602820, P00576843]). Dikwa District, Gwoza [Gwowa; 13° 40' E, 10° 29' N], January [no year], McClintock 142 (FHI [FHI0039013], K spirit 15803). North-East Cameroun, Rhumsiki [13° 36' E, 10° 29' N], single shrub, 19.11.1969, Hepper 3917 (K spirit 34485 & 27461). Shrub 1.5 m high, with short spines, flowers green, Pitoa, foot of Tinguilin, 13° 29' E, 9° 26' N, 7.2.1980, Wit & Geerling 3282 (WAG [WAG.1793739]). Roches granitiques, Mt. Mandara [mapped as this; 13° 23' E, 10° 04' N], 15 km NNO de Mokolo [13° 48' E, 10° 44' N], 1250 m, 16.9.1964, Letouzey 6952 (BR [BR0000016001459], P [P00576842]). Djengreng [15° 12' E, 10° 04' N] près Yagona ten ZO Marona, 15.4.1958, Letouzey s.n. (WAG [WAG.1793743]). Shrub to 1.2 m, stem spiny, stony hills in savanna, Garoua, Bauch-Yankari / Bauchi-Gombi cross roads, 10° 10' E, 10° 15' N, 24.1.1980, Wit & Geerling 3276 (WAG [WAG.1793741]). Bauchi State; Bauchi-Yankari/Bauchi-Gombi crossroads, 10° 10' E, 10° 15' N, 24.1.1980, Wit & Geerling 3277 (WAG [WAG.1793739]). Shrub to 2 m high, trunk 20–30 cm in diam., branches 2–4 cm in diam., spiny, cyathia green, dry grass savanna in mountains, North Region; km 6 on Roumsiki [13° 36' E, 10° 29' N] - Mogodé [13° 34' E, 10° 36' N] road, [mapped as 13° 35' E, 10° 33' N], 1200 m., 25.1.1966, Leeuwenberg 7562 (P [P00576841], WAG [WAG.1793744]). Arbuste, tiges cylindriques, Marona [?], 7.1945, Vaillant 47 (P [P00576845]). Arbuste bas (0.6–1 m), rameaux très épais, épinés 1 cm, Torok [mapped as this; 14° 33' E, 10° 03' N], 15 km south-east of Kaele [14° 41' E, 10° 06' N], 29.9.1977, Fotius 2846 (P [P00576867, P00576868]). Fleur jaune verdâtre, arbuste bas à tiges courtes et épaisses, ø 5 cm, Popologozom [mapped as this; 13° 42' E, 10° 04' N], 30 km South-East of Bourrah [13° 31' E, 10° 15' N], 9.12.1977, Fotius 2872 (P [P00576869]).

Central African Republic: Sur termitière, Moyen-Chari, Koulfé [?], Région du lac Iro [?], 6.7.1903, Chevalier 9247 (P, cited from Chevalier 1913: 267) & 9247bis (P [P00576847]). Sur termitières, Moyen-Chari, Baguirmé [?], 8.1903, Chevalier s.n. (P [P00576846]). Bouali [?], Mt. Guigouis [?], 10.1960, Guigonis 1969 (P00576848). Du Zaco et de Bacouma [mapped as this; 17° 27' E, 6° 09' N], 23.11.1922, Le Testu s.n. (P [P00576848]). Haute Kotto [23° 00' E, 7° 00' N], 2.2.1922, Le Testu s.n. (P [P00576850]). Haute Kotto [23° 00' E, 7° 00' N], 17.1.1922, Le Testu 3592 (P [P00576851, P00576852, P00576853]). Haut Chari, pays Ndouka et Kouti, Gouz-Amer [?] près Ndellé [20° 39' E, 8° 24' N], 2-12.5.1902, Chevalier 8289 (P [P00576373]) [cited as *E. sapinii* by Chevalier 1913: 267]. Moyen Chari, pays de Saras, entre Oulgou [Oulou: 22° 01' E, 10° 05' N] et Morroh [?], 2.6.1903, Chevalier 8595 (P [P04831722,

P00576374]) [cited as *E. sapinii* by Chevalier 1913: 267]).

Chad: Jachère à *Hyparrhenia dissoluta* (rônèraie claire), Balinga [15° 26' E, 10° 41' N], 6.10.1968, Fotius 1012 (P [P00576857]). Mayo-Kebbi, 5 km au N de Pala [14° 56' E, 9° 23' N]. 4.9.1984, Lisowski B-998 (BR [BR0000016011243]).

Democratic Republic of Congo: Ndue, Mt. Mukonza, 28° 59' E, 1° 50' N, c. 1300 m a.s.l., 5.1.1976, Lisowski 41932 (BR [BR0000016011434]). Bas-Uele, au N de Bondo, route Sambili-Lobo, km. 40 [mapped as 23° 43' E, 4° 22' N], 2.7.1978, Lisowski 49977 (BR [BR0000016001466]). Aketu Hill, 28° 48' E, 2° 05' N, 1060 m a.s.l., 4.3.1994, Gerau, Esulanji & Arubeni 5438 (MO, BR [BR0000016011427], WAG [WAG.1798830]).

South Sudan: “Lande der Djur”, Seriba Ghattas, [28° 32' E, 7° 26' N], 4.4.1869, Schweinfurth 1375 (B [destroyed], BM, K, P [P00576870, P00576871], W [W0078598]). “Lande der Djur”, Abu Gurun’s Seriba [28° 27' E, 7° 32' N], 11.5.1869, Schweinfurth 1827 (B [destroyed], BM, K, P [P00576872], W [W0078600]). “Lande der Djur”, Dokkuttu [29° 15' E, 5° 45' N], 14.1.1870, Schweinfurth 2829 (B [destroyed], BM, K (fragment), P [P00576872, P00576873], W [W0078597]). Zeriba Kuchuk Ali [28° 06' E, 7° 31' N], [no date], 1871, Schweinfurth s.n. (sight record and drawing by Schweinfurth at B, http://ww2.bgbm.org/schweinfurth/query.cfm?id=B_SZ_0000276). Hills at Idris Wod Daftar’s Zeriba [26° 13' E, 7° 40' N, 9-10.1.1871], sight record by Schweinfurth (1873b: 351; locality according to Wickens 1972: 145). Locally abundant tree to 20 ft. high, up to 4 inches in diam., when young covered with grey spines, cylindrical branches in whorls, inflorescences short, at tips of branches, dry grassland, Imatong Mountains, Nokolong, [33° 04' E, 3° 58' N], 4000 ft., 31.12.1935, Thomas 1897 (BM, K).

Uganda: Prickly succulent plant to 4 ft high, with single ascending stem and 2 or 3 whorls of side branches, each about 1 ft long and in 3s, almost leafless when collected, the whole plant spiny, South Imatong Mountains, Agoro Rest Camp [32° 59' E, 3° 48' N], no date, Egging 1209 (K). A stiffly, many-branched succulent tree up to 15 feet tall with cylindrical yellow green branches covered with simple spines, latex copious, sterile when collected, common, but scattered on dry stony hills in *Combretum-Terminalia* woodland, West Madi District, Leya [31° 35' E, 3° 35' N] and Ayu [30° 58' E, 3° 11' N], [mapped as 31° 40' E, 3° 25' N], at river junction, c. 4000 ft a.s.l., 25.3.1945, Greenway & Egging 7245 (K).

Sudan: Upper Sennaar: Dar Foq mountains, Kaçane, [34° 55' E, 11° 05' N, c. 890 m. a.s.l.], 1848, Trémaux s.n. (lithographs in Trémaux 1854, Plate 12 & 13; a sheet at P [P00540288] may possibly have been collected by Trémaux at this locality). Upper Sennaar, between Jebel Ghule [J. Guli; 33° 29' E, 11° 44' N] and Jebel Seneh, at Dull Roro [J. Roru; 33° 40' E, 11° 53' N], etc., [mapped as 33° 35' E, 11° 50' N], 6.1860, Hartmann s.n. (sight record and drawing reproduced as woodcut [Hartmann 1863: 517, Fig.25]; no collection preserved at B, probably destroyed). Upper Sennaar, Fazugli [near Ethiopian border; 34° 46' E, 11° 15' N, c. 1200 m], May 1848, Cienkowski s.n. (B, probably destroyed; no duplicates at LE or W). [Kordofan], frutex candelabrifomis, 4–5 pedes altus, aphyllus, in montibus Nubanorum Tira [30° 38' E, 11° 04' N] dictis frequens, rarior, in planitie septentrionali montium Kodro [first character not clear, perhaps = Hedra] et Debatna [?], 5.1837, Kotschy s.n. (W [W0078596]). [Kordofan]. Frequens in montibus Tira [30° 38' E, 11° 04' N] ubi lacte gummosa sagittae invenenatur. Inter Hedra [Jebel Hedra / Hadra: 30° 07' E, 11° 27' N] et Debatna [?] in savannis Nubanorum, 5.1837, Kotschy s.n. (W [W0078599]). Teggele Mountains, west of Gualik and Deri and northwest of Njukur and Turban, [mountains north of Rashad; mapped as 31° 03' E, 12° 10' N], Russeger and Kotschy (no specimen; notes and descriptions in Russeger 1844: 182–183). Shrub or small tree with grey bark and solitary spines, milky latex, inflorescence [cyathia] green, leafless when in flower, old leaves seen, oblanceolate, locally abundant by road between Dilling and Kadugli, west of road, 700–800 m [only one location fits this altitude, mapped at 29° 45' E, 11° 36' N], 28.1.1934, Dandy 319 (BM). 2–3 m high, growing on stony clays, Kordofan Province, [Jebel] Rashad [31° 05' E, 11° 52' N], 10.6.1969, Wickens 3090 (K).

Ethiopia (Southern Nations, Nationalities and Peoples Regional State (SNNPRS)): Succulent shrub or small tree to 3 m high, common in grassland along Omo River, Omo/Gibe IV hydroelectric project area, 7 km along the new road from Konta-Koyisha to Ameca and then along the old footpath from Konta-Koyisha to a ford on the Omo River; UTM coordinates [square 37N] 0736641N, 0232991E, [= 36° 35' 06" E, 6° 39' 30" N], 860 m a.s.l., 13.8.2015, Tesfaye Awas 2627 (ETH). Succulent shrub to c 2 m, the almost equally thick stem branches from base and higher up, 3 km north of new bridge and dam on Omo River, south of Koyisha village, 36° 33' E, 6° 36' N, 750 m a.s.l., 12.10.2018, Friis, Weber, Ergua Atinafe & Ermias Getachew 15889 (ETH, C [photo], K [photo]).

Uses and vernacular names: According to Burkill (1994; recorded as *E. unispina*), the caustic and vesicant latex of this species is used from the Ivory Coast to Sudan as a component in arrow-poisons (see also Lewin (1893; 1923) about the use in Sudan to poison other weapons) and is added to bait in traps. From the Ivory Coast to Nigeria it is used by medicine-men for various medicinal purposes, for example as an external vesicant on areas of leprosy, small-pox, chicken-pox, measles, etc. Uses in relation to magic have also been recorded from various parts of West Africa. The Konta people in south-western Ethiopia told Tesfaye Awas that they mix the latex of this plant with flour to make a poison that kills rats. The species is well known by a variety of names to the peoples of the areas where it occurs; Burkill (1994) records more than 25 different vernacular names in languages spoken from Senegal to Cameroon. From Sudan, Lewin (1923) recorded the Arab name "schedr e' simm", meaning "poisonous tree", and from the Fung-Hammeg people near the Blue Nile the name "Dinqil". Tesfaye Awas recorded the name "worza" from the Konta language of south-western Ethiopia.

Conservation assessment: As circumscribed here, the species is very widespread, but with scattered populations. Although the populations are of limited size and occur both on dry rocky outcrops and in woodland, they are mostly found in rocky localities, which are unsuitable for cultivation. The plants flower and have leaves in the wet season and do not seem to suffer from grass fires in the dry season, being protected by a thin, grey mantle of corky tissue, but the plants are slow growing. Rauh et al. (1969: 212) observed a growth of a few mm per year in cultivation, and even if growth is faster in nature, plants 2–5 m tall must have a remarkable age and be dependent on relatively undisturbed habitats. Although succulent growers desire to get plants of this species, the populations are so widely distributed that we do not see any immediate threat from this. We therefore propose the conservation assessment 'Least Concern' (LC).

Euphorbia poissonii Pax in Poisson & Pax (1902: 62)

Brown (1911: 560); Chevalier (1920: 552); Lewin (1923: 241); Chevalier (1933: 549); Holland (1922: 574); Aubréville (1950: 177); Keay (1958: 422); Irvine (1961: 230); Barad (1992: 35-37); Newton (1992: 120); Govaerts et al. (2000: 808); Arbonnier (2004: 296); Lebrun & Stork (2006: 130, 131 [map]); Lisowski (2009: 162); Thiombiano et al. (2012: 206); César & Chatelain (2019: 425 & photo on p. 329 – the plant in this photo has spiny stems as *E. venefica*). - Type: Benin, Dahomey, [no further locality], E. Poisson s.n. No herbarium material of Poisson's collection has been traced at B or P, and type material was not seen by Brown (1911: 560). According to Poisson in Poisson & Pax (1902: 61), material may have been preserved in liquid and sent to Pax for study in Breslau, but no such material has been encountered.

Shrub or small tree, usually 2–3(–5) m high. Normally with one stems from the base, sparsely branched, mostly with three branches at each point of branching, the branches rarely rebranched. Branches soon ascending and parallel with the main stem, cylindrical, 2.5–4.5 cm thick, whitish to pale green when fresh, grey when dried, soon developing a thin corky mantle around assimilating, succulent tissue, inside of which a cylinder of lignified tissue around a spongy marrow. Branches that have flowered with clearly marked zones from previous flowering below the current flowering at the end of the branches. Spine-shields numerous, but poorly developed, evenly distributed, or c. 8 spiral series can be distinguished, usually almost circular, 6–8 mm in diameter, usually without a spine or occasionally with a poorly developed, centrally placed single spine. Smaller prickles absent. Leaves develop during the rainy season, sessile or on 1–3 mm long pedicels, fleshy to chartaceous, usually obovate or narrowly to widely obtriangular or almost 2-lobed, 6–14 × 2–6.5 cm; base cuneate, apex rarely broadly acute, more often truncate or broadly to deeply emarginate with a small apiculum in the notch, margin rarely entire, often minutely crisped, particularly in young plants. Cymes solitary, developing immediately above the leaf or leaf-scar, unbranched or forking once, with peduncles and cyme-branches up to c. 5 mm long. Cyathia sub-

globular to shortly campanulate, c. 3 mm wide, 3–5 mm long, glabrous; lobes c. 1 mm long, c. 1.5 mm wide, fimbriate; glands five, transversely oblong, 2–2.5 × 3–3.5 mm, yellowish green. Male flowers: c. 5 mm long, said to be crimson. Female flower: styles 1.5 mm long, joined at the base, apices thickened. Capsules on a reflexed pedicel which elongate during ripening up to a length of 6–8(–10) mm; capsule 3-lobed, 5–6 mm in diam., smooth and glabrous, greyish-green at maturity. Seeds ellipsoid, c. 2.5 × 2 mm, light grey, mottled with a few irregular darker markings, smooth.

Stable Internet images: http://www.africanplants.senckenberg.de/root/index.php?page_id=78&id=692#image=26371, image=26365, image=26372, image=26368, and image=26369.

Guinée: [Without further locality], Pobeguini s.n. [cited from Keay 1958: 422; Lisowski 2009: 162].

Niger: [Without further locality], 13.11.1981, Boudouresque 5527 (K).

Burkina Faso: Bitou [0° 18' W, 11° 15' N], Toutain 2729 [cited from Lebrun et al. 1991: 84]

Ivory Coast: Mossi [?] and ? Gourma [?] [cited from Chevalier 1933: 549]. Treelet to c. 2 m high, stamens reddish, on granite hill, c. 25 km East of Gawi, 3° 35' W, 9° 00' N, 15.9.1967, Geerling & Bokdam 886 (BR [BR0000016001435], WAG [WAG.1793745]).

Ghana: [Without further locality], Anderson s.n. (K). Tamale, where cultivated, originally from coast north of Accra [not mapped], 4.1947, Bally 5192 (K). [Leaves only; certain identification not possible], Bujan to Bugoboi, 1927, Kitson 543 (K).

Togo: [without further locality], Kersting 88, 91, 574 [B, destroyed; cited from Keay 1958: 422]. [without further locality], Kersting 414 (B [B101013200] and two wood samples). Hügelzug mit steinigem Boden, lichter Monotes-Wald mit offenen Grasflächen, 9 km nördlich von Sokodé [1° 08' E, 8° 59' N], zwischen Pangalam [1° 09' E, 9° 02' N] und Koumoniadé [1° 08' E, 9° 04' N], [mapped as 1° 09' E, 9° 04' N], 20.4.1978, Hakki, Leuenberger & Schiers 296 (B, K). Buschwald, Bassar [0° 47' E, 9° 15' N], südlich der Stadt, 500 m, 22.4.1978, Hakki, Leuenberger & Schiers 383 (B, K). Felsiges Gelände, Alédjo [?], 21. 9. 1976, Ern et al. 819 (B, cited from Leuenberger 1979: 78). Felsige, zum Teil kultivierte Hänge, zwischen Alédjo-Kadara und Péwa, 1° 13' E, 9° 16' N, c. 700 m, 16.10.1977, Ern, Leuenberger, Scholz & Schwarz 1867 (B, K, P [P00576192]). Nördlich von Sokodé Aleheride [1° 12' E, 9° 13'

N], 2.10.1974, Mathey & Scholz 473 (B, cited from Leuenberger 1979: 78). [Brunel 236, 6609, 6610 are cited by Brunel et al. (1984: 197), but without localities].

Bénin: Dassa [?], Hougenon 1713 [cited from Akoègninou et al. 2006: 564]. Sovlèdji (Sovlègni), [1° 50' N, 7° 20' E], Essou 3138 [cited from Akoègninou et al. 2006: 564]. [Without further locality], Poisson s.n. [cited from Keay 1958: 422, presumably the missing type of *E. poissonii*]. [Without further locality], 2.6.1937, Lafitte 155bis (P [P00576840]). Haut-Dahomey, cercle de Savallou, à Bassila [1° 40' E, 9° 01' N], dans le village, [no date], Chevalier 23792 (P [P00576190]).

Nigeria: Cultivated in the arboretum, Ibadan [not mapped], 14.10.1963, Onyeachusim & Binyo FHI 47897 (K, FHI [FHI0047897]). Cuttings from the Ibadan plants cultivated and preserved at Kew, Keay s.n. (K spirit 35183). Kasaye [?] to Lom [?], 4.1. [no year; probably 1857-1859], Barter 1491 (K). Naliworks [?], Jos Plateau [9° 30' E, 10° 00' N], 21.12.1949, Monod 9707 (K). Bokkos [9° 00' E, 9° 18' N] to Jos Plateau [9° 30' E, 10° 00' N], [mapped as 9° 25' E, 9° 40' N], 17.12.1949, Monod 9706 (K). 44 miles from Katsina [?] towards Daura [?], 3.4.1950, Meikle 1370 (K & K spirit 22664). 36 miles on Ilorin [4° 33' E, 8° 30' N] – Jebba [4° 50' E, 9° 08' N] road, [mapped as 4° 44' E, 8° 50' N], 1.12.1949, Meikle 682 (K & K spirit 16752, P [P00576191]). Between Gwari Hill [interpreted as Birni Gwari; 6° 33' E, 10° 39' N] and Minna [6° 33' E, 9° 37' N], [mapped as 6° 33' E, 10° 24' N], Meikle s.n. (K). Lokoja [6° 44' E, 7° 48' N], Dalziel 917 (K spirit 22025). Bauchi Plateau [9° 30' E, 10° 00' N], near Jos, Batten-Poole FHI 12894 (K spirit 22028). Based on field work, Rauh et al. (1969: 219) has reported localities for this species 25 km east of Okene [6° 14' E, 7° 33' N] near the road Okene-Ajoakuta [6° 42' E, 7° 28' N], [mapped as 6° 28' E, 7° 31' E], and near Ukpilla [?].

Cameroon: Shrub to 1 m, stem 4.5 cm in diam., rather fleshy [no mentioning of spines and none to be seen on material], rocky area, near Rhumsiki, 13° 36' E, 10° 30' N, 9.2.1980, Wit & Geerling 3290 (WAG [WAG.1793738]). 15 km ouest de Meting, piste Matsare-Linte, 11° 55' E, 5° 22' N, 14-16.5.1979, Biholon 524 (P [P00576189]).

Uses and vernacular names: According to Burkill (1994), the uses of this species are similar to those of *E. venefica*, including the frequent use as a component in arrow-poison. However, the latex of *E. poissonii* is also recorded to be used sometimes as a pain-killer or laxative. Similar to the use of the latex of *E. venefica* to kill rats, as recorded by

Tesfaye Awas, this species is used as a general rodenticide. It is also used to kill other mammals and birds, in poison baits or as a fish-poison. Unlike *E. venefica*, this species is reported to be cultivated or partially tended in villages as an ornamental or as a fetish, as stated generally for its entire West African distribution by Stäuble (1986) and documented with a photograph from Togo by Newton (1992). Burkill (1994) quotes 25 vernacular names in West African languages from Mali to Nigeria; some of these are similar to those recorded for *E. venefica*.

Conservation assessment: As for *E. venefica*, 'Least Concern' (LC).

Euphorbia darbandensis N.E. Br. (1913: 1040)

Chevalier (1913: 266); Chevalier (1933: 552 & Planche 8 on p. 551); Govaerts et al. (2000: 708); Lebrun & Stork (2006: 92). Type: [Central African Republic], Haute Chari, brousse sèche, plateaux ferrugineux, Dar Banda, ça et là entre le Bamingui [?] et le Bangoran, [7° 00' N, 20° 30' E], 6.12.1902, Chevalier 6699 (K [K000252782, K000252783], P [P00540214], isosyntypes). Plante cactiforme, haute de 0.15 à 0.40 m; latex blanc, très caustique, donne de la résine, Haute Chari, Dar Banda, district de Bangoran [20° 40' E, 7° 55' N], 10.12.1902, Chevalier 6752 (P [P00540211], syntype). Haute Chari, Dar Banda, Pays de Senoussi, entre le Boro [?] et Ndélé [20° 30' E, 7° 00' N], 3.1.1903, Chevalier 7162 (P [P00540215], syntype).

Central African Republic: Material insufficient; only known from the type material.

Euphorbia sapinii De Wild. (De Wildeman 1908: 290)

Chevalier (1933: 552); Govaerts et al. (2000: 824); Lebrun & Stork (2006: 138). Type: [Democratic Republic of Congo, Kasai], brousse de Madibi [4° 18' S, 18° 24' E], 2.7.1906, Sapin s.n. (BR [BR0000008893703], holotype). Democratic Republic of Congo: Material insufficient; only known from the type material.

3.5. Distribution in major African vegetation-types and phytogeographical discussion

We superimposed the distribution of this entire group of succulent spine-shield *Euphorbia* with cylindrical stems and spirally arranged single spines on UNESCO'S

Table 2. Climatic ranges modelled with DIVA-GIS (based on data from BioClim 30 s).

	Number of obser- vations	% within envelope	Range of mean annual temperature (°C)	Most fre- quent tem- perature interval (°C)	Range of mean annual rain- fall (mm)	Most fre- quent rain- fall interval (°C)	Rainfall in driest quarter (mm)	Rainfall in wettest quarter (mm)
<i>E. venefica</i>	46	83	22.5-28.0	25.5-27.0	700-1600	650-1350	0-50	550-750
<i>E. poissonii</i>	15	87	23.0-28.0	25.0-27.0	900-1500	850-1250	0-28	500-700
All species	61	90	22.5-28.0	25.0-27.0	700-1600	650-1350	0-50	500-750

vegetation map of Africa (Fig. 9). The vegetation belts in which most records of our species of *Euphorbia* occur are the ones marked as 20-41, which are various types of woodland that cover a belt from the Atlantic Ocean to the foothills of the Ethiopian highlands and surround the moist edaphic grasslands in the Nile Valley and large river valleys elsewhere. A few records, both of *E. venefica* and *E. poissonii*, enter the Guinea-Congolia/Sudania regional transition zone (on Fig. 9 marked as 11-18, 'Mosaics of lowland forests and woodlands and secondary grasslands'). Field notes indicated that these records are based on collections from rocky outcrops, e.g. along the Niger River or tributaries to the Congo River. Two records of *E. venefica* from the north-eastern Democratic Republic of Congo occur within the Guineo-Congolian rain forest (on Fig. 9 marked as 1-10, 'Lowland rainforest, ...'), but field notes show that these collections too are from rocky outcrops.

Recent palaeoecological studies in the Sudanian zone of woodlands and wooded grassland, e.g. Salzmann et al. (2002), demonstrate relative floristic stability within the Sudanian zone, but also how at least since Pleistocene, humid and arid periods have alternated, causing the zone to oscillate in a north-south direction. These climatic changes have also caused changes in the water table of the lakes in the West African lowlands, particularly Lake Chad, and the swamps and flooded areas with grasslands in the Nile Valley (in Fig. 9 both areas are marked as 60-64, 'Moist edaphic grasslands ...'). As mentioned and documented with examples in 3.3.1, woodland species that reach from the Atlantic Ocean to the western escarpment of Ethiopia are not rare, but

the eastern limit at Lake Chad of *E. poissonii* as defined here agrees with the pattern of distribution of *Boswellia dalzielii* mentioned in 3.3.1.

Tolerant species in the Sudanian zone, among which are many of the dominant woodland trees and a large number of herbaceous species, are widespread within the zone, and many range from its western to its eastern border, but other widespread species show considerable gaps in their distribution area. A species occurring on hillslopes in West Africa and South Sudan, but with significant gaps in its known distribution, may provide a parallel to the distribution of *Euphorbia venefica*. Friis & Vollesen (1999) showed that *Drimia sudanica* Friis & Vollesen (Asparagaceae subfamily Scilloideae, formerly Hyacinthaceae) occurs in Sierra Leone, Guinée and South Sudan on the slopes of hills with frequently burnt deciduous woodlands and wooded grasslands. The large gap in the distribution between West Africa and South Sudan, much bigger than the gaps in the distribution of *Euphorbia venefica*, may be explained by undercollecting or may reflect the absence of suitable hillslopes in the areas in between the known localities. Another reason for gaps in the distribution of species, which do not tolerate moist ground, could be the extensive flooding during humid periods in the basins of Lake Chad and the Niger and in the Nile Valley (the Sudd in South Sudan). Flooded areas, particularly the Nile Valley, are avoided by *Euphorbia venefica*.

Rauh et al. (1969) suggested that the seeds of the Sudanian succulent species of *Euphorbia* have not been dispersed by birds, but, although they require a high temperature and relatively high humidity during their

active growth periods, they must have reached their present suitable localities during a former period with a climate different from now, probably drier. The fact that at least one species of the group of shrub-like succulent spine-shield *Euphorbia* with cylindrical stems and spirally arranged single spines has reached across Africa, almost from the Atlantic coast to western Ethiopia, is therefore unusual in the genus. There are very many local species in the genus *Euphorbia* in Africa, which suggests that long distance dispersal is not common (M.G. Gilbert pers. com.). From what we know about the seasonality of leaves and flowers of *E. venefica*, it seems necessary that, in order to allow expansion of the species, the climate does not only need to have been generally drier than now, but must also have had a marked contrast between a dry and a moist season as indicated for the present climate in Table 2.

Responsibility of authors

Tesfaye Awas and Odile Weber discovered independently specimens of *Euphorbia venefica* in Ethiopia. All authors have taken part in the recording of information about the plant and its environment. Odile Weber (<https://orcid.org/0000-0002-0861-2752>) and Ib Friis (<https://orcid.org/0000-0002-2438-1528>) recorded information on the material from outside Ethiopia and wrote the paper.

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