Addressing the *Vepris verdoorniana* complex (Rutaceae) in West Africa, with two new species

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**Summary.** *Vepris verdoorniana* (Rutaceae) has long been regarded as a widespread and variable species occurring from Guinea to Gabon. Recent evidence has shown that the original material from the type locality in Cameroon consists of two different species, *V. verdoorniana* in the strict sense, endemic to Lower Guinea (Cameroon, Gabon and C.A.R. in W-C Africa) and *V. letouzeyi* Onana, which was thought to occur from Guinea to Cameroon. In this paper we show that the West African (Upper Guinea) material previously referred to as *V. letouzeyi/V. verdoorniana* is separate morphologically from that in Cameroon (Lower Guinea). In fact the West African material referred to comprises two distinct species, here described as *V. occidentalis* Cheek & Onana (Guinea to Ghana, but probably extending to Benin) a tree of lowland marginal dry evergreen and semi-deciduous forest, and *V. fer* Cheek, a species restricted to four mainly lower submontane forest locations on iron substrates in Liberia and Sierra Leone (also Upper Guinea). *Vepris occidentalis* is here assessed as Least Concern due to its wide range and high frequency, whilst *V. fer* is assessed as Endangered due to the low number of locations and threats from iron ore mining projects. Both new species are illustrated and mapped.

**Key Words.** Arcelor Mittal, conservation assessments, endangered, Gola, iron substrate, mining natural products, *Teclea*.

**Introduction**

*Vepris* Comm. ex A.Juss. (Rutaceae-Toddalieae), is a genus with 86 accepted species, 22 in Madagascar and 65 in Continental Africa with one species extending to Arabia and another endemic to India (Plants of the World Online, downloaded 25 May 2018). Four new species were recently described from Cameroon (Onana & Chevillotte 2015; Cheek et al. 2018a) and one more is in press (Onana et al. 2019), taking the total in Cameroon to 22 species, the joint highest number for any country. Many of these 22 species are endemic to western Cameroon (SouthWest Region and NorthWest Regions of Cameroon) and several are threatened (Onana & Cheek 2011). Western Cameroon is the most species-diverse area for vascular plants per degree square in tropical Africa and contains several refugia areas (Barthlott et al. 1996; Cheek et al. 2001).

In continental Africa, *Vepris* are easily recognised. They differ from all other Rutaceae because they have digitately (1 – 3) (–5)-foliolate (not pinnate) leaves, and unarmed (not spiny) stems. The genus consists of evergreen shrubs and trees, predominantly of tropical lowland evergreen forest, but with some species extending into submontane forests and some into drier forests and woodland. *Vepris* species are often indicators of good quality, relatively undisturbed evergreen forest since they are not pioneers (Cheek, Onana pers. obs. 1992 – 2016).

Species of *Vepris* in Africa extend from South Africa, e.g. *Vepris natalensis* (Sond.) Mziray, to the Guinean woodland in the fringes of the Sahara desert (*V. heterophylla* (Engl.) Letouzey). Mziray (1992) subsumed the genera *Araliopsis* Engl., *Diphasia* Pierre, *Diphasiopsis* Mendonça, *Oricia* Pierre, *Teclea* Delile, and *Toddaliopsis* Engl. into *Vepris*, although several species were only formally transferred subsequently (e.g. Cheek et al. 2009; Onana & Chevillotte 2015). Mziray’s conclusions were confirmed by the molecular phylogenetic studies of Morton (2017) but sampling was limited, identifications appeared problematic (several species appear simultaneously in different parts of the phylogenetic trees) and more molecular work would be desirable. Morton studied about 14 taxa of *Vepris,*
mainly those from eastern Africa. Nevertheless, characteristics of some of the former genera are useful today in grouping species. The “araliopsoid” species have subglobose, 4-locular fruit with 4 external grooves; the “oricioid” species are apocarpous in fruit; the fruits of “diphiasoid” species are laterally compressed in one plane, bilocular and bilobed at the apex; while “teclooid” species are unilocular in fruit and 1-seeded, lacking external lobes or grooves. There is limited support for these groupings in Morton’s study.

Due to the essential oils distributed in their leaves, and the alkaloids distributed in their roots, several species of Vepris have traditional medicinal value (Burkill 1997). Burkill details the uses, essential oils and alkaloids known from 5 species in west Africa: V. hiernii Gereau (as Diphasia klaineana Pierre), V. suaveolens (Engl.) Mziray (as Teclea suaveolens Engl.), V. afzelii (Engl.) Mziray (as T. afzelii Engl.), V. heterophylla (Engl.) Letouzey (as T. sudanica A.Chev.) and V. verdoorniana (Exell & Mendonça) Mziray (as T. verdoorniana Exell & Mendonça) (Burkill 1997: 651 – 653). Research into the characterisation and antimicrobial and anti-malarial applications of alkaloid and limonoid compounds in Vepris is active and ongoing, although sometimes published under generic names no longer in current use, e.g. Wansi et al. (2008). Applications include as synergists for insecticides (Langat 2011). Cheplogo et al. (2008) and Imbenzi et al. (2014) respectively list 14 and 15 species of Vepris that have been studied for such compounds.

The most recent revision of the African Toddalieae was by Verdoorn (1926), who recognised 49 taxa in the genera now included in Vepris. Her revision underpinned subsequent Flora accounts. In the account for Conspectus Florae Angolensis, Exell & Mendonça (1951) evidenced that she had mistakenly attributed the name Teclea grandifolia Engl. (now Vepris grandifolia (Engl.) Mziray) for which the type is Angolan, to another, undescribed species diagnosed by pedicellate flowers and axillary inflorescences, for which they published the new name T. verdoorniana Exell & Mendonça. Verdoorn (1926) had cited three specimens for her “Teclea grandifolia” from Cameroon (Staudt 472, 493 and Mildbraed 9234) and one from Sierra Leone (Barter s.n.). Exell & Mendonça (1951) selected one of these, Staudt 472 (K) as type. In the second edition of Flora of West Tropical Africa, Keay (1958) recognised three species of Teclea in West Africa, separating T. verdoorniana from T. afzelii Engl. and T. sudanica A.Chev. (now V. heterophylla) by the possession of inflorescences both axillary and terminal, hairy, to 4 cm long, (vs all axillary, glabrous, to 2.5 cm long), petioles often winged and leaflets sessile (vs non-winged, leaflets petiolulate). Letouzey followed this delimitation in Flore du Cameroun (1963) and pointed out that the Mildbraed specimen is from C.A.R.

Onana & Chevillotte (2015) showed that since Verdoorn (1926), authors had unwittingly included more than one species in Vepris verdoorniana. Onana & Chevillotte (2015) linked Staudt 493, which has winged, not terete petioles, with additional specimens from Southwest Region Cameroon and described them as V. letouzeyi Onana, showing that it is a diphiasoid, not a tecleoid species. They gave V. letouzeyi the range formerly attributed to V. verdoorniana, i.e. Guinea to Gabon, that is occurring in both Upper Guinea (Guinea to Ghana) and Lower Guinea (Nigeria to Congo Republic).

These two phytogeographic units are separated by the Dahomey Gap (see e.g. Demenou et al. 2017). Vepris verdoorniana, differentiated among other characters by terete petioles and based on the type Staudt 472, was now shown to be restricted to the Cameroon coastal plain (Onana & Chevillotte 2015), Bioko, Gabon and C.A.R.

However, comparison of the West African (that is, Upper Guinea) material attributed to, or attributable to, Vepris verdoorniana by the definition of Keay (1958) shows that it is morphologically separate from both V. verdoorniana and V. letouzeyi of Lower Guinea. The Upper Guinean (Guinea to Ghana, possibly Benin) winged-petiole material considered to be V. letouzeyi in Onana & Chevillotte (2015) is a different taxon, named below as V. occidentalis. Further, a second undescribed taxon is present in Upper Guinea, which had also been included in Teclea verdoorniana by Keay (1958). The species represented by Barker 1181 (K!) has opposite leaves, nearly glabrous inflorescences and very large, pitted fruits. It occurs in the Gola Forest of Sierra Leone near the border with Liberia and in Liberia at the southern end of Mt Nimba and in the Putu Hills. This species is here termed V. fer Cheek.

Here we present a key and table of characters (Table 1) separating the taxa of the Vepris verdoorniana complex based largely on morphology. We also present a key and table of characters (Table 2) to all the teclooid (unilocular) West African (Upper Guinean) species and present a synopsis of the species with descriptions, illustrations and conservation assessment of the two new species to science.

Approximately 2000 new flowering plant species are described each year (Willis 2017), adding to the estimated 369,000 already known to science (Nic Lughadha et al. 2016) although this total is disputed (Nic Lughadha et al. 2017). Evidence based conservation assessments exist for about 21 – 26% of these species, and 30 – 44% of these assessments rate the species concerned as threatened (Bachman et al. 2018). Widespread species tend to have already been discovered, so that many newly discovered species are those that are range-restricted and so more likely to be threatened, e.g. Vepris bali Cheek (Cheek et al. 2018a). This makes it imperative to discover and
publish such species so that they can assessed, and, if merited, conservation actions taken to reduce their extinction risks, such as through designating and implementing Important Plant Areas (Darbyshire et al. 2017).

Materials and Methods

This study is based on herbarium specimens. All specimens seen by the authors are indicated "!". Herbarium citations follow Index Herbariorum (Thiers continuously updated), nomenclature follows Turland et al. (2018) and binomial authorities follow IPNI (continuously updated). Material of the suspected new species was compared morphologically with material of all other African Vepris, principally at K, but also using material and images from BM, BR, FHO, G, GC, HNG, P and YA. Specimens at WAG were unavailable during the period of study due to building work, and but low resolution images of specimens were viewed on the Naturalis website (https://bioportal.naturalis.nl/). Specimens referred to in Aké Assi (2001) are held privately in Ivory Coast and are not accessible at present. The main online herbarium used during the study apart from that of WAG was that of P (https://science.mnhn.fr/all/search). Points were georeferenced using locality information from herbarium specimens. The map was made using ArcMap version 10.5, with additional layers showing protected areas (IUCN & UNEP-WCMC 2017) and lakes (Esri 1992). The conservation assessment was made using the categories and criteria of IUCN (2012). Herbarium material was examined with a Leica Wild M8 dissecting binocular microscope fitted with an eyepiece graticule measuring in units of 0.025 mm at maximum magnification. The drawing was made with the same equipment using a Leica 308700 camera lucida attachment.

Results

We present tables and keys separating the two new taxa from those with which they have previously been included. The species treatments that follow are presented in the order of the taxa in Table 1 above, beginning with Vepris verdoorniana under which name all four taxa treated in this paper were previously known (hence the “Vepris verdoorniana complex”, followed by V. letouzeyi, recently segregated from the former, followed by the two new species.

Table 1. Characters distinguishing the species of the Vepris verdoorniana complex (data for V. verdoorniana sensu stricto and V. letouzeyi from Onana & Chevillotte 2015).

| Characters                        | Vepris verdoorniana | Vepris letouzeyi | Vepris fer | Vepris occidentalis |
|----------------------------------|---------------------|------------------|------------|---------------------|
| Geography                        | Cameroon, Bioko, C.A.R., Gabon | SW Region | Cameroon | Sierra Leone & Liberia |
|                                  | terete (rarely slightly canaliculate) | canalicate | canalicate | canalicate |
| Gland dots on lower surface of leaflets observed with naked eye | fine black dots, conspicuous | fine black dots, conspicuous | fine black dots, conspicuous | dots concolorous with blade, not conspicuous |
| Stamen number                     | 4                   | 8                | 4          | 4                   |
| Carpel number                     | 1                   | 2                | 1          | 1                   |
| Fruit shape & dimensions (cm)     | narrowly ovoid      | bilobed          | ellipsoid  | ovoid-ellipsoid     |
|                                  | 1.2 × 0.4           | 2 – 2.75 × 1 – 1.5 | (0.6 – 1.1 – 1.5 × (0.4 – 0.5 – 0.6 – (0.8) | 0.4 – 0.8 (– 0.9) × |
| Phyllotaxy                        | alternate           | alternate        | opposite   | alternate           |
|                                  | (rarely subopposite at some nodes) | opposite (rarely alternate) | | |
| Inflorescence indumentum          | densely yellow pubescent | densely yellow pubescent | inconspicuously and sparsely yellow hairy | densely yellow pubescent |

Table 2. Characters distinguishing the West African (Guinea to Ghana) tecleoid (unilocular) Vepris species.

| Characters                        | Vepris afzelii | Vepris heterophylla | Vepris fer | Vepris occidentalis |
|----------------------------------|---------------|---------------------|------------|---------------------|
| Phyllotaxy                        | alternate     | alternate           | fully opposite (rarely alternate) | alternate |
|                                  | terete        | to 2.5              | canalicate | laterally winged    |
| Inflorescence length (cm)         | 0.7 – 0.8     | 0.8 – 0.9           | 2.4 – 5.4  | to 3.6              |
| Inflorescence indumentum          | glabrous      | glabrous            | sparsely hairy | densely hairy      |
|                                  | petiolulate   | petiolulate         | sessile    | sessile             |
| Leaflets petiolulate or sessile   |              |                    |           |                     |
| Fruit length (cm)                 | 0.7 – 0.8     | 0.8 – 0.9           | (0.6 –) 1.1 – 1.5 | 0.6 – 0.8 (– 0.9) |
Key to the species of the *Vepris verdoorniana* complex

1. Petiole terete, not (rarely slightly) canaliculate or winged; fruits narrowly ovoid with persistent style
   - 1. Vepris verdoorniana

1. Petiole winged or canaliculate; fruits ellipsoid or bilobed, lacking persistent style
   - 2. Vepris occidentalis

2. Petioles laterally winged; leaflets with oil glands not visible to the naked eye on the abaxial surface (concolorous); fruits 0.8 cm long
   - 4. Vepris occidentalis

2. Petioles canaliculate, without lateral wings; leaflets with oil glands visible with naked eye as black dots on abaxial surface; fruits 1.1 – 2.75 cm long
   - 3. Vepris fer

3. Leaves opposite (rarely alternate); inflorescence sparsely and inconspicuously hairy; fruit ellipsoid 1.1 – 1.5 × 0.5 – 0.6 cm; stamens 4
   - 3. Vepris fer

3. Leaves alternate; inflorescence densely yellow pubescent; fruit bilobed 2 – 2.75 × 1 – 1.5 cm; stamens 8
   - 2. Vepris letouzeyi


Key to the tecleoid (unilocular) species of West African *Vepris*

1. Petioles laterally winged; inflorescences densely hairy
   - Vepris occidentalis

1. Petioles terete or canaliculate; inflorescences glabrous or sparsely hairy
   - 2. Vepris letouzeyi

2. Leaves fully opposite (rarely alternate); leaflets sessile; inflorescence sparsely hairy; fruit > 1 cm long, pits, deep, conspicuous
   - Vepris fer

2. Leaves alternate; leaflets petiolulate; inflorescence glabrous; fruit < 1 cm long, pits absent or inconspicuous

3. Petioles canaliculate; young stems and inflorescences drying black; plants of humid, submontane forest
   - Vepris afzelii

3. Petioles terete; young stems and inflorescences drying pale brown or grey; plants of dry, wooded grassland
   - Vepris heterophylla

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Synopsis of the species of the *Vepris verdoorniana* complex

1. *Vepris verdoorniana* (Exell & Mendonça) Miziry (1992: 76); Heller & Cheek in Cheek et al. (2004: 396). Type: Kamerun, Johann Albrechtshöhe (now Cameroon, Kumba), fl. 1896, *Staudt* 472 sheet 2 (lectotype formally designated here, K000094280!).
   - *Teclea verdoorniana* Exell & Mendonça (1951: 270);
     - Letouzey (1963: 118); Keay (1958: 689)

**DISTRIBUTION.** Cameroon, Gabon, C.A.R., Bioko.

**HABITAT.** Lowland evergreen forest.

**CONSERVATION STATUS.** Provisionally assessed here as Near Threatened since c. 12 locations are known, the area of occupancy is estimated as 48 km² (using the 4 km² cells recommended by IUCN 2012) with threats being the clearance of forest habitat at seven or eight of those locations.

**ETYMOLOGY.** Named in honour of Inez Clare Verdoorn (1896 – 1989), South African botanist noted for her numerous taxonomic revisions.

**LOCAL NAMES.** None known.

**LOCAL USES.** None known.

**NOTES.** The type number indicated by Exell & Mendonça (1951), *Staudt* 472, K, consists of two sheets each with a different species. That labelled sheet 2 (K000094280!) is selected here as the lectotype of *Vepris verdoorniana* since, having e.g. terete petioles, it is consistent with the concept of *V. verdoorniana* in the sense of Onana & Chevillotte (2015), while sheet 1 (K000094281!) has short, winged petioles and appears to be *V. letouzeyi*, a species already known to have been collected at the same location by the same collector (*Staudt* 493).

2. *Vepris letouzeyi* Onana, in Onana & Chevillotte (2015: 117). Type: Cameroon, Southwest Region, Mundemba, Fabe Rd, fr. 22 Nov. 1986, Nemba & Thomas 335 (holotype YA0060230!; isotype MO).

**DISTRIBUTION.** Southwest Region, Cameroon.

**REPRESENTATIVE SPECIMEN EXAMINED.** CAMEROON, Southwest Region, Kumba “Kamerun, Johann Albrechtshöhe” [now Cameroon, Kumba], fl. 1896, *Staudt* 493 (K000094288!).

**HABITAT.** Lowland evergreen forest.

**CONSERVATION STATUS.** Endangered B2 ab(iv) since three locations are known, none of which are in protected areas, and all are near towns or villages and so at risk of clearance for small-scale agriculture (pers. obs. Cheek 2006). Area of occupancy is estimated as 12 km² using the standard IUCN preferred 4 km² cells.
ETYMOLOGY. Commemorating René Letouzey, founder of the Étude de la Flore du Cameroun programme, Flore du Cameroun series and the National Herbarium of Cameroon (Onana et al. 2017).

LOCAL NAMES. None known.

LOCAL USES. None known.

NOTES. Staudt 493, assigned to this species by Onana & Chevillotte (2015), was amongst the original material of Vepris verdoorniana (see above under that species and in introduction). Here we also assign sheet 1 of Staudt 493 to this species (see under V. verdoorniana above).

The protologue indicates that this species has 8-stamened male flowers and bilocular, apically bilobed fruits, characteristic of the “diphasoid” Vepris species, completely distinct from the 4-stamened, 1 locular, non-lobed “tecledol” species that comprise the rest of the Vepris verdoorniana complex.

3. Vepris fer Cheek sp. nov. Type: Sierra Leone, Kenema Dist., Ganta Chiefdom, Gola Forest Reserve, fl. fr. 23 April 1965, Fox 124 (holotype K000875068!; isotype SL n.v.).

http://www.ipni.org/urn:lsid:ipni.org:names:77198957-1

Teclea verdoorniana sensu Keay (1958: 689) pro parte quoad Barker 1181 (K!); sensu Adam (1975: 1494, fig 771).

 Dioecious (probably) tree or shrub. 7 – 9 m tall, circumference (girth) to 30 cm. Trunk features unknown. Leaffy stems terete, 2.5 mm diam., internodes 1.8 – 10 cm long, pale grey-brown, with sparse longitudinal ridges and scattered, slightly raised, elliptic or orbicular lenticels (0.25 – 0.4 – 0.75 (– 0.9) × (0.2 – 0.4) – 0.5 mm, becoming most conspicuous in the second and third internodes from the apex, glabrous. Leaves opposite (rarely alternate — part of one short fruiting stem on Fox 124, K), trifoliolate, petioles canaliculate, 2.2 – 4.5 (– 7) × 0.1 cm, glabrous, slightly swollen at base. Leaflets oblong-elliptic or elliptic, subequal, the lateral leaflets 2/3 to the same length as the median; median 6.9 – 16.6 × 2.5 – 6.9 cm, laterals 6.5 – 13.5 × 2.4 – 4.5 cm; acumen 0.8 – 1.8 × 0.28 – 0.45 cm, apex rounded; base of leaflet subsessile gradually decurrent into an indistinct, narrowly winged petiolo (0.2 – 0.5 – 0.6 (– 0.75) cm long. Lateral nerves 11 – 15 on each side of the midrib, arising at c. 80° from the midrib, connecting towards the margin and forming a looping inframarginal nerve, sometimes with a further, weak parallel nerve between the margin and the looping secondary nerve; intersecondary nerves 1 (– 3) between and parallel, each pair of secondary nerves, connecting with the marginal nerve, almost as thick as the secondary nerves; tertiary and quaternary nerves conspicuous, raised, forming a loose reticulum; oil glands visible to the naked eye on lower surface, black, 0.125 mm diam., 600 – 1100 per cm², both surfaces glabrous.

Inflorescence axillary, 70 – 100-flowered, subtended by leaves, often caducous, 2.4 – 5.4 cm long, axis very sparsely and inconspicuously hairy, hairs 0.05 mm long, patent. Peduncle (1 – 7) 17 – 17 mm long, sometimes branching from near the base; bracts narrowly oblong, densely yellow-hairy, 0.6 – 1 mm long. Pedicel terete, glabrous, 1 – 1.5 mm long, accrescent in fruit, (0.3 – 0.5 (– 0.8) × 0.1 – 0.15 cm. Male flowers cream-coloured or greenish-white, c. 2.5 × 3 mm at anthesis; calyx shallowly cup-shaped, 0.2 – 0.3 × 1.2 mm, with 4 shallow, broadly triangular lobes c. 0.2 × 0.7 mm, glabrous, oil glands not conspicuous. Petals 4, free, ovate-oblong (1.5 – 1.7 – 2 × 0.7 – 0.8 mm, apex acute, glabrous, oil glands not conspicuous. Stamens white, 4, free, anthers partly exerted above petals; filaments cylindrical 1.8 × 0.2 mm, apex geniculate, narrowing; anthers elliptic, 4-celled, 0.7 – 0.8 × 0.5 mm. Pistillode ovoid (proximal half) – cylindrical (distal half), 1 mm long, 0.5 mm wide (proximal half), 0.2 mm diam. (distal half), apex rounded, sparsely hairy, hairs spreading, bristle-like, 0.1 mm long. Female flowers unknown. Inflorescences 2 – 6, on leafy stems, axillary, each c. 2 – 3 cm long and wide, 1 – 5-fruitled, peduncle 0.1 cm. Fruit ripening yellow, surface deeply pitted (J. G. Adam 27597), ellipsoid-ovoid (0.6 – 1.1 – 1.5 × (0.4 – 0.5 – 0.6 (– 0.8) cm, apex acute to obtuse, base rounded to truncate, surface pits dense, conspicuous, elliptic 0.4 – 0.6 (– 1) mm long, fruit wall c. 2 mm thick, 1-locular, 1-seeded (Adam 1975: Planche 771). Fig. 1.

RECOGNITION. Differing from Vepris verdoorniana in the canaliculate (not terete) pedioles, the ovoid-ellipsoidal, conspicuously and deeply pitted fruits (not narrowly ellipsoid, pits absent or inconspicuous), leaves opposite (not usually alternate).

DISTRIBUTION. Sierra Leone, Gola Forest and Liberia, Mount Bele (= Mt Bili), Mount Tokadeh area and Putu Hills. Map 1.

SPECIMENS EXAMINED. SIERRA LEONE. Gola Forest Reserve, Geuta Chiefdom, Kenema distr., on red brown gravel soil – flat ground, fl. fr., 23 March 1965, Fox 124 (K000875068!). LIBERIA. Mt. Nimba: Mt Belé, Mt Bili, 25 Dec. 1951, fl., A. Barker 1181 (K000875067!, P066005581!), fr., 17 May 1973, J. G. Adam 27597 (P02143761!, BR0000019425542!); Mt Bele, 7°25′2″N 8°35′31″W, 617 m, st., 20 May 2010, Hawthorne DBSL16 (FHO!); Mt Bele, 7°25′1″N 8°35′42″W, 690 m, st., 20 May 2010, Hawthorne DBSL15 (FHO!); Mt Bele, 7°25′0″N 8°35′27″W, 573 m, st., 20 May 2010, Hawthorne EPSL22 (FHO!): Road to Zotarpa from Grassfield, opposite Mt Bele, 7°25′19″N 8°35′20″W, 546 m, st., 4 June 2010, Hawthorne EPHT20

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Fig. 1. *Vepris fer* A habit, stem showing abaxial leaf surfaces and male (possibly abnormally contracted) inflorescence; B habit, fruited stem, adaxial leaf surfaces; C detail of leaf-blade showing raised surface gland dots (abaxial surface); D detail of junction of canaliculate petiole with subsessile leaflets, including transverse section of petiole (left); E male flowers, side view; F pistillode, side view; G pitted fruit with pedicel. All from Fox 124 (K). DRAWN BY ANDREW BROWN.
Yuelliton DSO, 7°33'40"N 8°37'49"W, 766 m, st., 28 May 2010, Hawthorne EPSL30 (FHO!); West Gangra close to Villi River, 7°32'56"N 8°38'55"W, 549 m, st., 24 April 2010, Hawthorne EPHT06 (FHO!); Mt Gangra DSO site, 7°32'52"N 8°37'40"W, 695 m, st., 14 May 2010, Hawthorne EPSL20 (FHO!); Mt Beeton, approx 3 km S from Bonlah, 7°32'48"N 8°39'32"W, 626 m, st., 3 May 2010, Hawthorne EPSL11 (FHO!); Bentor Area, 7°30'29"N 8°40'4"W, 591 m, st., 29 Nov. 2011, Hawthorne PSSL07 (FHO!); Bentor to Gbapa footpath, 7°30'19"N 8°39'43"W, 651 m, st., 29 Nov 2011, Hawthorne PSHT14 (FHO!); Tokadeh, close to steel ladder, 7°26'40"N 8°39'35"W, 658 m, st., 20 April 2010, Hawthorne EPVB02 (FHO!); Mt Tokadeh, 7°27'42"N 8°40'36"W, 791 m, st., 21 April 2010, Hawthorne DBPM01 (FHO!); SW of stock pile 2 by proposed road, 7°27'4"N 8°39'53"W, 622 m, st., 7 May 2010, Hawthorne DBSL10 (FHO!); Tokadeh — along old haul road, 7°25'50"N 8°40'3"W, 776 m, st., 17 May 2010, Mt Zorvu (Tokadeh), 7°28'18"N 8°39'48"W, 779 m, st., 25 Nov. 2011, Hawthorne PSHT12 (FHO!); Hawthorne EPHR02 (FHO!); Vayampa, next to road in community forest, approx 3 km before 7°26'38"N 8°42'9"W, 481 m, st., 15 May 2010, Hawthorne DBPF03 (FHO!); 2 km E of Vayampa nr road, 7°26'16"N 8°41'54"W, 494 m, st., 1 Nov. 2011, Hawthorne PSUS01 (FHO!); Putu Hills: Mt Ghi (Putu W) ridge, 5°39'37"N 8°12'48"W, 504 m, st., 28 Nov. 2010, Hawthorne EPHT02 (FHO!); David’s town to Mt Montroh, 2.5 km NW of David’s Town, 5°43'21"N 8°7'7"W, 239 m, st., 15 Dec. 2010, Hawthorne EPSL10 (FHO!); Panwloh to Mt Montroh, 2 km N of Panwloh Town and S of Mt Montroh ridge, 5°41'10"N 8°7'29"W, 239 m, st., 16 Dec. 2010, Hawthorne EPFL07 (FHO!); HABITAT. Undisturbed submontane evergreen forest; (239 –) 480 – 790 m alt. “On red brown gravel soil – flat ground” (Fox 124). The lower boundary of submontane forest is often taken as the 500 m contour in the Guinea Highlands (e.g. Cheek & Williams 2016).

CONSERVATION STATUS. Vepris fer is known from three fertile specimens at two locations, Gola and Mt Bili. However, 20, (see list above) sterile plot voucher specimens are also known, 17 from Mt Bili and neighbouring Mt Tokadeh locations, and three also from a disjunct location in eastern Liberia, the Putu Hills.

The Sierra Leone location is within the Gola National Park which is protected. At Gola the species seems to be extremely rare. Botanical surveys in the Gola Forest in recent years by Hawthorne (FHO, pers. comm.), Cuni-Sanchez (Dec. 2012), and in March and
Of the four known locations, only one, the Gola Forest Reserve (Sierra Leone), is protected.

Using the georeferenced specimens cited in this paper, the area of occupancy (AOO, 44 km²) and extent of occurrence (EOO 27,691 km²) have been calculated using GeoCat (Bachman et al. 2011).

Given the continued loss of plants of this species at the Mont Tokadeh site, and the impending losses at Mount Bele and Putu Hills locations, we here assess *Vepris fer* as Endangered EN B1+B2a,b(iii).

**ETYMOLOGY.** Named (French noun in apposition) for the iron substrate on which this species usually occurs.

**LOCAL NAMES.** Samakin (Ganta: Fox 124, K).

**LOCAL USES.** None known.

**NOTES.** The description above is based on both the specimens cited and on the description of Adam (1975) which is derived solely from Adam 27597.

Mount Bele is the southern tip of the extensive Nimba Mountain range for which Adam completed the Flora (Adam 1975). Notably his specimen is the only record of the genus recorded in his extensive work on the main range of Nimba.

Initially we connected Barter s.n. (Sugar Loaf Mt, Sierra Leone) with this taxon since it has a canaliculate petiole and similar aspect.

However, it differs from our taxon in that it has alternate only leaves, much more densely hairy inflorescences, a long and well-defined petiolule to the median leaf, and many more secondary nerves per leaflet. The identity of this specimen remains uncertain.

*Vepris fer* is unique in West Africa (Senegal-Ghana) for the combination of large (>1 cm long) fruit which is 1-seeded, with conspicuous large-pits, and the regularly opposite leaves. *Vepris balii* Cheek of the Cameroon Highlands (Cheek et al. 2018a) is the only other *Vepris* species in W-C Africa with regularly opposite leaves. That species however has bilocular ovaries and 8 stamens, and long petiolules (not unilocular, 4 stamens, sessile leaflets).

The inflorescence of the type specimen shows scarring on the main axes suggesting damage early in development. This may account for the discrepancy in dimensions of the male inflorescences between *Barter* 1181 (c. 5 cm long, long internodes) and that of the type (3.5 cm long, more congested, possibly stunted).

The disjunction between Gola and Nimba locations is about 220 km, and between Nimba and the Putu Hills c. 180 km. It is likely that this is not due to under-sampling in the surviving habitat between these locations but due to the preference of the species for submontane forest. This disjunct pattern is seen in other submontane forest species in the Guinea Highlands e.g. *Trichilia djalonis* A.Chev., and the more recently discovered *Isoglossa dispersa* I.Darbysh. (Darbyshire et al. 2011), *Brachystephanus oreacanthus* Champl. (Champluvier & Darbyshire 2009),
Vepris verdoorniana sensu Aké Assi (2001: 110 – 115); Hawthorne (1990: 165); Hawthorne & Jongkind (2006: 706); Akèogninou et al. (2006: 914).

Dioecious (probably) shrub or small tree 4 – 10 (~ 15) m tall, "trunk 10 cm diam., dark brown, basally peeling off in scales, higher up smooth and with large pale grey spots" (Leenavenberg 3905, K). Leafy stems terete, 2 – 3 (~ 4) mm diam. at lowest leafy node, pale greenish grey, internodes (0.3 – 1 – 6.2 (~ 0.7) cm long with longitudinal ridges and elliptic slightly raised convex white lenticels (0.25 – 0.35 – 0.5 (~ 0.65) × (0.2 – 0.25 – 0.4 (~ 0.5) mm, surface glabrous. Apical leaf bud densely appressed hairy, hairs 0.2 mm long, pale brown. Leaves alternate, trifoliolate; petiole 2 – 4 cm long, with strongly developed patent wings from the adaxial margins, wings widest near the distal end, 0.3 – 0.5 (~ 1) mm wide, the combined width of the wings often exceeding the width of the central, non-winged part of the petiole (Fig. 2E); in dried specimens wings usually revolute, glabrous; adaxial surface of central non-winged portion of petiole with thinly scattered simple hairs 0.1 – 0.3 mm long, extending along the leaflet midribs; densely pubescent at junction of leaflets with petiole (Fig. 2E). Leaflets equal or subequal, the lateral leaflets sometimes only 2/3 the size of the median; narrowly elliptic or elliptic-oblong, median (7.8 – 8 – 15.4 (~ 16.6) × (2.3 – 2.4 – 5 (~ 5.8) cm; laterals 5.2 – 13.2 (~ 13.6) × (1.5 – 1.9 – 3.8 (~ 5.0) cm, base cuneate, slightly asymmetrical with lateral leaflets, tapering gradually to the junction with the petiole, petiololes indistinct; acumen 0.2 – 1.2 cm long, apex acute; lateral secondary nerves 15 – 23 on each side of midrib, arising at 50 – 80° from midrib, the distal part of the nerves looping upwards to the nerve above (brochidodromous) connected by fine tertiary nerves to an infra-marginal nerve (Fig. 2C); intersecondary nerves 1 – 4 between secondaries, parallel to the secondaries and almost as well-developed; quaternary nerves, visible to the naked eye, not uniting to form a reticulum; oil glands 0.05 – 0.1 mm diam., c. 100 – 600 per cm², appearing as raised discs only on the abaxial surface, concolorous, not visible with the naked eye. Inflorescences axillary, 1.3 – 3.6 cm long, flowers 10 – 15 (female) arranged in 2 – 4-flowered fascicles along the main axis and the shorter basal branches, bracts narrowly triangular 0.1 – 0.5 mm long, axes and bracts densely puberulent (c. 50% cover), hairs 0.2 mm long. Petioles 0.5 – 2 × 0.4 mm, indumentum as inflorescence. Calyx tube 0.1 – 0.2 × 0.7 – 1.1 mm; lobes 4, broadly triangular, c. 0.25 × 0.5 mm, apex obtuse, indumentum as pedicel, oil glands not conspicuous. Petals 4, white, free to base, lanceolate or narrowly elliptic, 2.4 – 3.1 × 0.7 – 1.1 mm, apex acute, slightly hooded, margins slightly involute, glabrous, oil glands not conspicuous.

4. Vepris occidentalis Cheek & Onana sp. nov. Type: Ghana, Mampong-Akwapim, fr. 16 March 1977, Ankoma-Ayew in GC 46141 (holotype K000875057!; isotype GC).

http://www.ipni.org/urn:lsid:ipni.orgnames:77197425-1

Teclia grandifolia sensu Aubréville (1936: 92, fig. 163) non Engl.

Teclia verdoorniana sensu Keay (1958: 689); Hall & Swaine (1981: 303).
flowers. Stamens 4, exserted beyond petals, erect; filaments cylindrical 2.2 – 3 x 0.1 mm, curving inward towards apex; anther two-celled, elliptic, c. 0.8 x 0.6 mm, medidixed. Pistilode pyriform, 1.5 x 0.75 mm, contracting to 0.3 mm diam. in the distal two-thirds, apex rounded, base with petal-opposed cavities; surface with spreading bristle-like hairs 0.2 – 0.3 mm long. Female flowers 10 – 20% larger than the males; ovary broadly ellipsoid, 1.5 x 1.3 mm, stipe c. 0.2 x 0.5 mm; style cylindrical or dilating towards apex, 0.25 x 0.3 mm; stigma irregularly disc-like 0.2 – 0.3 x 0.8 mm. Fruit orange or red when ripe, ellipsoid, 0.6 – 0.9 cm, apex and base rounded, surface drying wrinkled, oil cavities elliptic, 0.5 mm long, usually slightly raised, convex; 1-seeded. Fig. 2.

RECOGNITION. Vepris occidentalis differs from all species within its range, and from V. verdoorniana, in the strongly laterally winged petioles (not terete), and by the oil glands on the lower surface of the leaflets being concolorous, not visible to the naked eye, (not black, conspicuous to the naked eye). It further differs from the last species in the ellipsoid fruits (not narrowly ovoid).

DISTRIBUTION. Guinea, Ivory Coast, Ghana, probably Benin (see note below). Map 2.

SPECIMENS EXAMINED. GUINEA-CONAKRY (GUINEA). Coyah Prefecture: Near Kouriya, near rd from Cohay to Kindia, 9°45’29.03”N, 13°18’7.19”W, 270 m, st., 11 Oct. 2016, X. M. van der Burg (K001243856!).

LIBERIA. Lofa. North Lorma National Forest, 8°01.53’N, 9°43.88’W, 408 m, fl. 24 Nov. 2005, C. C. H. Jongkind (P04757389!, WAG1413490!, G1). IVORY COAST. Abidjan, Lamto, st.16 Jan. 1969, Hainard 173 (G1); ibid, Sous-Préf. Tiassale, Lamto, st. 20 Jan. 1969, Poecilot 3812CI (G1!); ibid. Res. du Lamto, fl. 25 March 1989, Gautier-Beguin 1181; ibid., fr. 4 June 1989, Gautier-Beguin 1346 (G1); Sous-Préf. Boua, PN Comoc Sud, 29 May 1991, Poecilot 4438 CI (G1!); Daloa, 8 – 10 km to the E of st., 5 – 6 March 1962, L. Bernardi 8468 (P06600570!); st., 1932, M. Aubréville 795 (P06600566!); fl. fr., 29 April 1936, M. Aubréville 2365 (P06600567!); Fôret de Bouaflé, c. 40 km E of Daloa, along rd to Bouaflé, c. 200 m, imm. fr., 13 April 1962, A. J. M. Leeuwenberg 3905 (K000875063!, four sheets: L.2127875!, L.2127876!, WAG1413501, WAG1413502! BR0000019425610 image!); Near Brafoquéi, 75 km NW of Abidjan, in a grove, c. 100 m fr., 24 April 1959, A. J. M. Leeuwenberg 8341 (K000875062!, WAG1413493! BR0000019425603 image!); Bouaké, c. 70 km W of, Fôret Classée Matumbo, c. 25 km S of Béoumi, 5 km SE of Ando, fr., 27 May 1963, W. J. F. O. de Wilde 92 (K000875058!, P06600565!, WAG1413497!); Kapkine, 8 km N of, on sandy soil, fl., 18 April 1968, C. Geering & J. Bokdam 2543 (K000875056!, two sheets: WAG1413503!, WAG1413504! BR0000019425573 image!); Forêt du Bandama, st., 26 Sept. 1982, M. Miege 1438 (P00058680!).

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Fig. 2. Vepris occidentalis. A habit, small-leaved specimen; B habit, large-leaved specimen; C venation, adaxial surface leaflet; D oil glands on abaxial leaflet surface; E leaf portion, junction of leaflets with distal portion of the winged petiole, with transverse section of petiole; F male flower, with petal and stamen removed to display pistillode; G detail of pistillode, showing proximal staminal concavities centre and left, and right portion of staminal filament; H female inflorescence; J female flower; K female flower, petals removed, showing stipitule pistil; L infructescence with immature fruits; M mature fruit, showing surface oil glands. A, C, D, L from Leeuwenberg 3341; B, E, H – K from Geerling & Bokdam 2543; F, G from Vigne 1100; L from Leeuwenberg 3405. DRAWN BY ANDREW BROWN.
“forêt dense semi-décidue” of Aubréville (1938). Aubréville surmised that before the advent of agriculture it had stretched far to the north, covering what is now “Guinean savanna” (woodland). Guillaumet & Adjanohoun (1971) name this vegetation “Forêt à Aubrevillrea kersingii et Khaya grandifoliola ”, and Chatelain et al. (2011) map the occurrence of V. occidentalis in Ivory Coast. However, we have not been able to verify all their 22 points for this species. The westernmost outliers of V. occidentalis occur in the northernmost, drier part of Liberia and in east-central Guinea.

It is likely that the easternmost extent of this species occurs in Benin, since Akoègninou & Yédomonhan in Akoègninou et al. (2006) list Veparis verdoorniana in that country citing Houngnon 3659 from Misséssinto. However, we have not been able to view this specimen to confirm the identification, so do not include it in Map 2, although we consider it feasible, even likely. Akoègninou & Yédomonhan give the distribution of this taxon as in their phytogeographic zones 3 (Ouémé) and 4 (Kouffo), in the southern part of Benin, just inland of the coastal belt. This is semi-deciduous forest receiving rainfall of 900 – 1200 mm (Akoègninou et al. 2006). No Veparis species is recorded from Togo (Brunel et al. 1984), but it is quite possible that V. occidentalis occurs there but has been overlooked since there are records immediately to the west in Ghana, and it appears to be present to the east in Benin (see above). Benin appears to be the eastern limit of the species since, although Nigeria is well studied for trees (e.g. Keay 1989), there are no records attributable to the species there.

Tarenna agnata Cheek has a partly overlapping distribution to that of Veparis occidentalis, also occurs in Dry Semi Deciduous Forest in Ghana, extending into Ivory Coast, but is seems much rarer, being known from fewer points and is considered possibly extinct (Cheek et al. 2015).

**CONSERVATION STATUS.** Veparis occidentalis has a large range (EOO = 6,191,100 km², AOO = 120 km²), and we have been able to verify records from 16 locations. Chatelain et al. (2011) map 22 points for Ivory Coast alone, but we have not been able to verify all of these records. However, if confirmed, the number of locations of this species may be much higher, potentially exceeding 30, on which basis the AOO was calculated.

Relatively little of the original 2,360 km² of the Ghanaian Southern Marginal Type of forest, (the habitat in which this species is most frequent in Ghana), is today covered by forest (Hall & Swaine 1981: 85), and of this area only 93 km² (4%) is within
the 10 reserved areas within this type (Hall & Swaine 1981: 69). In the last 35 years, several of these reserves have been largely destroyed by fire (Hawthorne pers. comm.). Generally speaking, good quality forest in Ghana only exists in reserves.

Much of the original lowland forest in Côte d’Ivoire has been destroyed or degraded over the last few decades and deforestation rates are still high (Bongers et al. in Poorter et al. 1994: 87 – 98) In Ivory Coast this species seems to be protected only in in the Comoé NP.

Given the large range, and large numbers of recorded locations we here assess this species as Least Concern. However, further study may well show that *Vepris occidentalis* has been lost from many of the sites at which it has been recorded, in which case it will need to be reassessed as Near Threatened, potentially even as Vulnerable under criterion B (low AOO and severely fragmented) and/or criterion A (reduction in population).

**ETYMOLOGY.** Signifying “western”: this is the most western species of *Vepris* currently known.

**LOCAL NAMES & USES.** Niépé: Bernardi 8468; Drézé: Aubréville 795; Jwebiribi, (Twi): Irvine 1155; Atuhon, (Ashanti): Irvine 952, Vigne 1100. Used as chewsticks (for dental hygiene): Irvine 952 Chewsticks, bark bitter, chewed to cure cough: Irvine 1155

**NOTES.** This paper was partly prompted by attempts to name material (van der Burg 2074) from Guinea as an example of a project to delimit the areas of highest priority for plant species conservation using the Important Plant Areas criteria of Darbyshire et al. (2017). The Guinea material cited fitted the concept of *Vepris (Teclea) verdoorniana* used in the *Flora of West Tropical Africa*, but not that of Onana & Chevillotte (2015) prompting further investigation.

*Vepris occidentalis* is unusual as a newly described species in having a large range (Guinea to Ghana, possibly extending to Benin), appearing relatively common and frequent in much of that range, and so not being of high conservation concern, as is the case with *Karina scarcei* (Scott Elliot) Cheek (Cheek et al. 2016) which has a similar range. In contrast, most recently discovered species within this area are much more range-restricted and in consequence, threatened with extinction. Examples are *Kindra gangan* Cheek (Cheek et al. 2018b), *Talbotiella chekii* van der Burgt (van der Burgt et al. 2018), *Koteia sseu* Cheek, K. *aboutou* Cheek (Cheek et al. 2018c), *Macropodiella cussetiana* Cheek & Ameika (2016) and *Striga magnivirgulata* E.B. Fisch. & I. Darbysh. (Fischer et al. 2011).

Many of the uses ascribed to *Teclea verdoorniana* by Burkhill (1997) pertain to this species, insofar as the material derived from Ghana and Ivory Coast. However, uses ascribed to this same species from Sierra Leone and Uganda must relate to other species of *Vepris* since *V. occidentalis* is not known from those countries.

**Acknowledgements**

We thank the scientists at the following institutions for responding to requests for assistance on this paper and where possible providing access to their herbarium specimens or data: at SL, Dr Aiah Lebbie; at GC, Patrick Ekpe; at FHO, Serena Marner and Dr William Hawthorne; at BM, Jacek Wajer; at L (WAG), Nicoliens Sol.

Dr Sekou Magassouba, Director General, Université de Camal Abdel Nasser-Herbier National de Guinée (Guinea-Conakry), is thanked for the arranging permits which allowed collection of the single Guinean specimen and for long term support and collaboration. Janis Shillito is thanked for typing the manuscript. This paper was completed under the project Important Plant Areas in the Republic of Guinea supported by the Darwin Initiative of the Department of the Environment Food and Rural Affairs (DEFRA), UK government (project Ref. 23 – 002). George Gosline and two anonymous reviewers are thanked for constructive comments on earlier drafts of the paper.

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