

¹*Inversodicraea koukoutamba* and *I. tassing* (Podostemaceae), new waterfall species from Guinea, West Africa

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Abstract. Two new species of *Inversodicraea*, *I. koukoutamba* and *I. tassing*, both from the Republic of Guinea, are described as new to science, increasing the number of species known in this African genus to 32, making it the most species-diverse among African *Podostemaceae*. Both species are remarkable, among other features, for their styles. *Inversodicraea koukoutamba* is only the third species of the genus with 3, not 2 styles, and is unique in the genus, and in the family, in having each style bifurcate. *Inversodicraea tassing* has styles equal or exceeding the length of the ovary, being nearly twice as long as those of the species which previously was noted for the longest styles in the genus. Both new species are single-site endemics, the first is assessed here as Critically Endangered according to the IUCN 2012 standard, due to the incipient construction of the World Bank backed Koukoutamba hydroelectric dam which threatens several other plant species assessed as Critically Endangered or Endangered. The second species, *I. tassing*, is assessed as Near Threatened, since there are currently no threats known at present to the single known site.

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Introduction

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Inversodicraea Engl. has been resurrected to accommodate those species previously included in *Ledermanniella* subg. *Phyllosoma* C. Cusset (Thiv *et al.* 2009, Schenk *et al.* 2015, Cheek & Haba 2016a). This paper builds on the recent synoptic account of the genus which recognised 30 species (Cheek *et al.* 2017a). Material collected in Guinea in 5 2018 appears to represent two additional highly distinct new species which are described in this paper as *Inversodicraea koukoutamba* Cheek and *Inversodicraea tassing* Cheek.

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) 10 although this total is disputed (Nic Lughadha *et al.* 2017). Widespread species tend to have already been discovered, so that many newly discovered species are those that are range-restricted and so are much more likely to be threatened, such as *Inversodicraea koukoutamba*. Evidence-based conservation assessments exist for about 21 – 26% of known species, and 30 – 44% of these assessments rate the species concerned as 15 threatened (Bachman *et al.* 2018). This makes it imperative to discover and publish such species so that they can be 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; continuously updated).

20 *Podostemaceae* are a pantropical family of annual or perennial herbs placed in Malpighiales in a sister relationship with Hypericaceae (Ruhfel *et al.* 2011). Koi *et al.* (2012) reported about 300 species globally, in c. 54 genera, however, discoveries in recent years have increased this number to about 335 species. Species numbers are highest in tropical America (160 species), followed by Africa (c. 90 species), with Asia, having 84 25 species. All species of the family are restricted to rocks in rapids and waterfalls of clear-water rivers and are therefore rheophytes. However this very habitat is being increasingly exploited for hydropower at great risk to the survival of the *Podostemaceae* they contain (Schenk *et al.* 2015, Cheek *et al.* 2015, Cheek & Ameka 2016, Cheek *et al.* 2017a,b) and these have resulted in documented local extinctions e.g. in Guinea (Cheek & Magassouba 30 2018). Most of the African species of *Podostemaceae* are narrow endemics, many being species known from only a single waterfall, such as *Inversodicrea pygmaea* G.Taylor (now extinct), *Inversodicraea lunda* Cheek (presumed extinct), *Inversodicraea achoundongii* J.J.Schenk, Herschlag & D.W.Thomas and *Inversodicraea ntemensis* (Y.Kita, Koi, Rutish.,

& M.Kato) J.J.Schenk, Herschlag & D.W.Thomas. New discoveries of species are still being made frequently (Schenk et al. 2015, Cheek et al. 2015, Cheek & Ameka 2008, 2016, Cheek & Haba 2016a, Cheek et al. 2017a,b, Beentje 2005, Schenk & Thomas 2004, Rial 2002, Cheek 2003, Kita et al. 2008, and also, recently, a new genus, Cheek & Lebbie 2018).

The current generic classification of African *Podostemaceae* is based on the framework established by Cusset (1973, 1974, 1978, 1983, 1984, 1987 and 1997). This work has been compiled and updated by Rutishauser et al. (2004) who recognise c. 85 species in 16 genera. Recently, combined morphological and molecular phylogenetic studies of African *Podostemaceae* have shown that *Ledermanniella* (as delimited by Cusset) is paraphyletic, including all other sampled genera of *Podostemaceae* recognised in Africa (Thiv et al. 2009, employing plastid markers *matK*, *trnD-trnT*, *rpoB-trnC* in sampling 9 genera and 17 species of African *Podostemaceae*, and Schenk et al. (2015), employing plastid markers *matK*, *trnL*, *rpoB-trnC*, *ndhF*, and *rbcL* and the mitochondrial marker *matR* in sampling 10 genera and 27 species of African *Podostemaceae*).

Molecular phylogenetic sampling of African *Podostemaceae* has been only c.30% complete at species level (Schenk et al. 2015). Thiv et al. (2009) and Schenk et al. (2015), have convincingly shown that *Ledermanniella* subg. *Phyllosoma* C. Cusset forms a well-supported clade of species that are sister to the rest of all other African *Podostemaceae* sampled, comprising *Ledermanniella* subg. *Ledermanniella* and, embedded within it, nine smaller genera: *Macropodiella*, *Winklerella*, *Djinga*, *Monandriella*, *Dicraeanthus*, *Leiothylax*, *Letestuella* and *Stonesia*. Thiv et al. (2009) and Schenk et al. (2015) both advocate resurrecting the generic name *Inversodicraea* Engl., as the oldest generic name for the species of *Ledermanniella* subg. *Phyllosoma* and both transfer species formerly included under the last taxon to *Inversodicraea*. The last seven remaining species names of subg. *Phyllosoma* for which formal transfer was necessary were placed into *Inversodicraea* in Cheek & Haba (2016a). A synoptic revision of *Inversodicraea*, with six new species, was recently published (Cheek et al. 2017a).

30 **Materials and methods**

Nomenclatural changes and lectotypifications were made according to the International Code of Nomenclature for algae, fungi, and plants (Turland et al. 2018). Names of species

and authors follow IPNI (continuously updated). 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 with a Leica 308700 camera lucida attachment.

5 The new material from Guinea, the subject of this paper, was compared to material of all known species of *Inversodicraea*. Specimens were inspected from the following herbaria: BM, FHO, HNG, K, P, WAG, WRSL, YA. COI specimens were not accessible since they were being digitized during the period of study.

The format of the descriptions follows Cheek et al. (2017a). All specimens cited have been
10 seen. The conservation assessment follows the IUCN (2012) standard. The main online search address used for retrieving specimen data from labels at P was https://science.mnhn.fr/institution/mnhn/collection/p/item/search/form?lang=en_US. However, resolution of images of herbarium specimens was not sufficient in all cases to confirm specimen identification. Herbarium codes follow Index Herbariorum (Thiers,
15 continuously updated).

Results

Material from Koukoutamba, represented by *Cheek* 18950 (HNG, K, WAG, ZT), keyed
20 out in Cheek et al. (2017a) to couplet 25 due to the scale-leaves both sparsely covering the principal axis and lacking projections to the abaxial surface, and due to the robustly erect, not horizontal, stems. It agrees most closely with the first of the two clauses at couplet 25, leading to *Inversodicraea abbayesii* G.Taylor, differing in that the scale-leaves on the short shoots are not needle-like (except next to the spathellum) as in that species, but
25 deeply lobed. Moreover, these two species differ significantly as depicted in table 1, consequently the material is formally described and named as *Inversodicraea koukoutamba*.

Character	<i>Inversodicraea abbayesii</i>	<i>Inversodicraea koukoutamba</i>
Principal stem, dimensions at base	<1 mm wide	(2–)4–10 mm wide
Stem, habit	Gracile, not self-supporting out of water	Stout, self-supporting out of water
Ovary in transverse section	Circular	Laterally compressed
Longitudinal ovary ribs	8	6
Commissural ribs	Present	Absent
Stigma number	2	3
Stigmas entire/bifurcate	Entire	Bifurcate
Tepal length	0.8 mm	0.2 mm
Number of spur-shoots per stem	10–20	27–90

Table 1. Characters separating *Inversodicraea abbayesii* and *Inversodicraea koukoutamba* (data for *I. abbayesii* from Taylor (1953)).

- 5 Material from the Plateau de Tassing, represented by *Jennings* 19 (HNG, K, WAG, ZT), keyed out in the identification key to all known *Inversodicraea* species in Cheek et al. (2017a) to couplet 17 due to the scale-leaves present only on the spur-shoots (side-branches) and being absent on the principal stems. It matches neither of the statements that form that couplet, but is closest to the first: “Principal stems >20 cm long, lax, floating in the water and lacking scale-leaves; scale-leaves dense on spur-shoots <1 cm long”,
10 differing in that in fact the scale-leaves are usually entirely absent from the spur-shoots except for a single whorl adjacent to the spathe itself. Thus, it matches no known species of the genus and is described below as *Inversodicraea tassing*. It is additionally unique from all other known species of the genus in the extremely long styles (see
15 diagnosis below).

Inversodicraea koukoutamba Cheek *sp. nov.* — Figs. 1 & 2.

Etymology. Named as a noun in apposition for the type and only known locality, the Koukoutamba falls in Tougé Prefecture, Labé Region, in the Fouta Djallon Highlands of Moyenne Guinée, Guinea.

- 5 Differs from all other species of *Inversodicraea* in that the 3 styles are each bifurcate at the base (flowers appearing 6-stylous); no other species has bifurcate styles, and all but two other species (see below) have 2 styles, not 3; it also differs from all other species in the massive size of the erect rubbery stems, 7–20(–35) cm tall (other species of the genus have stems either horizontal, not free-standing, or if free-standing usually <4 cm tall; if
10 exceeding this, the stems woody 4–8(–20 cm) tall). Type: *Cheek* 18950 (K holo.; iso HNG, P). Guinea, Guinée-Moyenne, Labé Region, Tougé Prefecture, Koukoutamba Falls, fl. 14 Jan. 2018.

Annual or perennial herb. Root ribbon-like 1.1–1.8 mm wide (Fig. 1D). *Stem* erect, free-
15 standing, rubbery, 7–20(–35) cm tall; (2–)4–10 mm diam. at base when live, basal half to third, unbranched, lacking scale-leaves; distal half to two thirds with spur-branches mostly 0.4–1.2 cm long, internodes 0.5–1 cm long, spur-branches increasing in length and number of shoots with distance from point of attachment, proximal spur-branches with 1–2 shoots, distal-most branches with c. 30 short flowering shoots. *Flowering shoots* short and stout,
20 2.5–4 by 2–2.5 mm (excluding spathellum) densely clad in scale-leaves, with a single terminal spathellum. *Leaves* not seen, possibly caducous or not produced. *Scale-leaves* heteromorphic, stage-dependent. Scale-leaves of proximal portion of main axis covering <5% of surface, broader than long, semi-circular 0.1–0.2(–0.5) by 0.5–0.6 mm, entire, apex rounded, entire (Fig. 1E). Scale-leaves of flowering shoots stout, more or less flat,
25 completely covering and adpressed to the stem surface, those at i) shoot base 0.5 mm long, deeply 3-lobed, broader than long, the basal, unbranched part 0.2 by 0.3 mm, the distal 3-lobed part with a large triangular central lobe 0.3 by 0.2 mm, the two lateral lobes 0.2 by 0.1 mm, slightly spreading; ii) mid-shoot scale-leaves c. 1.3 mm long, the basal unbranched portion 0.8 by 0.3 mm, the central lobe 0.5 by 0.15 mm, the two lateral lobes
30 as in the shoot basal scale-leaves; iii) distal scale-leaves (subtending the spathellum) entire, unlobed, narrowly triangular 1.3 by 0.3–0.4 mm (i– iii) depicted left to right, with intermediates, Fig. 1H). *Spathellum* shortly ellipsoid, 2 by 1.5 mm, apex with a short, broad mucro 0.2 mm long, dehiscing irregularly. *Pedicel* 6.5–7 mm long, *Tepals* 2,

filiform, erect 0.2 mm long. *Androecium* with two stamens. Andropodium 1.5 mm long. Free filaments 1.5–1.6 mm long. Anthers 1.2–1.4 by 0.6–0.7 mm. Gynophore 0.5–0.6 mm long. *Ovary* narrowly ellipsoid 2.5–2.75 mm long by 0.8–1.05 mm, wide (non-commissural plane), laterally flattened, in the commissural plane (c. 0.6 mm wide),
5 unilocular, longitudinal ribs 6, broad and deep, ribs each 0.2 by 0.1 mm. *Stigmas* 3, purple red, each bifurcate from the base, horizontal, (0.4–) 0.5 mm long, sometimes the branches themselves bifurcate at apex, apices tapering to an acute point. *Fruit* and *seed* not known.

Distribution — Guinea, Fouta Djallon, Moyenne-Bafing, Bafing River, known only from
10 the Koukoutamba Falls.

Ecology — Rheophyte growing on rocks in the full-force of the torrent, in full sunlight; 470 m altitude.

15 *Additional specimen* — Guinea, Guinée-Moyenne, Labé Region, Tougé Prefecture, Koukoutamba Falls, fl. 13 Jan. 2018, Cheek 18943 (K, HNG).

Conservation — *Inversodicraea koukoutamba* is known from a single location, the Koukoutamba Falls, at which we measured its AOO (and so also the EOO) as less than 4
20 km², using the IUCN-preferred cells of that size. Here it is threatened with extinction by the imminent placement of the Koukoutamba hydroelectric dam. Following environmental studies by Tractebel Engineering, construction by Sinohydro is due to begin in 2019 (Pigeon 2017). The World Bank is reported to have supervised the Environmental and Social Impact Assessment (ESIA) for the project, although the outcome of these has been
25 controversial (Watts 2018). The construction works have been commissioned by the Organisation pour la mise en valeur du fleuve Sénégal (OMVS), led by Hamed Diane Semega who announced in April 2018 that the work would go ahead soon (Atcha 2018). It is to be hoped that this species will be found at additional locations where it might survive, so reducing the extinction risk, but this is far from certain. Many species of
30 *Podostemaceae* are known to be single-site endemics. Therefore, using the precautionary principal advocated by IUCN (2012), the species is here assessed as Critically Endangered (CR B1+B2ab (iii) since placement of hydroelectric dams at waterfalls with endemic

species of *Podostemaceae* has been documented to have caused local species extinctions (Cheek et al. 2017a, Cheek & Magassouba 2018, Cheek 2018).

It is to be hoped that efforts will be made to bank the seed of this species and to make efforts to translocate it to suitable safe sites, or that other measures can be taken to protect it from extinction at Koukoutamba.

Notes — *Inversodicraea koukoutamba* was initially identified in the field by the first author as *Inversodicraea abbayesii* which also occurs in the Fouta Djallon of Guinea, but in a different drainage system, an affluent of the Konkouré River. However, although the scale-leaves of the two species are similar (see Taylor 1953: 68) there are numerous points of separation (see Table 1).

Inversodicraea koukoutamba is only the third species of *Inversodicraea* known to have three, not two, stigmas. Those other species are:

1. *Inversodicraea ntemensis* (Y. Kita, Koi, Rutish & M. Kato) J.J. Schenk, Herschlag & D.W. Thomas and,
2. *I. ebo* (Cheek et al. 2017a).

Both are globally endemic to the Memve'ele Falls of Cameroon. However, *Inversodicraea koukoutamba* is unique in the genus in having each of the three stigmas bifurcate. The species is also unusual in being the tallest (6–20(–35 cm) free-standing member of the genus, exceeding *I. cristata* Engl., *I. ebo* Cheek (both c. 7–8 cm tall) and *I. tchoutoi* Cheek (4(–20) cm tall), all of which occur in Cameroon, far to the east of Guinea. *Inversodicraea koukoutamba* also differs from the preceding three species in the stem being rubbery and not woody.

The Koukoutamba Falls on the Bafing River of Guinea, with five species, have the highest species-diversity for *Podostemaceae* of all waterfalls documented to date in Guinea, and possibly in the whole of West Africa. This is exceeded in Central Africa by the Lobé Falls of Cameroon, with ten species, which holds the record for *Podostemaceae* species-diversity in Africa (Cheek et al. 2017a).

The other four species of *Podostemaceae* present at Koukoutamba Falls are:

- 1) *Tristicha trifaria* L. (the most widespread and common *Podostemaceae* in Africa);

2) *Stonesia taylorii* C. Cusset (restricted to the Bafing River, with only three global locations, assessed as EN (Cheek & Molmou 2018);

3) *Inversodicraea harrisii* (C. Cusset) Cheek restricted to Guinea and Sierra Leone and assessed as Endangered (Cheek *et al.* 2017a) but which has subsequently been discovered at additional locations (Cheek pers. obs. Jan. 2018);

4) *Lebbiea grandiflora* Cheek, assessed as Critically Endangered (Cheek & Lebbie 2018).

Each of these five species has its own niche within the falls at Koukoutamba, and usually different phenologies. In January 2018 we observed that the plants of species 1) and 3) had already long been fully exposed and were dead and dried, being c. 60 cm above the water-level at that time. Plants of 4) occupied flat, horizontal surfaces of rock and c. 90% of the individuals were dried and died with only c. 10% live and flowering. Plants of 2) were attached to vertical rock steps in the falls, the long flexible stems draping down, covering the vertical surfaces, they were only c. 5% at flowering stage, the remainder post-anthetic.

Inversodicraea koukoutamba occurred only in foaming white water in the fastest flowing and most turbulent places at the top edges of the falls, with only the apices of the stems rising above the spume. Of all the five species present, it alone had not yet reached the fruiting stage in January. It is possible that it alone at this site is perennial since it grows deeper in the water than the other species at sites which may remain wet through the dry season, while the other species seem to be annuals completely drying and so dying after fruiting.

Below the Koukoutamba Falls, a flat open apron of rock and rubble 250 m long spreads out 70 m wide on the north side of the river. In the wet season this must be covered in fast-running water since it supports a community of specialised plants, all of which seem to be rheophytic (adapted to fast-flowing water). These include unusual species of herb, including *Portulaca* and *Pennisetum*, shrubs including *Zizyphus* and *Ormocarpum*, and scattered stunted trees of *Pterocarpus santalinoides*. This community will be reported on in detail in a separate publication when identifications are completed.

The Bafing River at this point in its descent from the Fouta Djallon highlands, flows through open woodland with *Borassus*, with areas of open ferrallitic bowal close by. *Barleria aterotricha* Benoist (Acanthaceae), assessed as Critically Endangered (Rokni 2017), was the only other rare, threatened species recorded by us at the Koukoutamba Falls themselves, being localised to the denser woodland in this area. While some sections of the river are lined by evergreen gallery forest some tens of metres wide, there is none at the falls themselves, but such forest begins just downstream where the river narrows and deepens to only 30–40 m wide, while at the falls the river spreads to 170 m wide, dropping in three shallow steps a few tens of metres apart. The total drop from the top (480 m above sea-level) to the bottom of the falls is about 11 m as measured on Google Earth.

Inversodicraea tassing Cheek *sp. nov.* — Figs. 3 & 4.

Differs from all other species of *Inversodicraea* in: a) the extreme length of the two styles, which equal or exceed the length of the ovary, and which at (2–) 2.3 mm long, are nearly twice as long as the longest otherwise known in the genus (1.2 mm long); b) the scale-leaves are mainly restricted to a single whorl around the spathe (not scattered on or densely covering the flowering shoot). — Type: *Jennings* 19 (holotype K; isotypes HNG, WAG, ZT) Guinea, border of Kindia & Coyah Prefectures, Plateau de Tassing, 9° 42' 30" N, 13° 12' 49.5" W, above Fossikouré Village, top of the 270 m high “Chute de Kili” on the Kili River, fl. 7 Dec 2017.

Etymology. Named in honour of the Plateau de Tassing, only known location for this species.

Perennial or annual herb, Root horizontal, dorsiventrally flattened, 1–1.5(–2) mm wide, 0.5–1 mm thick, internodes 2–3 mm long, root branches opposite or alternate, sometimes subtending erect shoots. *Stems* 15–30 cm long, streaming in the water, terete, 1.5–2.5 mm diam. along most of their length, internodes 3–7 mm long, phyllotaxy spiral, with 3–8 lateral branches each 1.2–6 cm long, mainly from the distal ½ of main axis. *Spur-shoots* single (Fig. 3E), in pairs (Fig. 3D, H) or in clusters of up to 10 (Fig. 3C), terete, 2–4 mm long, 0.55–0.7 mm wide at base, usually naked apart from a whorl of 5–7 scale-leaves at the apex. *Scale-leaves* dorsiventrally flattened, more or less appressed, quadrangular to

oblong in outline, 0.5–1 mm long, 0.4–0.6 mm wide, divided by 1/3 to 9/10 into three subequal forward-directed, triangular lobes; scale-leaves absent from the principal axis, mostly only immediately below the flowering shoot apex, part covering the developing spathellum (Fig. 3D), both 3-lobed and entire, triangular-ovate 0.3 by 0.25–0.3 mm, apex obtuse to rounded. Sometimes additionally with several scale-leaves scattered along the length of the spur-shoot (Fig. 3E), or on the branch stems bearing the spur-shoots (Fig. 3D), however, the structures here called scale-leaves may in fact be the bases of fallen leaves. *Leaves* not sheathing, astipulate, dorsiventrally flattened, narrowly ribbon-like, 0.4–8.5 cm by 0.02–0.1 cm, towards the base more or less canaliculate, apex obtuse to acute; leaves at base of principal axis entire and short, extending in length towards the apex of the principal axes, and in the distal half becoming once-bifurcate, and ultimately twice-bifurcate, sometimes subtending lateral branches or spur-shoots (Fig. 3E) or inserted on a spur-shoot (Fig. 3H). *Spathellum* (pre-anthetic) oblong-ellipsoid 2.5–3 by 1.1–1.4 mm, mucro absent or obscure, stipe inconspicuous; post-dehiscence cylindrical or narrowly funnel-shaped, 3.5–4.5 by 1.4–2 mm, with 2–4 irregular triangular lobes. *Pedicel* 11–12 mm long, 0.25–0.3 mm diam. *Tepals* 2, inserted opposite the base of the androecium, ligulate or slightly spatulate, 0.3–0.5 mm long, apex rounded. *Androecium* of 2 stamens, about as long as ovary; andropodium (united filaments) 1–1.2 mm long, free filaments 1.7–2.8 mm long, diverging; anthers 4-celled, 1.4–1.5 mm long, 0.4–0.5 mm wide. *Gynoecium* with gynophore 0.5–0.9 mm long. *Ovary* unilocular, narrowly ellipsoid in side view, 2.1–2.3 by (0.5–) 0.7–0.8 mm, in transverse section isodiametric, with 8 equal longitudinal ridges (commissural ridges developed). *Styles* cream, as long as or exceeding ovary, narrowly cylindrical (2–) 2.3 mm long, connate for the basal 0.2 mm, apex acute, 0.1 mm diam., surface minutely papillate. *Fruit and seed* not known.

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Distribution – Guinea, border of Kindia & Coyah Prefectures, Plateau de Tassing.

Ecology – on rocks in fast-flowing water above waterfall at top of sandstone table mountain; 430 m altitude.

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Conservation – known from one location where currently there are no threats, but since a single event might eliminate the species globally, we here assess the species as Near Threatened. The area of occupancy is calculated as 1 km². Hundreds of individuals of this species were seen, but no other Podostemacaeae were present (Jennings pers. obs. 2017).

The river flows over flat sandstone bedrock along a fault line on the sandstone plateau. The river is about 10 m wide where the species grows, but divided into braided channels, each of which is only 0.5–1 m wide, and can be 1 m deep. Although fast-flowing, no white water was present at the time of collection. The plants were seen along c. 50 m along the river at this point (Jennings pers. obs. 2017). Suitable habitat for this species was seen on Google Earth, along the Kili River, up to several km upstream.

Notes — *Inversodicraea tassing* is unique in the genus for the extraordinary length of the styles, and for the restriction of the scale-leaves to the apex of the spur-shoots (see diagnosis). Its closest affinities may be with *I. feika* Cheek of Port Loko, Sierra Leone, since the two species have similar habit, branching, and leaf-arrangement, differing principally in the details of the flowers and the shape of the scale-leaves due to which they cannot be confused.

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Discussion

These two new species of *Inversodicraea*, *I. koukoutamba* and *I. tassing*, expand the known morphological diversity of the genus, and their recent discovery shows how incompletely known for *Podostemaceae* are parts of West Africa, in particular the Fouta Djallon Highlands of Guinea. It is likely that with further survey effort additional species of *Podostemaceae* will be discovered at waterfalls previously unvisited by botanists. Guinea has numerous endemic species and a high diversity of species in the context of West Tropical African countries (Lisowski 2009 details c. 3000 species), including several endemic genera. However, botanical exploration, discovery and publication of new species appeared to drop and to have nearly stopped in the 1960s. In recent years, this has begun to change as botanical exploration, often associated with the more environmentally responsible mining companies, such as Rio Tinto, has restarted. *Allophylus samoritourei* Cheek (Cheek & Haba 2016b), *Brachystephanus oreacanthus* Champl. (Champluvier & Darbyshire 2009), *Eriocaulon cryptocephalum* S.M. Phillips & Mesterházy (Phillips & Mesterházy 2015), *Eriosema triformum* Burgt (Burgt et al. 2012), *Gymnosiphon samoritoureanus* Cheek (Cheek & Burgt 2010), *Inversodicraea pepehabai* Cheek (Cheek & Haba 2016a), *Isoglossa dispersa* I. Darbysh. & L.J. Pearce (Darbyshire et al. 2012),

Keetia futa Cheek, *K. susu* Cheek (Cheek et al. 2018a), *Napoleonaea alata* Jongkind (Prance & Jongkind 2015), *Striga magnibracteata* Eb.Fisch. & I. Darbysh. (Fischer et al. 2011), *Psychotria samouritourei* Cheek (Cheek & Williams 2016), *Talbotiella cheekii* Burgt (Burgt et al. 2018) and *Xysmalobium samouritourei* Goyder (2009), are examples of
5 the recent new discoveries from Guinea resulting from this impetus. Just over the border in Mali, *Calophyllum africanum* Cheek & Q. Luke (Cheek & Luke 2016) was recently found, and in Ivory Coast *Macropodiella cussetiana* Cheek (Cheek & Ameka 2016), now transferred to *Inversodicraea* (Cheek et al. 2017a). Two new genera, *Karima* Cheek & Riina and *Kindia* Cheek have recently come to light in Guinea (Cheek et al. 2016; 2018b).
10 Most of these species are range-restricted and so at heightened risk of extinction at a time when development projects are proceeding rapidly in Guinea. For this reason, the authors are engaged in a project to evidence and demarcate the most important areas for plant conservation in Guinea in terms of areas with unique and threatened species, high species richness, priority habitats and socio-economic species (TIPAs Guinea project 2016–2019;
15 Darbyshire et al. 2017).

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Fig. 1. *Inversodicraea koukoutamba* Cheek a. habit, erect stem of flowering plant; b. habit, atypically small plant; c. portion of a distal spur-branch with flowers approaching anthesis (rehydrated); d. base of stem at attachment to ribbon-like roots; e. scale-leaves of proximal portion of main axis; f. degraded scale-leaves from base of spur-shoots; g. scale-leaves from base of flowering shoot; h. variation in scale-leaves from base to apex of a flowering shoot; i. flowering shoot with spathe undehiscent; j. as i. with spathe dehiscent and inverted flower emerging; k. as i. with flower at anthesis; l. view of k from opposite direction; m. and n. views of an ovary apex from two directions; o. view from above of stigmas shown in m & n; p. transverse section of ovary. Scale-bars: a-b = 5 cm; c-f = 5 mm; g, i-l = 2 mm; h, m-p = 1 mm. Drawn by Andrew Brown from *Cheek* 18950 (a-j) and from *Cheek* 18943 (k-p).

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5 **Fig. 2.** *Inversodicraea koukoutamba* Cheek a. Koukoutamba Falls, Guinea, sole habitat known of *Inversodicraea koukoutamba*; b. plant in habitat; c. whole plant in flower; d. close-up of spur-shoots with flowers. All photos by Martin Cheek.

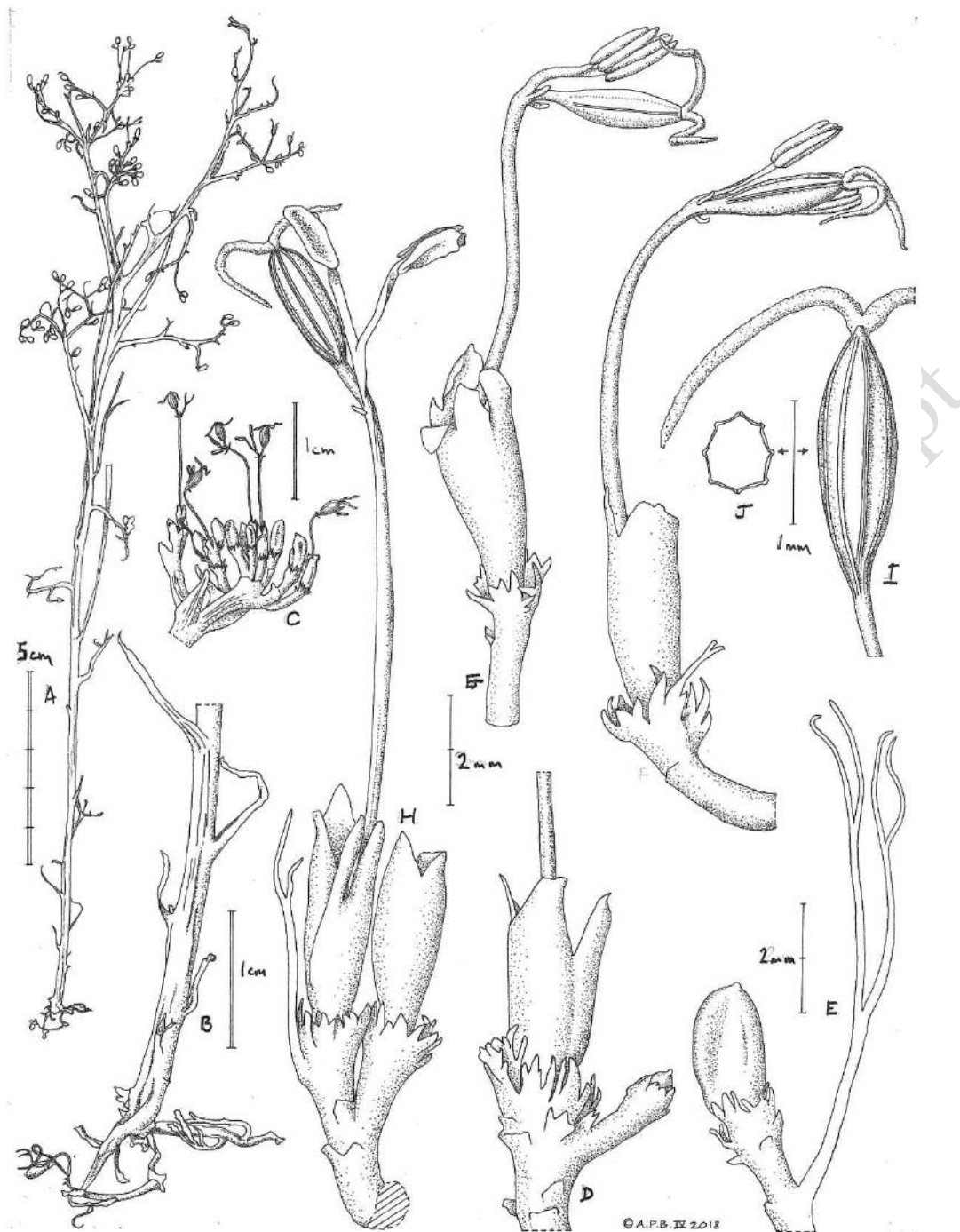


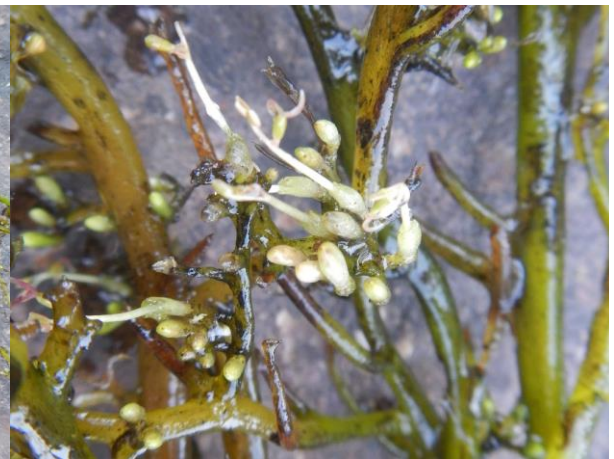
Fig. 3. *Inversodicraea tassing* Cheek a. habit, flowering plant; b. habit, base of stem and roots; c. lateral branch with numerous spur stems; d. pair of spur-shoots with spathe dehiscing (left), and in bud (right); e. leaf subtending spur-shoot with undeveloped spathe; f. & g. spur-shoot with emergent flower; h. pair of spur-shoots with flower at anthesis; i. gynoecium; j. transverse section of ovary. Scale-bars: a = 5 cm; b, c = 1 cm; e-h = 2 mm; i, j = 1 mm. Drawn by Andrew Brown from Jennings 19 (K).



a



b



c

Fig. 4. *Inversodicraea tassing* Cheek. a. Kili Falls, Plateau de Tassing, Guinea, sole habitat known of *Inversodicraea tassing*; b. habit, whole plant in flower; c. close-up of flowers. All photos by Xander van der Burgt.