

The Chemical Systematics of the Rutaceae, Subfamily Toddalioideae, in Africa

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Key Word Index—*Araliopsis*; *Diphasia*; *Oricia*; *Oriciopsis*; *Teclea*; *Vepris*; Rutaceae; Toddalioideae; quinoline alkaloids; acridone alkaloids; limonoids; chemical taxonomy.

Abstract—A recent investigation of five Ethiopian species of the Rutaceae subfamily Toddalioideae, *Teclea nobilis*, *T. simplicifolia*, *T. borensis*, *Vepris dainellii* and *V. glomerata* has led to the identification of alkaloids of the 2-quinolone, dihydrofuroquinoline, linear pyranoquinoline, furoquinoline and acridone types. The distribution of alkaloids and limonoids among African genera of the Toddalioideae is discussed in relation to their potential importance for an understanding of the systematics of this group of species.

Introduction

Traditionally the majority of the Rutaceae has been divided between three subfamilies, the Rutoideae, Toddalioideae and Aurantioideae [1]. While the position of the Aurantioideae appears to be well established the same cannot be said for the other two subfamilies. Hartley [2] states that the criteria employed to distinguish between Toddalioideae and Rutoideae are, in terms of the Rutaceae, unnatural, artificially dividing many obviously allied taxa. For example, in his revision of *Tetradium* (Rutoideae) Hartley [2] recognises its close relationship with *Phellodendron* (Toddalioideae) and *Zanthoxylum* (Rutoideae). Similarly he proposes a close affinity between *Acronychia* (Toddalioideae) and *Melicope* (Rutoideae).

The distribution of alkaloids, coumarins and limonoids in the Rutoideae and Toddalioideae offer support for Hartley's arguments [3], particularly in respect to the association between *Phellodendron*, *Zanthoxylum*, *Tetradium*, *Toddalia* and *Fagaropsis* [4]. The African genera *Toddalia*, which also occurs on the Indian sub-continent, and *Fagaropsis* were considered by both Engler [5] and Verdoorn [6] to form part of the Toddalioideae (Table 1). However, the clear

TABLE 1. AFRICAN GENERA OF THE TODDALIOIDEAE [5]

Subtribe	Genus
Phellodendrinae	<i>Fagaropsis</i>
Oriciinae	<i>Oricia</i>
	<i>Diphasia</i>
Toddaliinae	<i>Araliopsis</i>
	<i>Vepris</i>
	<i>Toddalia</i>
	<i>Toddaliopsis</i>
	<i>Oriciopsis</i>
Amyridinae	<i>Teclea</i>

differentiation, on the basis of secondary metabolism, between these two and the other genera of the Toddalioideae occurring in Africa is evidence against such a relationship [3]. On the other hand, analyses of the distribution of alkaloids among the remaining genera of the African Toddalioideae [7, 8] has revealed a high degree of correlation, supporting their close association, but not the sub-tribal distinctions proposed by Engler [5]. Since previous chemotaxonomic assessments of the African Toddalioideae, which were based to a large extent on data from a few West African species [7, 8], a considerable amount of additional information has become available for taxa from throughout sub-Saharan Africa. In this paper we report on the major alkaloidal constituents of five Ethiopian species

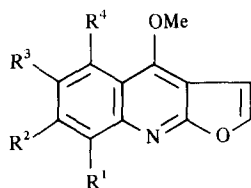
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and review our present knowledge of the distribution of secondary metabolites within the African Toddalioideae and its taxonomic implications.

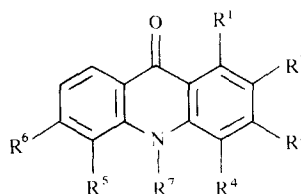
Results and Discussion

Isolation of alkaloids

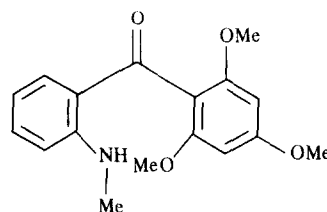
In the course of this study five species of Ethiopian origin were analysed; *Vepris dainellii* (Pichi-Serm) Kokwaro, *V. glomerata* (F. Hoffm.) Engl., *Teclea borensis* M. Gilbert, *T. simplicifolia* (Engl.) Verdoorn and *T. nobilis* Delile. *V. dainellii* yielded only the common furoquinolines kokusaginine (**1a**) and skimmianine (**1b**), and the acridones xanthoxoline (**2a**) and arborinine (**2b**), the latter identified only by TLC. *V. glomerata* also gave **1b** together with the rare furoquinoline monrifoline (**1c**). Kokwaro [9] considers *V. glomerata* to include *V. pilosa* which has previously been reported to contain **1a** and acridones. *Teclea borensis* gave only arbori-



- 1a** R¹=R⁴=H, R²=R³=OMe
1b R¹=R²=OMe, R³=R⁴=H
1c R¹=R⁴=H, R²=OMe, R³=OCH₂CH(OH)C(OH)Me₂
1d R¹=OH, R²=OMe, R³=R⁴=H
1e R¹=OCH₂CH=CMe₂, R²=OMe, R³=R⁴=H
1f R¹=R⁴=H, R²R³=O—CH₂—O
1g R¹=OMe, R²R³=O—CH₂—O, R⁴=H
1h R¹=R⁴=H, R²=OCH₂CH=CMe₂, R³=OMe
1i R¹=OMe, R²=R³=R⁴=H
1j R¹=OMe, R²=OCH₂CH(OH)C(OH)Me₂, R³=R⁴=H
1k R¹=R²=R³=OMe, R⁴=H
1l R¹=OH, R²R³=O—CH₂—O, R⁴=CH₂CH=CMe₂
1m R¹=OCH₂CH=CMe₂, R²R³=O—CH₂—O, R⁴=H
1n R¹=OH, R²R³=O—CH₂—O, R⁴=H
1o R¹=OH, R²R³=O—CH₂—O, R⁴=CH₂CH₂C(OH)Me₂
1p R¹=R³=OMe, R²=R⁴=H

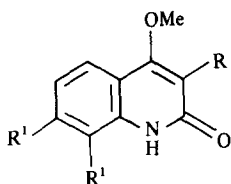


	R ¹	R ²	R ³	R ⁴	R ⁵	R ⁶	R ⁷
2a	OH	OMe	OMe	H	H	H	H
2b	OH	OMe	OMe	H	H	H	Me
2c	OH	H	OMe	H	H	H	Me
2d	OMe	H	OMe	H	H	H	Me
2e	OMe	OMe	OMe	H	H	H	Me
2f	OMe	O—CH ₂ —O		H	H	H	Me
2g	OH	O—CH ₂ —O		H	H	H	Me
2h	OMe	H	OMe	OMe	H	H	Me
2i	OMe	OMe	OMe	OMe	H	H	Me
2j	OMe	O—CH ₂ —O		H	OMe	H	Me
2k	OMe	H	OMe	H	OMe	H	Me
2l	OMe	O—CH ₂ —O		H	OMe	OMe	Me



2m

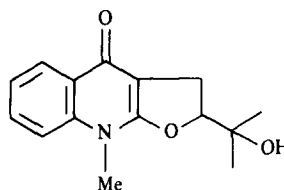
nine (**2b**). From *T. simplicifolia*, a species which had previously been reported to contain unidentified furoquinolines and a simple phenylethylamine [10], we have now obtained **1b** and **1c** together with edulinine (**3a**), isoplatydesmine (**4**) and ribalinine (**5**). In addition, this species has yielded two novel furoquinolines, isohaplopyrine (**1d**) and the corresponding 3,3-dimethylallyl ether (**1e**), details of which will be published elsewhere. Compounds **1a**, **1b**, **2b**, **3a**, **4** and **5** were identified by direct comparison with authentic samples and **2a** and **1c** by spectroscopic analysis. In the case of **1c** the position of the methoxyl and prenyloxy substituents were fixed



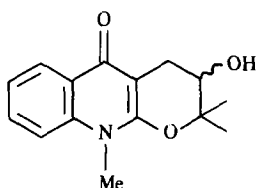
3a R = CH₂CH(OH)C(OH)Me₂ R¹ = H

3b R = CH₂CH=CMe₂ R¹ = OMe

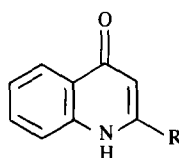
3c R = CH₂COC(OH)Me₂ R¹ = OMe



4



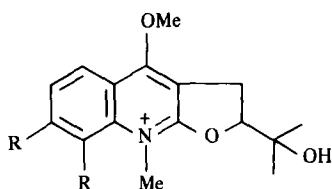
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6a R = (CH₂)₂CH=CHCH₂CH=CHCH₂Me

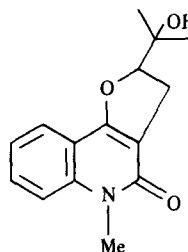
6b R = (CH₂)₈CH₂OH

6c R = (CH₂)₉COMe



7a R = H

7b R = OMe



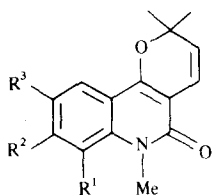
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by means of NOE experiments [11]. The isolation of **1b**, **1c**, **3a**, **4**, **5** and the further furoquinolones maculine (**1f**), flindersiamine (**1g**) and nobiline (**1h**) from *T. nobilis* has already been reported [11].

Distribution of alkaloids

Since the last review of alkaloid distribution throughout the African Toddalioidae [7] there

have been reports for a further 16 species, making a total of 24 which are known to yield alkaloids derived wholly or in part from anthranilic acid. These alkaloids include 4-quinolones (**6a–6c**), 3-prenyl-2-quinolones (**3a–3c**), quaternary 2-isopropyl-2,3-dihydrofuroquinolones (**7a**, **7b**), linear (**4**) and angular (**8**) 2-isopropyl-2,3-dihydrofuroquinolones, furoquinolones (**1a–1p**), a linear dihydropyranoquinolone (**5**), angular pyranoquinolones (**9a–9f**), quinolone dimers



9a $R^1 = \text{OMe}, R^2 = R^3 = \text{H}$

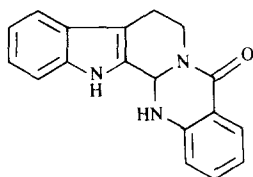
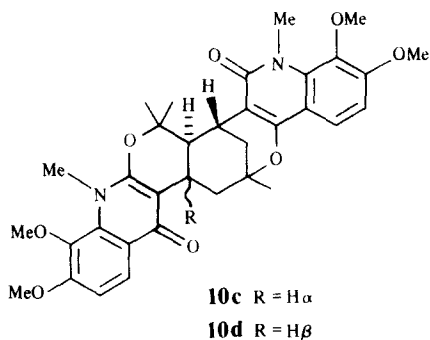
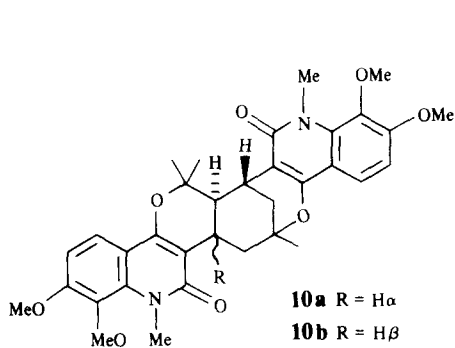
9b $R^1 = \text{H}, R^2 = R^3 = \text{OMe}$

9c $R^1 = R^2 = \text{OMe}, R^3 = \text{H}$

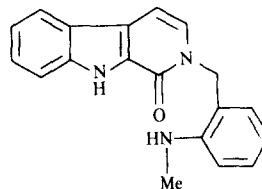
9d $R^1 = R^3 = \text{H}, R^2 = \text{OCH}_2\text{CH}=\text{CMe}_2$

9e $R^1 = \text{OMe}, R^2 = \text{OCH}_2\text{CH}=\text{CMe}_2, R^3 = \text{H}$

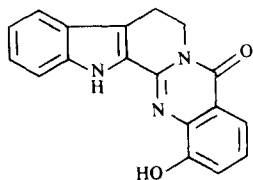
9f $R^1 = \text{OMe}, R^2 = \text{OCH}_2\text{CH}-\text{CMe}_2, R^3 = \text{H}$



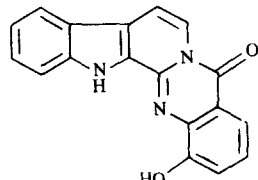
11a



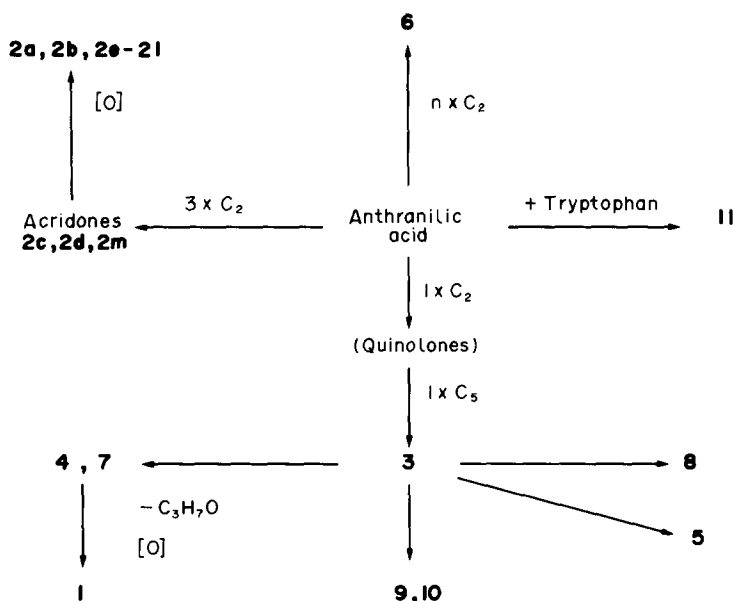
11b



11c



11d



SCHEME 1. RELATIONSHIPS BETWEEN THE ALKALOIDS OF THE AFRICAN TODDALIOIDEAE (excluding *Toddalia* and *Fagaropsis*). C_2 =acetate; C_5 =mevalonate.

(10a–10d), acridones (2a–2m) and indoloquinazolines (11a–11d). The biogenetic relationships between these alkaloid types are shown in Scheme 1 and specific sources within the African Toddalioideae in Table 2.

Although the number of alkaloids recorded has more than doubled since the last review there has been little extension in biosynthetic range. The quinolone dimers (10a–10d) from *V. louisii* and *O. renieri* are probably best considered as artefacts of angular pyranoquinolone precursors [12]. The 3-prenylated 2-quinolones (3a–3c) from *V. louisii* and *T. nobilis* can be regarded as precursors, or in the case of edulinine (3a) a breakdown product, of dihydrofuroquinolines. The 2-alkyl-4-quinolones (6a–6c) are still known only from *V. ampody*. Tecleanone (2m) can be considered as a trapped intermediate in the formation of acridones and is always found with them. The dihydrofuroquinolines (4a, 7a, 7b) are rare and are associated with furoquinolines which are presumably derived from them. The linear pyranoquinolone (5) is restricted to three species and indoloquinazolines (11a–11d) to two. However, recent HPLC studies (Dagne, E. and Yenesew, A., unpublished results) suggest that both compounds 4 and 5 may be more

widely distributed than previous analyses have indicated. Both indoloquinazolines and quaternary dihydrofuroquinolines are also relatively difficult to isolate and are likely to have been overlooked, making them poor taxonomic markers at present.

From the above analysis potentially useful taxonomic markers are narrowed to the furoquinolines (1a–1p), angular pyranoquinolones (9a–9f), the linear dihydropyranoquinolone ribalinine (5) and acridones (2a–2l) (Table 3 shows the distribution of these types among the species examined to date). Three of these have been sub-divided according to oxygen substitution patterns as follows: (a) furoquinolines: oxygenation at 6,7, 7,8 and 6,7,8 are tabulated separately. It is presumed that the 6,7,8-pattern derives from one or both of the others. Single examples of simple 8-substitution (*V. stolzii*) and 6,8-substitution (*O. renieri*) are not included; (b) angular pyranoquinolones: similarly separated into 7 only, 6,7 and 7,8-substitution; (c) acridones: the 1,3-oxygenation pattern represents the lowest oxidation level. Further oxidation at C-2 is tabulated separately. Equivalent oxidation at C-4 is limited to acridones from *T. boiviniana* and is not included. Ability to oxygenate acridones in

TABLE 2. ALKALOIDS REPORTED FROM SPECIES OF THE AFRICAN TODDALIOIDEAE (*Toddalia* and *Fagaropsis* have been omitted, source ref. [10] unless otherwise noted)

Alkaloid	Sources*
4-Quinolones	
6a-6c	Va
2-Quinolones	
Edulinine (3a)	Tno[11], Tsi
Preskimmianine (3b)	VI
Veprisolone (3c)	VI
Dihydrofuroquinolines	
<i>N</i> -Methylplatydesminium (7a)	As
Veprisinium (7b)	VI
Dihydrofuroquinolones	
Isoplatydesmine (4)	As, Tno[11], Tsi
Araliopsine (8)	As
Furoquinolines	
γ-Fagarine (1i)	Vs
Maculine (1f)	As, Tno[11], Ts, Tu, Vb
Kokusaginine (1a)	As, Og, Or, Os, To, Tu, Tv, Va, Vb, Vd, Vg
Montrifoline (1c)	Tno[11], To, Tsi, Tv, Tg
Nobiline (1h)	Tno[11]
Skimmianine (1b)	As, Dk, Tno[11], Ts, Tsi, Tu, Tv, Vb, Vd, Vg, Vs
Evoxine (1j)	Tb
Isohaplopine (1d)	Tsi
— (1e)	Tsi
Flindersiamine (1g)	As, ORg, Tno[11], To, Ts, Tv, Vb
Halfordinine (1k)	As, Da, Os, Tv
Tecleaverdoornine (11)	Tv
Tecleamine (1m)	To
Tecleine (1n)	To[21], Tv[22]
Tecleaverdine (1o)	Tc[12]22
Maculosidine (1p)	Or
Linear pyranoquinolone	
Ribalinine/folifine (5)	As, Tno[11], Tsi
Angular pyranoquinolone	
— (9a)	Or
Oricine (9b)	Or, Os
Veprisine (9c)	Or, VI, Vs
— (9d)	Vs
— (9e)	Vs
— (9f)	Vs
Pyranoquinolone dimers	
Vepridimerines A-D (10a-10d)	Or, VI
Acridones	
Xanthoxoline (2a)	Vd
— (2c)	Vp
— (2d)	Da, Os, Tv, Va, Vb, Vp
— (2e)	Vb
Arborinine (2b)	Dk, Or, Tb, Tbo, Tn, Vb, Vp
Evoxanthine (2f)	Dk, Og, Or, Os, Tb, Tg, Tn, Tv, Va, Vb
Norevioxanthine (2g)	Tg
— (2h)	Tb
Melicopicine (2i)	Tb, Tt[23]
Tecleanone (2m)	Dk, Or, Os, Tg, Tv
Tecleanthine (2j)	Da, Os, Tb, Tn, Tt[13], Tv
— (2k)	Tb
— (2l)	Tb, Tt[23]
Indoloquinazolines	
(11a, 11b)	As
(11c, 11d)	VI

*For codes to species see Table 3.

the B-ring (C-5 and/or C-6) is tabulated separately. All acridones are *N*-methylated, except for xanthoxoline (**2a**).

The striking feature of Table 3 is the uniformity in distribution of furoquinoline and acridone alkaloids. Furoquinolines occur in all six genera and are missing only from a group of *Teclea* species (*T. boiviniana*, *T. grandifolia*, *T. natalensis*) that are rich in acridones. All three substitution patterns occur widely; the 6,7 and 7,8 patterns are common throughout much of the Rutaceae [3, 10] but the African Toddalioidae can be considered as a centre for production of the 6,7,8 pattern.

Acridones occur in four of the six genera but have not been recorded in either *Araliopsis* or *Oriciopsis*. The commonest pattern of oxidation is for the 1,2,3 positions of ring A. Oxidation of the B-ring has been found in species of *Diphasia*, *Oricia* and *Teclea* but not to date in *Vepris*. Perhaps the most interesting observation is that in *Teclea* there appears to be a group of species (*T. nobilis*, *T. oubanguiense*, *T. simplicifolia*, *T. sudanica*, *T. unifoliolata*) that do not produce this class of alkaloids but are sources of furoquinolines.

To date angular pyranoquinolones have been recorded only from two species of *Oricia* and two of *Vepris*. The similarity in the pyranoquinolone production between these four species is pronounced but is noteworthy that the two *Oricia* spp. also produce acridones but the two *Vepris* spp. do not. Ribalinine is reported only from *Araliopsis* and *Teclea* but is almost certainly to be found in *Vepris* as well (Dagne, E. and Yenesew, A., unpublished results).

Distribution of limonoids

In comparison with the alkaloids very little is known about the distribution of limonoids. Flindissol (**12**), isolated from *A. soyauxii* [7], is an obvious protolimonoid. *Teclea grandifolia* has been reported to contain three limonoids (**13a**, **14**, **15**) in which ring-A is modified but ring-D lactonization has not occurred [13]. *Teclea oubanguiense* has also yielded **13a**, **14**, **15** together with two further limonoids of the same type (**13b**, **16**) [14] and **13a** is reported from *T. verdoorniana* [15]. A new limonoid, oriciopsin (**17**), in which fission has occurred in ring-D and

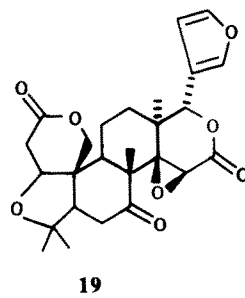
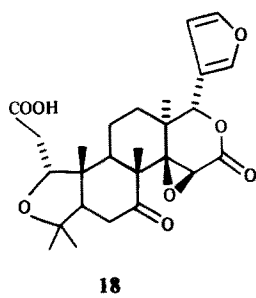
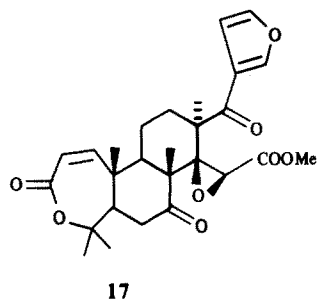
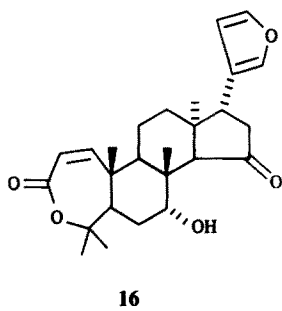
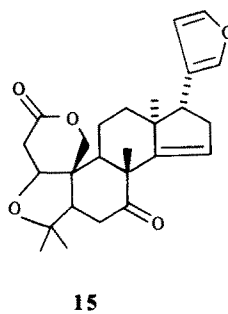
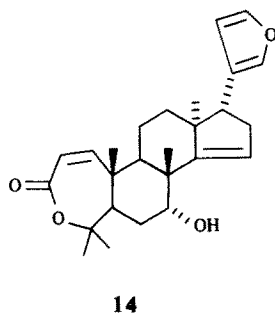
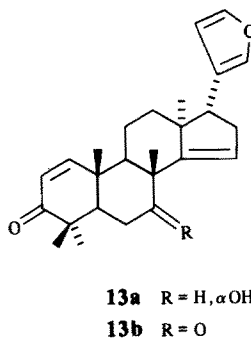
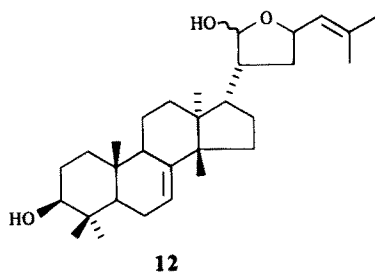


TABLE 3. DISTRIBUTION OF SOME ALKALOID TYPES AMONG THE AFRICAN TODDALIOIDEAE

Genus/Species (Code)	Fq			L	7	Pq		13	Acr	
	67	78	678			67	78		123	5/6
<i>Araliopsis</i>										
<i>A. soyauxii</i> Engl. (As)*	+	+	+	+						
<i>Diphasia</i>										
<i>D. angolensis</i> Verdoorn (Da)			+					+	+†	+
<i>D. klaineana</i> Pierre (Dk)		+							+	
<i>Oricia</i>										
<i>O. gabonensis</i> Pierre (Og)	+								+	
<i>O. renieri</i> Gilbert (Or)	+				+	+	+		+	
<i>O. suaveolens</i> Verdoorn (Os)	+		+				+		+	+
<i>Oriciopsis</i>										
<i>O. glaberrima</i> Engl. (ORg)			+							
<i>Teclea</i>										
<i>T. boiviniana</i> H. Perr. (Tb)			+					+	+‡	+
<i>T. borensis</i> M. Gilbert (Tbo)									+	
<i>T. grandifolia</i> Engl. (Tg)									+	
<i>T. natalensis</i> Engl. (Tn)									+	+
<i>T. nobilis</i> Delile (Tno)	+	+	+	+						
<i>T. oubanguiense</i> Aubrev. et Perr. (To)	+		+							
<i>T. simplicifolia</i> Verdoorn (Tsi)	+	+		+						
<i>T. sudanica</i> A. Chev. (Ts) ²	+	+	+							
<i>T. unifoliolata</i> Baill. (Tu)	+	+								
<i>T. verdoorniana</i> Exell et Mendonca (Tv)	+	+	+					+	+	+
<i>Vepris</i>										
<i>V. ampody</i> H. Perr. (Va)	+							+	+	
<i>V. bilocularis</i> Wight et Arn. (Vb)	+	+	+					+	+	
<i>V. dainellii</i> Kokwaro (Vd)	+	+							+	
<i>V. glomerata</i> Engl. (Vg)	+	+								
<i>V. louisii</i> Gilbert (Vl)		+§					+			
<i>V. pilosa</i> Engl. (Vp)	+							+	+	
<i>V. stolzii</i> Verdoorn (Vs)	+				+	+				

Fq=furoquinoline (67, 78, 678=substitution patterns), Pq=pyranoquinolone (L=linear, 7, 67, 78=substitution patterns for angular), Acr=acridones (13, 123, 5/6=substitution patterns).

*Including *A. tabouensis* Aubrev. et Pellegr.

†*V. heterophylla* Letouzey.

‡This pattern has been found only in conjunction with oxygenation at C-5 and/or C-6.

§This pattern found in dihydrofuroquinolines.

ring-A, has been isolated from *Oriciopsis glaberrima* [16]. Finally two *Vepris* species have also given limonoids in which both rings A and D have been modified; veprisone (**18**) from *V. bilocularis* [13] and limonin (**19**) from *V. louisii* [17]. In *Oriciopsis* the ring-A modification is of the obacunone type, in *Vepris* it is of the limonin type.

The picture that exists is therefore one of potential chemotaxonomic interest. In *Teclea* the limonoids isolated from three species show the full range of ring-A modifications found in the Rutaceae [13] but a lack of the ability to open ring-D with subsequent lactonisation suggesting that *Teclea* may lack oxidation systems relating to ring-D that are to be found in *Vepris* and *Oriciopsis*. Further information on the distribution of limonoids in these genera would be of considerable chemotaxonomic interest.

General comments

The uniformity in alkaloid profiles in the African Toddalioidae (excluding *Fagaropsis* and *Toddalia*) remains a striking feature not confounded by this further considerable influx of data. This, coupled with an apparent inability to synthesise coumarins, sets these genera apart from most of the remainder of Engler's Toddalioidae and Rutoideae, in which coumarins feature strongly [3]. Their closest affinity, in chemical terms, would appear to be with *Acronychia* (including *Baurella*), a genus probably originating in Australia [18] and which is a rich source of acridones and furoquinolines [10] but again appears to lack coumarins.

Within the African Toddalioidae it is not clear that alkaloid distribution offers any insight into phylogenetic relationships. Verdoorn [6] regarded *Araliopsis* as the most primitive genus.

Araliopsis soyauxii appears to lack acridone alkaloids, but then so do several species of *Teclea* and *Oriciopsis glaberrima*. This is probably best interpreted as loss of biosynthetic capacity rather than indicative of evolution from ancestors lacking the ability to produce acridone alkaloids. A similar interpretation should be placed on the apparent absence of furoquinolines from several *Teclea* species. Hall [8] questioned the validity of assigning separate generic status to many of the taxa within the African Toddalioidae and in particular was doubtful about the separation of *Teclea* and *Vepris*. Alkaloid data does not contradict Hall's view.

As noted above limonoid distribution may offer more hope for interpretation of phylogeny within the African Toddalioidae. *Araliopsis* yields a protolimonoid, whereas in *Teclea* limonoids occur with the typical obacunone-type (14) and limonin-type (15) A-ring modifications of the Rutaceae [13] but with ring-D not undergoing oxidative cleavage and lactone formation. In *Vepris* and *Oriciopsis* limonoids are found with modifications of ring-A and ring-D along the anticipated lines. This conforms well with Verdoorn's [6] suggestion that *Araliopsis*, *Teclea* and *Vepris* formed one line of development within the African Toddalioidae, with *Diphasia* and *Oricia* forming a second. Engler [5] placed *Oriciopsis* near *Vepris* and if that is accepted then Verdoorn's phylogeny shows one line of development producing limonoids of progressively higher oxidation levels and the other line is devoid of limonoids. The validity of this dichotomy awaits the test of further detailed phytochemical studies, particularly for limonoids.

Experimental

Plant material. *Teclea borensis* was collected from Sidamo Province at a locality 30 km N.E. of Negele at 1200 m. The voucher represents the type of the species [19]; *Vepris dainellii*, voucher Zemedede-532, at the Herbarium of the University of Addis Ababa was collected from the Harena State Forest in Bale Province (1500 m); *Vepris glomerata*, voucher Gilbert-7829, at the Herbarium of the University of Addis Ababa, material collected near Sof Omar, Bale Province (1450 m); *Teclea simplicifolia*, voucher Lisanework-104, at the Herbarium of the University of Addis Ababa, material collected in the Harena State Forest (as *V. dainellii*).

Isolation and identification of alkaloids from *Teclea borensis*. Powdered leaves (500 g) were extracted with EtOH. The alkaloid fraction was isolated by acid/base extraction and subjected to CC over silica gel eluting with CHCl_3 and then Sephadex LH20 chromatography eluting with CHCl_3 -MeOH

(1:1) to give **2b** (120 mg), mp 170–173° identical in all respects (UV, IR, ^1H NMR, EIMS, mmp) with an authentic specimen [20].

Isolation and identification of alkaloids from *Vepris glomerata*. Aerial parts (800 g) were extracted in a Soxhlet with EtOH. The alkaloid containing fraction was isolated from the EtOH concentrate by acid extraction and was then separated by CC over silica gel eluting with CHCl_3 -MeOH (98:2) to give **1b** (2 mg; identical with an authentic sample by UV, IR, ^1H NMR, EIMS, mmp, co-TLC) and with CHCl_3 -MeOH (95:5) to give **1c** (6 mg), mp 182–184°. Found, M^+ 347.1369; $\text{C}_{19}\text{H}_{21}\text{NO}_6$ requires 347.1369. ^1H NMR (360MHz, CDCl_3), δ 7.57 (1H, *d*, $J=2.8$ Hz, H-2), 7.51 (1H, *s*, H-5), 7.33 (1H, *s*, H-8), 7.04 (1H, *d*, $J=2.8$ Hz, H-3), 4.43 (3H, *s*, 4-OMe), 4.39 (1H, *dd*, $J=9.7$, 2.5 Hz, H-1'A), 4.23 (1H, *dd*, $J=9.7$, 5.8 Hz, H-1'B), 3.98 (3H, *s*, 7-OMe), 3.81 (1H, *dd*, $J=5.8$, 2.5 Hz, H-2'), 1.36 (3H, *s*, 3'-Me), 1.31 (3H, *s*, 3'-Me). NOE [signal irradiated; signal(s) enhanced (%)] : 3'-Me at δ 1.31 enhances H-2' (2.2%), H-1'B (2.3%); 3'-Me at δ 1.36 enhances H-2' (3.5%); 7-OMe enhances H-8 (21.3%); 4-OMe enhances H-3 (14.2%); H-1'B enhances H-8 (4.5%), H-1'A (8.2%), H-2' (2%); H-1'A enhances H-8 (6.5%), H-1'B (7.2%).

Isolation and identification of alkaloids from *Vepris dainellii*. Leaves (500 g) were extracted as for *V. glomerata*. The alkaloids were first separated on a Sephadex LH-20 column, eluting with CHCl_3 -MeOH (1:1) and then by CC over silica gel eluting with CHCl_3 -MeOH (99:1). From the eluates **1a** (65 mg), **1b** (73 mg), **2a** (6 mg) and **2b** (trace) were isolated. **1a** and **1b** were identified by direct comparison with 2 authentic samples (UV, IR, ^1H NMR, EIMS, co-TLC). **2a** was obtained as an amorphous powder: Found, M^+ 271.0845; $\text{C}_{16}\text{H}_{13}\text{NO}_4$ requires 271.0845. ^1H NMR (250 MHz, $\text{Me}_2\text{CO}-d_6$): δ 14.22 (1H, *s*, 1-OH), 10.90 (1H, *brs*, NH), 8.27 (1H, *d*, $J=8.3$ Hz, H-8), 7.71 (1H, *t*, $J=8.2$ Hz, H-6), 7.51 (1H, *d*, $J=8.6$ Hz, H-5), 7.28 (1H, *t*, $J=8.0$ Hz, H-7), 6.50 (1H, *s*, H-4), 3.92, 3.77 (2 \times 3H, 2 \times *s*, 2 \times OMe).

Isolation and identification of alkaloids from *Teclea simplicifolia*. Powdered leaves (500 g) were extracted as for *V. glomerata*. The alkaloid fraction was obtained by acid/base extraction and chromatographed over silica gel eluting with CHCl_3 containing increasing amounts of MeOH with the separated bands then being purified by prep. TLC on silica gel (CHCl_3 -MeOH 9:1). The following were identified by direct comparison with authentic compounds; **1b** (major), **1c**, **3a**, **4**, **5**. The structure elucidation of the novel alkaloids **1d** and **1e** will be reported elsewhere.

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