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ALKALOIDS FROM STEM BARKS OF *ORICIA RENIERI* AND *ORICIA GABONENSIS**

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Key Word Index—*Oricia renieri*; *Oricia gabonensis*; Rutaceae; furoquinoline alkaloids; acridone alkaloids; 3,4-pyrano-2-quinolone alkaloids; 7-methoxy-*N*-methylflindersine; 2-amino-benzophenones; chemical taxonomy.

Abstract—The stem barks of *Oricia renieri* and *O. gabonensis* have yielded nine alkaloids, including furoquinolines, acridones, 3,4-pyrano-2-quinolones and a 2-amino-benzophenone. One of the pyranoquinolones isolated from *O. renieri*, 7-methoxy-*N*-methylflindersine, is reported for the first time. All alkaloids were identified on the basis of spectral data. The chemotaxonomic significance of the alkaloids of these two species is discussed.

INTRODUCTION

The genus *Oricia* Pierre (Rutaceae) occurs throughout tropical Africa [1]. It forms part of the sub-family Toddalioideae which, as presently constituted in Africa, consists of between 50 and 100 species distributed between a number of closely allied and taxonomically difficult genera [2,3].

Previous studies on the chemistry of *Oricia* have been limited to two west African species; *O. suaveolens* Verdoorn and *O. gabonensis* Pierre. The initial investigation of *O. suaveolens* [4] revealed the wood of Nigerian material to contain large amounts of the pyrano-2-quinolone oricine (**1**). Later studies on the stem bark of Ghanaian material of this species [3, 5] yielded the amino-benzophenone tecleanone (**2**), the acridones (**3**), evoxanthine (**4**) and tecleanthine (**5**) and the furoquinolines, flindersiamine (**6**) and halfordinine (**7**). Oricine could not be detected in the Ghanaian material but a further investigation of the stem bark of Nigerian material confirmed [3] that oricine was the major product, accompanied by **4** in trace amounts. The stem bark of *O. gabonensis* is reported to contain the acridone **4** [6]. In addition to alkaloids both species yield large amounts of the pentacyclic triterpene, lupeol.

O. renieri Gilbert is a tree of the montane forests of Rwanda [7]. It is thought to be closely related to *O. suaveolens* [8]. In this paper we report the isolation and identification of nine alkaloids, one of them novel, from the stem bark of *O. renieri* and discuss their chemotaxonomic implications. We also report the results of a re-examination of the stem bark of *O. gabonensis*.

RESULTS AND DISCUSSION

Nine alkaloids and lupeol were isolated from a petrol extract of the stem bark of *O. renieri* by column chromatography and subsequent preparative TLC. Five of the alkaloids, oricine (**1**), tecleanone (**2**), evoxanthine (**4**), skimmianine (**8**) and arborinine (**10**) were identified by direct comparison with authentic samples. The identity of kokusaginine (**9**) was established on the basis of the absence of coupling between the two aromatic protons in the ^{1}H NMR spectrum and by the absence of a significant $[M-CHO]^+$ ion in the mass spectrum (cf. **8** [9] and **11**) which is indicative of lack of substitution at C-8. By contrast the isomeric maculosidine (**11**) showed *meta*-coupling between the two aromatic protons and gave a significant $[M-CHO]^+$ ion in the mass spectrum.

High resolution mass spectrometry indicated a composition $C_{17}H_{19}NO_4$ for the major alkaloid which gave spectral data typical of a pyranoquinolone, suggesting that it was an isomer of oricine (**1**). The absence of a shift in the UV spectrum on the addition of acid denoted an angular pyrano-2-quinolone rather than a linear pyrano-4-quinolone [10]. This was confirmed by the ^{13}C NMR which showed no resonances above 163.0 ppm. Typical resonance positions for the carbonyl carbons of 2-quinolones are reported to be close to 162 ppm whilst in 4-quinolones they resonate at *ca* 177 ppm [11,12].

In addition to the protons attributable to the pyran ring the ^{1}H NMR spectrum showed the presence of three Me substituents and two aromatic protons. On the basis of the ^{13}C NMR spectrum two of the Me signals could be assigned to OMe groups and the third was an *N*-Me. The two aromatic protons took the form of an AB quartet ($J = 8$ Hz) indicating *ortho*-coupling. The deshielded position of one of these protons (δ 7.69) is typical of H-5 [13] thus permitting placement of the OMe substituents at C-7 and C-8 with the assignment of structure (**12**). This alkaloid was recently reported for the first time from another African species of Rutaceae, *Vepris louisii*, and assigned the trivial name veprisine [14].

A further alkaloid, isolated in minor amounts, analysed for $C_{16}H_{17}NO_4$ by high resolution mass spectrometry. Analysis of spectral data showed it to be an angular pyranoquinoline differing from **12** by the absence of one of the OMe substituents. The H-5 proton was again present and showed *ortho*-coupling, thus requiring H-6 to be present. In addition H-6 showed *meta*-coupling

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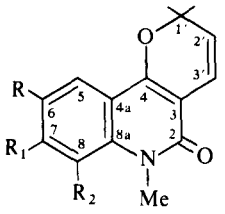
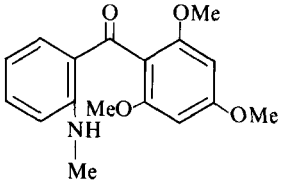
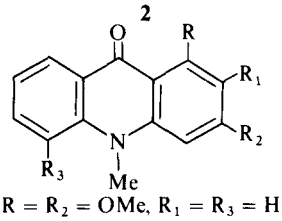


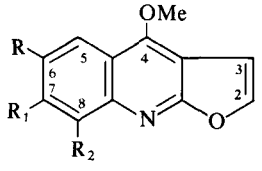
1 R = R_1 = OMe, R_2 = H
12 R_1 = R_2 = OMe, R = H
13 R_1 = OMe, R = R_2 = H





2

3 R = R_2 = OMe, R_1 = R_3 = H
4 R = OMe, R_1R_2 = O—Me—O, R_3 = H
5 R = R_3 = OMe, R_1R_2 = O—Me—O
10 R OH, R_1 = R_2 = OMe, R_3 = H



6 R_2 = OMe, RR_1 = O—Me—O
7 R = R_1 = R_2 = OMe
8 R_1 = R_2 = OMe, R = H
9 R = R_1 = OMe, R_2 = H
11 R = R_2 = OMe, R_1 = H

(J = 2 Hz) to a further aromatic proton which must therefore be placed at H-8. These data permit the assignment of structure (**13**) to this compound.

A similar examination of a small sample of the stem bark of *O. gabonensis* yielded only **4** and **8**, both identified by direct comparison with authentic samples.

Most of the nine alkaloids isolated from *O. renieri* are typical of and of widespread occurrence within the Rutaceae [15]. Tecleanone (**2**) has previously been reported only from three other species of the African Toddalioideae, including Ghanaian material of *O. suaveolens* [3]. Oricine (**1**) was previously known only from Nigerian material of *O. suaveolens* [4].

The least widely distributed of the alkaloid types produced by *O. reneiri* are the pyrano-2-quinolones. To date alkaloids of this type have been recorded in species of the genera *Vepris* [14], *Geijera* [15], *Haplophyllum* [15], *Flindersia* [15], *Atalantia* [16], *Zanthoxylum* [17,18], *Myrtopsis* [19], *Oricia* [15], *Adiscanthus* [20], *Spathelia* [15] and *Ptelea* [21]. Despite the apparently sporadic incidence of alkaloids of this type (the above 11 genera contain representatives of all five of the sub-families of the Rutaceae for which data is available) their occurrence in *O. renieri* may have some systematic significance.

The co-occurrence of **1** and **2** in *O. suaveolens* and *O. renieri*, but not in *O. gabonensis*, tends to support the suggestion [8] of a close affinity between those two taxa. The absence of pyranoquinolones from the isolated Ghanaian population of *O. suaveolens* and the absence or relative paucity of furoquinolines and acridones in Nigerian material of *O. suaveolens* contrasts markedly with the ability of *O. renieri* to produce considerable amounts of all three types of alkaloids. It has been suggested that the Nigerian and Ghanaian populations of *O. suaveolens* are in the process of speciation [3]. If this is so and if, in the process, the alkaloid profiles of the evolving species are becoming simplified then it would be expected that the parent species would possess a range of alkaloids similar to that found in *O. renieri*.

EXPERIMENTAL

Mps are uncorr. UV spectra were run in MeOH and IR spectra as KCl discs. ^{1}H NMR spectra were obtained at 90 MHz in $CDCl_3$ with TMS as int. standard. ^{13}C NMR spectra were obtained at 25.1 MHz using the same solvent and standard. EIMS were obtained at 70 eV (probe).

Plant material. Stem bark of *O. renieri* was collected in the prefecture of Cyangugu, Rwanda, from near the Cyangugu–Butere road in March 1980. A voucher, D. Bridson 478, has been deposited at the Herbarium of the Royal Botanic Cardens, Kew. Stem bark of *O. gabonensis* was collected in the Korup Forest Reserve, Cameroon, in April 1979. A voucher, D. W. Thomas 1151, has also been deposited at the Herbarium of the Royal Botanic Gardens, Kew.

Extraction of O. renieri *stem bark.* The ground bark (385 g) was extrd with petrol (bp 40–60°). On concn the petrol extract gave a ppt. which, on recryst from petrol (bp 60–80°)–EtOAc, yielded lupeol (4 g). The supernatant was subjected to CC over Si gel. Elution of the column with petrol (bp 60–80°) containing increasing amounts of EtOAc gave 10 compounds as follows: 10% EtOAc lupeol (3.9 g); 15% EtOAc **2** (43 mg); 20% EtOAc **12** (134 mg); 25% EtOAc **13** (29 mg); 30% EtOAc gave a mixture which was separated by prep. TLC (Si gel; toluene–EtOAc–HCO_2H, 5:4:1) to yield **8** (R_f 0.10, 72 mg) and **9** (R_f 0.17, 38 mg); 40% EtOAc gave a mixture which was separated by prep. TLC as before to yield **11** (R_f 0.21, 28 mg) and **10** (R_f 0.60, 47 mg); 45% EtOAc gave a mixture which was sepd by prep. TLC as before to yield **4** (R_f 0.10, 42 mg) and **1** (R_f 0.45, 37 mg).

Identification of isolated compounds. Oricine (**1**) [4], tecleanone (**2**) [22], evoxanthine (**4**) [23], skimmianine (**8**) [24], arborinine (**10**) [24] and lupeol were identified by direct comparison with authentic samples (mmp, co-TLC, UV, IR, ^{1}H NMR, EIMS).

Kokusaginine (**9**). Needles from EtOAc, mp 168° (lit. [5] 166°). Found: M^+ 259.0857; $C_{14}H_{13}NO_4$ requires 259.0844. UV and IR spectra identical with published data [5]. ^{1}H NMR: δ 4.02 (6 H, *s*, 6-OMe and 7-OMe), 4.43 (3 H, *s*, 4-OMe), 7.03, 7.58 (2 H, AB*q*, J = 2.5 Hz, H-3 and H-2), 7.36 (1 H, *s*, H-8), 7.50 (1 H, *s*, 5-H). EIMS *m/z* (rel. int.): 259 $[M]^+$ (100), 244 (47), 229 (2), 216 (12).

Maculosidine (**11**). Needles from EtOAc–C_6H_{14}, mp 170–171° (lit. [25] 184°). Found: M^+ 259.0831; $C_{14}H_{13}NO_4$ requires 259.0844. UV and IR spectra identical with published data [25]. ^{1}H NMR: δ 3.91 (3 H, *s*, 8-OMe), 4.04 (3 H, *s*, 6-OMe), 4.42 (3 H, *s*, 4-OMe), 6.73, 7.65 (2 H, AB*q*, J = 2 Hz, H-6 and H-8), 7.03, 7.35 (2 H, AB*q*, J = 2.5 Hz, H-3 and H-2). EIMS *m/z* (rel. int.):

259 $[M]^+$ (100), 258 (20), 244 (17), 230 $[M - CHO]^+$ (14), 229 (5), 216 (3), 214 (3).

Veprisine (**12**). Needles from EtOAc–C_6H_{14}, mp 87–89° (lit. [14] 89–90°). Found: M^+ 301.1327; $C_{17}H_{19}NO_4$ requires 301.1314. UV λ_{max} nm: 235, 263, 272, 334, 349, 364; no shift with HCl. IR ν_{max} cm^{-1}: 1650 (CO), 1600. ^1H NMR: δ 1.52 (6 H, *s*, 1′-Me_2), 3.76 (3 H, *s*, N–Me), 3.92, 3.95 (2 × 3 H, 2 × *s*, 7-OMe and 8-OMe), 5.46, 6.73 (2 H, AB*q*, J = 10 Hz, H-2′ and H-3′), 6.85, 7.69 (2 H, AB*q*, J = 8 Hz, H-6 and H-5). ^{13}C NMR: δ 28.3 (*q*, 1′-Me_2), 33.6 (*q*, N–Me), 56.5 (*q*, 7-OMe), 61.8 (*q*, 8-OMe), 78.9 (*s*, C-1′), 104.3 (*s*, C-4a), 107.6 (*d*, C-6), 112.4 (*s*, C-3), 118.4, 119.4 (2 × *d*, C-2′ and C-5), 125.9 (*d*, C-3′), 135.0, 137.3 (2 × *s*, C-8 and C-8a), 155.5, 156.0 (2 × *s*, C-4 and C-7), 163.0 (*s*, C-2). EIMS *m/z* (rel. int.): 301 $[M]^+$ (30), 286 (100), 228 (3), 95 (13).

7-*Methoxy*-N-*methyl flindersine* (**13**). An oily liquid that could not be crystallized. Found: M^+ 271.1214; $C_{16}H_{17}NO_3$ requires 271.1208. UV λ_{max} nm: 233, 260, 269, 336, 350, 366; no shift with HCl. IR ν_{max} cm^{-1}: 1640. ^1H NMR: δ 1.50 [6 H, *s*, 1′-Me_2], 3.64 (3 H, *s*, N–Me), 3.91 (3 H, *s*, 7-OMe), 5.46, 6.74 (2 H, AB*q*, J = 10 Hz, H-2′ and H-3′), 6.77 (1 H, *d*, J = 2 Hz, H-8), 6.87 (1 H, *dd*, J_1 = 8 Hz, J_2 = 2 Hz, H-6), 7.89 (1 H, *d*, J = 8 Hz, H-5). EIMS *m/z* (rel. int.): 271 $[M]^+$ (71), 256 (100).

Isolation and characterization of compounds from O. gabonensis *stem bark*. The ground stem bark (20 g) was extracted with petrol (bp 40–60°). On concn the petrol extract gave a ppt. of lupeol (500 mg). Prep. TLC of the supernatant over Si gel (C_6H_6–EtOAc, 1:1) gave **4** (75 mg) and **8** (28 mg), both identical with authentic samples.

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