Chemical Constituents of *Polyalthia nemoralis*

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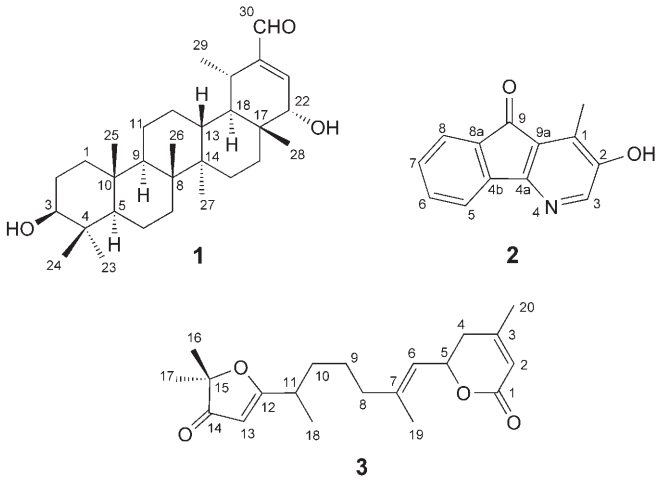
Three new natural products, the taraxastane-type triterpenoid **1**, the azafluorene-based constituent 2-hydroxyonychine (**2**), and the diterpenoid nemoralisin (**3**) were isolated from the EtOH extract of *Polyalthia nemoralis*, along with five known compounds. The structures of the new compounds were established by in-depth spectroscopic and mass-spectrometric analyses, as well as by chemical transformation.

Introduction. – The genus *Polyalthia* (Annonaceae), comprising *ca.* 120 species, is widely distributed in tropical and subtropical areas, with 17 species occurring in southern China [1]. Previous chemical studies on this genus have led to the isolation of diterpenes of the clerodane, halimane, and labdane types [2–6], of triterpenes [7][8], benzopyran derivatives [9], and several types of alkaloids, including aporphines [4][10], indolosesquiterpenes [11][12], benzylisoquinolines [13], tetrahydroprotoberberines [14][15], morphinanedienones [16], and some azafluorene alkaloids [17][18]. Many constituents exhibited cytotoxic [4], antimicrobial [19], antimalarial [20], and anti-HIV activities [21].

Polyalthia nemoralis A. DC., a shrub distributed in southern China and Vietnam [1], has been applied as an antimalarial agent in traditional folklore medicine. Herein, we describe the isolation and structure elucidation of three new compounds, (3β,22α)-3,22-dihydroxytaraxast-20-en-30-al (**1**), 2-hydroxyonychine (**2**), and nemoralisin (**3**) from the EtOH extract of the twigs and leaves of *P. nemoralis*. Also isolated were five known compounds: 1-aza-9,10-dimethoxy-4-methyl-2-oxo-1,2-dihydroanthracene, (3β)-lupane-3,20,28-triol, spermatheridine, (3β,24*R*)-cycloartane-3,24,25-triol, and cyperusol C.

Results and Discussion. – Compound **1**, a colorless, amorphous powder, was assigned the molecular formula $C_{30}H_{48}O_3$, based on HR-EI-MS (M^+ at m/z 456.3604; calc. 456.3603) in combination with NMR data (*Table 1*). The IR spectrum of **1** showed strong absorption bands at 3442 and 1681 cm^{-1} due to OH and conjugated C=O groups, respectively. Its ^{1}H-NMR spectrum displayed six Me *singlet*s at δ(H) 0.77, 0.98, 0.86, 1.04, 1.00, and 0.61, one Me *doublet* at δ(H) 1.06 (*d*, $J = 6.5$ Hz), two oxygenated methines close to the OH groups [δ(H) 3.21 (*dd*, $J = 11.2$, 5.1 Hz); 3.70 (*d*, $J = 6.3$ Hz)], an olefinic resonance at δ(H) 6.79 (*d*, $J = 6.3$ Hz), and an aldehyde function at δ(H) 9.46 (*s*). The ^{13}C-NMR spectrum of **1** exhibited 30 signals, which were assigned



as seven Me, eight CH_2, seven sp^3 CH (two being oxygenated; δ(C) 79.0, 72.9), a trisubstituted C=C bond (δ(C) 150.1, 145.5), an aldehyde C=O group (δ(C) 194.7), and five quaternary sp^3 C-atoms. These data suggested that **1** was an oxygenated triterpenoid bearing an aldehyde group.

The NMR data of rings *A*–*D* of **1** were very similar to those of (3β,22β)-taraxast-20-ene-3,22-diol [22], indicating that they shared the same partial structure. The HMBC correlations (*Fig. 1*) confirmed the above deduction, and established the planar structure of **1**. The two geminal Me(23) and Me(24) groups at δ(H) 0.77 and 0.98 showed HMBC correlations with C(3), C(4), and C(5) at δ(C) 79.0, 38.9, and 55.3, respectively, which indicated that they were attached to C(4), and indirectly confirming the presence of a 3-OH group. The HMBC correlations of Me(29)/C(20), H–C(19)/C(20), H–C(19)/C(21), H–C(21)/C(19), and H–C(21)/C(17) revealed Δ^{20} unsaturation. The aldehyde H-atom at δ(H) 9.46 correlated with both C-atoms of the C=C bond, suggesting that they were conjugated; so, the CHO group was linked to C(20). This was further confirmed by HMBC correlations of H–C(30)/C(19) and H–C(21)/C(30), and by a ^4J correlation from H–C(30) to C(18) (δ(C) 40.4). In the ^{1}H-NMR spectrum, the oxymethine resonance at δ(H) 3.70 had the same coupling constant (6.3 Hz) as H–C(21) (δ(H) 6.79), indicating that they were adjacent. Further HMBC cross-peaks of H–C(21) to C(22), and of H–C(22) to C(16), C(17), C(18), C(20), and C(21), as well as of Me(28)/C(22) confirmed the location of the second OH group at C(22) (*Fig. 1*).

Regarding the configuration of **1**, the NOESY correlations (*Fig. 2*) of H–C(3)/H–C(5), H–C(3)/H–C(23), H–C(5)/H–C(9), H–C(5)/H–C(23), H–C(9)/H–C(27), H–C(13)/H–C(26), H–C(13)/H–C(28), H–C(18)/H–C(27), H–C(18)/H–C(29), H–C(19)/H–C(28), H–C(25)/H–C(24), and H–C(25)/H–C(26) showed that H–C(3), H–C(5), H–C(9), H–C(18), Me(23), Me(27), and Me(29) were all α-orientated, whereas H–C(13), H–C(19), 3-OH, Me(24), Me(25), Me(26), and Me(28) were in β-orientation, just as in (3β,22β)-taraxast-20-ene-3,22-diol [22]. The NOESY correlation between H–C(22) and H–C(28) indicated

Table 1. *^{1}H-, ^{13}C-, and 2D-NMR Data of* **1**. At 400/100 MHz, resp., in $CDCl_3$; δ in ppm, J in Hz.

Atom	δ(H)	δ(C)	HMBC (H → C)	NOESY
CH_2(1)	1.70–1.72 (*m*)	38.8	2, 3, 5, 10, 25	
CH_2(2)	1.61–1.64 (*m*)	27.4	1, 3, 4	
	1.55–1.57 (*m*)			
H–C(3)	3.21 (*dd*, J = 11.2, 5.1)	79.0	1, 2, 4, 23, 24	5, 24
C(4)		38.9		
H–C(5)	0.69–0.73 (*m*)	55.3	4, 6, 7, 10, 25	9, 24
CH_2(6)	1.38–1.41 (*m*)	18.3	4, 5, 7, 10	
	1.52–1.55 (*m*)			
CH_2(7)	1.40–1.42 (*m*)	34.2	5, 6, 14, 26	
C(8)		42.2		
H–C(9)	1.29–1.31 (*m*)	50.4	10, 11, 25	27
C(10)		37.1		
CH_2(11)	1.57–1.59 (*m*)	21.4	10	
	1.30–1.32 (*m*)			
CH_2(12)	1.28–1.30 (*m*)	27.3		
	1.76–1.79 (*m*)			
H–C(13)	1.73–1.76 (*m*)	38.5	8, 12, 19, 27	26, 28
C(14)		41.0		
CH_2(15)	1.77–1.82 (*m*)	26.6	13, 16, 26	
	1.12–1.16 (*m*)			
CH_2(16)	1.98 (*dt*, J = 4.3, 13.6)	29.5	15, 17, 28	
	1.02–1.04 (*m*)			
C(17)		38.3		
H–C(18)	1.50–1.52 (*m*)	40.4	13, 19, 28, 29	27, 29
H–C(19)	2.22–2.29 (*m*)	29.5	13, 18, 20, 21, 29	28
C(20)		150.1		
H–C(21)	6.79 (*d*, J = 6.3)	145.5	17, 19, 22, 29, 30	
H–C(22)	3.70 (*d*, J = 6.3)	72.9	16, 17, 18, 20, 21, 28	26, 28
Me(23)	0.77 (*s*)	15.4	3, 4, 5, 24	
Me(24)	0.98 (*s*)	28.0	3, 4, 5, 23	
Me(25)	0.86 (*s*)	16.3	1, 5, 9, 10	23, 26
Me(26)	1.04 (*s*)	16.0	7, 8, 9, 14	
Me(27)	1.00 (*s*)	14.7	8, 13, 14, 15	
Me(28)	0.61 (*s*)	17.9	16, 17, 18, 22	
Me(29)	1.06 (*d*, J = 6.5)	23.4	18, 19, 20	
H–C(30)	9.46 (*s*)	194.7	18, 19, 20, 21	

that the 22-OH group was α-orientated. This was confirmed by the relatively large coupling constant (J = 6.3 Hz) between H–C(21) and H_β–C(22). In the case of a β-oriented 22-OH group, a very small coupling constant would have been expected, because a dihedral angle of *ca.* 90° would be present for H–C(21)–C(22)–H_α [22]. From these data, the structure of compound **1** was fully assigned.

Compound **2**, obtained as a yellowish solid, had the molecular formula $C_{13}H_9NO_2$, based on HR-EI-MS (M^+ peak at m/z 211.0629 (calc. 211.0633)). Two noticeable EI-MS fragment-ion peaks at m/z 51 and 77 indicated the presence of a substituted benzene ring. The IR spectrum showed absorption bands at 3428 (OH), 1714 (C=O), and at 1608, 1457, 920, and 742 cm^{-1} (aromatic ring). Its ^{1}H-NMR spectrum (*Table 2*)

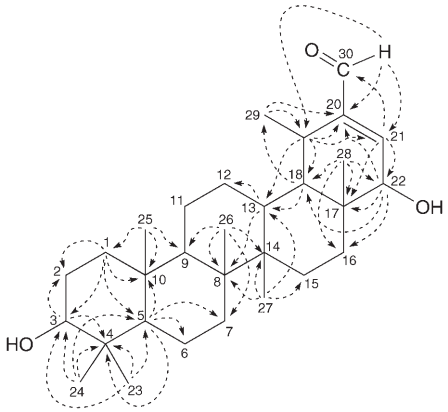


Fig. 1. *Key HMBC correlations of* **1**

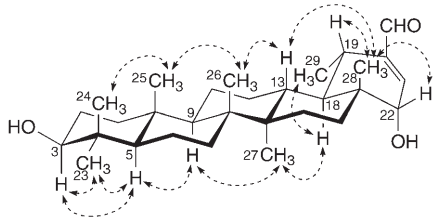


Fig. 2. *Key NOESY correlations of* **1**

Table 2. *^{1}H-, ^{13}C-, and 2D-NMR Data of* **2**. At 400/100 MHz, resp., in CD_3OD; δ in ppm, J in Hz.

Atom[1])	δ(H)	δ(C)	HMBC
C(1)		137.7	
C(2)		155.7	
H–C(3)	7.94 (*d*, *J* = 1.2)	139.3	1, 2, 4a
C(4a)		157.6	
C(4b)		144.7	
H–C(5)	7.68 (*ddd*, *J*= 7.4, 2.0, 1.2)	121.3	6, 7, 4a
H–C(6)	7.57 (*ddd*, *J* = 7.4, 7.4, 1.0)	136.9	8, 4b
H–C(7)	7.37 (*ddd*, *J* = 7.4, 7.4, 1.0)	131.3	5, 6, 8, 8a
H–C(8)	7.60 (*ddd*, *J* = 7.4, 1.9, 1.1)	125.1	6, 7, 4b
C(8a)		136.8	
C(9)		194.8	
C(9a)		128.7	
Me–C(1)	2.49 (*d*, *J* = 1.2, 3 H)	10.7	1, 2, 9a
OH–C(2)	4.59 (*s*)		

displayed signals due to five aromatic H-atoms at δ(H) 7.37 – 7.94, a Me *doublet* at δ(H) 2.49, which was probably linked to an sp^2 C-atom, and an exchangeable *singlet* at δ(H) 4.59.

[1]) Arbitrary atom numbering.

The ^{13}C-NMR spectrum of **2** (*Table 2*) indicated the presence of one Me, five sp^2 CH, one C=O (δ(C) 194.8), and six sp^2 quaternary C-atoms. A typical 1,2-disubstituted benzene unit was inferred from the coupling pattern of the resonances at δ(H) 7.37, 7.57, 7.60, and 7.68. The resonance at δ(H) 7.94 (J = 1.2 Hz, 1 H), which coupled with δ(H) 2.49 (Me), was assigned to a second aromatic ring. In the HMBC spectrum of **2** (*Fig. 3*)[1]), the Me group showed correlations with C(1) (δ(C) 137.7), C(2) (155.7), and C(9a) (128.7), and the downfield signal at δ(H) 7.94 correlated with C(1), C(2), and C(4a) (δ(C) 157.6). Therefore, the other aromatic ring was established as a tetrasubstituted pyridine. From analysis of the HMBC data, together with inspection of NMR chemical shifts and coupling constants, the structure of compound **2** was elucidated as 2-hydroxyonychine, which corresponds to 2-hydroxy-1-methyl-4-azafluoren-9-one (= 3-hydroxy-4-methyl-5*H*-indeno[1,2-*b*]pyridin-5-one). This was additionally corroborated by chemical derivatization. Thus, methylation of **2** with MeI in acetone gave, as the major product, 2-methoxyonychine, whose ^{1}H-NMR data were identical to those reported previously [23].

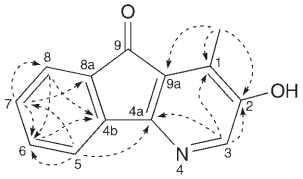


Fig. 3. *HMBC Correlations of* **2**

Compound **3** was assigned the molecular formula $C_{20}H_{28}O_4$ by HR-EI-MS (M^+ at m/z 332.1995 (calc. 332.1988)), in combination with NMR data, indicating seven degrees of unsaturation. Its IR spectrum showed a strong absorption at 1697 cm^{-1} assignable to conjugated C=O groups. The ^{1}H-NMR spectrum of **3** (*Table 3*) displayed two methyl *doublet*s at δ(H) 1.14 (J = 7.0 Hz) and 1.63 (J = 1.2 Hz), three Me *singlet*s at δ(H) 1.30 (6 H) and 1.93 (3 H), and four methine signals at δ(H) 5.75 (*s*-like), 5.27 (*s*), 5.26 (*dq*, J = 8.5, 1.1 Hz), and 5.05 (*ddd*, J = 12.1, 8.4, 4.1 Hz). The ^{13}C-NMR (DEPT) spectrum showed five Me, four CH_2, and five CH groups, and six quaternary C-atoms (*Table 3*).

The planar structure of **3** was deduced by extensive 2D-NMR experiments, including HSQC, ^{1}H,^{1}H-COSY, and HMBC techniques (*Fig. 4*). The furan-3(2*H*)-one unit was established by HMBC correlations of H–C(13) to C(12), C(14), and C(15), and of both H–C(16) and H–C(17) to C(15) and C(14). The ^{1}H- and ^{13}C-NMR chemical shifts of this moiety were in agreement with those reported previously [24]. Compared with common C=C bonds, C(12) at δ(C) 195.5 and C(13) at δ(C) 99.7 in the furanone moiety were severely down- and upfield shifted, respectively, due to the enhanced effect from the O-atom at C(12)[1]) and the conjugated C=O group. The presence of an α,β-unsaturated δ-lactone was established by HMBC correlations of H–C(1) to C(2), C(4), and C(20), of H–C(20) to C(2), C(3), and C(4), and of H–C(4) to C(2), C(3), C(5), and C(20), respectively. The connection between the furanone and the α,β-unsaturated δ-lactone units through an aliphatic chain was established by ^{1}H,^{1}H-COSY and HMBC analyses (*Fig. 4*). The structural fragments

Table 3. *^{1}H-, ^{13}C-, and 2D-NMR Data of* **3**. At 400/100 MHz, resp., in $CDCl_3$; δ in ppm, J in Hz.

Atom[1])	δ(H)	δ(C)	HMBC	NOESY
C(1)		165.1		
H–C(2)	5.75 (*s*-like)	116.4	4, 1, 20	20
C(3)		156.9		
H–C(4a)	2.32 (*ddq*, J = 18.5, 11.1, 1.1)	34.9	5, 3, 2, 20	6, 20
H–C(4b)	2.16 (*dd*, J = 18.0, 4.0)			5, 20
H–C(5)	5.05 (*ddd*, J = 12.1, 8.4, 4.1)	73.9		6, 19
H–C(6)	5.26 (*dq*, J = 8.5, 1.1)	122.1	8, 4, 5, 19	8, 5, 4a
C(7)		141.8		
CH_2(8)	1.98 (*t*, J = 7.0)	38.9	10, 9, 7, 6, 19	
CH_2(9)	1.37–1.43 (*m*)	24.6	11, 10, 8, 7	
H–C(10a)	1.55–1.60 (*m*)	33.3	12, 11, 9, 8, 18	
H–C(10b)	1.37–1.43 (*m*)			
H–C(11)	2.53–2.59 (*m*)	35.3	12, 10, 9, 18	10a, 10b, 9, 18
C(12)		195.5		
H–C(13)	5.27 (*s*)	99.7	15, 14, 12	10a, 18
C(14)		207.3		
C(15)		88.1		
Me(16)	1.30 (*s*)	22.7	15, 14, 17	
Me(17)	1.30 (*s*)	22.7	15, 14, 16	
Me(18)	1.14 (*d*, J = 7.0)	17.5	12, 11, 10	
Me(19)	1.63 (*d*, J = 1.2)	16.4	8, 7, 6	
Me(20)	1.93 (*s*)	22.8	4, 3, 2	

C(11)–C(18), C(8)–C(9)–C(10), and C(4)–C(5)–C(6) were readily established from the ^{1}H,^{1}H-COSY spectrum. The key HMBC correlations of Me(18) to C(10), C(11) and C(12), and of Me(19) to C(6), C(7) and C(8) enabled us to draw the planar structure of **3**.

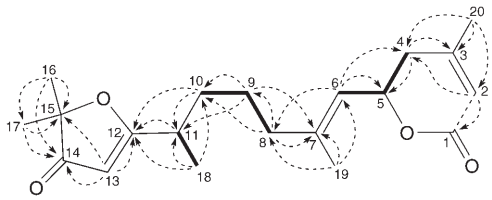


Fig. 4. *HMBC* (H → C) *and ^{1}H,^{1}H-COSY* (▬) *correlations of* **3**

In the NOESY spectrum of **3** (*Fig. 5*), the correlations of H–C(5)/H_b–C(4), H–C(5)/Me(19), and H_a–C(4)/H–C(6) indicated pseudo-equatorial configuration of the C=C moiety on the pyran ring. The strong correlation between H–C(6) and H–C(8) indicated (*E*)-configuration for the C(6)=C(7) bond. This was confirmed by the upfield resonance of the vinylic Me(19) group at δ(C) 16.4 [25]. The configuration at C(11) could not be assigned from the available data. Thus, the structure of **3** was elucidated as 6-[(1*E*)-6-(5,5-dimethyl-4-oxo-4,5-dihydrofuran-2-yl)-2-methylhept-1-en-1-yl]-4-methyl-5,6-dihydro-2*H*-pyran-2-one.

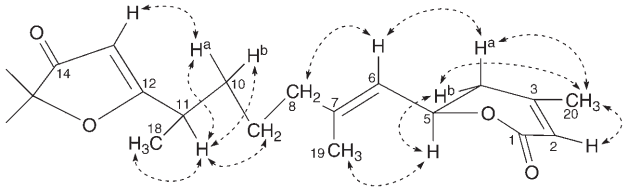


Fig. 5. *Key NOESY correlations of* **3**

The five known compounds were identified as 1-aza-9,10-dimethoxy-4-methyl-2-oxo-1,2-dihydroanthracene [26], (3β)-lupane-3,20,28-triol [27], spermatheridine [28], (3β,24*R*)-cycloartane-3,24,25-triol [29], and cyperusol C [30], based on comparison of their spectroscopic and mass-spectrometric data with those published. All of them were obtained for the first time from this specific plant.

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Experimental Part

General. All solvents were of anal. grade (*Shanghai Chemical Plant*, China). Thin-layer chromatography (TLC): precoated silica-gel GF_{254} plates (*Qingdao Haiyang Chemical Plant*, China). Column chromatography (CC): silica gel (200–300 mesh; *Qingdao*), *C18* reverse-phase silica gel (150–200 mesh; *Merck*), *MCI* gel (*CHP20P*, 75–150 μm, *Mitsubishi Chemical Industries, Ltd.*), and *Sephadex LH-20* gel (*Amersham Biosciences*). UV Spectra were recorded on a *Hitachi U-2010* spectrophotometer; λ_{max} (log ε) in nm. Optical rotations were measured on a *Perkin-Elmer 341* polarimeter. IR spectra were recorded on a *Perkin-Elmer 577* spectrometer with KBr disks; in cm^{-1}. ^1H- and ^{13}C-NMR Spectra were recorded on a *Bruker AM-400* spectrometer; δ in ppm rel. to Me_4Si, *J* in Hz. Electrospray-ionization mass spectrometry (EI-MS) was performed at 70 eV with a *Finnigan MAT-95* mass spectrometer; in *m*/*z* (rel. %).

Plant Material. The twigs and leaves of *P. nemoralis* were collected from Hainan Province, P. R. China, and were authenticated by Prof. *Shi-Man Huang* (Department of Biology, Hainan University, P. R. China). A voucher specimen (No. PN-2004-1Y) was deposited at the Shanghai Institute of Materia Medica.

Extraction and Isolation. The air-dried, powdered twigs and leaves of *P. nemoralis* (2.1 kg) were percolated with 95% aq. EtOH at r.t. After removal of the solvent under reduced pressure, the crude extract (440 g) was dispersed in H_2O, and then extracted with AcOEt to afford a dark, viscous residue (122 g), which was subjected to CC (*MCI* gel; MeOH/H_2O 0:100 → 90:10) to afford five fractions (*Fr. E1–E5*). *Fr. E5* (17.4 g) was separated by CC (SiO_2; petroleum ether (PE)/acetone 100:1 → 3:1) to afford seven fractions (*Fr. E5a–E5g*). *Fr. E5f* (2.3 g) was subjected to CC (SiO_2; CH_2Cl_2/MeOH 200:1) to provide six fractions (*Fr. E5f1–E5f6*). *Fr. E5f3* (200 mg) was purified by RP-CC (*C18*; 70% aq. MeOH) to afford **1** (25 mg) and 9,10-dimethoxy-4-methyl-2-oxo-1,2-dihydro-1-azaanthracene (6 mg). *Fr. E5f5* (564 mg) was separated by RP-CC (1. *C18*; 65% aq. MeOH; 2. *Sephadex LH-20*; EtOH) to yield **2** (3 mg), (3β)-lupane-3,20,28-triol (12 mg), and (3β,24*R*)-cycloartane-3,24,25-triol (20 mg). *Fr. E4* (3.6 g) was subjected to CC (SiO_2; PE/acetone 100:1 → 2:1) to give five factions (*Fr. E4a–E4e*). *Fr. E4a* (730 mg) was further purified by CC (SiO_2; CH_2Cl_2/MeOH 100:1) to afford **3** (40 mg). *Fr. E4b* (360 mg) was separated in the same way as *Fr. E4a* to afford cyperusol C (5 mg). *Fr. E4c* (1.2 g) was subjected to RP-CC (*C18*; 60% aq. MeOH) to afford spermatheridine (80 mg).

(3β,22α)-3,22-Dihydroxytaraxast-20-en-30-al (**1**). Colorless, amorphous powder. $[\alpha]_D^{20} = +106$ ($c = 1.25$, $CHCl_3$). UV ($CHCl_3$): 238 (3.82). IR (KBr): 3442, 2966, 2871, 1681, 1464, 1384, 1041. ^{1}H- and ^{13}C-NMR: see *Table 1*. EI-MS: 456 (54, M^+), 468 (41), 207 (52), 189 (100), 136 (55), 107 (52), 95 (63), 81 (51). HR-EI-MS: 456.3604 (M^+, $C_{30}H_{48}O_3^+$; calc. 456.3603).

2-Hydroxyonychine (*=3-Hydroxy-4-methyl-5*H*-indeno[1,2-*b*]pyridin-5-one*; **2**). Yellow, amorphous powder. UV (MeOH): 269 (4.12), 249 (4.10), 214 (3.99). IR (KBr): 3429, 2923, 1714, 1608, 1415, 1309, 920, 743. ^{1}H- and ^{13}C-NMR: see *Table 2*. EI-MS: 212 (24, $[M + H]^+$), 211 (100, M^+), 182 (48), 154 (12), 127 (18), 77 (7), 63 (5), 51 (4). HR-EI-MS: 211.0629 (M^+, $C_{13}H_9NO_2^+$; calc. 211.0633).

Nemoralisin (*=6-[(1*E*)-6-(5,5-Dimethyl-4-oxo-4,5-dihydrofuran-2-yl)-2-methylhept-1-en-1-yl]-4-methyl-5,6-dihydro-2*H*-pyran-2-one*; **3**). Colorless oil. $[\alpha]_D^{20} = -61$ ($c = 1.20$, $CHCl_3$). UV ($CHCl_3$): 261 (4.18), 235 (3.94). IR (KBr): 2933, 1697, 1587, 1383, 1246, 1176, 1041. ^{1}H- and ^{13}C-NMR: see *Table 3*. EI-MS: 332 (19, M^+), 179 (63), 166 (18), 153 (100), 140 (29), 82 (63), 69 (25), 55 (24). HR-EI-MS: 332.1995 (M^+, $C_{20}H_{28}O_4^+$; calc. 332.1988).

Methylation of **2**. An anal. sample of **2** (2 mg) was dissolved in acetone (2 ml), and treated with MeI (0.3 ml) and anh. K_2CO_3 (100 mg). The mixture was stirred at r.t. for 3 h. The resulting yellow solid was dispersed in H_2O and extracted with $CHCl_3$. After removal of the solvent under reduced pressure, 2-methoxyonychine (2 mg) was obtained.

REFERENCES

[1] 'Flora of China' (Zhongguo Zhiwu Zhi), Eds. Y. Jiang, B. T. Li, Science Press, Beijing, 1979, Vol. 30(2), p. 87.
[2] N. Hara, H. Asaki, Y. Fujimoto, Y. K. Gupta, A. K. Singh, M. Sahai, *Phytochemistry* **1995**, *38*, 189.
[3] X. Ma, I. S. Lee, H. B. Chai, K. Zaw, N. R. Farnsworth, D. D. Soejarto, G. A. Cordell, J. M. Pezzuto, A. D. Kinghorn, *Phytochemistry* **1994**, *37*, 1659.
[4] C. Y. Chen, F. R. Chang, Y. C. Shih, T. J. Hsieh, Y. C. Chia, H. Y. Tseng, H. C. Chen, S. J. Chen, M. C. Hsu, Y. C. Wu, *J. Nat. Prod.* **2000**, *63*, 1475.
[5] A. Kijjoa, M. M. M. Pinto, P. M. M. Pinho, B. Tantisewie, W. Herz, *Phytochemistry* **1990**, *29*, 653.
[6] P. Richomme, M. C. Godet, F. Foussard, L. Toupet, T. Sévenet, J. Bruneton, *Planta Med.* **1991**, *57*, 552.
[7] H. Y. Li, N. J. Sun, Y. Kashiwada, L. Sun, J. V. Snider, L. M. Cosentino, K. H. Lee, *J. Nat. Prod.* **1993**, *56*, 1130.
[8] Y. P. Lue, Q. Mu, H. L. Zheng, C. M. Li, *Phytochemistry* **1998**, *49*, 2053.
[9] M. C. González, M. A. Sentandreu, K. S. Rao, M. C. Zafra-Polo, D. Cortes, *Phytochemistry* **1996**, *43*, 1361.
[10] J. D. Connolly, M. E. Haque, A. A. Kadir, *Phytochemistry* **1996**, *43*, 295.
[11] R. Hocquemiller, G. Dubois, M. Leboeuf, A. Cavé, N. Kunesch, C. Riche, A. Chiaroni, *Terahedron Lett.* **1981**, *22*, 5057.
[12] N. Kunesch, A. Cavé, M. Leboeuf, R. Hocquemiller, G. Dubois, E. Guittet, J.-Y. Lallemand, *Terahedron Lett.* **1985**, *26*, 4937.
[13] A. Jossang, M. Leboeuf, P. Cabalion, A. Cavé, *Planta Med.* **1983**, *49*, 20.
[14] M. Chakrabarty, A. Patra, *Indian J. Chem., Sect. B* **1990**, *29*, 394.
[15] M. Lavault, H. Guinaudeau, J. Bruneton, T. Sévenet, H. A. Hadi, *Phytochemistry* **1990**, *29*, 3845.
[16] A. Jossang, M. Leboeuf, A. Cavé, T. Sevenet, K. Padmawinata, *J. Nat. Prod.* **1984**, *47*, 504.
[17] Y. C. Wu, *Heterocycles* **1989**, *29*, 463.
[18] Y. C. Wu, C. Y. Duh, S. K. Wang, K. S. Chen, T. H. Yang, *J. Nat. Prod.* **1990**, *53*, 1327.
[19] C. W. Wright, S. J. Marshall, P. F. Russell, M. M. Anderson, J. D. Phillipson, G. C. Kirby, D. C. Warhurst, P. L. Schiff Jr., *J. Nat. Prod.* **2000**, *63*, 1638.
[20] S. Kanokmedhakul, K. Kanokmedhakul, D. Yodbuddee, N. Phonkerd, *J. Nat. Prod.* **2003**, *66*, 616.
[21] H. Y. Li, N. J. Sun, Y. Kashiwada, L. Sun, J. V. Snider, L. M. Cosentino, K. H. Lee, *J. Nat. Prod.* **1993**, *56*, 1130.
[22] Y. H. Kuo, Y. M. Chaiang, *Chem. Pharm. Bull.* **1999**, *47*, 498.

[23] H. Achenbach, A. Schwinn, *Arch. Pharm. (Weinheim)* **1994**, *327*, 755.
[24] S. Chimichi, M. Boccalini, B. Cosimelli, G. Viola, D. Vedaldi, F. Dall'Acqua, *Terahedron Lett.* **2002**, *43*, 7473.
[25] Y. C. Shen, K. L. Lo, Y. C. Lin, A. T. Khalil, Y. H. Kuo, P. S. Shih, *Tetrahedron Lett.* **2006**, *47*, 4007; Y. Liu, B. H. Bae, N. Alam, J. Hong, C. J. Sim, C.-O. Lee, K. S. Im, J. H. Jung, *J. Nat. Prod.* **2001**, *64*, 1301.
[26] P. Tuchinda, M. Pohmakotr, B. Munyoo, V. Reutrakul, T. Santisuk, *Phytochemistry* **2000**, *53*, 1079.
[27] H. Fuchino, T. Satoh, N. Tanaka, *Chem. Pharm. Bull.* **1996**, *44*, 1748.
[28] I. R. C. Bick, C. K. Douglas, *Terahedron Lett.* **1964**, *25*, 1629.
[29] A. Inada, S. Ohtsuki, T. Sorano, H. Murata, Y. Inatomi, D. Darnaedi, T. Nakanishi, *Phytochemistry* **1997**, *46*, 379.
[30] F. Xu, T. Morikawa, H. Matsuda, K. Ninimiya, M. Yoshikawa, *J. Nat. Prod.* **2004**, *67*, 569.

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