Five New Quassinoids from the Bark of *Picrasma quassioides*

by **Sheng-Ping Yang**, and **Jian-Min Yue***

State Key Laboratory of Drug Research, Institute of Materia Medica, Shanghai, Institutes for Biological Sciences, Chinese Academy of Sciences, 555 Zu Chong Zhi Road, Zhangjian Hi-Tech Park, Shanghai, 201203, P.R. China

(phone: +86-21-50806718; fax: +86-21-50806718; e-mail: jmyue@mail.shcnc.ac.cn)

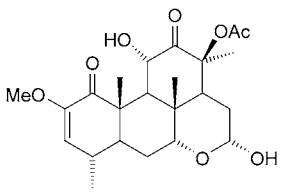
Five new quassinoids, named picraqualides A–E (**1**–**5**), together with eleven known ones, nigakilactone E (**6**), nigakilactone F (**7**), kusulactone (**8**), javanicin U (**9**), 12-norquassin (**10**), quassin (**11**), 2,3-didehydropicrasin B (**12**), nigakilactone B (**13**), nigakilactone C (**14**), picrasin B (**15**), and simalikalacton C (**16**), were isolated from the EtOH extract of the bark of *Picrasma quassioides* (D. DON) BENN. Their structures were determined mainly by spectroscopic methods, especially by 2D-NMR techniques and circular dichroism (CD). Some empirical rules were summarized on the basis of ^{13}C-NMR spectral analysis to distinguish between OH (or Ac) groups attached at C(11) *vs.* C(13).

Introduction. – Quassinoids are a group of biogenetically significant secondary metabolites. They have been found only in members of the Simaroubaceae family, such as the genera of *Castela* [1], *Ailanthus* [2], *Picrasma* [3], and *Brucea* [4]. Although the basic skeleton of quassinoids comprises 20 C-atoms, these compounds were proposed to originate biogenetically from tetracyclic triterpenoids. Hence, quassinoids were classified as a special category of triterpenoids [5]. Some quassinoids exhibit remarkable antitumor activities against a number of tumor cell lines, as well as antimalarial activities [6].

The plant *Picrasma quassioides* (D. DON) BENN. is widely distributed over Asia [7] and most areas of mainland China. In China, *P. quassioides* was falsely identified as *Rhus ailanthoides* BUNGE, *P. ailanthoides* (BUNGE) PLANCHON., and *P. japonica* A. GRAY., and was recently revised [7]. *P. quassioides* is one of the important sources of Chinese traditional folklore medicine. The bark of this plant, known as 'Ku-Mu-Pi' (named by its strong bitter taste) in Chinese traditional folklore medicine, is used as a vermicide and an antibacterial [8].

The plant material of *P. quassioides* used in this study was collected in the Qinling Mountains, Shanxi province, China. A number of quassinoids [9] and carboline alkaloids [10] have been reported from this plant. Here, we describe the isolation of five new quassinoids from the EtOH extract of the bark of *P. quassioides*, named picraqualides A–E (**1**–**5**), along with eleven known compounds, nigakilactone E (**6**), nigakilactone F (**7**), kusulactone (**8**), javanicin U (**9**), 12-norquassin (**10**), quassin (**11**), 2,3-didehydropicrasin B (**12**), nigakilactone B (**13**), nigakilactone C (**14**), picrasin B (**15**) and simalikalacton C (**16**).

Results and Discussion. – Picraqualide A (**1**) was obtained in the form of optically active needles, with $[\alpha]_D^{20} = +25.6$ (acetone/MeOH). The HR-EI mass spectrum of **1**



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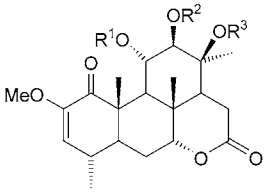
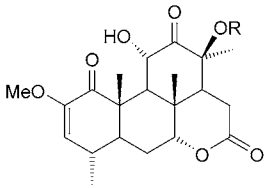


	R^1	R^2	R^3
2	Ac	Ac	H
6	Ac	Me	H
7	H	Me	H
8	H	Ac	Ac
9	H	Ac	H



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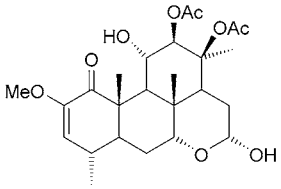

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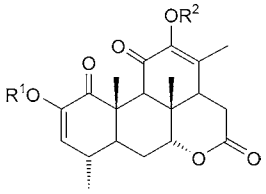
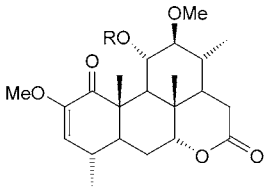
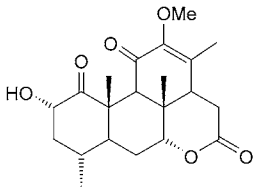


	R^1	R^2
10	Me	H
11	Me	Me
12	H	Me



13 R = H
14 R = Ac



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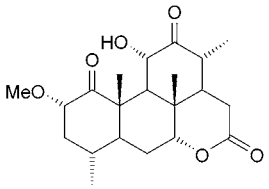

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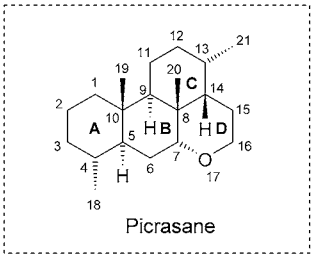

exhibited the M^+ signal at m/z 436.2114 ($C_{23}H_{32}O_8^+$; calc. 436.2097), indicating eight degrees of unsaturation. The broad IR band at 3600–2500 cm^{-1} was assigned to OH groups, and the absorptions at 1736, 1680, and 1637 cm^{-1} indicated the presence of ester and ketone C=O groups, as well as of a C=C bond, respectively. The ^{1}H-NMR (*Table 1*), ^{13}C-NMR (*Table 2*), DEPT, and HMQC spectra of **1** revealed the presence of two keto groups (δ(C) 205.72, 203.19), one trisubstituted C=C bond, one MeO and one AcO group, two sp^3-CH_2, seven sp^3-CH, and four Me groups, as well as three quaternary sp^3-C-atoms. The two keto, the ester C=O, and the C=C functions, accounting for four degrees of unsaturation, indicated that the remaining four degrees

Table 1. *^{1}H-NMR Data of Compounds* **1**–**5** *and* **8**. In $CDCl_3$; δ in ppm, J in Hz.

	1	**2**	**3**	**4**	**5**	**8**
H−C(3)	5.33 (*d*, *J* = 2.3)	5.12 (*d*, *J* = 1.7)	5.44 (*d*, *J* = 3.4)	5.36 (*d*, *J* = 2.3)	5.38 (*d*, *J* = 2.0)	5.42 (*d*, *J* = 2.3)
H−C(4)	2.43 (*m*)	2.39 (*m*)	2.51 (*m*)	2.50 (*dqd*, *J* = 13.1, 6.9, 2.4)	2.44 (*m*)	2.52 (*m*)
H−C(5)	1.94 (*m*)	1.85 (*m*)	1.91 (*m*)	1.82 (br. *td*, *J* = 13.1, 4.2)	2.04 (*m*)	1.90 (*m*)
H_α−C(6)	1.91 (*m*, 2 H)	2.02 (*ddd*, *J* = 14.0, 3.5, 3.3)	2.09 (*ddd*, *J* = 13.0, 5.6, 2.4)	2.09 (*ddd*, *J* = 14.6, 4.2, 3.5)	1.88 (*m*, 2 H)	2.09 (*dd*, *J* = 13.6, 7.4)
H_β−C(6)		1.92 (br. *t*, *J* = 14.0)	1.94 (br. *td*, *J* = 13.0, 1.9)	1.98 (*ddd*, *J* = 14.6, 12.6, 2.1)		1.95 (*m*)
H−C(7)	3.40 (br. *s*)	4.18 (br. *s*)	4.23 (*dd*, *J* = 2.4, 1.9)	4.24 (*dd*, *J* = 3.5, 2.1)	3.31 (br. *s*)	4.16 (br. *s*)
H−C(9)	2.56 (*d*, *J* = 12.1)	2.70 (*d*, *J* = 11.2)	2.36 (*d*, *J* = 10.1)	2.25 (*d*, *J* = 11.9)	2.67 (*d*, *J* = 11.1)	2.33 (*d*, *J* = 10.9)
H−C(11)	4.64 (*dd*, *J* = 12.1, 11.8)	5.59 (br. *t*, *J* = 10.5)	4.80 (*dd*, *J* = 10.1, 8.5)	4.71 (*dd*, *J* = 11.9, 11.8)	4.05 (br. *q*, *J* = 10.9)	4.09 (br. *q*, *J* = 10.7)
H−C(12)		5.26 (*d*, *J* = 9.6)			5.02 (*d*, *J* = 9.9)	5.09 (*d*, *J* = 9.9)
H−C(14)	2.28 (*dd*, *J* = 13.6, 4.4)	2.07 (*dd*, *J* = 12.5, 7.8)	2.19 (*dd*, *J* = 11.7, 7.3)	2.62 (br. *t*, *J* = 7.3)	2.75 (*dd*, *J* = 13.4, 4.1)	3.15 (*dd*, *J* = 12.8, 7.5)
H_β−C(15)	1.70 (*ddd*, *J* = 13.4, 4.4, 2.2)	2.71 (*dd*, *J* = 19.1, 7.8)	2.66 (*dd*, *J* = 18.5, 7.3)	2.57 (br. *d*, *J* = 16.9)	1.92 (*ddd*, *J* = 13.2, 4.1, 2.2)	2.77 (*dd*, *J* = 19.0, 7.5)
H_α−C(15)	1.17 (*ddd*, *J* = 13.6, 13.4, 9.7)	2.57 (*dd*, *J* = 19.1, 12.5)	2.35 (*dd*, *J* = 18.5, 11.7)	2.11 (*m*)	1.58 (*ddd*, *J* = 13.4, 13.2, 9.6)	2.53 (*dd*, *J* = 19.0, 12.8)
H−C(16)	4.70 (br. *t*, *J* = 7.4)				4.82 (br. *t*, *J* = 7.0)	
Me(18)	1.09 (*d*, *J* = 6.9)	1.08 (*d*, *J* = 7.0)	1.14 (*d*, *J* = 7.0)	1.12 (*d*, *J* = 6.9)	1.11 (*d*, *J* = 6.9)	1.13 (*d*, *J* = 6.9)
Me(19)	1.47 (*s*)	1.27 (*s*)	1.47 (*s*)	1.50 (*s*)	1.41 (*s*)	1.46 (*s*)
Me(20)	1.44 (*s*)	1.56 (*s*)	1.47 (*s*)	1.57 (*s*)	1.20 (*s*)	1.34 (*s*)
Me(21)	1.43 (*s*)	1.14 (*s*)	1.38 (*s*)	1.46 (*s*)	1.49 (*s*)	1.50 (*s*)
11-OAc		1.88 (*s*)				
12-OAc		2.08 (*s*)			2.15 (*s*)	2.17 (*s*)
13-OAc	2.08 (*s*)			2.11 (*s*)	2.03 (*s*)	2.06 (*s*)
2-MeO	3.57 (*s*)	3.55 (*s*)	3.60 (*s*)	3.59 (*s*)	3.57 (*s*)	3.59 (*s*)
11-OH	3.81 (*d*, *J* = 11.8)		4.35 (*d*, *J* = 8.4)	3.78 (*d*, *J* = 11.8)	3.65 (*d*, *J* = 10.9)	3.72 (*d*, *J* = 10.7)
13-OH		2.30 (br. *s*)	3.08 (br. *s*)			
16-OH	3.54 (br. *d*, *J* = 6.9)				3.05 (br. *d*, *J* = 6.3)	

Table 2. *^{13}C-NMR Data of Compounds* **1**–**5** *and* **8**. In $CDCl_3$; δ in ppm.

Position	**1**	**2**	**3**	**4**	**5**	**8**
1	203.19	198.64	202.73	202.20	205.29	204.31
2	148.21	148.64	148.09	148.29	148.37	148.18
3	117.23	113.26	118.75	117.24	118.17	118.37
4	32.04	31.95	31.97	31.99	32.25	32.02
5	43.55	43.06	42.92	42.95	43.93	43.09
6	25.46	25.37	25.40	25.45	25.61	25.36
7	76.53	81.67	81.23	80.63	76.85	80.96
8	37.40	36.21	35.91	36.37	37.89	36.61
9	42.54	36.37	42.78	42.01	39.04	38.65
10	48.59	46.52	48.39	48.12	48.34	47.80
11	71.40	69.04	71.58	71.69	68.26	67.97
12	205.72	77.13	210.22	204.76	79.46	78.40
13	87.41	75.44	77.98	86.36	86.01	84.70
14	52.54	48.91	50.89	49.43	46.68	43.93
15	30.52	29.86	29.23	27.78	32.84	29.89
16	95.76	169.24	169.45	168.40	96.27	168.85
18	19.44	19.51	19.52	19.53	19.55	19.46
19	12.22	12.47	12.98	12.33	12.52	12.54
20	23.24	23.33	23.29	23.45	22.60	22.38
21	18.16	25.87	23.29	18.04	21.74	20.84
11-*Me*COO		21.04				
11-Me*C*OO		170.69				
12-*Me*COO		20.53			20.92	20.84
12-Me*C*OO		169.24			171.13	171.03
13-*Me*COO	21.51			21.50	22.88	22.76
13-Me*C*OO	169.55			169.38	170.73	170.62
2-MeO	55.12	55.04	55.35	55.34	55.32	55.36

of unsaturation had to be assigned to a tetracyclic ring system. All these data suggested that **1** is a tetracyclic quassinoid.

A direct comparison of the spectral data of **1** with those of nigakilactone F (**7**) [9c], which was also isolated from this plant, indicated that **1** is an analogue of **7**, both compounds having the same substitution patterns in rings *A* and *B*, but not in rings *C* and *D*. Compound **1** differs from **7** by an additional Ac (δ(H) 2.08 (*s*)), keto C=O (δ(C) 205.72), and a hemiacetal group (δ(C) 95.76, δ(H) 4.70), as well as by the absence of a MeO group and a lactone resonance, suggesting that the hemiacetal was located at C(16), while the keto function was assignable to C(11) or C(12). The ^{1}H-NMR signal at δ(H) 4.64 (*dd*, $J = 12.1$, 11.8 Hz), assigned to H–C(11), suggested the presence of an α-OH group at C(11), as confirmed by the HMBC interactions between H–C(11) and C(8), and between HO–C(11) and C(11) (*Fig. 1*,*a*). The large coupling constant ($J = 11.8$ Hz) between HO–C(11) and H–C(11) revealed an antiperiplanar arrangement of these groups under formation of asymmetric, bifurcated H-bonds between HO–C(11) and the two C=O groups at C(1) and C(12) (*Fig. 1*,*b*) [11]. As a consequence, the C=O group at δ(C) 205.72 was attributed to C(12), as confirmed by the HMBC correlations of C(12) with H–C(9) and H–C(11), and between HO–C(11) and Me(21). A quaternary C-atom was identified at δ(C) 87.41,

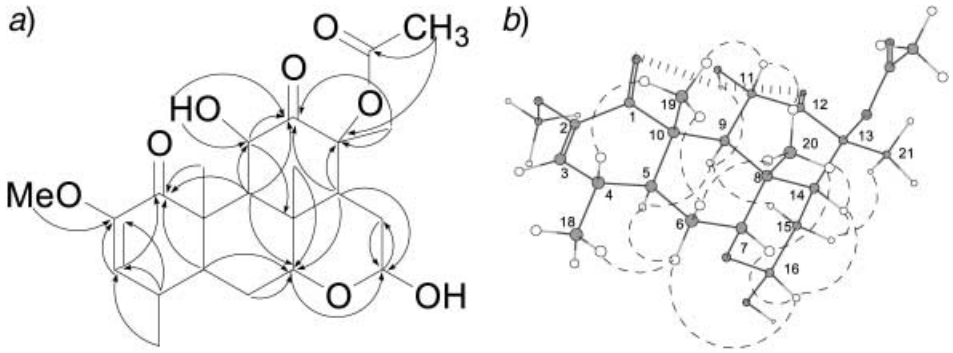

Fig. 1. *Key* a) *HMBC and* b) *NOE interactions in* **1**. In the molecular model *b*, H-bonds are indicated with broad dashed lines.

which was attributed to C(13), bearing the AcO group, and corroborated by a weak HMBC ^4J-correlation between the AcO H-atoms at δ(H) 2.08 and C(13).

The relative configuration of **1** was derived from NOESY interactions (*Fig. 1,b*). NOESY Correlation pairs of H–C(4)/Me(19), Me(19)/H–C(11), H–C(11)/Me(20), Me(20)/H–C(14), Me(20)/H–C(7), H–C(7)/H–C(16), and H–C(14)/H–C(16) clearly indicated that H–C(4), Me(19), H–C(11), Me(20), H–C(14), H–C(7), and H–C(16) were β-configured. The signal for H–C(9) showed NOESY correlations with both H–C(5) and the H-atom of HO–C(11), suggesting that these groups were all α-oriented. The α-configuration for Me(21) was established based on NOESY interactions with the equatorial H_β–C(15). A 3D structure of compound **1**, generated by MM2 computer modeling (*Chem 3D Pro*, Version 6.0; *Cambridge Soft*, Cambridge, MA, USA), is shown in *Fig. 1,b*. The relative configuration thus obtained was in good agreement with the NOESY data. Therefore, the structure of picraqualide A (**1**) was established as (11α,13*S*,16α)-13-acetoxy-11,16-dihydroxy-2-methoxypicras-2-ene-1,12-dione.

Picraqualide B (**2**), a white amorphous powder, had the molecular formula $C_{25}H_{34}O_9$, as determined by HR-EI-MS (*m*/*z* 478.2188 (M^+; calc. 478.2203)). All 25 C-atoms were resolved in the ^{13}C-NMR spectrum (*Table 2*), with three ester and one keto C=O group(s), one trisubstituted C=C bond, seven Me, two sp^3 CH_2, and seven sp^3 CH groups, as well as three quaternary sp^3 C-atoms. Also, two Ac groups were distinguishable from the 1D- and 2D-NMR data. Comparison of the ^{1}H- and ^{13}C-NMR data of **2** with those of the known quassinoids nigakilactone E (**6**) [12], nigakilactone F (**7**) [12], kusulactone (**8**) [13], and javanicin U (**9**) [9c], which were also isolated from this plant, indicated that **2** was a quassinoid analogue, compounds **2** and **6**–**9** having the same substitution patterns in rings *A*, *B*, and *D*. The downfield-shifted signal at δ(H) 5.59 (br. *t*, J = 10.5 Hz), assignable to H–C(11), indicated that an AcO group was at C(11). The HMBC ^3J-correlations between H–C(11) and the signal at δ(C) 170.69 verified the presence of an AcO group at C(11). The strongly downfield-shifted signal of H–C(12) at δ(H) 5.26 (*d*, J = 9.6 Hz) indicated the presence of an AcO group (δ(C) 169.24) at C(12), as confirmed by a HMBC experiment. The oxygenated quaternary C-atom at δ(C) 75.44, assigned to C(13), showed HMBC correlations with H–C(14) and

Me(21), confirming the presence of an OH group at C(13). The large coupling constants between H–C(9) and H–C(11) ($J = 11.2$ Hz), and between H–C(11) and H–C(12) ($J = 9.6$ Hz), indicated that these H-atoms were *trans*-configured. The ^{1}H- and ^{13}C-NMR data of picraqualide B (**2**) could be completely assigned by 2D-NMR spectra, and the structure was identified as (11α,12β,13*S*)-11,12-bis(acetoxy)-13-hydroxy-2-methoxypicras-2-ene-1,16-dione.

Picraqualide C (**3**) was determined to have the molecular formula $C_{21}H_{28}O_7$, as deduced by HR-EI-MS (*m*/*z* 392.1818 (M^+; calc. 392.1835)). The ^{1}H- and ^{13}C-NMR data (*Tables 1* and *2*) of **3** showed quassinoid features, and the substitution patterns of rings *A*, *B*, and *D* were identical to those of **2**. In the ^{1}H-NMR spectrum of **3**, H–C(11) at δ(H) 4.80 (*dd*, J(9,11) = 10.0, J(11,11-OH) = 8.4 Hz) indicated the presence of an α-OH group at C(11), as well as the presence of a C(12) keto function at δ(C) 210.22, similar as in **2**. An oxygenated quaternary C-atom at δ(C) 77.98, attributable to C(13), indicated an OH group at C(13), which was confirmed by the HMBC correlation between the Me(21) and C(13). In the HMBC spectrum of **3** (*Fig. 2*,*a*), C(12) correlated with both Me(21) and H–C(11). The connectivity of **3** was, therefore, determined.

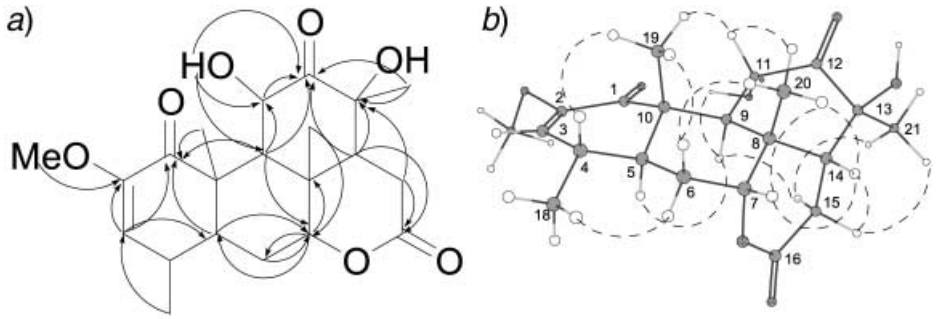

Fig. 2. *Key* a) *HMBC and* b) *NOE interactions in* **3**

The relative configuration of **3** was investigated by a NOESY experiment (*Fig. 2*,*b*). Correlations between H–C(9) and HO–C(11), between H–C(9) and H_α–C(15), and between H_α–C(15) and Me(21) were observed, indicating that the HO–C(11) and HO–C(13) groups were α- and β-configured, respectively. The NOESY data were consistent with a 3D structure generated by computer modeling (*Fig. 2*,*b*). The ^{1}H- and ^{13}C-NMR spectra of **3** were fully assigned by means of a combination of 1D- and 2D-NMR techniques. Thus, the structure of **3** was identified as (11α,13*S*)-11,13-dihydroxy-2-methoxypicras-2-ene-1,12,16-trione.

Picraqualide D (**4**) had the molecular formula $C_{23}H_{30}O_8$, as deduced by HR-EI-MS (*m*/*z* 434.1946 (M^+; calc. 434.1941)), suggesting the presence of an additional Ac group relative to **3**. Comparison of the ^{1}H- and ^{13}C-NMR data of **4** with those of **3** showed very high similarities, indicating that both compounds had the same oxygenation and substitution patterns. Crucial for the structural determination of **4** was the location of the single Ac group, which could be either at C(11) or C(13). Compared with the ^{1}H- and ^{13}C-NMR data of **3**, the signal of H(14) at δ(H) 2.62 was shifted downfield by $\Delta\delta$ = 0.43 ppm, and the C(13) signal at δ(C) 86.36 was shifted downfield by 8.38 ppm,

suggesting that the AcO group was at C(13), which was confirmed by the HMBC ^4J-correlation between the AcO H-atoms and C(13). The relative configuration of **4** was identical to that of **3**, as demonstrated by a NOESY experiment. The large coupling constant ($J = 11.8$ Hz) between HO–C(11) and H–C(11) also revealed their antiperiplanar arrangement, with formation of asymmetric, bifurcated H-bonds between HO–C(11) and the two C=O groups at C(1) and C(12) [11]. The structure of picraqualide D (**4**) was, thus, elucidated as (11α,13*S*)-13-acetoxy-11-hydroxy-2-methoxypicras-2-ene-1,12,16-trione.

Picraqualide E (**5**), a white amorphous powder, was established to have the molecular formula $C_{25}H_{36}O_9$ by HR-EI-MS (*m*/*z* 480.2366 (M^+; calc. 480.2359)), which is two mass units higher than that of compound **8**. Comparison of the ^{1}H-NMR and ^{13}C-NMR data of **5** and **8** indicated that the only difference is the presence of a hemiacetal group at C(16), as deduced from the signal at δ(C) 96.27 for **5** instead of a lactone resonance at δ(C) 168.85 for **8**. The hemiacetal structure of **5** was further confirmed by HMBC correlations between CH_2(15) and C(16), between H–C(16) and C(15), and between HO–C(16) and C(16) (*Fig. 3*,*a*), although the key HMBC correlations between H–C(7) and C(16), or between H–C(16) and C(7), were not observed. The key NOESY-correlation pairs of H–C(7)/H–C(16), H–C(16)/H_β–C(15), and H–C(16)/H–C(14), however, clearly demonstrated the presence of an α-OH group at C(16), and the relative configuration of **5** was also established by NOESY experiments (*Fig. 3*,*b*). Thus, the structure of picraqualide E (**5**) was identified as (11α,12β,13*S*,16α)-12,13-bis(acetoxy)-11,16-dihydroxy-2-methoxypicras-2-ene-1,12-dione.

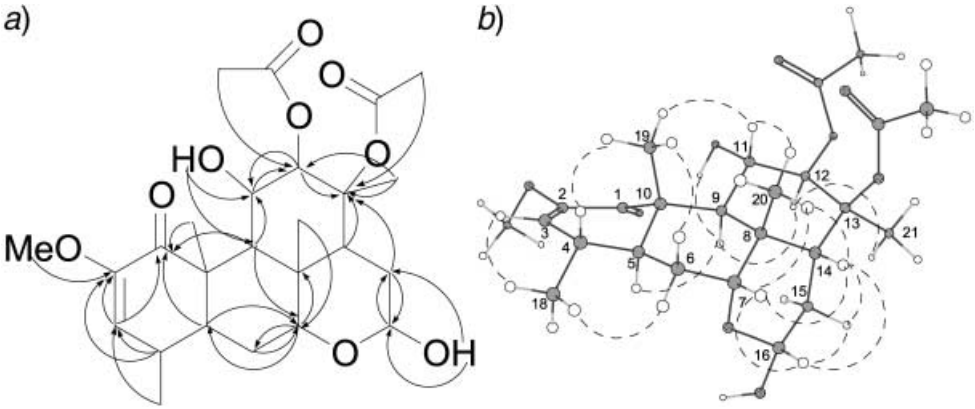

Fig. 3. *Key* a) *HMBC and* b) *NOE interactions in* **5**

The absolute configurations of picraqualides A–E (**1**–**5**) were investigated by circular dichroism (CD). All compounds share the same *A*-ring, comprising an α,β-unsaturated cyclohexanone moiety, which gives rise to *Cotton* effects centered at *ca.* 260 nm (*Fig. 4*). The patterns of the CD curves of **1**–**5** were very similar to those of quassin (**11**) (maximum negative $\Delta\varepsilon$ value at 255 nm; *Fig. 4*) [14] and nigakilactone B (**13**) (262 nm) [14b]. This indicates that **1**–**5**, **11**, and **13** have the same absolute

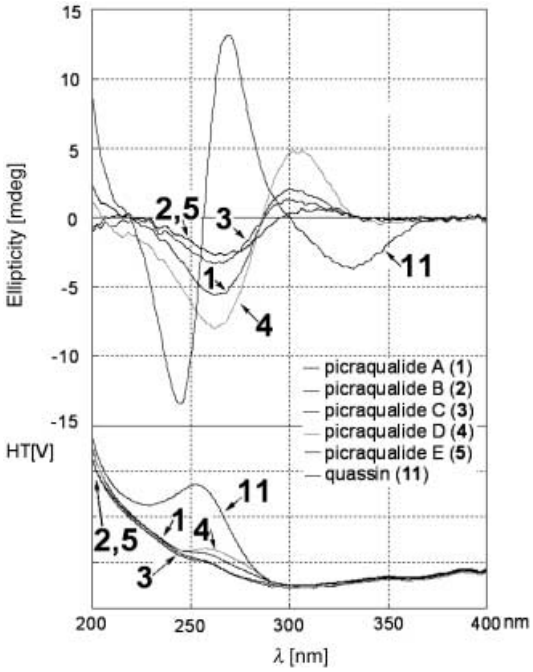

Fig. 4. *Circular-dichroism spectra of picraqualides A–E* (**1–5**) *and quassin* (**11**). Solvent: MeOH, at 20°.

configuration with respect to the junction of rings *A* and *B* [14]. In combination with the relative-configuration data of **1–5** derived by NOESY experiments, the absolute configurations of picraqualides A–E could, thus, be fully established.

The eleven known quassinoids also isolated from *P. quassioides* were identified as nigakilactone E (**6**) [12], nigakilactone F (**7**) [12], kusulactone (**8**) [13], javanicin U (**9**) [9c], 12-norquassin (**10**) [15], quassin (**11**) [16], 2,3-didehydropicrasin B (**12**) [17], nigakilactone B (**13**) [12], nigakilactone C (**14**) [12], picrasin B (**15**) [14b], and simalikalacton C (**16**) [18] on the basis of their ^{1}H- and ^{13}C-NMR data as well as HR-EI mass-spectral data. The complete NMR assignment of **8** was achieved by a combination of 2D-NMR techniques (see *Tables 1* and *2*).

With the full assignments of the ^{13}C-NMR data (*Table 2*) of a series of similar quassinoids, some empirical regularities could be identified that can help to distinguish between 11- and 13-OH or -AcO groups, respectively. For quassinoids with a HO–C(11) group, the chemical shifts of C(1), such as in **1**, **3**, and **5**, resonate at δ(C) 202–206, while, in compounds with an 11-AcO group (such as **2**), the chemical shifts of C(1) are shifted upfield to δ(C) 198–199. The main reason for this phenomenon is most likely due to intramolecular H-bond formation of the type C(1)=O ··· H–O–C(11), which causes a downfield-shifted signal for C(1) in the case of **1**, **3**, and **5** [18][19]. Moreover, for quassinoids with a HO–C(13) function (such as in **2** and **3**), C(13) resonates at δ(C) 75–78, whereas, in the case of an AcO–C(13) group (as in **1**, **4**, **5**, and **8**), C(13) resonates more downfield at δ(C) 84–88. This effect most likely results from deshielding of the additional AcO group.

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Experimental Part

General. All solvents used were of anal. grade (*Shanghai Chemical Plant*). TLC: precoated silica-gel GF_{254} plates (*Qingdao Haiyang Chemical Plant*). Column chromatography (CC): silica gel (200–300 mesh); *MCI Gel CHP20P* (75–150 μm; *Mitsubishi Chemical Industries*); C_{18} reverse-phased silica-gel (150–200 mesh; *Merck*). Optical rotations: *Perkin-Elmer 341* polarimeter. CD Spectra: *JASCO J-810* instrument. IR Spectra: *Perkin-Elmer 577* spectrometer; in cm^{-1}. NMR Spectra: *Bruker AM-400* spectrometer (400 (^{1}H) and 100 MHz (^{13}C); *J* in Hz, δ in ppm rel. to $SiMe_4$ (=0 ppm) as internal standard. EI-MS (70 eV): *Finnigan MAT-95* mass spectrometer; in *m*/*z* (rel. %).

Plant Material. The bark of *Picrasma quassioides* (D. DONN) BENN. was collected in July 2002 in the area of Shanxi province in the Qinling Mountains, P.R. China. The plant was identified by Prof. *Xiao-An Wang*, School of Biology, Shanxi Normal University. A voucher specimen was deposited at the Shanghai Institute of Materia Medica (Accession number: Pquas-2002-1Y).

Extraction and Isolation of Compounds. The air-dried bark (0.8 kg) of *P. quassioides* was extracted with 95% aq. EtOH to yield a crude extract (83 g), which was suspended in H_2O (200 ml). The H_2O suspension was extracted with AcOEt (4 × 200 ml). Removal of the org. solvent under reduced pressure afforded a dark residue (49 g), which was subjected to CC (*MCI* gel; MeOH/H_2O 50:50 → 95:5, then MeOH): Fractions *Fr. 1*–*Fr. 5* (monitored by TLC). *Fr. 1* (3.90 g) consisted mainly of phenols, carboline alkaloids, and other polar components. *Fr. 4* (12.90 g) and *Fr. 5* (16.52 g) were mainly composed of fatty acids, sterols, and triterpenoids. *Fr. 2* and *Fr. 3* contained mixtures of enriched quassinoids. *Fr. 2* (4.40 g) was subjected to CC (SiO_2; $CHCl_3$/MeOH 98:2): *Fr. 2a*–*Fr. 2j*, each of which was further purified by CC (1. C_{18} SiO_2, acetone/H_2O 35:65; 2. SiO_2, petroleum ether/AcOEt 1:5) to yield compounds **2** (10 mg), **5** (20 mg), **7** (30 mg), **8** (60 mg), **10** (10 mg), **11** (30 mg), **12** (30 mg), **13** (20 mg), **14** (80 mg) and **15** (110 mg), respectively. *Fr. 3* (1.94 g) was fractionated by CC (SiO_2; petroleum ether/AcOEt 40:60): *Fr. 3a*–*Fr. 3f*. Each subfraction was purified by CC (1. C_{18} SiO_2, MeOH/H_2O 40:60; 2. SiO_2, $CHCl_3$/MeOH 75:10) to afford **1** (20 mg), **3** (20 mg), **4** (6 mg), **6** (90 mg), **9** (20 mg), and **16** (20 mg), respectively.

(11α,13S,16α)-13-Acetoxy-11,16-dihydroxy-2-methoxypicras-2-ene-1,12-dione (= *Picraqualide A*; **1**). Needles (from acetone/MeOH). $[\alpha]_D^{20} = +25.6$ ($c = 0.77$, $CHCl_3$). IR (KBr): 3477, 2962, 1736, 1680, 1637, 1452, 1375, 1254, 1043, 1113, 1043 and 752. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*. EI-MS: 436 (3), 376 (20), 358 (37), 348 (48), 330 (100), 315 (39), 301 (6), 287 (24), 269 (13), 152 (41), 121 (38), 69 (22). HR-EI-MS: 436.2114 (M^+, $C_{23}H_{32}O_8^+$; calc. 436.2097).

(11α,12β,13S)-11,12-Bis(acetoxy)-13-hydroxy-2-methoxypicras-2-ene-1,16-dione (= *Picraqualide B*; **2**). White amorphous powder. $[\alpha]_D^{20} = +48.9$ ($c = 0.76$, $CHCl_3$). IR (KBr): 3431, 2964, 2939, 2837, 1743, 1709, 1643, 1456, 1371, 1242, 1144, 1055, 1036, 831 and 606. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*. EI-MS: 478 (24), 419 (31), 418 (100), 376 (27), 358 (43), 343 (56), 330 (29), 315 (43), 299 (26), 281 (23), 255 (28), 165 (29), 149 (19), 121 (36), 91 (22). HR-EI-MS: 478.2188 (M^+, $C_{25}H_{34}O_9^+$; calc. 478.2203).

(11α,13S)-11,13-Dihydroxy-2-methoxypicras-2-ene-1,12,16-trione (= *Picraqualide C*; **3**). White gum. $[\alpha]_D^{20} = +25.7$ ($c = 0.85$, $CHCl_3$). IR (KBr): 3500, 3328, 2953, 2872, 1724, 1701, 1635, 1375, 1269, 1238, 1144, 1043, 856 and 710. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*. EI-MS: 392 (8), 374 (22), 364 (34), 359 (69), 349 (43), 346 (70), 331 (91), 313 (20), 285 (12), 271 (13), 165 (35), 153 (62), 152 (100), 121 (57), 91 (21), 69 (34). HR-EI-MS: 392.1818 (M^+, $C_{21}H_{28}O_7^+$; calc. 392.1835).

(11α,13S)-13-Acetoxy-11-hydroxy-2-methoxypicras-2-ene-1,12,16-trione (= *Picraqualide D*; **4**). White amorphous powder. $[\alpha]_D^{20} = +38.4$ ($c = 0.57$, $CHCl_3$). IR (KBr): 3460, 2962, 1751, 1732, 1674, 1635, 1456, 1383, 1250, 1113, 1041, 1001, 760 and 702. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*. EI-MS: 434 (5), 374 (58), 359 (55), 346 (100), 331 (40), 313 (13), 287 (19), 255 (14), 165 (12), 12 (22), 121 (18), 91 (10), 69 (18). HR-EI-MS: 434.1946 (M^+, $C_{23}H_{30}O_8^+$; calc. 434.1941).

(11α,12β,13S,16α)-12,13-Bis(acetoxy)-11,16-dihydroxy-2-methoxypicras-2-ene-1,12-dione (= *Picraqualide E*; **5**). White amorphous powder. $[\alpha]_D^{20} = +58.7$ ($c = 0.57$, $CHCl_3$). IR (KBr): 3319, 2962, 1747, 1720, 1672, 1635, 1456, 1375, 1225, 1111, 1057, 1014, 939 and 607. ^{1}H- and ^{13}C-NMR: see *Tables 1* and *2*. EI-MS: 480 (2.5), 462

(6), 444 (5), 402 (6), 384 (6), 361 (100), 343 (25), 327 (5), 299 (5), 152 (18), 121 (5). HR-EI-MS: 480.2366 (M^+, $C_{25}H_{36}O_9^+$, calc. 480.2359).

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