

TERPENOID CONSTITUENTS OF *VIGUIERA DENTATA*FENG GAO,<sup>1</sup> MAHMUT MISKI, DOUGLAS A. GAGE, and TOM J. MABRY

Department of Botany, University of Texas at Austin, Austin, TX 78713-7640

In a continuation of our chemical studies of the genus *Viguiera* (Asteraceae, Heliantheae) (1), we investigated *Viguiera dentata* (Cav.) Spreng, one of the most widely distributed species in the genus. We report here the isolation and characterization of seven diterpenes, a sesquiterpene lactone (diversifolin), and a sesquiterpene alcohol (spathulenol).

Previously, a Bolivian population of this species was studied by Bohlmann *et al.* (2), and *ent*-kaurenic acid and 9,11-dehydro-*ent*-kaurenic acid were reported. The CH<sub>2</sub>Cl<sub>2</sub> extract of the aerial parts of *V. dentata* collected in Mexico afforded, in addition to *ent*-kaurenic acid (3), six other known diterpenes, namely, manool (4,5), *ent*-kauranol (6), grandifloric acid (7), angeloyl-grandifloric acid (8), 15-oxo-*ent*-kaurenic acid (9), and trachylobanic acid (6,10). From this collection, we were unable to isolate 9,11-dehydro-*ent*-kaurenic acid found in the Bolivian population. However, the Mexican plant material did afford a known furanoheliangolide sesquiterpene lactone, diversifolin (11), and another known sesquiterpene alcohol, spathulenol (12,13).

Identification of all these compounds was made by spectral and physical data comparison, and for *ent*-kaurenic, grandifloric, and angeloylgrandifloric acids by direct comparison with standard samples.

Because the stereochemistry of the asymmetric center at C-8 of diversifolin was not established previously,<sup>2</sup> we have as-

signed the configuration of the acyl function at this position as  $\beta$  by the coupling constants observed in the <sup>1</sup>H-nmr spectrum. In C<sub>6</sub>D<sub>6</sub>, H-8 appeared at  $\delta$  5.53 as a ddd ( $J=4, 5.3, \text{ and } 10$  Hz). From double resonance experiments, the signal for H-8 had coupling constants with H-9 $\beta$  and H-9 $\alpha$  of 10 and 4 Hz, respectively. Inspection of Dreiding models clearly indicated that the observed coupling constants agree with those of an  $\alpha$  H-8. Therefore, the acyl group at this center should be in the  $\beta$  position. In addition, we present the previously unreported <sup>13</sup>C-nmr data of diversifolin (Table 1).

## EXPERIMENTAL

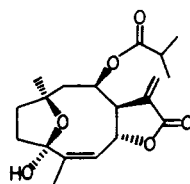
GENERAL EXPERIMENTAL PROCEDURE.—Spectral data were recorded on the following instruments: <sup>1</sup>H nmr, NT-200 (200 MHz); <sup>13</sup>C nmr, Bruker WH-90 (22.6 MHz).

PLANT MATERIAL.—*V. dentata* was collected in Chiapas, 28.5 km east of Tuxtla Gutierrez, Mexico, by D. Gage and J. Norris on December 29, 1983. A voucher specimen (no. 1179) is deposited in the Herbarium of the University of Texas at Austin.

ISOLATION OF THE COMPOUNDS.—Air-dried aerial parts of *V. dentata* (2.03 kg) were crushed into small pieces and extracted with 21 liters of CH<sub>2</sub>Cl<sub>2</sub>. The solvent was evaporated in vacuo, and the residue (45 g) was chromatographed over a silica gel column (8.6  $\times$  60 cm). The column was eluted with a hexane-EtOAc gradient solvent system. Further purification of the different compounds was achieved by crystallization and/or Sephadex LH-20 column chromatography, using hexane-CH<sub>2</sub>Cl<sub>2</sub>-MeOH (7:4:1) as the eluting solvent. Yields: *ent*-kaurenic acid (2.6 g), manool (104 mg), *ent*-kauranol (50 mg), grandifloric acid (28 mg), angeloyl-grandifloric acid (10 mg), 15-oxo-*ent*-kaurenic acid (29 mg), trachylobanic acid (360 mg), diversifolin (223 mg), and spathulenol (7.3 mg). The trachylobanic acid was most easily separated from the mixture of *ent*-kaurenic acid and trachylobanic acid by epoxidizing with *m*-chloroperbenzoic acid in CH<sub>2</sub>Cl<sub>2</sub>, and then by separating trachylobanic acid from the epoxide of *ent*-kaurenic acid over a Sephadex LH-20 column.

<sup>1</sup>Permanent address: South China Institute of Botany, Academic Sinica, Guangzhou, the People's Republic of China.

<sup>2</sup>Recently, diversifolin was reported from *Syncretocarpus sericeus* (14) with the stereochemistry at C-8 shown with the acyl function in the  $\beta$  position without any discussion.

TABLE 1.  $^{13}\text{C}$ -nmr and  $^1\text{H}$ -nmr Data of Diversifolin

Diversifolin

Atom	$^{13}\text{C}$ nmr <sup>a</sup>	Atom	$^1\text{H}$ nmr	
			$\text{CDCl}_3$ <sup>b</sup>	$\text{C}_6\text{D}_6$ <sup>b</sup>
C-1	37.5t			
C-2	38.2t	H-1	—	—
C-3	106.5s	H-2	—	—
C-4	141.8s	H-5	5.58 <sup>c</sup>	5.46(dd)
C-5	127.9d	H-6	5.41(ddd)	5.27(ddd)
C-6	75.8d	H-7	4.1(ddd)	3.96(ddd)
C-7	49.9d	H-8	5.54 <sup>c</sup> (ddd)	5.53(ddd)
C-8	71.7d	H-9	—	—
C-9	40.8t	H-13a	6.27(d)	6.28(d)
C-10	83.2s	H-13b	5.6 <sup>c</sup> (d)	5.18(d)
C-11	136.9s	H-14	1.51(s)	1.17(s)
C-12	170.1s	H-15	1.85(t)	1.6(t)
C-13	122.8t	H-2'	2.42(septet)	2.31(septet)
C-14	28.2q <sup>d</sup>	H-3'	1.06(d)	1.04(d)
C-15	22.3q <sup>d</sup>	H-4'	1.08(d)	1.03(d)
C-1'	176.1s	—	—	—
C-2'	34.1d	—	—	—
C-3'	19.1q <sup>e</sup>	—	—	—
C-4'	18.7q <sup>e</sup>	—	—	—

<sup>a</sup> $\delta$  ppm in  $\text{CDCl}_3$  with TMS as internal standard.

<sup>b</sup> $\delta$  ppm with TMS as internal standard.

<sup>c</sup>Obscured.

<sup>d,e</sup>Signals in vertical column may be interchanged.  $^1\text{H}$ -nmr coupling constants: 5, 15=6, 15=2 Hz; 5, 6=4.5 Hz; 6, 7=3.8 Hz; 7, 13=2.5 Hz; 7, 8=5.3 Hz; 8, 9a=4 Hz; 8, 9b=10 Hz; 3', 2'=4', 2'=7 Hz. For numbering scheme, see Ciccio *et al.* (11).

Full details of the isolation and identification of the compounds are available on request to the senior author.

#### ACKNOWLEDGMENTS

This work was supported by the National Institutes of Health (Grant HDO-4488) and the Robert A. Welch Foundation (Grand F-130).

#### LITERATURE CITED

- J. Gershenzon, Y.L. Liu, T.J. Mabry, J.D. Korp, and I. Bernal, *Phytochemistry*, **23**, 1281 (1984).
- F. Bohlmann, J. Jakupovic, M. Ahmed, M. Grenz, H. Suding, H. Robinson, and R.M. King, *Phytochemistry*, **20**, 113 (1981).
- J.R. Cannon, P.W. Chow, P.R. Jefferies, and G.V. Meehan, *Aust. J. Chem.*, **19**, 861 (1966).
- S.O. Almqvist, C.R. Enzell, and F.W. Wehrli, *Acta Chem. Scand.*, **B29**, 695 (1975).
- N.S. Bhacca, D.P. Hollis, L.F. Johnson, and E.A. Pier, "NMR Spectra Catalog," vol. 2, Palo Alto, CA: The National Press, 1963, p. 685.
- G. Hugel, L. Lods, J.M. Mellor, D.W. Theobald, and G. Ourisson, *Bull. Soc. Chim. Fr.*, 2882 (1965).
- N. Ohno and T.J. Mabry, *Phytochemistry*, **19**, 609 (1980).
- N. Ohno, T.J. Mabry, V. Zabel, and W.H. Watson, *Phytochemistry*, **18**, 1687 (1979).

9. T. Murakami, H. Iida, N. Tanaka, Y. Saiki, C.M. Chen, and Y. Iitaka, *Chem. Pharm. Bull.*, **29**, 657 (1981).
10. J. St. Pyrek, *Tetrahedron*, **26**, 5029 (1970).
11. J.F. Ciccio, V.H. Castro, and J.G. Calzada, *Rev. Latinoamer. Quim.*, **10**, 134 (1979).
12. R.C. Bowyer and P.R. Jefferies, *Chem. Ind.*, July 27, 1245 (1963).
13. O. Motl, M. Repcak, and P. Sedmera, *Arch. Pharm.*, **311**, 75 (1978).
14. F. Bohlmann, C. Zdero, R.M. King, and H. Robinson, *Phytochemistry*, **22**, 1288 (1983).

Received 20 August 1984