# PACIFENOL FROM THE MEDITERRANEAN RED ALGA *LAURENCIA MAJUSCULA*

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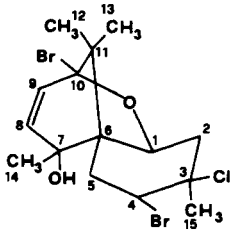
The red seaweed genus *Laurencia* is a very prolific source of halogenated metabolites (1,2). In connection with our interest in this field (3), we report here the isolation of pacifenol (**1**) from *Laurencia majuscula* (Harvey) Lucas as a major component and a complete assignment of its $^1$H-nmr spectrum.




**1**

This compound has been reported as having been isolated from other *Laurencia* species indigenous to the Pacific Ocean (4-8) and from the digestive gland of the Californian mollusk *Aplysia*, which feeds on *Laurencia* species (9), but this is the first report of it being isolated from this species and from the Mediterranean Sea.

Evidence for the natural origin of pacifenol is also shown.

## EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—Spectra were recorded on the following instruments: hrms, Finnigan MAT 731; ms (ei and ci) VG Micromass 7070 E; $^1$H nmr, Varian XL-200 equipped with HOMCOR and HOM 2DJ pulse sequences; $^{13}$C nmr, Bruker AM-400 equipped with DEPT pulse sequence. Optical rotation was determined with a Perkin-Elmer 141 polarimeter (1 dm tube); preparative hplc was performed on a Jobin-Yvon Miniprep LC instrument.

PLANT MATERIAL.—The alga was collected at Castelluccio, eastern Sicily, in September 1983 and August 1984. It grows as scattered, red-brown clumps 2-3 cm tall in littoral zones. It was identified as *L. majuscula* by Prof. Y. Saito. A voucher specimen was deposited in the Herbarium of the Algology Laboratory of the Institute of Botany at the University of Catania.

EXTRACTION AND ISOLATION.—Shade-dried, ground alga (190 g) was extracted three times with MeOH-toluene (3:1) to give a residue that was partitioned between a $NaNO_3$ solution (1M) and *t*-butylmethylether. The ether extract (4.5 g) was chromatographed on a silica gel column, using increasing concentrations of $Et_2O$ in petroleum ether. A series of fractions eluted with 30% $Et_2O$ were pooled and subjected to preparative hplc (LiChroprep 60, hexane-$Et_2O$, 80:20). The first eluate yielded a white solid that was cleaned through a silica gel SepPak cartridge (same solvent) to give **1** (570 mg, 0.3% dry wt), mp 145-147, [lit(4) 149-150.5°]; $[\alpha]^{20}$ ($\lambda$, nm) −2.5° (589) in $CHCl_3$, unreported in the literature. The elemental composition was established by hrms: $C_{15}H_{19}O\,^{79}Br_2Cl$ (obs. *m/z* 407.9504, $\Delta$ = −1.4 mmu) for the M-$H_2O$]$^+$ fragment and $C_{15}H_{19}O\,^{79}Br^{35}Cl$ (obs. *m/z* 329.0312, $\Delta$ = −0.5 mmu) for the M-$H_2O$-Br]$^+$ fragment. The molecular ion was only detected in cims as M+H]$^+$ cluster. The $^{13}$C-nmr resonances ($CDCl_3$, DEPT sequence) matched with those reported for pacifenol (10). The $^1$H-nmr chemical shifts agreed fairly well with those previously reported (9). The assignment of the resonances and coupling constants (hitherto unreported) is the following. $^1$H nmr (200 MHz, δ, $CDCl_3$), 4.68 (dd, H-1, $J_{1,2e}$=5.2, $J_{1\text{-}2a}$=12.5 Hz), 2.69 (dd, H-2e, $J_{1,2e}$=5.2, $J_{2a,2e}$=15.0 Hz), 2.35 (dd, H-2a, $J_{1,2a}$=12.5, $J_{2a,2e}$=15.0 Hz), 5.44 (dd, H-4, $J_{4,5e}$=3.6, $J_{4,5a}$=13.1 Hz), 2.34 (dd, H-5e, $J_{4,5e}$=3.6, $J_{5a,5e}$=14.4 Hz), 2.18 (dd, H-5a, $J_{4,5a}$=13.1, $J_{5a,5e}$=14.4 Hz), 1.91 (s, OH-7, $D_2O$ exchangeable), 5.38 (d, H-8, $J_{8,9}$=9.8 Hz), 6.06 (d, H-9, $J_{8,9}$=9.8 Hz), 1.29 and 1.11 (s, $CH_3$-12, $CH_3$-13, interchangeables), 1.51 (s, $CH_3$-14), 1.78 (s, $CH_3$-15). The above assignment was done with the aid of two-dimensional spectroscopy. In fact, in the HOMCOR two-dimensional spectrum, the doublet of doublets at δ 4.68 (H-1) exhibits off-diagonal peaks that correlate it with the resonances at δ 2.69 and 2.35, thus delineating the ABX system H-1, H-2e, H-2a. Analogously, the doublet of doublets at δ 5.44 (H-4) is correlated with the resonances at δ 2.34 and 2.18, delineating the ABX system H-4, H-5e, H-5a. The coupling constants were obtained by

a HOM two-dimensional *J* spectrum and by analysis of the two overlapped ABX spin systems in the 1D spectrum, which resolved all the 16 lines of both AB portions in the severely crowded range δ 2.18-2.69. Moreover, since the stereochemistry of the protons at C-1 and C-4 is axial (4), it was possible to relate unequivocally the chemical shift of each proton at C-2 and at C-5, respectively, to their axial or equatorial position from the magnitude of the coupling constants.

To rule out the possibility that pacifenol is an artifact formed by rearrangement from prepacifenol through the silica gel chromatography (5), hexane extraction of *L. majuscula* gave a residue that, after washing with cold pentane and slow evaporation, gave crystalline pacifenol which is thus present as a natural product.

Details of the isolation procedure and the spectral data are available on request to the senior author.

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# VOLATILE CONSTITUENTS OF *BORONIA LATIPINNA* LEAF

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*Boronia latipinna* J.H. Willis or Grampians boronia (tribe Boronieae, family Rutaceae) (1), formerly grouped with *B. pinnata* (2), is endemic to the Grampian mountain regions of southwestern Victoria, Australia. This shrub, which prefers rocky situations often near mountain peaks, grows erect as a small-to-medium bush reaching from 1-4 m with pinnate leaves and bearing bright pink flowers. Although, as with other boronias, the pleasant aroma of crushed leaves indicates perfumery value, this species has hitherto escaped chemical investigation.

Other members of the genus *Boronia* are rich in citronellol (*B. citriodora*) (3), cyclocolorenone (*B. ledifolia*) (4), elemicin (*B. muelleri*) (5), ocimene (*B. anemonifolia*) (6), β-ionone (*B. megastigma*) (7,8), safrole (*B. safrolifera*) (9) and thujone (*B. thujona*) (10). Of these, the concentrated floral extract of *B. megastigma* is highly regarded commercially in perfumes and flavors (7,8).