Phytochemistry, Vol. 26, No. 4, pp. 1053–1057, 1987.
Printed in Great Britain.

0031-9422/87 $3.00 + 0.00

CHAMIGRANE METABOLITES FROM A JAMAICAN VARIETY OF *LAURENCIA OBTUSA*

MARY R. BRENNAN, KAREN L. ERICKSON,* DONNA A. MINOTT† and KEITH O. PASCOE†

Jeppson Laboratory, Clark University, Worcester, MA 01610, U.S.A.; †Department of Chemistry, University of the West Indies, Kingston 7, Jamaica

(*Received* 14 *May* 1986)

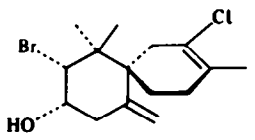
Key Word Index—*Laurencia obtusa*; Rhodomelaceae; marine algae; sesquiterpenes; halochamigrenes.

Abstract—Two new sesquiterpenoid metabolites have been characterized from a Jamaican variety of the marine alga *Laurencia obtusa*. These are 2-chloro-3-hydroxy-α-chamigren-9-one, with an unusual *cis*-relationship of the heteroatoms at the 2,3-positions, and its intramolecular conjugate addition derivative possessing a cineole moiety fused to a cyclohexane ring.

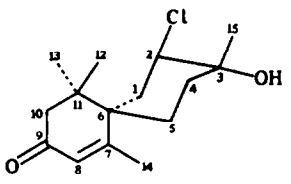
INTRODUCTION

The *Laurencia* genus of marine algae is a prolific elaborator of novel secondary metabolites [1]. These metabolites purportedly confer a special ecological advantage on the plants, protecting them from excessive predation. While some species of *Laurencia* produce a characteristic set of secondary metabolites independent of growth locality [2], others produce a bewildering array of vastly different compounds which vary from one locality to another. The cosmopolitan species *L. obtusa* falls into this latter category [1, 3–5].

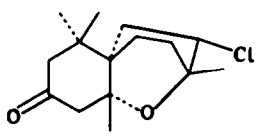
(+)-Elatol (**1**) was originally reported as the major secondary metabolite of *L. elata* collected in Australian waters [6]. Later, it was isolated from *L. obtusa* collections in the Canary Islands [7] and Belize [8], while its enantiomer was found in a different Caribbean collection [9]. In examining a variety of *L. obtusa* collected in Jamaican waters, we have characterized (+)-elatol as the major secondary metabolite. Accompanying the elatol are two related metabolites with new structures, **2** and **3**.



1



2

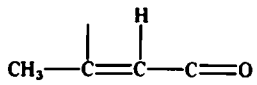


3

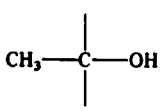
* To whom correspondence should be addressed.

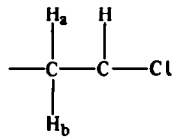
RESULTS AND DISCUSSION

Compound **2** analysed for $C_{15}H_{23}ClO_2$ by high-resolution mass spectrometry. Its IR spectrum displayed hydroxyl absorption at 3450 cm^{-1} and conjugated carbonyl absorption at 1665 and 1615 cm^{-1}. The latter functionality was confirmed by a λ_{max} of 237 nm in the UV spectrum and absorption in the ^{13}C NMR spectrum at δ198.2 (*s*), 127.0 (*d*) and 167.7 (*s*). These data, together with a vinyl methyl signal at δ2.05 in the ^1H NMR spectrum which was allylically coupled (1.1 Hz) to a vinyl proton at 5.83, established the presence of the following moiety:



Deshielded signals at δ69.8 (*s*) and 68.1 (*d*) were assigned to those carbons bearing the hydroxyl and the chloro groups. A methyl carbon absorption at δ28.8 (*q*) and its attendant proton absorption in the ^1H NMR spectrum at 1.36 (*s*) led to the assignment of the hydroxyl group to the quaternary carbon (69.8, *s*) and the chlorine to the tertiary carbon (68.1, *d*). Since the chloromethine signal appeared as a double doublet in the ^1H NMR spectrum (δ4.32), two non-equivalent protons are adjacent:





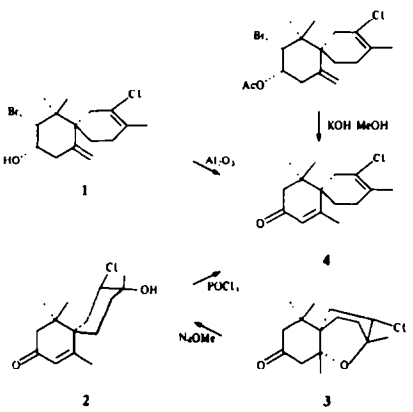
Two additional methyl groups, two additional quaternary carbons and four CH_2 groups were also identified in the NMR spectra (Table 1).

Assuming an α-chamigrene base, the most reasonable structure to fit these data is that shown by **2**. Confirmation of the gross structure was provided by interrelating compound **2** with elatol. Thus, $POCl_3$–pyridine dehydration of **2** gave a mixture of olefins with **4** as a major

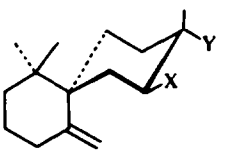
Table 1. ^{13}C NMR* and ^{1}H NMR† data for compound **2**

Carbon No.	^{13}C δ	^{1}H δ	^{1}H multiplicity and J (Hz)
1	34.65 (*t*)	2.30 (ax)	*dd*; $J_{1ax,1eq} = 14.3$, $J_{1ax,2} = 12.5$ (additional 0.5 Hz coupling present)
		2.16 (eq)	*ddd*; $J_{1eq,1ax} = 14.3$, $J_{1eq,2} = 4.7$, $J_{1eq,5eq} = 1.6$
2	68.10 (*d*)	4.32	*dd*; $J_{2,1ax} = 12.5$, $J_{2,1eq} = 4.7$
3	69.76 (*s*)		
4	36.15 (*t*)	1.80 (ax)	*ddd*; $J_{4ax,4eq} = 14.4$, $J_{4ax,5ax} = 12.8$, $J_{4ax,5eq} = 4.6$
		1.97 (eq)	*ddd*; $J_{4eq,4ax} = 14.4$, $J_{4eq,5ax} = 5.2$, $J_{4eq,5eq} = 3.7$
5	23.20 (*t*)	2.04 (ax)	*ddd*; $J_{5ax,5eq} = 14.1$, $J_{5ax,4ax} = 12.8$, $J_{5ax,4eq} = 5.2$
		1.72 (eq)	*br ddd*; $J_{5eq,5ax} = 14.1$, $J_{5eq,4ax} = 4.6$, $J_{5eq,4eq} = 3.7$, $J_{5eq,1eq} = 1.6$
6	47.89 (*s*)		
7	167.75 (*s*)		
8	127.01 (*d*)	5.83	*d*; $J_{8,14} = 1.1$
9	198.18 (*s*)		
10	49.95 (*t*)	2.37 (ax)‡	*d*; $J_{10ax,10eq} = 18$
		2.33 (eq)‡	*d*; $J_{10eq,10ax} = 18$
11	40.41 (*s*)		
12	27.39 (*q*)‡,§	1.12‡	*s*
13	27.50 (*q*)‡,§	1.16‡	*s*
14	22.51 (*q*)§	2.05	*d*; $J_{14,8} = 1.1$
15	28.81 (*q*)§	1.36	*s*

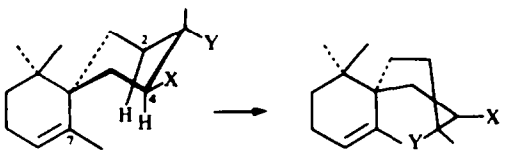
*Proton decoupled values (referenced to $CDCl_3$ at 77.0 ppm) in $CDCl_3$.
†500 MHz values (ppm downfield from Me_4Si) in $CDCl_3$.
‡Assignments may be reversed.
§Assigned by crossover experiments.



Scheme 1.



5



6

component. Compound **4** was also derived from (+)-elatol by dehydrobromination–isomerization with aluminium oxide [10] and from base treatment of (+)-elatol acetate [11] (Scheme 1).

The *cis*-relationship of the adjacent chloro and hydroxyl groups in compound **2** is an unusual arrangement. All other known *Laurencia* 2,3- (or 3,4-) disubstituted chamigrene metabolites display a *trans*-orientation of the two heteroatoms at these positions. The B-ring conformation for the known *trans*-derivatives has been shown to be a function of the endo- (α-series) or exocyclic (β-series) nature of the C-7 double bond [12]. In the β-series, the B-ring adopts the chair conformation shown in **5** with both heteroatoms equatorial. In the α-series, interactions between the C-2 axial hydrogens with the C-7 methyl group forces the B-ring into a flattened twist boat (**6**).

In the present α-chamigrene case, with the *cis*-relationship of the 2,3-heteroatoms in **2**, the C-2 hydrogen–C-7 methyl interaction of **6** is replaced by a C-2 chlorine–C-7 methyl interaction which is severe. Relief is obtained by adoption of the alternative chair conformation, allowing the chlorine to assume an equatorial position. This conformation is clearly evident from the spectral data of **2** where the chloromethine shows axial–axial coupling (J = 12.5 Hz) and axial–equatorial coupling (J = 4.7 Hz) with the adjacent C-1 hydrogens. Moreover, the downfield chemical shifts of the axial hydrogens at C-1 and C-5 (Table 1) are explicable in terms of their nearness to the axial hydroxyl at C-3.

Compound **3** analysed for $C_{15}H_{23}ClO_2$ by high-resolution mass spectrometry. Its IR spectrum displayed carbonyl absorption at 1710 cm^{-1} as the only distinguish-

Table 2. ^{13}C NMR* and ^{1}H NMR† data for compound 3

Carbon No.	^{13}C δ	^{1}H δ	^{1}H multiplicity and J (Hz)
1	39.13 (*t*)	2.63 (exo)‡	*dd*; $J_{1exo,1endo} = 14.8$, $J_{1exo,2} = 10.5$
		2.42 (endo)‡	*ddd*; $J_{1endo,1exo} = 14.8$, $J_{1endo,2} = 4.4$, $J_{1endo,5endo} = 3.6$
2	63.24 (*d*)	4.12	*dd*; $J_{2,1exo} = 10.5$, $J_{2,1endo} = 4.4$
3	70.92 (*s*)		
4	31.64 (*t*)	1.70 (exo)‡	*ddd*; $J_{4exo,4endo} = 13.4$, $J_{4exo,5exo} = 12.0$, $J_{4exo,5endo} = 2.0$
		2.02 (endo)‡	*ddd*; $J_{4endo,4exo} = 13.4$, $J_{4endo,5exo} = 6.5$, $J_{4endo,5endo} = 12.3$
5	21.63 (*t*)	1.52 (exo)‡	*dddd*; $J_{5exo,5endo} = 13.0$, $J_{5exo,4exo} = 12.0$, $J_{5exo,4endo} = 6.5$, $J_{5exo,8eq} = 0.6$
		1.95 (endo)‡	*dddd*; $J_{5endo,5exo} = 13.0$, $J_{5endo,4exo} = 2.0$, $J_{5endo,4endo} = 12.3$, $J_{5endo,1endo} = 3.6$
6	40.80 (*s*)		
7	79.57 (*s*)		
8	53.80 (*t*)§	3.09 (ax)	*ddd*; $J_{8ax,8eq} = 13.6$, $J_{8ax,14} = 1.2$, $J_{8ax,10ax} = 0.9$
		2.50 (eq)	*ddd*; $J_{8eq,8ax} = 13.6$, $J_{8eq,10eq} = 2.4$, $J_{8eq,5exo} = 0.6$
9	208.05 (*s*)		
10	53.02 (*t*)§	2.55 (ax)	*dd*; $J_{10ax,10eq} = 14.1$, $J_{10ax,8ax} = 0.9$
		2.04 (eq)	*dd*; $J_{10eq,10ax} = 14.1$, $J_{10eq,8eq} = 2.4$
11	38.31 (*s*)		
12	26.05 (*q*)§	1.00	*s*
13	27.33 (*q*)§	1.00	*s*
14	29.16 (*q*)§	1.36	*d*; $J_{14,8ax} = 1.2$
15	24.45 (*q*)§	1.21	*s*

*Proton decoupled values (referenced to $CDCl_3$ at 77.0 ppm) in CDCl.

†500 MHz values (ppm downfield from Me_4Si) in $CDCl_3$.

‡Protons on carbocyclic ring B are assigned endo if *cis* to the oxide bridge and exo if *trans* to the oxide bridge [26].

§Partially assigned by crossover experiments.

ing feature. The ^{13}C NMR data (Table 2) showed the carbonyl group at δ208.0 to be the only unsaturated carbon, hence the molecule is tricyclic. Two quaternary deshielded carbons were evident (δ70.9 and 70.6) as well as one deshielded CH group (63.2), indicative of ether and chloro functionalities, respectively.

The 500 MHz ^{1}H NMR spectrum (Table 2) was well resolved and showed two methyl singlets (δ1.00 and 1.21), a methyl doublet at 1.36 (J = 1.2 Hz), a deshielded methine at 4.12 (*dd*, J = 10.5, 4.4 Hz) and several other sets of multiplets in the 1.5–3.1 region of the spectrum. Extensive homonuclear decoupling provided the proton sequence for the molecule and allowed **3** to be written as a tentative structure. The B-carbocyclic ring of **3**, together with its oxide bridge, defines a cineole structure. In an elegant study of the fate of eucalyptus oil in the aqueous environment, Carman and Fletcher [13] synthesized seven monochlorocineoles and reported their ^{1}H NMR and ^{13}C NMR properties. Comparison of our data for **3** with Carman and Fletcher's for chlorocineole (**7**) gave excellent agreement for the equivalent portions of the molecule (Tables 2 and 3).

7

The downfield shift of H-1_{endo}, H-4_{endo}, and H-5_{endo} of **3** reflects their *cis*-relationship to the oxide bridge, and, in the case of H-1_{endo}, to the chlorine at C-2 as well. (In the absence of the heteroatoms, these protons resonate at δ1.5 [14].) H-1_{exo} and H-2_{exo} are also deshielded compared to those of chlorocineole, a consequence of their location in the nodal plane of the C-9 carbonyl group [15, 16].

A 4-bond *W*-coupling [17] (3.6 Hz) between H-1_{endo} and H-5_{endo} established the assignment of the latter at δ1.95 and further confirmed the assignment of H-1_{endo} at 2.42. In addition, a 5-bond extended zig-zag coupling [18] (0.6 Hz) was evident between H-5_{exo} and H-8_{eq}, supporting their assignments. The difference in coupling constants between H-4_{endo} – H-5_{exo} (6.5 Hz) and H-4_{exo} – H-5_{endo} (2.0 Hz) suggests a slight twist ($\simeq 15°$) to the cyclohexyl ring of the cineole portion of the molecule, thus reducing the interaction of the chlorine with the oxide bridge.

The higher-field position for equatorial protons adjacent to a carbonyl relative to their axial counterparts [19] is consistent with the proton assignments at C-8 and C-10. In addition, the small 1,3-diaxial coupling (0.9 Hz) of H-8_{ax}–H-10_{ax} [20, 21] and the larger (2.4 Hz) diequatorial *W*-coupling of H-8_{eq}–H-10_{eq} [17] are in line with the expected values. H-8_{ax} also displays a *W*-coupling to the C-7 methyl hydrogens (H-14). The carbon values for C-8, C-10 and the four methyl groups were assigned by cross-over experiments [22] and the usual substituent effects.

Compound **3** could be quantitatively converted to **2** upon treatment with methanolic sodium methoxide (Scheme 1). This interconversion confirms the structure

Table 3. ^{13}C NMR and ^{1}H NMR data for compound 7*

Carbon No.	^{13}C δ	^{1}H δ	^{1}H multiplicity and J (Hz)
1	36.36 (*t*)	2.29 (exo)	*ddd*; J = 2.9, 10.4, 15.0
		2.39 (endo)	*ddd*; J = 2.8, 3.1, 4.4, 15.0
2	62.33 (*d*)	3.97	*dd*; J = 10.4, 4.4
3	71.74 (*s*)		
4	31.09 (*t*)	1.4–1.6	
5	22.08 (*t*)	1.4–1.6	J_{5endo} = 3.1
6	33.97 (*d*)	1.4–1.6	J = 2.8, 2.9
7	74.12 (*s*)		
8	28.75 (*q*)†	1.37	*s*
14	28.36 (*q*)†	1.28	*s*
15	25.10 (*q*)	1.18	*s*

* Data taken from ref. [13]. Spectra recorded in $CDCl_3$ with Me_4Si as internal standard.

† Assignments may be interchanged.

and stereochemistry of **3** except for C-7. The stereochemistry at this position was established by NOE difference spectroscopy [23, 24] (see Experimental for details). Irradiation of the C-7 methyl hydrogens (H-14) gave rise to an enhancement in intensity of the endo-hydrogen at C-5 (~ 3%) and the equatorial hydrogen at C-8 (~ 4%). The C-7 epimer would also have given enhancement of H-8_{eq}, but H-5_{endo} (δ1.95) would have been unaffected. Instead, the C-1_{endo} proton (δ2.42) would have been enhanced.

H-8_{ax} experiences a population inversion upon irradiation of the C-7 methyl to which it is coupled. A similar, but much smaller effect on H-5_{exo}, coupled to H-5_{endo}, was also noted and provided supporting evidence for its chemical shift assignment.

Since compound **3** was not present in all collections, the possibility of it representing an artefact of storage or isolation cannot be ruled out.

Elatol displayed modest antifungal activity towards *Cladosporium cucumerinum* and was toxic to brine shrimp hatchlings (78% dead after 24 hr). Compounds **3** and **4** displayed similar activity but at reduced levels.

EXPERIMENTAL

Analytical TLC was done on commercial BakerFlex (silica gel IB_2-F) and prep. TLC on Brinkmann HF 254 + 366, type 60 silica gel. Optical rotations were obtained in $CHCl_3$ on a Perkin–Elmer 241 polarimeter. Low-resolution mass spectra were obtained on a MAT 212 double focusing GC/MS at 70 eV, and high-resolution mass spectra were recorded on a CEC-110B dual focusing mass spectrometer at 70 eV. UV spectra were recorded on a Varian Cary 219 spectrometer and are for EtOH solns. IR spectra were taken on a Perkin–Elmer 710B spectrometer in $CHCl_3$. The ^{1}H NMR spectra were recorded on Bruker WP-250/and 500 MHz spectrometers, and the ^{13}C NMR spectra were recorded on a Bruker WP-250 spectrometer with $CDCl_3$ as solvent unless stated otherwise.

Isolation and purification of compounds **1–3**. *Laurencia obtusa* was collected at Discovery Bay on the north coast of Jamaica in April 1983. The alga was washed and sun-dried to give 148 g of dried material which was extracted with $CHCl_3$–MeOH (1:1, 1.3 l.) and the solvent evaporated to give a brown gum (9.5 g, 6.4% of dry wt). The gum was subjected to flash chromatography, with 20% EtOAc–$CHCl_3$ as eluting solvent. The first 300 ml of eluate was combined and concentrated to give fraction A and the next 300 ml combined and concentrated to give fraction B.

Fraction A was purified by prep. TLC ($CHCl_3$) to give elatol (**1**), $[\alpha]_D^{25}$ +75.4° (*c* 1.01) (1.105 g, 0.7% of dry alga). Fraction B was purified by prep. TLC (25% Me_2CO–petrol) to yield a mixture of **2** and **3** (36 mg, 0.024% of dry alga). This mixture (25 mg) was further purified by prep. TLC (10% EtOAc–$CHCl_3$, 2 ×) to yield **2** (17 mg, 0.011% of dry alga) and **3** (4 mg, 0.003% of dry alga).

2-Chloro-3-hydroxy-α-chamigren-9-one (**2**). $[\alpha]_D^{25}$ −46° (*c* 0.22); MS *m/z* (rel. int.): 270.1362 (65) for $C_{15}H_{23}Cl^{35}O_2$ (calc. 270.1387), 255 (71), 252 (98), 235 (53), 224 (10), 217 (62), 214 (100), 178 (93), 161 (97), 151 (68), 145 (81), 135 (80), 132 (18) (this is the base peak in the low-resolution MS), 121 (78), 109 (74), 107 (78), 105 (73), 93 (87), 92 (32), 91 (91), 79 (81), 77 (79), 71 (68); IR ν_{max} cm^{-1}: 3450, 3020, 2975, 2930, 1665, 1615, 1470, 1450, 1440, 1380, 1335, 1120, 1040, 1000, 935, 915; ^{1}H NMR ($CDCl_3$): see Table 1; 250 MHz (C_6D_6): δ0.65 (*s*, H-12 or 13), 0.67 (*s*, H-12 or 13), 1.06 (*s*, H-15), 1.60 (*d*, J = 1.1 Hz, H-14), 1.19 (*m*, H-5_{eq}), 1.26 (*ddd*, H-4_{ax}), 1.55 (*dd*, H-4_{eq}) 1.74 (*ddd*, H-5_{ax}), 1.93 (*ddd*, H-1_{eq}), 2.07 (*br s*, H-$10_{ax,eq}$), 2.14 (*t*, H-1_{ax}), 3.96 (*dd*, H-2), 5.77 (*d*, J = 1.1 Hz, H-8); ^{13}C NMR: see Table 1.

Compound **3**. MS *m/z* (rel. int.): 270.1416 (95) for $C_{15}H_{23}Cl^{35}O_2$ (calc. 270.1387), 255 (89), 235 (89), 217 (35), 200 (13), 177 (55), 159 (53), 143 (58), 135 (88) (this is the base peak in the low-resolution MS), 132 (9), 121 (68), 119 (62), 107 (62), 93 (81), 91 (100), 83 (82), 81 (76), 79 (81); IR ν_{max} cm^{-1}: 2970, 1710, 1460, 1400, 1380, 1305, 1285, 1265, 1240, 1090, 1070, 1050, 1020, 1010, 980, 915; ^{1}H NMR ($CDCl_3$), Table 2, 250 MHz (C_6D_6): δ0.44 (*s*, H-12 or 13), 0.65 (*s*, H-12 or 13), 0.76 (*dd*, H-5_{exo}), 1.01 (*t*, H-4_{exo}), 1.16 (*s*, H-14, 15), 1.30 (*br t*, H-5_{endo}), 1.51 (*m*, H-4_{endo}), 1.76 (*br d*, H-10_{eq}), 2.11 (*ddd*, H-1_{endo}), 2.57 (*br d*, H-8_{eq}), 1.89 (*d*, H-10_{ax}), 1.93 (*dd*, H-1_{exo}), 3.01 (*br d*, H-8_{ax}), 3.56 (*dd*, H-2) [25]; ^{13}C NMR: see Table 2.

For NOE difference spectroscopy a modified Bruker microprogram was used. The transient loop included a 1 sec relaxation delay with decoupler gated off, a single frequency irradiation period of 3 sec (decoupler power of 45 L, uncalibrated), 90° pulse, 1.386 sec acquisition time (sweep width 3000 Hz). After four dummy scans, 80 transients were collected. With a 100 msec delay, the decoupler frequency was changed to an off-resonance

position 95 Hz upfield of the highest field peak and 185 Hz upfield of the on-resonance position. The 80-transient cycle was repeated for the off-resonance control. A total of 48 passes were made through the on-resonance, off-resonance cycles. The difference spectrum was obtained by subtracting the control spectrum from the on-resonance spectrum which was phased identically. A line broadening of 0.4 Hz was used in transforming the FIDs.

Dehydrobromination of elatol (**1**). Elatol (20.5 mg, 0.0614 mmol) and Al_2O_3 (neutral, oven-dried at 110° for 4 days) were suspended in dry Et_2O. The suspension was stirred at 25° for 4 days. The reaction mixture was filtered to remove alumina, and the Et_2O was removed from the filtrate under vacuum to give 13.1 mg of crude product. Pure ketone (**4**) was obtained (5.7 mg, 37%) after prep. TLC with 6% EtOAc–CH_2Cl_2 as the developing solvent: $[\alpha]_D^{25} + 58.3°$ (*c* 0.36); MS *m/z*: 252.1269 for $C_{15}H_{21}Cl^{35}O$ (calc. 252.1281); IR ν_{max} cm^{-1}: 3000, 2950, 2900, 2850, 1660, 1610; ^1H NMR (250 MHz, $CDCl_3$): δ0.97 (*s*, H-12), 1.07 (*s*, H-13), 1.81 (*s*, H-15), 1.98 (*d*, J = 0.9 Hz, H-14), 1.6–2.3 (*m*, 6H), 2.59 (AB multiplet, H-10), 5.89 (*br s*, H-8); ^{13}C NMR ($CDCl_3$): δ19.69 (C-15), 23.81 (C-12), 23.89 (C-5), 24.80 (C-14), 30.22 (C-13), 30.37 (C-4), 36.33 (C-1), 40.45 (C-11), 46.38 (C-6), 48.90 (C-10), 126.23 (C-2), 127.54 (C-8), 129.64 (C-3), 168.38 (C-7), 198.04 (C-9).

Base treatment of elatol acetate. Elatol acetate (300 mg, 0.824 mmol), obtained from standard acetylation of elatol (Ac_2O–pyridine), was dissolved in 40 ml MeOH and 100 ml 5% KOH in MeOH was added. After refluxing for 15 min, the reaction mixture was diluted with brine (250 ml) and extracted with EtOAc (3 × 150 ml). The organic extract was washed, dried and concentrated to give 188 mg of crude product. Pure ketone (**4**) was obtained after prep. TLC with 25% EtOAc–hexane as developing solvent.

Dehydration of **2**. Two mg of **2** was dissolved in 0.5 ml dry pyridine and 3 drops of freshly distilled $POCl_3$ was added. The mixture was maintained at 25° for 48 hr. Ice was added, and the aq. layer was extracted with Et_2O. The Et_2O extracts were washed with aq. HCl then aq. $NaHCO_3$ and finally brine. The Et_2O was dried and removed to give an oil which consisted of a small quantity of starting alcohol and a mixture of olefins. The mixture was not completely resolvable by TLC (2% EtOAc–CH_2Cl_2, 5 ×), but a fraction enriched in the slower-moving isomer clearly showed its identity to **4** (TLC, ^1H NMR).

Conversion of compound **3** to **2**. Compound **3** (2 mg) was dissolved in several drops of MeOH and was added to a methanolic soln of Na methoxide at 25°. The mixture was stirred at this temp. for 5 hr, H_2O was added, and an Et_2O extraction was carried out. The Et_2O was washed with brine, dried and removed to give 3 mg of a colourless solid. Prep. TLC (10% EtOAc–$CHCl_3$, 2 ×) afforded **2**, identified by TLC and ^1H NMR comparisons.

Acknowledgements—We would like to thank Dr. B. Jupp, Department of Botany, U.W.I., who collected and identified *L. obtusa*. We acknowledge support of the NSF Northeast Regional NMR Facility at Yale University (Grant No. CHE-7916210), the Worcester Consortium NMR Facility at Clark University (NSF Grant No. DMR-8108697) and the NIH Mass Spectrometry Facility at MIT (Grant No. RR00317). We thank Dr. P. T. Inglefield for assistance with the NOE experiments.

REFERENCES

1. Erickson, K. L., (1983) in *Marine Natural Products. Chemical and Biological Perspectives* (Scheuer, P. J., ed.) Vol. 5, pp. 131–257. Academic Press, New York.
2. Suzuki, M., Koizumi, K., Kikuchi, H., Suzuki, T. and Kurosawa, E. (1983) *Bull. Chem. Soc. Jpn.* **56**, 715.
3. Suzuki, T., Suzuki, M., Furusaki, A., Matsumoto, T., Kato, A., Imanaka, Y. and Kurosawa, E. (1985) *Tetrahedron Letters* **26**, 1329.
4. Gonzalez, A. G., Martin, J. D., Norte, M., Perez, R., Rivera, P., Ruano, J. Z., Rodriguez, M. L., Fayos, J. and Peralas, A. (1983) *Tetrahedron Letters* **24**, 4143.
5. Gonzalez, A. G., Martin, J. D., Norte, M., Rivera, P. and Ruano, J. Z. (1984) *Tetrahedron* **40**, 3443.
6. Sims, J. J., Lin, G. H. Y. and Wing, R. A. (1974) *Tetrahedron Letters* 3487.
7. Gonzalez, A. G., Darias, J., Diaz, A., Fourneron, J. D., Martin, J. D. and Perez, C. (1976) *Tetrahedron Letters* 3051.
8. Norris, J. N. and Fenical, W. (1982) in *The Atlantic Barrier Reef Ecosystem at Carrie Bay Cay, Belize, I. Structure and Communities* (Rutzler, K. and MacIntyre, I. G., eds) p. 417. Smithsonian Institute Press, Washington, DC.
9. Rinehart, K. L. (1980) Third International Symposium on Marine Natural Products, IUPAC, Brussels.
10. Gonzalez, A. G., Martin, J. D., Martin, V. S. and Norte, M. (1979) *Tetrahedron Letters* 2719.
11. Suzuki, M. and Kurosawa, E. (1978) *Tetrahedron Letters* 4805.
12. Suzuki, M., Furusaki, A. and Kurosawa, E. (1979) *Tetrahedron* **35**, 823.
13. Carman, R. M. and Fletcher, M. T. (1983) *Aust. J. Chem.* **36**, 1483.
14. Boaz, H. (1973) *Tetrahedron Letters* 55.
15. Bhacca, N. S. and Williams, D. H. (1964) *Applications of NMR Spectroscopy in Organic Chemistry*, p. 73. Holden Day, San Francisco.
16. Jackman, L. M. and Sternhell, S. (1969) *Applications of Nuclear Magnetic Resonance Spectroscopy in Organic Chemistry*, 2nd edn, p. 92. Pergamon Press, New York.
17. Jackman, L. M. and Sternhell, S. (1969) *Applications of Nuclear Magnetic Resonance Spectroscopy in Organic Chemistry*, 2nd edn, p. 334. Pergamon Press, New York.
18. Jackman, L. M. and Sternhell, S. (1969) *Applications of Nuclear Magnetic Resonance Spectroscopy in Organic Chemistry*, 2nd edn, p. 333, Pergamon Press, New York.
19. Jackman, L. M. and Sternhell, S. (1969) *Applications of Nuclear Magnetic Resonance Spectroscopy in Organic Chemistry*, 2nd edn, p. 241. Pergamon Press, New York.
20. Osawa, Y. and Neeman, M. (1963) *J. Am. Chem. Soc.* **85**, 2856.
21. Laszlo, P. and Musher, J. I. (1964) *Bull. Soc. Chim. Fr.* 2558.
22. Silverstein, R. M., Bassler, G. C. and Morrill, T. C. (1981) *Spectrometric Identification of Organic Compounds*, 4th edn, pp. 275–277. Wiley, New York.
23. Sanders, J. K. M. and Mersh, J. D. (1982) *Prog. Nucl. Magn. Reson. Spectrosc.* **15**, 353.
24. Neuhaus, D., Sheppard, R. N. and Bick, I. R. C. (1983) *J. Am. Chem. Soc.* **105**, 5996.
25. Narayanan, C. R. and Bhadane, N. R. (1968) *Tetrahedron Letters* 1557.
26. March, J. (1985) *Advanced Organic Chemistry*, 3rd edn, pp. 114–115. Wiley-Interscience, New York.