AN ALTERNATIVE ROUTE TO A BENZOFURAN NATURAL PRODUCT DEHYDROTREMETONE

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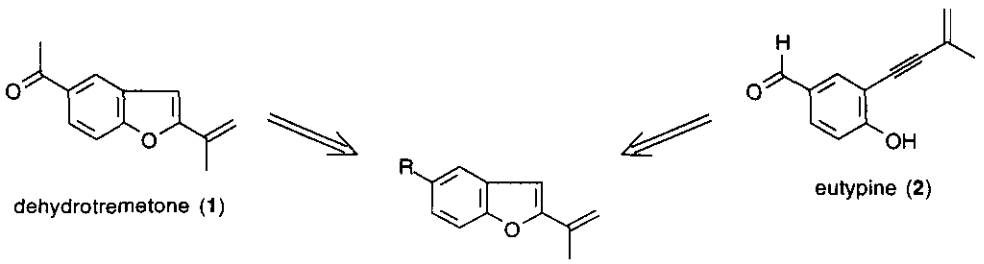
Abstract —— Dehydrotremetone, a toxic ketone isolated from the weeds *Eupatorium urticaefolium* and *Aplopappus heterophyllus*, has been synthesized from isovanillin *via* palladium-mediated cross-coupling reaction and lithium chloride-mediated concurrent demethylation-benzofuran formation reaction. The present procedure also allows a simple preparation of three other non-heterocyclic acetylenic phytotoxic compounds isolated from the culture medium of *Eutypa lata*.

Interconversion between benzofurans and *o*-hydroxyphenylacetylenes has been well-established Namely, benzofurans afford *o*-hydroxyphenylacetylenes on treatment with strong bases,[1] on the other hand, *o*-hydroxyphenylacetylenes, generated transiently by the reaction between *o*-halophenols and copper acetylides, cyclize under the conditions employed to give benzofurans[2] (**Scheme 1**).

Scheme 1

Since we became aware that two biologically active natural products dehydrotremetone (**1**)[3,4] and eutypine (**2**)[5,6] are just in the same benzofuran-*o*-hydroxyphenylacetylene relationship, we were interested in

synthesizing these two natural products *via* a common intermediate having the same benzofuran framework such as **3** (**Scheme 2**). Dehydrotremetone (**1**) is one of the toxic principle of the weeds *Eupatorium urticaefolium* and *Aplopappus heterophyllus* responsible for the cattle illness 'trembles' and milk sickness in humans, while eutypine (**2**) is the most phytotoxic principle isolated from the culture medium of *Eutypa lata* responsible for the dieback of vineyards in central Europe.



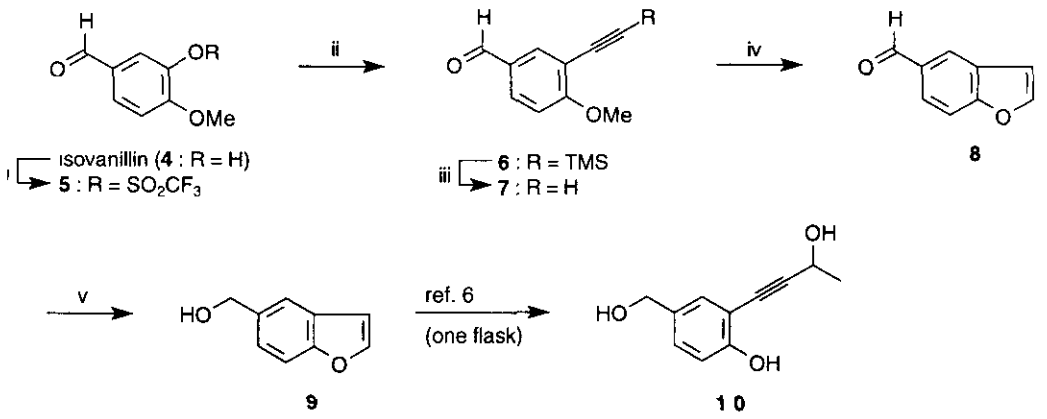
dehydrotremetone (**1**) eutypine (**2**)

3

Scheme 2

As the common starting material we chose readily accessible isovanillin (**4**) which was first transformed into the triflate (**5**) in 85% yield. Reaction[7] of this compound with trimethylsilylacetylene in the presence of a catalytic amount (1 mol %) of *bis*(triphenylphosphine)palladium(II) chloride [$Pd(II)(PPh_3)_2Cl_2$] in dimethylformamide (DMF) containing triethylamine at 90 °C afforded the cross-coupling product (**6**) in 88% yield. Although we could not succeed in cleaving the methyl ether linkage of **6** to give the phenolic product, we found that the desilylated ynal (**7**), obtained in 68% yield from **6** by reaction with methanolic potassium carbonate,[8] furnished 5-formylbenzofuran (**8**) in 58% yield *via* concurrent demthylation and cyclization on heating with lithium chloride[9] in hexamethylphosphoric triamide (HMPA) at 130 °C. Structure was confirmed by transformation into the known primary alcohol[6] (**9**) in 96% yield on reduction with sodium borohydride. This compound has been transformed into the ynetriol[6] (**10**), a phytotoxic principle from *Eutypa lata*, on sequential treatment with *n*-butyllithium and acetaldehyde in the same reaction flask[6] (**Scheme 3**).

To obtain dehydrotremetone (**1**) and eutypine (**2**) we next treated the triflate (**5**) with 3-hydroxy-3-methyl-1-butyne under the same palladium-mediated coupling conditions[7] which generated the ynal (**11**) in 63% yield. After having examined several standard dehydration conditions, **11** could be transformed into the enynal (**12**) in 79% yield on heating at 60 °C in benzene containing a catalytic amount of *p*-toluenesulfonic acid. This



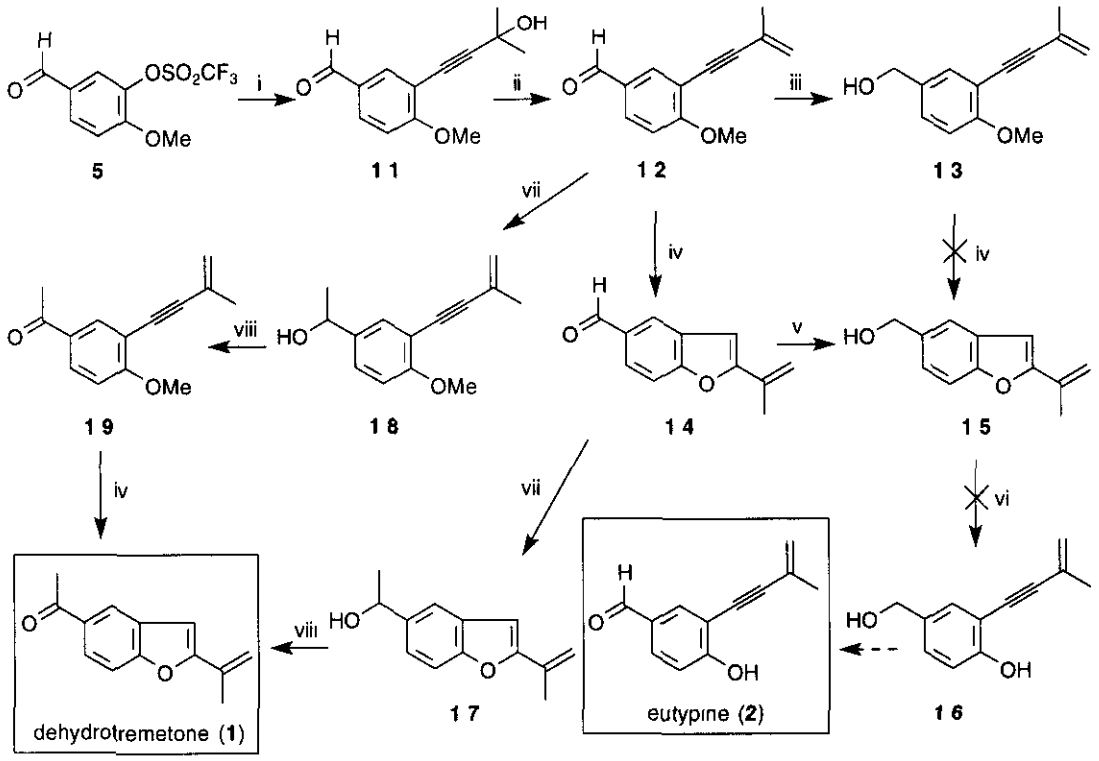
Scheme 3

Reagents: i) $(CF_3SO_2)_2O$, *i*-Pr_2NEt; ii) TMS-acetylene, $Pd(PPh_3)_2Cl_2$ (cat.), Et_3N; iii) K_2CO_3, MeOH; iv) LiCl, HMPA; v) $NaBH_4$

compound was reduced to the primary alcohol (**13**) in 83% yield with sodium borohydride Both **12** and **13** have also been isolated as metabolites of *Eutypa lata* whose physical and spectral data were identical with those reported.[6]

Again these compounds failed to give the phenolic products by the cleavage of the ether linkage under a variety of conditions. Of these only the former (**12**) afforded the formylbenzofuran (**14**) in 23% on treatment with lithium chloride in HMPA at 120 °C. Because we could still assume **14** to be the common key intermediate of both dehydrotremetone (**1**) and eutypine (**2**), we further examined the cyclization of the enyne (**12**) and found that the yield of the benzofuran (**14**) increased to 50% when **12** was heated with lithium chloride in 1,3-dimethyl-3,4,5,6-tetrahydro-2(1*H*)-pyrimidinone (DMPU) at 170 °C On the other hand, the primary alcohol (**13**), obtained from **12** in 83% yield by reduction with sodium borohydride, did not give the benzofuran alcohol (**15**) under the same demethylation-cyclization conditions owing to its instability under these conditions. In order to carry out the base catalyzed benzofuran-phenylacetylene conversion,[1,6] we then transformed the aldehyde (**14**) into the primary alcohol (**15**) in 71% yield with sodium borohydride. Very disappointedly, when **15** was exposed to *n*-butyllithium in THF containing HMPA,[6] the expected reaction did not take place at all and the benzofuran (**15**) was recovered unchanged without giving the penultimate intermediate (**16**) under these basic conditions.

We, therefore, gave up to transform **14** into the acetylene natural product (**2**) and turned our effort to transform **14** into the benzofuran natural product dehydrotremetone (**1**) instead. We first treated **14** with methyllithium to give the secondary alcohol (**17**), in 71% yield, which afforded dehydrotremetone (**1**) in 74% yield on oxidation with pyridinium dichromate (PDC) On the other hand, the enynal (**12**) was treated with methyllithium followed by PDC to give the enynone (**19**) in 75% overall yield *via* the secondary alcohol (**18**). The reaction of **19** with lithium chloride in DMPU at 170 °C occurred again with concurrent demethylation and cyclization to afford dehydrotremetone (**1**) in 33% yield. However, the yield could not be improved even though other solvents such as HMPA (23% yield) and DMSO (13% yield) were used in place of DMPU (**Scheme 4**).



Scheme 4

Reagents: i) 3-hydroxy-3-methyl-1-butyne, $Pd(PPh_3)_2Cl_2$ (cat), Et_3N; ii) *p*-TsOH (cat.); iii) $NaBH_4$; iv) LiCl, DMPU; v) $NaBH_4$; vi) *n*-BuLi, HMPA; vii) MeLi; viii) PDC

In conclusion, we have developed an alternative route to dehydrotremetone (**1**), a toxic benzofuran natural product, along with three phytotoxic *non-heterocyclic natural* phenylacetylenes *via* palladium-mediated cross-coupling reaction between an aryl triflate and a terminal acetylene and lithium chloride-mediated concurrent demethylation-benzofuran formation reaction though we failed to cleave the ether linkage keeping the acetylenic bond intact

EXPERIMENTAL SECTION

Ir spectra were measured with a JASCO-IR-700 spectrophotometer. ^{1}H Nmr spectra were recorded on JEOL-JNM-FX-90A (90 MHz) and Hitachi *R*-3000 (300 MHz) spectrometers. Mass spectra were measured with JEOL JMS-DX-303 and JMS-AX-500 instruments. Reactions were carried out under argon.

5-Formyl-2-methoxyphenyl Trifluoromethanesulfonate (5) —— To a stirred solution of isovanillin (**4**) (2.0 g, 13.1 mmol) and ethyldiisopropylamine (3.4 ml, 19.7 mmol) in CH_2Cl_2 (25 ml) was added trifluoromethanesulfonic anhydride (2.8 ml, 17.1 mmol) dropwise at –78 °C and the stirring was continued for 20 min at the same temperature, then for 20 min at room temperature. The mixture was diluted with CH_2Cl_2 and washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (200 g, EtOAc/hexane, 1:3 v/v) to give the triflate (**5**) (3.16 g, 85%) as a pale orange oil. Ir (film) ν_{max}: 1700 cm^{-1}; ^{1}H nmr (300 MHz, $CDCl_3$) δ: 9.90 (s, 1H), 7.89 (dd, *J*=1.8, 8.8 Hz, 1H), 7.76 (d, *J*=1.8 Hz, 1H), 7.18 (d, *J*=8.8 Hz, 1H), 4.03 (s, 3H); ms (m/z): 284 (M^+), 151 (100%); Exact Mass Calcd for $C_9H_7F_3O_5S$ (M^+). 283.9966. Found: 283.9981. *Anal.* Calcd for $C_9H_7O_5F_3S$. C 38.04, H 2.48, S 11.28. Found: C 38.02, H 2.57, S 11.31

4-Methoxy-3-(2-trimethylsilylethynyl)benzaldehyde (6) —— A mixture of the triflate (**5**) (591 mg, 2.09 mmol), triethylamine (1.3 ml, 8.36 mmol), trimethylsilylacetylene (1230 mg, 12.5 mmol), and $Pd(PPh_3)_2Cl_2$ (73.5 mg, 0.11 mmol) in DMF (4 ml) was stirred at 90 °C for 1.5 h. The mixture was diluted with water and extracted with ether. The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (30 g, EtOAc/hexane, 1:4 v/v) to give the silylacetylene (**6**) (428 mg, 88%) as an orange oil. Ir (film) ν_{max}: 2154, 1694 cm^{-1}; ^{1}H nmr (300 MHz, $CDCl_3$) δ: 9.85 (s, 1H), 7.97 (d, *J*=2.2 Hz, 1H), 7.83 (dd, *J*=2.2, 8.4 Hz, 1H), 6.98 (d, *J*=8.4 Hz,

1H), 3 97 (s, 3H), 0.28 (s, 9H); ms (m/z): 232 (M^+), 217 (100%); Exact Mass Calcd for $C_{13}H_{16}O_2Si$ (M^+): 232 0920. Found: 232.0926.

3-Ethynyl-4-methoxybenzaldehyde (7) —— A mixture of the silylacetylene (**6**) (150 mg, 0.65 mmol) and K_2CO_3 (134 mg, 0.97 mmol) in MeOH (6.5 ml) was stirred at room temperature for 8.5 h. After having evaporated the most of the solvent under reduced pressure, the residue was diluted with water and extracted with ether. The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (20 g, EtOAc/hexane, 1:4 v/v) to give the terminal acetylene (**7**) (70.0 mg, 68%) as yellow crystals (benzene-hexane); mp 102-103 °C. Ir (film) ν_{max}: 3274, 1687 cm^{-1}; ^1H nmr (300 MHz, $CDCl_3$) δ: 9.87 (s, 1H), 7.99 (d, *J*=2.2 Hz, 1H), 7.88 (dd, *J*=2 2, 8.4 Hz, 1H), 7 02 (d, *J*=8.4 Hz, 1H), 4.00 (s, 3H), 3.36 (s, 1H); ms (m/z): 160 (M^+, 100%); Exact Mass Calcd for $C_{10}H_8O_2$ (M^+). 160.0524. Found: 160.0536. *Anal.* Calcd for $C_{10}H_8O_2$: C 74.99, H 5.03. Found: C 74.82, H 5.11.

5-Formylbenzofuran (8) —— A mixture of the arylacetylene (**7**) (23.4 mg, 0.15 mmol) and lithium chloride (18.6 mg, 0 44 mmol) in HMPA (1 ml) was stirred at 130 °C for 1.5 h. After cooling, the mixture was diluted with water and extracted with benzene. The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (5 g, EtOAc/hexane, 1:4 v/v) to give the benzofuran (**8**) (12.3 mg, 58%) as colorless crystals (benzene-hexane); mp 31.5-32.0 °C. Ir (film) ν_{max}: 1702 cm^{-1}, ^1H nmr (300 MHz, $CDCl_3$) δ: 10.07 (s, 1H), 8.16 (d, *J*=1.5 Hz, 1H), 7.88 (dd, *J*=1.8, 8.4 Hz, 1H), 7.73 (d, *J*=2.2 Hz, 1H), 7.63 (d, *J*=8.4 Hz, 1H), 6.90 (d, *J*=2.2 Hz, 1H); ms (m/z): 146 (M^+), 145 (100%); Exact Mass Calcd for $C_9H_6O_2$ (M^+): 146.0368. Found: 146.0368.

5-Hydroxymethylbenzofuran (9) —— To a stirred solution of the aldehyde (**8**) (7 0 mg, 0.05 mmol) in methanol (2 ml) was added $NaBH_4$ (8 mg, 0 21 mmol) at 0 °C and the stirring was continued for 10 min at the same temperature. The reaction was quenched by addition of acetone and the mixture was evaporated under reduced pressure. The residue was diluted with water and extracted with ethyl acetate. The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (2 g, AcOEt/hexane, 1.3 v/v) to give the primary alcohol (**9**) (6.8 mg, 96%) as a colorless oil. Ir (film) ν_{max}: 3346 cm^{-1}; ^1H nmr (300 MHz, $CDCl_3$) δ: 7.63 (d, *J*=2.4 Hz, 1H), 7.61 (br s, 1H), 7.49 (s, 1H), 7.31 (dd, *J*=8.5, 1.8 Hz, 1H), 6.76 (m, 1H), 4 78 (s, 2H), 1.64 (s, 1H, exchangeable with D_2O); ms (m/z): 148 (M^+, 100%); Exact Mass Calcd for $C_9H_8O_2$ (M^+): 148.0524. Found: 148.0530.

4-Methoxy-3-(3-hydroxy-3-methyl-1-butynyl)benzaldehyde (11) —— A mixture of the triflate (**5**) (123 mg, 0.43 mmol), triethylamine (0.26 ml, 1.87 mmol), 3-hydroxy-3-methyl-1-butyne (0.13 ml, 1.34 mmol), and $Pd(PPh_3)_2Cl_2$ (15.2 mg, 0.02 mmol) in DMF (8 ml) was stirred at 90 °C for 2.5 h. The mixture was diluted with water and extracted with ether The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (15 g, EtOAc/hexane, 1:3 v/v) to give the phenylacetylene (**11**) (59.5 mg, 63%) as pale yellow crystals (benzene-hexane); mp 87 °C. Ir (film) ν_{max}: 3416, 2260, 1694 cm^{-1}; ^1H nmr (300 MHz, $CDCl_3$) δ: 9.85 (s, 1H), 7.91 (d, *J*=2.2 Hz, 1H), 7.82 (dd, *J*=2.2, 8.4 Hz, 1H), 6.98 (d, *J*=8.8 Hz, 1H), 3.96 (s, 3H), 2.25 (s, 1H, exchangeable with D_2O), 1.65 (s, 6H); ms (m/z): 218 (M^+), 161 (100%); Exact Mass Calcd for $C_{13}H_{14}O_3$ (M^+): 218.0943. Found: 218.0933. *Anal.* Calcd for $C_{13}H_{14}O_3$: C 71.54, H 6.47. Found: C 71.38, H 6.62.

4-Methoxy-3-(3-methylbut-3-en-1-ynyl)benzaldehyde (12) —— A solution of the ynol (**11**) (130 mg, 0.60 mmol) in benzene (6 ml) was stirred at 60 °C for 1.5 h in the presence of a catalytic amount of *p*-toluenesulfonic acid. The solution was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (30 g, AcOEt/hexane, 1:6 v/v) to give the enyne (**12**) (94.7 mg, 79%) as pale yellow crystals (Et_2O-hexane); mp 48-49 °C (lit.,[6] mp 49-50 °C).

4-Methoxy-3-(3-methylbut-3-en-1-ynyl)benzyl Alcohol (13) —— To a stirred solution of the aldehyde (**12**) (350 mg, 1.75 mmol) in methanol (18 ml) was added $NaBH_4$ (135 mg, 3.50 mmol) portionwise at 0 °C and the stirring was continued for 10 min at the same temperature. The reaction was quenched by addition of acetone and the mixture was evaporated under reduced pressure. The residue was diluted with water and extracted with ethyl ether. The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (40 g, AcOEt/hexane, 1:2 v/v) to give the primary alcohol (**13**) (295 mg, 83%) as pale yellow oil. Ir (film) ν_{max}: 3342 cm^{-1}; ^1H nmr (300 MHz, $CDCl_3$) δ: 7.42 (d, *J*=2.2 Hz, 1H), 7.27 (dd, *J*=8.5, 2.2 Hz, 1H), 6.85 (d, *J*=8.5 Hz, 1H), 5.41 (m, 1H), 5.29 (m, 1H), 4.59 (d, *J*=5.1 Hz, 2H), 3.88 (s, 3H), 2.00 (s, 3H), 1.63 (t, *J*=5 7 Hz, 1H exchangeable with D_2O); ms (m/z): 202 (M^+, 100%). Exact Mass Calcd for $C_{13}H_{14}O_2$ (M^+): 202 0994. Found: 202 1000.

5-Formyl-2-isopropenylbenzofuran (14) —— A mixture of the enyne (**12**) (129 mg, 0.65 mmol) and lithium chloride (82 mg, 1.94 mmol) in DMPU (6.5 ml) was stirred at 150 °C for 2 h. After cooling, the mixture was diluted with water and extracted with benzene. The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (30

g, EtOAc/hexane, 1:20 v/v) to give the benzofuran (**14**) (60.0 mg, 50%) as colorless crystals (benzene-hexane); mp 50-50.5 °C. Ir (film) ν_{max}: 1695 cm^{-1}; ^1H nmr (300 MHz, $CDCl_3$) δ: 10.04 (s, 1H), 8.08 (d, *J*=1.8 Hz, 1H), 7.84 (dd, *J*=1 8, 8.4 Hz, 1H), 7.56 (d, *J*=8 4 Hz, 1H), 6.73 (s, 1H), 5.85 (s, 1H), 5.26 (d, *J*=1.0 Hz, 1H), 2.15 (t, *J*=1.0 Hz, 3H); ms (m/z): 186 (M^+, 100%); Exact Mass Calcd for $C_{12}H_{10}O_2$ (M^+): 186.0681. Found: 186.0677.

5-(1-Hydroxyethyl)-2-isopropenylbenzofuran (17) —— To a stirred solution of the aldehyde (**14**) (40 mg, 0.22 mmol) in ether (2.5 ml) was added methyllithium (1.09 M in ether, 0.5 ml, 0.55 mmol) at –20 °C and the stirring was continued for 5 min at the same temperature. The reaction was quenched by addition of sat aqueous NH_4Cl and the mixture was extracted with Et_2O. The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (5 g, AcOEt/hexane, 1:4 v/v) to give the secondary alcohol (**17**) (31 mg, 71%) as colorless crystals; mp 86-87 °C (Et_2O-hexane). Ir (Nujol) ν_{max}: 3434 cm^{-1}; ^1H nmr (300 MHz, $CDCl_3$) δ: 7.52 (d, *J*=1 8 Hz, 1H), 7.40 (d, *J*=8.4 Hz, 1H), 7.27 (dd, *J*=8.4, 1.8 Hz, 1H), 6 60 (s, 1H), 5.78 (s, 1H), 5 17 (m, 1H), 4.79 (q, *J*=6 2 Hz, 1H), 2.12 (s, 3H), 1.90 (s, 1H, exchangeable with D_2O), 1.53 (d, *J*=6 6 Hz, 3H); ms (m/z): 202 (M^+), 131 (100%). Exact Mass Calcd for $C_{13}H_{14}O_2$ (M^+): 202.0994. Found: 202.0988.

1-[4-Methoxy-3-(3-methyl-3-buten-1-ynyl)phenyl]ethanol (18) —— To a stirred solution of the enynal (**12**) (255 mg, 1.28 mmol) in ether (6.5 ml) was added methyllithium (1.40 M Et_2O solution 1.4 ml, 1 96 mmol) dropwise at 0 °C and the stirring was continued for 5 min. The reaction was quenched by addition of sat. aqueous NH_4Cl and extracted with ethyl acetate. The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (30 g, AcOEt/hexane, 1:6 v/v) to give the secondary alcohol (**18**) (255 mg, 92%) as a pale yellow oil. Ir (film) ν_{max}: 3378, 2202 cm^{-1}; ^1H nmr (300 MHz, $CDCl_3$) δ: 7.43 (d, *J*=2.2 Hz, 1H), 7.29 (dd, *J*=2.2, 8.4 Hz, 1H), 6.85 (d, *J*=8.4 Hz, 1H), 5.42 (q, *J*=1.0 Hz, 1H), 5.30 (q, *J*=1.8 Hz, 1H), 4.83 (dq, *J*=2.9, 6.6 Hz, 1H), 3.88 (s, 3H), 2.01 (t, *J*=1.1 Hz, 3H), 1.73 (d, *J*=2.9 Hz, 1H exchangeable with D_2O), 1.47 (d, *J*=6.6 Hz, 3H); ms (m/z): 216 (M^+), 201 (100%). Exact Mass Calcd for $C_{14}H_{16}O_2$ (M^+): 216.1150. Found: 216.1165. *Anal.* Calcd for $C_{14}H_{16}O_2$: C 77.75, H 7.46. Found: C 77 51, H 7.56.

4-Methoxy-3-(3-methyl-3-buten-1-ynyl)acetophenone (19) —— To a stirred solution of pyridinium dichromate (172 mg, 0.46 mmol) in dichloromethane (1.5 ml) was added the enynol (**18**) (33.0 mg, 0.15 mmol) at room temperature and the stirring was continued for 6 h at the same temperature. To this stirred mixture was added Florisil (1.70 g) and then diluted with ether. The mixture, after having filtered

through a Celite pad, was evaporated under reduced pressure and the residue was chromatographed on a silica gel column (4.0 g, AcOEt/hexane, 1:10 v/v) to give the ketone (**19**) (27 0 mg, 82%) as colorless crystals; mp 47-48 °C. Ir (film) ν_{max}: 2200, 1675 cm^{-1}; ^1H *nmr* (300 MHz, $CDCl_3$) δ: 8.02 (d, *J*=2.2 Hz, 1H), 7 93 (dd, *J*=2.2, 8 8 Hz, 1H), 6.92 (d, *J*=8.8 Hz, 1H), 5.45 (q, *J*=1.0 Hz, 1H), 5.34 (m, 1H), 3.95 (s, 3H), 2.56 (s, 3H), 2.02 (m, 3H), ms (m/z): 214 (M^+), 199 (100%) Exact Mass Calcd for $C_{14}H_{14}O_2$ (M^+): 214.0994. Found: 214.1008 *Anal.* Calcd for $C_{14}H_{14}O_2$: C 78.48, H 6.59 Found: C 78 54, H 6.58.

Dehydrotremetone (1): **(a) From the Benzofuran Alcohol (17)** —— To a stirred solution of PDC (170 mg, 0.45 mmol) in methylene chloride (3 ml) was added the secondary alcohol (**17**) (30 mg, 0.15 mmol) at room temperature and the stirring was continued for overnight at the same temperature. To this stirred mixture was added Florisil (1.6 g) and then diluted with ether. The mixture was filtrated through a Celite pad and the filtrate, after having evaporated under reduced pressure, was chromatographed on a silica gel column (10 g, AcOEt/hexane, 1:6 v/v) to give dehydrotremetone (**1**) (22 mg, 74%) as colorless crystals; mp 82.5-83 °C (lit.,[3,4] 82.5-83.5 °C). Ir (film) ν_{max}: 1679 cm^{-1}; ^1H nmr (300 MHz, $CDCl_3$) δ: 8.18 (d, *J*=1.8 Hz, 1H), 7.94 (dd, *J*=1 8, 8.4 Hz, 1H), 7.48 (d, *J*=8.4 Hz, 1H), 6 70 (s, 1H), 5.83 (s, 1H), 5.24 (s, 1H), 2 66 (s, 3H), 2 14 (s, 3H); ms (m/z): 200 (M^+), 185 (100%). Exact Mass Calcd for $C_{13}H_{12}O_2$ (M^+): 200.0837. Found: 200.0876. *Anal.* Calcd for $C_{13}H_{12}O_2$: C 77.98, H 6 04. Found: C 78.05, H 6.03 Spectral data (ir and ^1H nmr) were identical with those reported.

(b) From the Enynone (19) —— A mixture of the enynone (**19**) (220 mg, 1.03 mmol) and lithium chloride (130 mg, 3.07 mmol) in DMPU (10 ml) was stirred at 170 °C for 2 3 h. After cooling, the mixture was diluted with water and extracted with ether. The extract was washed with brine, dried over $MgSO_4$, evaporated under reduced pressure, and the residue was chromatographed on a silica gel column (25 g, AcOEt/hexane, 1:20 v/v) to give dehydrotremetone (**1**) (68.0 mg, 33%) as colorless crystals; mp 82.5-83 °C. Spectral data and tlc behavior were identical in all respects with those of the product obtained from **14**.

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