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1 mM FeTPP(Cl) and O₂ (2 mol/mol of FeTPP(Cl)) and characterized by visible and ¹H NMR spectra superimposable on those of an authentic sample.²¹ Complex 2' is much more stable toward O₂ (*t*_{1/2} in aerated C₆H₆ ≈ 12 h^{21c}) than 2. On the contrary, the diazene complex 1', Fe^{II}TPP(C₆H₅N=NH)₂, is much less stable than 1; it has been only observed by visible spectroscopy (λ 426 nm, 529, 561) upon reaction of C₆H₅N=NH with FeTPP in anaerobic conditions but could not be isolated so far because of its fast transformation into 2' in the presence of O₂ traces. These data explain why 2' is the main complex derived from the binding of an oxidized product of C₆H₅NHNH₂ to iron, observed during FeTPP and O₂-dependent oxidation of C₆H₅NHNH₂.

The aforementioned results establish the formation of two Fe-RNHNH₂-derived ligand complexes upon reaction of RNHNH₂ hydrazines or the corresponding diazenes with an iron porphyrin and O₂ (Scheme I): an Fe(II)-diazene and a σ-Fe(III)-R complex. They show, at least when R = CH₃, that the σ-Fe(III)-R complex can be formed by a O₂-dependent oxidation of the diazene Fe(II)-RN=NH complex. There are great similarities between these results and those concerning reactions of hemoglobin (Hb) or myoglobin (Mb) with RNHNH₂ (R = CH₃ or C₆H₅) and O₂.¹⁰ when R = CH₃, two iron complexes are formed, the first one, a hemoprotein Fe(II)-CH₃N=NH complex being further oxidized by 1 equiv of Fe(CN)₆K₃ (or by O₂) to give another complex, B, of unknown structure. When R = C₆H₅, the Fe(II)-C₆H₅N=NH complex has never been observed, the only entity formed being a complex spectrally similar to B.²⁷ This paper describes the first isolation of a porphyriniron(II)-alkyl-diazene complex²² and points to the great instability of Fe(II)-C₆H₅N=NH complexes, thus strongly supporting the existence of Mb- (or Hb-) Fe(II)-CH₃N=NH complexes¹⁰ and explaining the failure to observe Mb-Fe(II)-C₆H₅N=NH complexes.^{9a,10,23} The diazene ligands are isoelectronic with their oxygen-containing analogues, nitrosoalkanes¹⁵ and O₂, and it is noteworthy that, as their diazene analogues, nitrosoarene-iron porphyrin complexes are considerably less stable than nitrosoalkane-iron complexes.^{15c} This paper also reports for the first time the formation of σ-Fe(III)-R complexes upon reaction of RNHNH₂ or RN=NH with iron porphyrins, indicating a possible HbFe^{III}-R (R = CH₃ or C₆H₅) structure for complexes B.²⁷ However, one cannot exclude presently the previously proposed⁹ HbFe^{III}-N=NR structure for these complexes. In that respect, it is noteworthy that hydrazines RNHNH₂ react with Co and Fe chelates to give Co(III)-R and Fe(III)-R σ complexes,²⁴ whereas C₆H₅NHNH₂ reacts with molybdenum porphyrins to give Mo-N=NC₆H₅ complexes.²⁵

Finally, very recent preliminary results are in favor of the formation of similar iron complexes during the cytochrome P-450 dependent oxidation of CH₃NHNH₂²⁶ and C₆H₅NHNH₂.^{2,26}

(21) (a) Reed, C. A.; Mashiko, T.; Bentley, S. P.; Kastner, M. E.; Scheidt, W. R.; Spitalian, K.; Lang, G. *J. Am. Chem. Soc.* **1979**, *101*, 2948. (b) The authentic sample was prepared by reaction of FeTPP(Cl) with C₆H₅MgBr.^{21c} The ¹H NMR spectrum of 2' (porphyrin signals δ -17.3, 3.0, 4.7, 4.9, 5.1, 6.0; phenyl ligand δ -25.55 (*p*-H), 13.4 (*m*-H) (the ortho hydrogens could not be detected because of their proximity to the paramagnetic center¹⁸)) was found superimposable on that of the authentic sample. (c) Mansuy, D.; Battioni, J.-P.; Dupré, D.; Sartori, E.; Chottard, G. *J. Am. Chem. Soc.* **1982**, *104*, 6159-6161.

(22) Diimide, NH=NH, complexes of iron(II) porphyrins and hemoglobin-iron(II) have been described: Hanstein, W. G.; Lett, J. B.; McKenna, C. E.; Traylor, T. G. *Proc. Natl. Acad. Sci. U.S.A.* **1967**, *58*, 1314-1316.

(23) Huang, P. K. C.; Kosower, E. M. *Biochim. Biophys. Acta* **1968**, *165*, 483-489.

(24) Goedken, V. L.; Peng, S. M.; Park, Y. *J. Am. Chem. Soc.* **1974**, *96*, 284-285.

(25) Colin, J.; Butler, G.; Weiss, R. *Inorg. Chem.* **1980**, *19*, 3828-3833.

(26) Battioni, P.; Delaforge, M.; Mahy, J.-P.; Mansuy, D., to be submitted for publication.

(27) It was shown that an aerobic acidic treatment of this complex B' formed upon reaction of Hb with C₆H₅NHNH₂ leads to *N*-phenylprotoporphyrin IX.^{6d,e} Since recent results showed that *N*-phenylporphyrins are formed upon similar treatment of σ-(porphyrins)Fe^{III}-C₆H₅ complexes,^{28a,21c} it is tempting to propose a σ-Fe^{III}-C₆H₅ structure for the Hb complex B'.^{28b}

(28) (a) Ortiz De Montellano, P. R.; Kunze, K. L.; Augusto, O. *J. Am. Chem. Soc.* **1982**, *104*, 3545-3546. (b) Augusto, O.; Kunze, K. L.; Ortiz De Montellano, P. R. *J. Biol. Chem.* **1982**, *257*, 6231-6240.

Organolanthanide Hydride Chemistry. 3. Reactivity of Low-Valent Samarium with Unsaturated Hydrocarbons Leading to a Structurally Characterized Samarium Hydride Complex¹

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Received September 3, 1982

Our general investigation of low-valent lanthanide chemistry³⁻¹⁰ has shown that the zerovalent metals react with neutral unsaturated hydrocarbons⁵⁻¹⁰ to form a variety of new classes of organolanthanides including some that display catalytic activity.^{6,7} This low-valent approach also provided the first soluble divalent organosamarium complex, (C₅Me₅)₂Sm(THF)₂ (I) a complex that functions as a catalyst precursor for the catalytic hydrogenation of alkynes.¹⁰ Since I was a crystallographically characterized low-valent complex that also had catalytic chemistry, it was an ideal candidate for the study of low-valent lanthanide reactivity. We report here the reaction of I with internal alkynes to form a new class of organolanthanide complexes, the enediyls, which can be converted into the first organosamarium hydride complex, a molecule that represents a new crystallographically characterized class of organolanthanide hydrides.^{11,12}

Addition of pentane to an equimolar mixture of the purple I and C₆H₅C≡CC₆H₅ in an inert-atmosphere glovebox immediately generates an intensely colored black solution. Removal of solvent after stirring overnight yields a black material containing unreacted alkyne by ¹H NMR spectroscopy. A pentane solution of this material precipitates the excess C₆H₅C≡CC₆H₅ at -78 °C, leaving a black mother liquor that is pure by ¹H NMR spectroscopy. Removal of solvent from the mother liquor leaves a black glassy material, II, which by complete elemental analysis has the formula [(C₅Me₅)₂SmCC₆H₅]_n (yield >95%). The ¹H NMR and IR spectra¹³ are consistent with an enediyl structure, [(C₅Me₅)₂Sm](C₆H₅)C=C(C₆H₅)[Sm(C₅Me₅)₂], and a trans configuration is likely on the basis of steric considerations.¹⁴

(1) Presented in part at the 39th Southwest and 6th Rocky Mountain Combined Regional Meeting of the American Chemical Society, El Paso, TX, Dec 1982, Abstr. 194.

(2) (a) Camille and Henry Dreyfus Teacher-Scholar. (b) University of Chicago; current address University of California, Irvine, CA 92717. (c) University of Alabama.

(3) Evans, W. J.; Wayda, A. L.; Chang, C. W.; Cwirla, W. M. *J. Am. Chem. Soc.* **1978**, *100*, 333-334.

(4) Zinnen, H. A.; Evans, W. J.; Pluth, J. J. *J. Chem. Soc., Chem. Commun.* **1980**, 810-812.

(5) Evans, W. J.; Engerer, S. C.; Neville, A. C. *J. Am. Chem. Soc.* **1978**, *100*, 331-333.

(6) Evans, W. J.; Engerer, S. C.; Piliero, P. A.; Wayda, A. L. *J. Chem. Soc., Chem. Commun.* **1979**, 1007-1008.

(7) Evans, W. J.; Engerer, S. C.; Piliero, P. A.; Wayda, A. L. "Fundamentals of Homogeneous Catalysis"; Tsutsui, M., Ed.; Plenum Press: New York, 1979; Vol. 3, pp 941-952.

(8) Evans, W. J.; Engerer, S. C.; Coleson, K. M. *J. Am. Chem. Soc.* **1981**, *103*, 6672-6677.

(9) Evans, W. J.; Coleson, K. M.; Engerer, S. C. *Inorg. Chem.* **1981**, *20*, 4115-4119.

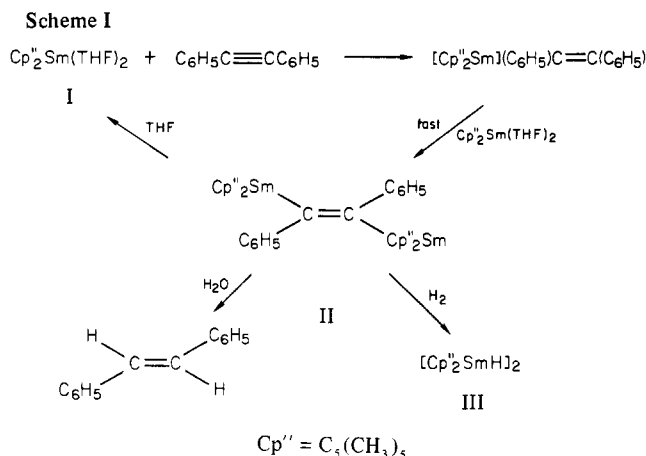
(10) Evans, W. J.; Bloom, I.; Hunter, W. E.; Atwood, J. L. *J. Am. Chem. Soc.* **1981**, *103*, 6507-6508.

(11) Evans, W. J.; Meadows, J. H.; Wayda, A. L.; Hunter, W. E.; Atwood, J. L. *J. Am. Chem. Soc.* **1982**, *104*, 2008-2114.

(12) Paper 2 in this series: Evans, W. J.; Meadows, J. H.; Wayda, A. L.; Hunter, W. E.; Atwood, J. L. *J. Am. Chem. Soc.* **1982**, *104*, 2115-2117.

(13) ¹H NMR (C₆D₆) δ 1.74 (s, C₅(CH₃)₅), -1.26 (br s, C₆H₅), -10.15 (br s, C₆H₅) (a third broad C₆H₅ signal resolvable from the other resonances in the spectrum was not observed); ¹³C NMR (C₆D₆) δ 123.2 (C₆H₅), 121.6 (C₆H₅), 119.4 (C₅(CH₃)₅), 115.3 (C₆H₅), 104.1 (=CC₆H₅) 19.8 (C₅(CH₃)₅); IR (Nujol) 3770 (w), 1670 (w), 1580 (s), 1495 (sh), 1300 (m), 1200 (w), 1160 (m), 1070 (w), 1020 (m), 975 (m), 955 (m), 750 (s), 720 (d, s), 690 (d, s), 625 (w) cm⁻¹.

(14) Lithium reacts with C₆H₅C≡CC₆H₅ to form the cis dianion on the basis of hydrolytic analysis. Sodium reacts with this alkyne to form the trans dianion: House, H. O. "Modern Synthetic Reactions"; W. A. Benjamin: Menlo Park, CA, 1972; pp 205-209 and references therein.



Hydrolysis generates pure *trans*-stilbene.

The formation of II can be rationalized (Scheme I) by initial formation of the radical, $[(\text{C}_5\text{Me}_5)_2\text{Sm}](\text{C}_6\text{H}_5)\text{C}\equiv\text{C}(\text{C}_6\text{H}_5)$, which is rapidly reduced by a second equivalent of the soluble I before dimerization can occur.¹⁵ Sm(II) is known to rapidly reduce radicals to anions,^{16,17} and it has previously been shown that diarylalkynes can be reduced to dianions under special conditions at low temperature.¹⁴ Both the magnetic susceptibility and the near-infrared spectrum of II are characteristic of Sm(III).¹⁸ However, the visible spectrum of II differs from those of previously reported Sm(III) organometallic complexes, which are usually yellow or orange, in that it contains an intense charge-transfer-like absorption starting at 1050 nm, which is responsible for the black color.¹⁹

Since Sm(II) is the most reactive of the accessible divalent lanthanides,^{10,20} the reactivity of the soluble I with $\text{C}_6\text{H}_5\text{C}\equiv\text{CC}_6\text{H}_5$ is not too surprising. However, it is remarkable that this reaction can be readily reversed: addition of THF to II generates a burgundy solution from which I and $\text{C}_6\text{H}_5\text{C}\equiv\text{CC}_6\text{H}_5$ can be recovered (Scheme I). This is the first evidence that the reversibility necessary for the development of catalytic cycles involving a Ln(II)/Ln(III) couple^{4,10,22} is available with the very reactive Sm(II).

A black hexane solution of II reacts with H_2 , turning orange within an hour and depositing an orange precipitate. Separation of the solid by filtration, extraction with toluene, and recrystallization provide red-orange prisms, III, which have an empirical formula $[\text{C}_5(\text{CH}_3)_5]_2\text{SmH}$ on the basis of analytical, magnetic, spectral, and chemical data.²³ We previously postulated the existence of such a complex in the reaction mixture obtained in

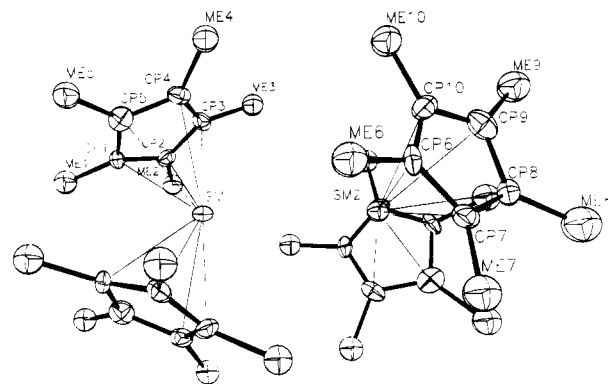


Figure 1. ORTEP plot of the molecular structure of $[(\text{C}_5\text{Me}_5)_2\text{SmH}]_2$.

the synthesis of I,¹⁰ but we were unable to isolate it in that case. Indeed, the thermal stability of III is limited to 1–2 days in solution and 5–7 days in the solid state. Nevertheless, we were able to characterize III by X-ray diffraction (Figure 1).²⁴

III crystallizes as a dimer in which the two samarium atoms are on a crystallographic 2-fold axis and are separated by 3.905 (3) Å. This distance is too long for a Sm–Sm bond, but it is quite reasonable for a hydride-bridged structure on the basis of our recent characterization of $[(\text{CH}_3\text{C}_5\text{H}_4)_2\text{Ln}(\text{THF})(\mu\text{-H})_2]$, V (Ln = Y, Er).^{11,25} A major difference between III and V is that the Ln_2H_2 plane in V bisects the Cp'(centroid)–Y–Cp'(centroid) angles for both Cp'₂Y units (Cp' = $\text{CH}_3\text{C}_5\text{H}_4$), whereas in III one $[\text{C}_5(\text{CH}_3)_5]_2\text{Sm}$ unit is rotated with respect to the other such that the molecule very nearly possesses an S_4 axis coincident with the crystallographic C_2 axis. The (ring 1 centroid)–Sm(1)–Sm(2)–(ring 2 centroid) dihedral angle is 87°. Hydrogen positions were not located due to the usual difficulty in finding hydrogen atoms near heavy metals.²⁷

It is remarkable that III could be isolated and structurally characterized. Samarium complexes in general are more difficult to isolate than complexes of the smaller, later lanthanides such as Er and Lu, since it is more difficult to sterically saturate the coordination sphere of this larger metal to achieve stability.²⁸ Given the need for higher coordination numbers for the larger metal and considering the nine-coordinate THF-solvated Lu, Er, and Y species, complexes V,¹¹ and the nine-coordinate actinide hydrides $[(\text{C}_5\text{Me}_5)_2\text{MH}(\mu\text{-H})_2]$ (M = Th, U),²⁹ in which the size of the cyclopentadienyl ligands is the same as in III (the Sm(III) radius is between the U(IV) and Th(IV) radii), one would expect at least a coordination number of nine for Sm in III.³⁰ A structure

(15) In the heterogeneous reaction of lithium with $\text{C}_6\text{H}_5\text{C}\equiv\text{CC}_6\text{H}_5$, dimerization does occur: Braye, E. H.; Hubel, W.; Caplier, I. *J. Am. Chem. Soc.* **1961**, *83*, 4406–4413.

(16) Girard, P.; Namy, J. L.; Kagan, H. B. *J. Am. Chem. Soc.* **1980**, *102*, 2693–2703.

(17) Ananthanarayan, T. P.; Gallagher, T.; Magnus, P. *J. Chem. Soc., Chem. Commun.* **1982**, 709–710.

(18) $10^6\chi_g$ (cgs) = 2.38; $\mu_{\text{eff}}^{290} = 1.7 \mu_B$; near IR–vis (λ_{max} , nm (ϵ)) 1550 (22), 1535 (28), 1475 (30), 1440 (80), 1365 (62), 1230 (30), 1160 (18), 1150 (26), 1125 (28), 1010 (4); the remainder of the spectrum is dominated by a charge-transfer-like absorption.

(19) Compare the intense dark colors of the products of cocondensation of lanthanide atoms with dienes and alkynes.^{3–8}

(20) $\text{Sm(III)} + e \rightarrow \text{Sm(II)}$, -1.55 V vs. NHE: Morss, L. R. *Chem. Rev.* **1976**, *76*, 827–841.

(21) A 30% yield of crystals of I is recovered by crystallization at -78°C (cf. ref 10).

(22) Watson, P. L. *J. Chem. Soc., Chem. Commun.* **1980**, 652–653.

(23) Anal. Calcd for $\text{SmC}_{20}\text{H}_{31}$: Sm, 35.9. Found: Sm, 33.3. $10^6\chi_g$ (cgs) = 1.99; $\mu_{\text{eff}} = 1.4 \mu_B$; ^1H NMR (C_6D_6) δ 15.61 (br, SmH), -0.80 (s, $\text{C}_5(\text{CH}_3)_5$); IR (KBr) 1435 (s), 1375 (m), 1140 (s, v br), 1010 (m), 975 (m, br), 970 (w, br) cm^{-1} . III exchanges with D_2 to form an analogous deuteride which lacks the δ 15.61 resonance in the ^1H NMR spectrum and has a reduced $\text{C}_5(\text{CH}_3)_5$ signal due to extensive incorporation of deuterium into the pentamethylcyclopentadienyl ligands (confirmed by GC–MS). The IR spectrum of the deuteride lacks the 1140-cm^{-1} absorption and contains a new strong absorption at 820-cm^{-1} ($\nu_{\text{H}}/\nu_{\text{D}} = 1.40$). Hydrolysis of III forms H_2 in 74% yield.

(24) Single crystals of III were obtained by diffusion of pentane into a toluene solution at -5°C . Space group $C2/c$; cell constants $a = 16.532$ (6) Å, $b = 14.260$ (4) Å, $c = 16.948$ (4) Å, $\beta = 104.26$ (4)° with four dimers per unit cell and $D_c = 1.48 \text{ g cm}^{-3}$. Least-squares refinement on the basis of 1004 observed reflections led to a final $R = \sum(|F_o| - |F_c|)/\sum|F_o| = 0.041$. The diffraction experiment was conducted as described in Holton et al.: Holton, J.; Lappert, M. F.; Ballard, D. G. H.; Pearce, R.; Atwood, J. L.; Hunter, W. E. *J. Chem. Soc., Dalton Trans.* **1979**, 45–53. An empirical absorption correction was done according to Churchill and Hollander: Churchill, M. R.; Hollander, F. J. *Inorg. Chem.* **1978**, *17*, 1957–1962. Anisotropic thermal parameters were those in SHELX, a system of computer programs for X-ray structure determinations by G. M. Sheldrick, 1976. The methyl groups had high thermal motion, but thermal parameters were acceptable and R was virtually the same for either isotropic or anisotropic refinement of the methyls.

(25) The atomic radius of samarium in rhombohedral α Sm is 1.802 Å: Moeller, T. In "Comprehensive Inorganic Chemistry"; Bailar, J. C., Jr., et al., Eds.; Pergamon Press: Oxford, 1973; Chapter 44. The Y–Y distance in complex V is 3.664 (1) Å¹¹, and the Y^{3+} radius is 0.084 Å smaller.²⁶

(26) Cotton, F. A.; Wilkinson, G. "Advanced Inorganic Chemistry", 4th ed.; Wiley: New York, 1980.

(27) Sm–C bond lengths in III varied from 2.72 (2) to 2.81 (2) Å with an average of 2.76 (3) Å.

(28) Evans, W. J. In "The Chemistry of the Metal–Carbon Bond"; Hartley, F. R.; Patai, S., Eds.; Wiley: New York, 1982; Chapter 12.

(29) Fagan, P. J.; Manriquez, J. M.; Maata, E. A.; Seyam, A. M.; Marks, T. J. *J. Am. Chem. Soc.* **1981**, *103*, 6650–6667. Broach, R. W.; Schultz, A. J.; Williams, J. M.; Brown, G. M.; Manriquez, J. M.; Fagan, R. J.; Marks, T. J. *Science (Washington, D.C.)* **1979**, *203*, 172–174.

(30) Raymond, K. N.; Eigenbrot, C. W., Jr. *Acc. Chem. Res.* **1980**, *13*, 276–283.

for III containing doubly bridging hydrogens would have a maximum coordination number of eight. The structure of III clearly demonstrates the variability in coordination number that can occur in organo-f-element complexes even when radial sizes and ligands are very similar.³¹

Like I, complexes II and III can also be used to initiate the catalytic hydrogenation of alkynes. Interestingly, the catalytic rates for I-III differ substantially, suggesting that several catalytic pathways are possible in this system. II displays the highest turnover rates, 1.5 min⁻¹ [Sm]⁻¹ for C₆H₅C≡CC₆H₅ to C₆H₅C-H₂CH₂C₆H₅ and 3.7 min⁻¹ [Sm]⁻¹ for 3-hexyne to hexane, which are the fastest observed for a homogeneous f-element-based system.^{6,32} Mechanistic and structural studies on this system are continuing.

Acknowledgment. We thank the National Science Foundation for support of this research and the Camille and Henry Dreyfus Foundation for a Teacher-Scholar Grant (to W.J.E.).

Supplementary Material Available: Tables of bond distances, angles, final fractional coordinates, and thermal parameters (3 pages). Ordering information is given on any current masthead page.

(31) Consistent with this variability, the differences in M-M distances, 0.102 Å, and in M-C(η⁵) distances, 0.075 Å, between III and the thorium complex are much greater than the difference in their ionic radii, 0.026.²⁶

(32) Bowman, R. G.; Nakamura, R.; Burwell, R. L., Jr.; Marks, T. J. *J. Chem. Soc., Chem. Commun.* **1981**, 257-258.

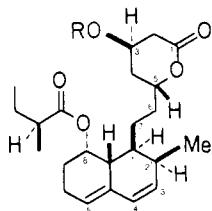
Total Synthesis of the Hypocholesterolemic Agent (+)-Compactin

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Received November 3, 1982

Compactin (**1**),¹ a fungal metabolite isolated from the strains

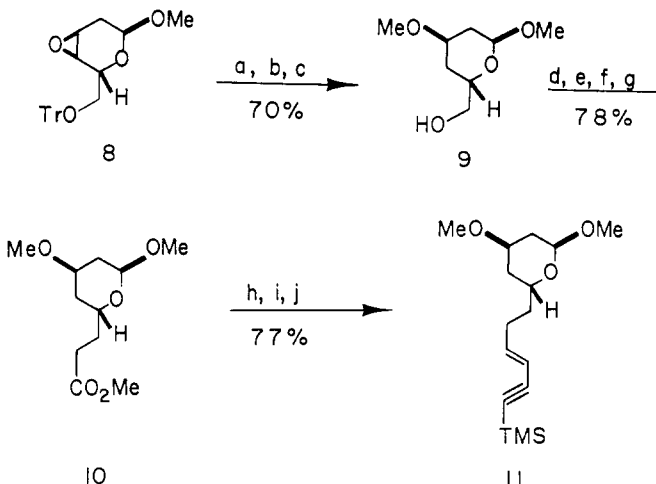


I, R = H

II, R = Me

of *Penicillium brevicompactum*, has been the object of intense synthetic activity^{2,3} since the disclosure⁴ that it is a potent competitive inhibitor of rat liver microsomal 3-hydroxy-3-methyl-

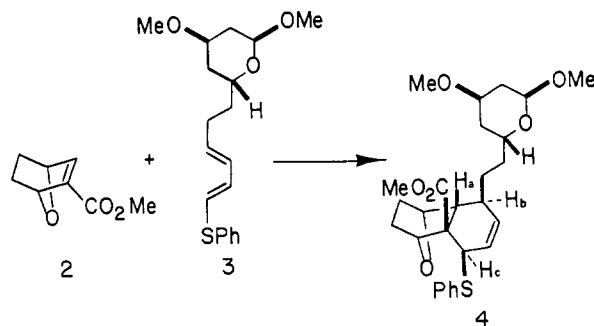
Scheme I. Preparation of Enyne 11^a



^a (a) LiAlH₄, Et₂O, -10 °C, 3.5 h; (b) NaH, THF, MeI, 18 h; (c) Na, NH₃, -78 °C (30 min) → -33 °C (30 min); (d) TsCl, py, 11 h; (e) NaI, MEK, reflux, 4 h; (f) C₆H₅SO₂CH₂CO₂Me, Me₂SO, Me₂SO⁻ Na⁺, 80 °C, 9 h; (g) 6% Na(Hg), MeOH, Na₂HPO₄, 0 °C, 15 min; (h) LiAlH₄, Et₂O, 0 °C, 15 min; (i) CrO₃·2py, CH₂Cl₂, 0 °C, 20 min; (j) (C₆H₅)₃P⁺CH₂C≡C(Me₃Si) Br⁻, BuLi, THF, -78 °C.

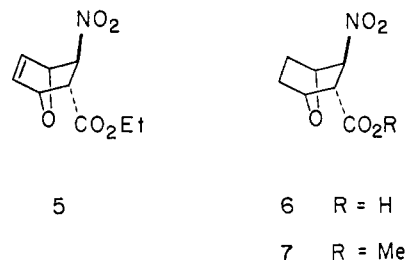
glutaryl coenzyme A reductase, the rate-controlling enzyme in cholesterol biosynthesis. We detail in this communication a highly convergent, enantiospecific total synthesis of (+)-compactin.

Our strategy for the construction of compactin centered around the Diels-Alder reaction between the chiral dienophile **2** and the



chiral diene **3**, which provides in a single operation the intact carbon framework (cf. **4**) of **1**.

Synthesis of the 7-oxabicyclo[2.2.1]heptane derivative **2** in chiral form commenced with the known Diels-Alder adduct **5**,⁵ readily



available from furan and ethyl β-nitroacrylate.⁶ Reduction (K⁺OOCN=NCOO⁻K⁺, MeOH, AcOH, 0 °C, 8 h) of the double bond in **5** followed by hydrolysis (10% KOH, THF, 0 °C) of the ester gave rise to a 92% yield of racemic acid **6**, mp 164-166 °C. Treatment of **6** with D(-)-α-phenylglycinol in acetonitrile containing 1.2 equiv of dicyclohexylcarbodiimide gave rise to a near quantitative yield of a diastereomeric mixture of sensitive amides, which were readily separated by HPLC.⁷ The less polar

(5) Cf.: Just, G.; Martel, A. *Tetrahedron Lett.* **1973**, 1517.

(6) McMurry, J. E.; Musser, J. H. *Org. Synth.* **1977**, 56, 65.