°C) δ 25.58 (CH_2), 39.90, 51.29, and 55.21 (NCH_2), 76.93 (NCH_2N), 130.42 and 151.32 (Ar C, one peak is overlapped by the signal of the deuterated solvent), 167.02 (C=O); FAB MS, *m/z* 304 (M + 1). Anal. Calcd for $C_{15}H_{21}N_5O_2 \cdot 0.75H_2O$: C, 56.87; H, 7.11; N, 22.11. Found: C, 57.11; H, 7.19; N, 21.28.

3,7,11,15,19-Pentaazatricyclo[15.3.1.1^{7,11}]docosa-1-(21),17,19-triene-2,16-dione (5b) (37%, mp 228 °C): ^{1}H NMR (DMSO, 135 °C) δ 9.04 (d, 2 H, Ar H), 8.41 (t, 1 H, Ar H), 3.33–3.65 (m, 4 H, NCH_2), 3.20 (s, 2 H, NCH_2N), 2.25–2.88 (m, 8 H, NCH_2), 1.58–2.0 (m, 4 H, CH_2), 1.19–1.58 (m, 2 H, CH_2); ^{13}C NMR ($CDCl_3$) δ 21.75 and 24.85 (CH_2), 41.34, 50.62, and 55.84 (NCH_2), 78.79 (NCH_2N), 129.26, 131.17, and 152.07 (Ar C), 164.54 (C=O); EI MS, *m/z* 331 (M). Anal. Calcd for $C_{17}H_{25}N_5O_2$: C, 61.61; H, 7.60; N, 21.13. Found: C, 61.07; H, 7.72; N, 20.91.

3,8,12,17,21-Pentaazatricyclo[17.3.1.1^{8,12}]tetracosa-1-(23),19,21-triene-2,18-dione (5c) (26%, mp 240 °C dec): ^{1}H NMR ($C_6D_5NO_2$, 130 °C) δ 9.33 (d, 2 H, Ar H), 8.37 (br t, 1 H, Ar H), 8.12 (br, 2 H, NH), 3.41–3.96 (br m, 4 H, NCH_2), 3.20 (s, 2 H, NCH_2N), 2.06–2.84 (br m, 8 H, NCH_2), 1.31–2.04 (br m, 10 H, CH_2); ^{13}C NMR ($CDCl_3$) δ 24.30, 24.45, and 26.35 (CH_2), 39.93, 52.33, and 55.63 (NCH_2), 78.60 (NCH_2N), 128.86, 130.96, and 152.60 (ArC), 165.11 (C=O); EI MS, *m/z* 359 (M). Anal. Calcd for $C_{19}H_{29}N_5O_2 \cdot 0.5H_2O$: C, 61.93; H, 8.20; N, 19.00. Found: C, 61.46; H, 8.48; N, 18.67.

General Procedure for the Cleavage of the CH_2 Group. Macrocycles **5** were converted to **3** by treatment with malonic acid and pyridine in ethanol at reflux temperature for 2 h.[11] The compounds were recrystallized from acetone to give pure **3** (**3a**, 54%; **3b**, 85%; **3c**, 65%). ^{1}H and ^{13}C NMR spectra and mp are identical with those obtained for **3** synthesized in one step from **1** and **2** by the method described above.

Registry No. **1a**, 4741-99-5; **1b**, 4605-14-5; **1c**, 70862-15-6; **2**, 15074-61-0; **3a**, 113431-02-0; **3b**, 113431-03-1; **3c**, 113431-04-2; **4a**, 113431-05-3; **4b**, 113431-06-4; **4c**, 113431-07-5; **5a**, 113431-08-6; **5b**, 113431-09-7; **5c**, 113431-10-0; **6b**, 77215-44-2; $H_2N(CH_2)_3NH_2$, 109-76-2; H_2C=CHCN, 107-13-1; HCHO, 50-00-0; *N,N'*-bis(2-cyanoethyl)-1,3-diaminopropane, 35514-00-2.

(11) Nagarajan, S.; Ganem, B. *J. Org. Chem.* **1985**, *50*, 5735.
(12) For macrocycles containing pyridine rings, see; e.g.: Newkome, G. R.; Sawer, J. D.; Roper, J. M.; Hager, D. C. *Chem. Rev.* **1977**, 513.

Unexpected Product from Nitration of 1,3-Diethoxybenzene

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Aromatic nitration has been studied very extensively in literature.[1] In this paper we wish to report a novel product obtained from nitration of 1,3-diethoxybenzene. Although nitration of 1,3-dimethoxybenzene[2,3] and 1,4-diethoxybenzene[4,5] give normal mono or dinitro compounds depending on the reaction conditions, we have found that the nitration of 1,3-diethoxybenzene (**1**) leads to the formation of 4-[(2,4-diethoxyphenyl)imino]-3-ethoxy-2,5-cyclohexadien-1-one *N*-oxide in greater than 90% yield. Its structure was fully characterized by elemental analysis,

(1) Moodie, R. B.; Schofield, K. *Acc. Chem. Res.* **1976**, *9*, 287 and the references cited therein.
(2) Muhlhauser, O. *Justus Liebigs Ann. Chem.* **1881**, *207*, 235.
(3) Meldola, R.; Eyre, J. V. *Proc. Chem. Soc., London* **1901**, *17*(238), 131.
(4) Nietzki, R. *Justus Liebigs Ann. Chem.* **1882**, *215*, 125.
(5) Nietzki, R.; Rechberg, F. *Chem. Ber.* **1890**, *23*, 1211.

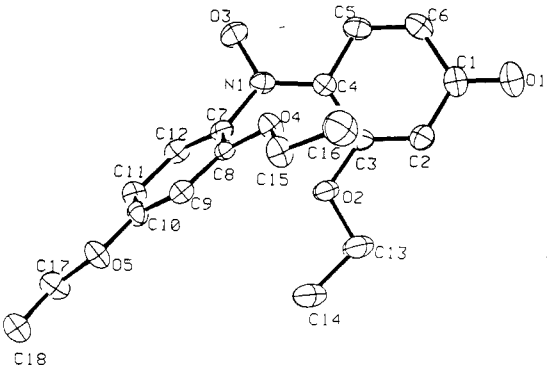
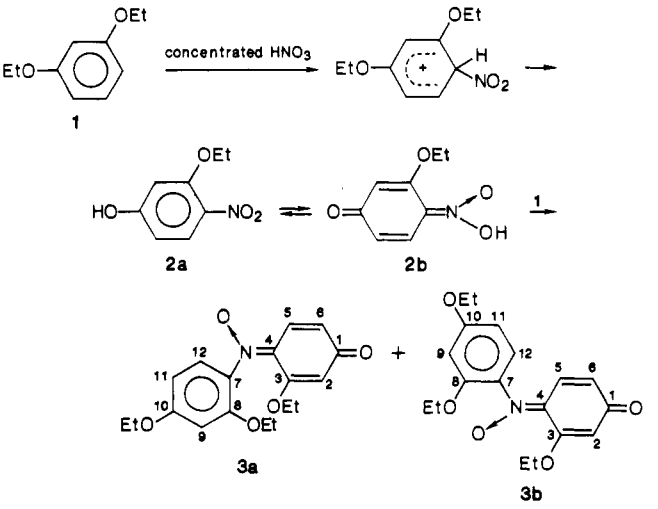


Figure 1. Perspective view of **3a** with numbering of atoms.

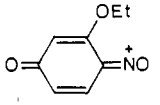
Scheme I



by mass spectrum, which showed a parent peak at mass 331, and by ^{1}H and ^{13}C NMR spectra. The infrared spectrum (KBr) exhibited a strong absorption at 1610 cm^{-1} due to the quinoid carbonyl. The ^{1}H NMR spectrum actually showed it to be a mixture of two isomers **3a** and **3b** in about 97:3 ratio. Table I lists the ^{1}H NMR data including some due to the minor component in the aromatic region. Its absorption is quite similar to that of the abundant component, indicating that they are isomers most likely differing in the orientation of N→O bond.

The X-ray crystal structure and powder diffraction pattern have shown that the abundant isomer (**3a**) is that in which the N→O bond is anti to the OEt group on the quinoid ring (Figure 1). The crystal data also show its benzene ring at a torsion angle of 60° with respect to the quinoid ring. Some of the pertinent X-ray data are summarized in Table II.

Scheme I depicts the formation of these isomers from nitration of 1,3-diethoxybenzene. The difference in its nitration vs that of 1,3-dimethoxybenzene is explained in terms of the formation of **2a**, presumably by olefin elimination from the mononitro product of **1**.[6] Its tautomeric form **2b**, via the cyclohexadiene iminium intermediate,



then reacts with **1** to give **3a** and **3b**. From the overall high yield of the products, it appears that the reaction of **2b**

(6) For a similar nitrosation reaction, see: Hodgson, H. H.; Clay, H. *J. Chem. Soc.* **1930**, 1872.

0022-3263/88/1953-1819$01.50/0

Table I. NMR Data of 3a and 3b[a]

δ_H[b] (ppm) and HH coupling constants (Hz)		δ_{13C} (ppm)
3a	3b	3a
H_2 = 5.64, $^4J_{H_2H_6}$ = 1.8	H_2 = 5.96	C_1 = 187.1
H_5 = 7.90, $^2J_{H_5H_6}$ = 10.2	H_5 = 6.94, $^3J_{HH}$ = 10.3	C_2 = 99.7
H_6 = 6.42, $^2J_{H_6H_5}$ = 10.2, $^4J_{H_6H_2}$ = 1.8	H_6 = 6.08, J_{HH} = 10.3	C_3 = 151.9
OEt (on C_3)		C_4 = 133.6
CH_3 = 1.26, $^3J_{HH}$ = 7.3		C_5 = 128.7
CH_2 (AB pattern): H_A = 4.02, H_B = 3.96, $^2J_{H_AH_B}$ = 9.5		C_6 = 125.7
H_9 = 6.43, $^4J_{H_9H_{11}}$ = 2.4	H_9 = 6.55	C_7 = 140.6
H_{11} = 6.49, $^3J_{H_{11}H_{12}}$ = 8.7, $^4J_{H_{11}H_9}$ = 2.4	H_{11}[c]	C_8 = 157.6
H_{12} = 7.24, $^3J_{H_{12}H_{11}}$ = 8.7	H_{12} = 7.31, $^3J_{HH}$ = 8.4	C_9 = 103.5
OEt (on C_8)		C_{10} = 161.3
CH_3 = 0.84, $^3J_{HH}$ = 6.9		C_{11} = 104.8
CH_2 (AB pattern): H_A = 3.71, H_B = 3.66, $^2J_{H_AH_B}$ = 9.5		C_{12} = 129.1
OEt (on C_{10})		
CH_3 = 1.43, $^3J_{HH}$ = 7.0		
CH_2 (AB pattern): H_A = 4.09, H_B = 4.06, $^2J_{H_AH_B} \simeq$ 9.2		

[a] See the numbering of atoms in Scheme I. [b] Downfield from internal TMS reference. [c] Absorption not observed due to overlap with those of the abundant isomer.

Table II. X-ray Structure Data of 3a[a]

Bond Distances, Å			
O(1)–C(1)	1.238 (4)	C(5)–C(6)	1.342 (5)
C(1)–C(2)	1.452 (5)	C(6)–C(1)	1.455 (5)
C(2)–C(3)	1.347 (5)	N(1)–C(4)	1.345 (4)
C(3)–C(4)	1.456 (5)	N(1)–O(3)	1.284 (4)
C(4)–C(5)	1.434 (5)	N(1)–C(7)	1.447 (5)
Bond Angles, deg			
O(3)–N(1)–C(4)	120.7 (3)	N(1)–C(4)–C(5)	117.5 (3)
O(3)–N(1)–C(7)	113.6 (3)	N(1)–C(7)–C(8)	120.3 (3)
N(1)–C(4)–C(3)	124.0 (3)	N(1)–C(7)–C(12)	118.2 (3)
Dihedral Angles, deg			
C(8)–C(7)–N(1)–C(4)	60	O(3)–N(1)–C(4)–C(5)	9.8

[a] Esd's in units of the least significant figure are in parentheses.

with 1 is much faster than its nitration.

In the ^1H NMR spectrum of **3a**, the CH_2 and CH_3 assignments for each of the ethoxy groups were made on the basis of spin–spin decoupling experiments. Actually, the CH_2's of OEt groups appeared as an AB pattern due to the high asymmetry of the molecule. Their CH_3's gave triplets (1:2:1) because of overlapping of doubled doublets resulting from coupling with the nonequivalent CH_2 protons. The ^{13}C NMR spectrum showed a total of 12 resonances in the aromatic region. The six peaks in the range of 187.1–133.6 ppm were appreciably weaker than the other six peaks (128.7–99.5 ppm). Since carbon atoms not carrying hydrogen atoms are expected to have relatively long relaxation times and the spectrum was run under conditions of partial saturation, the weaker six peaks were assigned to carbon atoms not carrying hydrogen atoms and the other six peaks to carbons with directly bonded hydrogen atoms. The ^{13}C NMR spectrum also showed peaks due to the three OEt groups: CH_2's at 64.5, 64.0, and 64.0 ppm; CH_3's at 14.6, 14.4, and 13.3 ppm.

Experimental Section

NMR Spectra. ^1H and ^{13}C NMR spectra were recorded in $CDCl_3$ solution on a Nicolet NT-300 spectrometer. The spectrometer was operated at 75.46 Hz for ^{13}C NMR with a time-shared deuterium lock on $CDCl_3$.

Nitration of 1,3-Diethoxybenzene (1). A mixture of 10.7 mL of 90% nitric acid and 50 mL of glacial acetic acid was added to a solution of 16.6 g (0.1 mol) of 1 in 50 mL of glacial acetic acid over 30 min during stirring at less than 10 °C. The solution was poured onto ice. After 10 min, an amber-red solid separated, which was collected by filtration, washed with water, and recrystallized from ethanol: 15 g (90.4%); mp 179–180 °C. Anal. Calcd for $C_{18}H_{21}NO_5$: C, 65.3; H, 6.3; N, 4.2; O, 24.2. Found: C, 65.4; H, 6.3; N, 4.1; O, 24.2.

X-ray Structure Determination of 3a. A parallelogram with dimensions ~0.31 × 0.25 × 0.32 mm was mounted on a Syntex R3 diffractometer equipped with a monochromator and an LT-1 low-temperature refrigeration unit operating at −100 °C. The diffractometer routines indicated a monoclinic unit cell with dimensions a = 11.294 (1) Å, b = 14.140 (2) Å, c = 11.180 (2) Å, β = 90.54 (1)°. With Z = 4 the calculated density of $C_{18}H_{21}NO_5$ is 1.233 g/cm^3. A total of 1520 unique reflections with $I \leq 3.0\sigma(I)$ were obtained from $4.6° \leq 2\theta \leq 55.0°$ by using the ω-scan method with scan width = 1.30ω, scan speed = 2.00–9.80°/min. The structure was solved with direct methods (MULTAN) and refined by full-matrix least squares on F with weights proportional to $[\sigma^2(I) + 0.0009I^2]^{-1/2}$ (217 parameters, refined anisotropic: all nonhydrogen atoms, fixed H atoms). Scattering factors were taken from *International Tables for X-ray Crystallography*, Vol. IV. The final R values are R = 0.049, R_w = 0.045, error of fit = 1.37, max Δ/σ = 0.06, largest residual density = 0.31 e/Å^3, near C_{15}.

The X-ray powder diffraction data were collected on a large sample of the isomer mixture by using an automated Norelco diffractometer. The calculated pattern from the single-crystal data matched very well with the powder pattern, indicating that the single crystal used in the structure analysis was indeed representative of the abundant isomer **3a**.

Acknowledgment. We are thankful to Dr. Derick W. Overnall for running the ^{13}C NMR spectrum and to Dr. Gade S. Reddy for the proton decoupled spectrum. The X-ray work is by Drs. J. C. Calabrese and R. L. Harlow.

Supplementary Material Available: Tables containing fractional coordinates, anisotropic thermal parameters, interatomic distances, and intramolecular angles for **3a** (3 pages). Ordering information is given on any current masthead page.

Photoisomers of Avermectins

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Avermectins are 16-membered lactones containing a diene function at positions 8, 9, 10, and 11 of the macrocycle.[1] They are widely used as drugs for the prophylaxis and control of parasitic infections of animals[2] and are

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(2) (a) Campbell, W. C. *Parasitol. Today* **1985**, *1*, 1. (b) Campbell, W. C.; Benz, G. W. *J. Vet. Pharamacol. Ther.* **1983**, *7*, 1.

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