was poured into water, acidified by dilute hydrochrolic acid, and extracted with ether. The crude product after the usual workup was added to a solution of acetic anhydride (0.35 g, 3.4 mmol) in pyridine (1 mL). The resulting solution was stirred at room temperature for 30 min, then poured into 5 mL of 2 N hydrochrolic acid, and extracted with ether. After the usual workup, the crude product was subjected to column chromatography (silica gel/benzene–hexane) to give **4a** (0.68 g, 72% yield): NMR ($CDCl_3$) δ 1.2–1.5 (m, 12 H), 2.04 (s, 3 H), 4.05 (m, 2 H), 4.30 (d, 2 H); IR (neat) 1720, 1530, 1460, 1360, 1240 cm^{-1}.

Anal. Calcd for $C_{12}N_{19}NO_6$: C, 52.74; H, 7.01; N, 5.13. Found: C, 52.53; H, 6.76; N, 5.09.

Synthesis of 12-(Acetoxymethyl)-12-nitro-15-pentadecanolide (4b). The same procedure starting from **2b** (1.13 g, 4.0 mmol) as in the preparation of **4a** gave **4b** (1.05 g, 75% yield): NMR ($CDCl_3$) δ 1.0–2.2 (m, 22 H), 2.04 (s, 3 H), 2.32 (t, J = 7 Hz, 2 H), 4.08 (t, J = Hz, 2 H), 4.36 (s, 2 H); IR (neat) 1715, 1700, 1530, 1440, 1230 cm^{-1}.

Anal. Calcd for $C_{18}H_{31}NO_6$: C, 60.48; H, 8.74; N, 3.92. Found: C, 60.43; H, 8.49; N, 3.88.

Synthesis of 6-(Acetoxymethyl)-9-nonanolide (5a). A mixture of **4a** (0.64 g, 2.3 mmol), Bu_3SnH (0.96 g, 3.28 mmol), and AIBN (0.12 g, 0.70 mmol) in benzene (5 mL) was heated at 80 °C for 90 min. Then the reaction mixture was subjected to column chromatography (silica gel/benzene–hexane) to give **5a** (0.47 g, 88% yield; NMR ($CDCl_3$) δ 0.8–2.6 (m, 13 H), 2.06 (s, 3 H), 3.66–4.04 (m, 2 H), 4.48–4.74 (m, 2 H); IR (neat) 1720, 1700, 1240 cm^{-1}.

Anal. Calcd for $C_{12}H_{20}O_4$: C, 63.14; H, 8,83. Found: C, 63.16; H, 8.66.

Synthesis of 12-(Acetoxymethyl)-15-pentadecanolide (5b). The same procedure as in the preparation of **5a** starting from **4b** (0.60 g, 1.7 mmol), Bu_3SnH (0.64 g, 2.2 mmol), and AIBN (0.09 g, 0.56 mmol) gave **5b** (0.48 g, 92% yield): NMR ($CDCl_3$) δ 0.9–1.8 (m, 23 H), 2.02 (s, 3 H), 2.32 (t, J = 7 Hz, 2 H), 3.92 (d, J = 7.5 Hz, 2 H), 4.10 (t, J = 7 Hz, 2 H); IR (neat) 1720, 1240 cm^{-1}.

Anal. Calcd for $C_{18}H_{32}O_4$: C, 69.19; H, 10.32. Found: C, 68.81; H, 10.09.

Registry No. **1a**, 84246-77-5; **1b**, 84246-80-0; **1c**, 92643-60-2; **2a**, 84246-81-1; **2b**, 84246-84-4; **2c**, 81590-80-9; **3a**, 6008-27-1; **3b**, 106-02-5; **3c**, 61448-27-9; **4a**, 92643-61-3; **4a**-ol, 92643-65-7; **4b**, 92643-62-4; **5a**, 92643-63-5; **5b**, 92643-64-6; Bu_3SnH, 688-73-3.

Reaction of 2-Nitrobenzaldehydes with Diethyl (Diethoxyphosphinyl)succinate: A New Synthesis of Quinoline-2,3-dicarboxylic Acid Esters via Their *N*-Oxides

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Received April 18, 1984

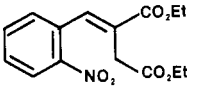
The synthesis of quinoline-2,3-dicarboxylic acid derivatives can be accomplished by the Friedlander reaction of 2-aminobenzaldehydes with diethyl oxaloacetate[1,2] or by an analogous reaction that utilizes the same aldehydes and acetylenedicarboxylic acid esters.[3] However, the difficulties encountered in preparing and storing 2-aminobenzaldehydes have severely limited the application of these synthetic procedures.

We report that when 2-nitrobenzaldehydes **1**, which are much more readily available and stable than their corresponding amino analogues, are treated with diethyl (diethoxyphosphinyl)succinate under alkaline conditions, a reaction frequently referred to as the modified Wittig reaction,[4] the appropriate diethyl quinoline-2,3-dicarboxylate *N*-oxides **2** are obtained. Subsequent reduction of the *N*-oxides with phosphorous trichloride provides, in toto, a novel and facile route to the preparation of quinoline-2,3-dicarboxylic acid esters **3** (Scheme I) that circumvents the problems associated with the use of 2-aminobenzaldehydes. Furthermore, while the participation of 2-nitrobenzaldehyde in the modified Wittig reaction[5] and the condensation of carbanions with nitro functionalities[6] have each been reported previously, the simultaneous occurrence of both types of reaction appears to be without precedent.

The reactions leading to the formation of the *N*-oxides were straightforward (Table I). Briefly, addition of diethyl (diethoxyphosphinyl)succinate to a solution of sodium and **1** in cold ethanol or ethanol–dimethylformamide resulted in a dark reaction mixture. Progress of the reaction was followed by thin-layer chromatography, and, after 1–3 h of stirring, the ethanol was evaporated and the residue purified by recrystallization or by chromatography. While yields were only modest, the effects of reaction variables such as temperature, solvent, and base were not investigated. In the case of **2a**, authentic material also was prepared by the reaction of **3a** with H_2O_2 in acetic acid. The **3a** used in the latter process was obtained by esterification of the corresponding dicarboxylic acid, a low-yield oxidation product of acridine.[7]

The NMR spectra of the quinoline/quinoline *N*-oxide pairs generally were similar except for the signals exhibited by the proton at position 8 of the quinoline nucleus. For example, in the spectrum of **2c** this proton produced a doublet centered at δ 8.83 (J = 8 Hz) while in that of **3c** the same doublet appeared at δ 8.17, an upfield shift engendered by reduction of the *N*-oxide moiety.

The proclivity of the modified Wittig reaction to afford *trans*-olefins is well-known.[4] Consequently, the likely initial product arising from the reaction of **1** with diethyl (diethoxyphosphinyl)succinate is the *trans*-cinnamate derivative **4** in which the juxtaposition of the acidic



4

methylene group and the nitro substituent appears to favor the condensation, probably through a radical anion mechanism,[6] culminating in **2**.

Experimental Section

Data on each quinoline *N*-oxide **2** and quinoline **3** are shown in Table I. Melting points are uncorrected. Starting aldehydes were obtained commercially except for **1d** which was prepared according to ref 8.

Diethyl Quinoline-2,3-dicarboxylate *N*-Oxide (2a). A cold solution of 3.8 g (0.025 mol) of 2-nitrobenzaldehyde and 0.62 g (0.027 mol) of sodium in 45 mL of ethanol was treated, during 15 min, with a solution of diethyl (diethoxyphosphinyl)succinate[9]

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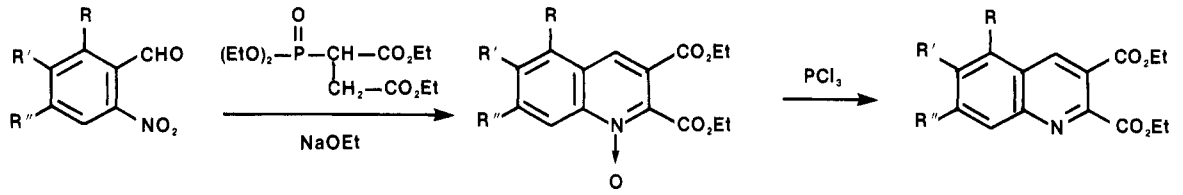
0022-3263/84/1949-4999$01.50/0

Scheme I



1 2 3

	R	R′	R″
a	H	H	H
b	Cl	H	H
c	H	Cl	H
d	H	F	H
e	H	OCH_3	OCH_3
f	H	$-O-CH_2-O-$	

Table I. Melting Points, Solvents of Recrystallization, and Yields of Quinoline *N*-Oxides[a] 2 and Quinolines[a] 3

compd	mp, °C	solvent of recrystalln	yield, %
2a	111–112	$CHCl_3$/IPE[b]	40
2b	95–96	IPE[b]	45
2c	120.5–121.5	IPO[c]	47
2d	84–85	IPE[b]	50
2e	214–215	CH_3CN	71
2f	174.5–175.5	C_2H_5OH	39
3a	54–55[d]	hexane	61
3b	42.5–43.5	PE[e]	59
3c	93–94	IPE[b]	47
3d	55.5–56.5	PE[e]	72
3e	131.5–132.5	IPO[c]	62
3f	132.5–133.5	IPO[c]	73

[a] All analyses are within ±0.3% of calculated values. [b] Isopropyl ether. [c] 2-Propanol. [d] Reported mp 55 °C (see ref 7). [e] Petroleum ether.

(0.027 mol) in 5 mL of ethanol. The resulting dark solution was stirred for 1.5 h while maintaining the reaction mixture in an ice bath. The solvent was evaporated under reduced pressure and the residue partitioned between ethyl acetate and water. The ethyl acetate was dried over Na_2SO_4 and then evaporated under reduced pressure. The residue was recrystallized from chloroform–isopropyl ether.

Compounds **2b–f** were prepared by the same procedure, following the course of the reactions by thin-layer chromatography. In the preparation of compounds **2b**, **2e**, and **2f**, small amounts of dimethylformamide were used to aid in dissolution of the starting aldehydes. For compounds **2b** and **2d**, purification was carried out by chromatography over silica gel, using $CHCl_3$ as eluent.

Compound **2a** also was synthesized by heating on the steam bath a solution of 0.27 g (0.001 mol) of diethyl quinoline-2,3-dicarboxylate[7] and 0.43 mL of 30% H_2O_2 in 0.5 mL of acetic acid for 3.5 h. The reaction mixture was poured into 20 mL of saturated $NaHCO_3$ and the precipitate obtained was filtered, dried, and recrystallized from isopropyl ether, mp 111–112 °C. Both infrared and NMR spectra were superimposable on those of **2a** prepared according to the above procedure.

Diethyl Quinoline-2,3-dicarboxylate (3a).[7] A solution of 0.87 g (0.003 mol) of **2a** and 1.24 g (0.009 mol) of PCl_3 in 40 mL of $CHCl_3$ was refluxed for 3 h. Solvent was removed under reduced pressure and the residue was partitioned between ethyl acetate and water. The organic layer was dried over Na_2SO_4, and, following evaporation, the residue was recrystallized from petroleum ether.

Compounds **3a–f** were prepared similarly except that compound **3b** was purified by chromatography over silica gel, using $CHCl_3$ as eluent.

Registry No. **1a**, 552-89-6; **1b**, 6361-22-4; 1c, 6628-86-0; **1d**, 395-81-3; **1e**, 20357-25-9; **1f**, 712-97-0; **2a**, 92525-68-3; **2b**, 92641-44-6; **2c**, 92525-69-4; **2d**, 92525-70-7; **2e**, 92525-71-8; **2f**, 92525-72-9; **3a**, 32413-08-4; **3b**, 92525-73-0; **3c**, 92525-74-1; **3d**, 92525-75-2; **3e**, 92525-76-3; **3f**, 92525-77-4; diethyl (diethoxyphosphinyl)succinate, 7071-15-0.

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Access to the 3,5,6,7-Tetrahydro-2*H*-1-benzopyran Ring System from 2,3,5,6,7,8-Hexahydrobenzo-4*H*-pyran-4-one Derivatives

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Received May 15, 1984

The hydride reduction of the cyclohexenone system has been a subject of numerous studies.[1] In contrast, only one study was made on 2,2,6-trimethyl-2,3-dihydro-4*H*-pyran-4-one.[2] It is therefore considered interesting to carry out experimental studies on 2,3,5,6,7,8-hexahydrobenzo-4*H*-pyran-4-one derivatives[3,4] in order to evaluate the directive effect of the oxygen atom.

Reduction of the hexahydrobenzopyran-4-ones **1a–d** with lithium aluminum hydride proceeded rapidly to afford the allylic alcohols **2a–d**. However, they underwent rapid polymerization to form a polymeric material at room temperature for 1 day. The reaction appeared stereoselective since only the cis 4-hydroxy-2-methyl isomers were otained in the case of **2b** and **2d**. These results require that the addition of the hydride ion occurs from the same side of the molecule as the axial hydrogen at C-2 in a half-chair conformation as in 5-substituted cyclohexenones.[1] Structure **2** was based on standard spectroscopic methods. The configurations of **2b** and **2d** were

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