^{1}H NMR ($CDCl_3$) δ 1.36 (s, 6), 4.28 (s, 2), 5.84 (s, 1), 6.60 (Br, 1), 8.10 (s, 1); mass spectrum (70 eV) *m/e* no parent ion, 181 (2 Cl), 168 (2 Cl), 116, 101, 72, 58.

Synthesis of 2-Dichloroacetoxy-2,4,4-trimethyloxazolidine (9) Monohydrate. Dichloroacetic acid (1.29 g, 0.01 mol) was added dropwise to 1.13 g (0.01 mol) of **3a** in ether to yield an initial precipitate which later dissolved. Concentration of the solution in vacuo produced a pale yellow oil which crystallized upon standing at 5°. Recrystallization with ether–hexane gave **9** monohydrate in 85% yield.

For **9** monohydrate: mp 110°; ir (CCl_4) 3000, 1755, 1680, 1390, 1230 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 1.39 (s, 6), 2.13 (s, 3), 4.12 (s, 2), 5.82 (s, 1), 7.6 (Br, 3); mass spectrum (70 eV) *m/e* no parent ion, 113, 98, 83, 70, 57.

Anal. Calcd for $C_8H_{15}Cl_2NO_4$: C, 36.94; H, 5.81; Cl, 27.26; N, 5.38. Found: C, 37.05; H, 5.84; Cl, 27.43; N, 5.40.

Reduction of 10 by Borohydride. Zwitterion **10** was formed by reaction of dichloroketene and **3b** using either methods 1 or 2 described above and treated with a threefold excess of sodium borohydride. The resulting slurry was stirred for 3 days under nitrogen, quenched with ice water acidified to pH 5, and extracted with ether which was then dried (Na_2SO_4) and evaporated in vacuo to yield a pale yellow oil. The oil, when saturated with ether, produced 65% of a white, crystalline material shown to be amido alcohol **8**.

Some ester **11** resulting from incomplete reduction of **10** was also recovered. Compound **11** was shown not to be hydrolyzed to **8** under the work-up conditions employed.

Acknowledgment. We thank the National Institutes of Health (AI 10389) for support of this work.

Registry No.—**3a**, 1772-43-6; **3b**, 30093-99-3; **4**, 55428-39-2; **5**, 55428-40-5; **6**, 55428-41-6; **8**, 55428-42-7; **9**, 55428-43-8; **10**, 55428-44-9; **11**, 55428-45-0; dichloroacetyl chloride, 79-36-7; triethylamine, 121-44-8; dichloroketene, 4591-28-0; oxazoline, 504-77-8; 2-amino-2-methylpropanol, 124-68-5; formic–acetic anhydride, 2258-42-6; dichloroacetic acid, 79-43-6; sodium borohydride, 16940-66-2.

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Synthesis of 3,11-Dimethyl-2-nonacosanone, a Sex Pheromone of the German Cockroach

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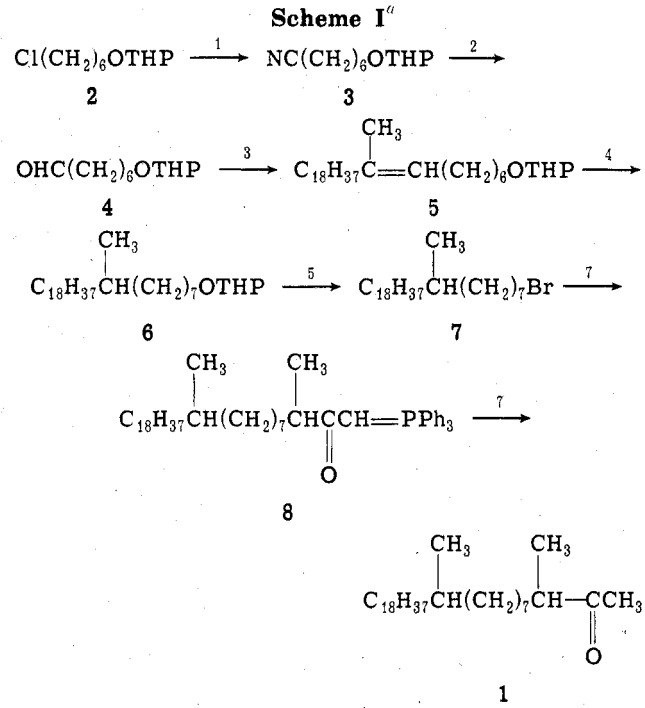
Recently Nishida et al.[1] reported the isolation of a sex pheromone of the German cockroach, *Blattella germanica* (L.), from its cuticular waxes. The compound was identified as 3,11-dimethyl-2-nonacosanone (**1**) with no information given concerning its absolute configuration. We wish to report a synthesis of the mixture of diastereomers of **1** as outlined in Scheme I.[2]

Scheme I[a]



[a] 1, NaCN–NaI–DMSO; 2, $Li(EtO)_2AlH_2$; 3, $C_{18}H_{37}C(CH_3)$=PPh_3; 4, H_2–Pd/C; 5, PPh_3Br_2; 6, $C_2H_5C(=O)CH=PPh_3$; 7, OH^-.

6-Chlorohexyl tetrahydro-2-pyranyl ether[3] **2** was converted to the corresponding cyanohexyl tetrahydropyranyl ether (**3**) with sodium cyanide in Me_2SO in the presence of a catalytic amount of sodium iodide. Reduction of **3** with lithium diethoxyhydroaluminate[4] yielded the corresponding aldehyde **4**. The Wittig reaction between **4** and (1-methylnonadecylidene)triphenylphosphorane (see Experimental Section) afforded presumably a cis and trans mixture of 8-methyl-7-hexacosenyl tetrahydropyranyl ethers (**5**) which was hydrogenated to compound **6**. Treatment of tetrahydropyranyl ether **6** with dibromotriphenylphosphorane[5] in methylene chloride gave 1-bromo-8-methylhexacosane (**7**) in excellent yield.[6] (2-Oxobutylidene)triphenylphosphorane,[7] prepared according to Cooke,[8] was converted to its anion by treatment with *n*-butyllithium and was alkylated with bromide **7**. Title compound **1**[9] was finally obtained by the hydrolysis of the crude alkylation product **8**. This extension of Cooke's procedure[8] thus represents a useful method for the preparation of α-branched methyl ketones.

Experimental Section[10]

Melting points were taken on a Thomas-Hoover apparatus and are uncorrected. Ir spectra were obtained with CCl_4 solutions on a Perkin-Elmer Model 457A grating spectrophotometer. NMR spectra were obtained on a Varian Model T-60 spectrometer with tetramethylsilane (Me_4Si) as an internal standard. Reported chemical shifts are in δ, parts per million downfield from Me_4Si. Elemental analyses were performed by Galbraith Laboratories, Knoxville, Tenn.

6-Cyanohexyl Tetrahydropyranyl Ether (3). A heterogeneous mixture of 6-chlorohexyl tetrahydropyranyl ether[3] (50 g, 0.227 mol), NaCN (17.2 g, 0.35 mol), and NaI (4.5 g, 0.03 mol) in dry DMSO (50 ml) was stirred at ambient temperature for 16 hr. The mixture was diluted with water and extracted with petroleum ether. The organic phase was washed with H_2O (2 × 100 ml) and dried ($MgSO_4$). Concentration followed by distillation afforded 44.0 g (90%) of **3**: bp 105–115° (0.7 mm); $n^{25}D$ 1.4550; ir 2260 cm^{-1}; NMR δ 2.30 (m, 2, CH_2CN), 3.2–4.0 (m, 4, CH_2O), 4.47 (s, 1,

OCHO). Anal. Calcd for $C_{12}H_{21}NO_2$: C, 68.21; H, 10.02; N, 6.63. Found: C, 67.98; H, 9.80; N, 6.80.

7-Oxoheptyl Tetrahydropyranyl Ether (4). Ethyl acetate (4.5 g, 0.05 mol) was added dropwise to a stirred suspension of $LiAlH_4$ (1.95 g, 0.05 mol) in ethyl ether at 0°. Then **3** (10.55 g, 0.05 mol) was added dropwise over a 10-min period and the reaction mixture was stirred for an additional 50 min at ice-bath temperature. Water (2 ml), 15% NaOH (2 ml), and water (6 ml) were added dropwise in that order, the mixture was filtered, and the filtrate was concentrated. The crude imine was stirred for 1 hr at room temperature in a mixture of 40 ml of water, 40 ml of ethyl alcohol, and 20 ml of glacial acetic acid;[11] then the mixture was diluted with water and extracted with petroleum ether. The organic layer was washed with brine, saturated sodium bicarbonate, and brine and dried. After removal of the solvent, **4** (5.0 g, 45%) was purified by short-path distillation: bp 95–100° (0.05 mm); ir 1729 cm^{-1}; NMR δ 2.35 (m, 2, $-CH_2CHO$), 3.2–4.0 (m, 4, $-CH_2O-$), 4.48 (broad s, 1, OCHO), 9.67 (t, 1, -CHO). Anal. Calcd for $C_{12}H_{22}O_3$: C, 67.25; H, 10.35. Found: C, 67.24, H, 10.22.

(*Z*)- and (*E*)-8-Methyl-7-hexacosenyl Tetrahydropyranyl Ethers (5). Ethylidenetriphenylphosphorane was prepared from ethyltriphenylphosphonium bromide in THF using 2.0 *M* *n*-butyllithium in hexane in the usual manner. One equivalent of 1-bromooctadecane was added to the ylide solution (ca. 10°) and 10 min later HMPA, 1 ml/ml THF, was added. The deep red solution remained homogeneous. After 2 days the solution, lighter in color but still red, was diluted with 1,2-dichloroethane and washed with H_2O several times. The organic phase was dried ($MgSO_4$) and concentrated. The oily salt, (1-methylnonadecyl)triphenylphosphonium bromide, was freed of traces of 1,2-dichloroethane by washing with anhydrous Et_2O several times and then concentrating the residue on a flash evaporator. A solution of the salt was prepared in dry THF and used as soon as possible.

The secondary alkylphosphonium salt (0.045 mol) was converted to its ylide at 5° in 100 ml of THF with *n*-butyllithium (23 ml of 2.0 *M* in hexane) and the aldehyde **4** (8.2 g, 0.038 mol) was added dropwise. The ice bath was removed and after 1 hr the reaction mixture was worked up in the usual manner with petroleum ether to extract the olefin **5**. The crude product was deposited on a column of silica gel (100 g) and then eluted with 200 ml of petroleum ether and 200 ml of 15% Et_2O in petroleum ether. The combined eluates were then rechromatographed (silica gel, 100 g) and eluted with 200 ml of petroleum ether and 400 ml of 15% Et_2O in petroleum ether. Compound **5** was obtained in the last 200 ml and weighed 18.3 g (56%); $n^{25}D$ 1.4625; NMR δ 0.88 (t, ca. 3, CH_3), 3.2–4.0 (m, 4, CH_2), 4.48 (s, 1, OCHO), 5.03 (t, 1, -CH). Anal. Calcd for $C_{32}H_{62}O_2$: C, 80.26; H, 13.05. Found: C, 80.50; H, 13.30.

8-Methylhexacosanyl Tetrahydropyranyl Ether (6). Olefin **5** (10.0 g, 0.021 mol) was hydrogenated at atmospheric pressure in hexane (150 ml) with 10% Pd/C (1 g). Filtration and concentration provided **6** quantitatively: $n^{25}D$ 1.4577; NMR δ 0.87 (t, ca. 3, CH_3), 3.2–4.0 (m, 4, CH_2O), 4.45 (s, 1, OCHO). Anal. Calcd for $C_{32}H_{64}O_2$: C, 79.93; H, 13.42. Found: C, 79.74; H, 13.22.

1-Bromo-8-methylhexacosane (7). A solution of triphenylphosphine dibromide was prepared by adding bromine (7.0 g, 0.0436 mol) dropwise to a chilled, stirred solution of triphenylphosphine (11.4 g, 0.0436 mol) in 120 ml of CH_2Cl_2 maintained at 0–10°. The THP ether **6** (9.5 g, 0.0198 mol) in 10 ml of CCH_2Cl_2 was then added at once. The mixture was allowed to stir for 16 hr under nitrogen at room temperature. The black solution was washed with H_2O (2 × 100 ml), dried ($MgSO_4$), and deposited on 45 g of alumina (Fisher, neutral). The resulting mixture was placed onto a column of silica gel (125 g) and eluted with petroleum ether (500 ml). Concentration of the eluate provided the bromide as a colorless liquid, 8.1 g (91%): $n^{25}D$ 1.4641; NMR δ 0.88 (t, ca. 3, CH_3), 3.30 (t, 2, CH_2Br). Anal. Calcd for $C_{27}H_{55}Br$: C, 70.55; H, 12.06; Br, 17.39. Found: C, 70.75; H, 12.08; Br, 17.16.

(2-Oxobutylidene)triphenylphosphorane. To a cooled solution (−78°) of 10.5 g (0.033 mol) of (2-oxopropylidene)triphenylphosphorane[12] in 250 ml of dry THF was added under nitrogen 20 ml (0.033 mol) of 1.6 *N* *n*-butyllithium in hexane. The deep red solution of the ylide anion was stirred at −78° for 15 min, then 6.0 g (0.042 mol) of methyl iodide was added slowly. The color of the anion was discharged at the end of the addition. The reaction mixture was allowed to warm to room temperature and a clear solution resulted. Excess solvents were removed with a flash evaporator and the remaining solid was filtered to yield 10 g of crude (2-oxobutylidene)triphenylphosphorane. Recrystallization from chloroform–ethyl acetate gave 8 g (75%) of product, mp 218–219° (lit.[7] mp 221–222°).

3,11-Dimethylnonacosan-2-one (1). A solution of (2-oxobutylidene)triphenylphosphorane (0.33 g, 0.001 mol) in THF (10 ml) was cooled to −78° under nitrogen and treated with 1.2 ml (0.002 mol) of 1.6 *M* *n*-butyllithium in hexane. The resulting deep red solution was stirred for 15 min, and then a solution of 1-bromo-8-methylhexacosane (**7**, 0.40 g, 0.00087 mol) in THF (15 ml) was added (**7** separated from solution at the low temperature). The cooling bath was removed, stirring was continued for 20 hr at room temperature, then water (ca. 5 ml) was added (color discharged) and the mixture was refluxed for 24 hr. The solvent was evaporated and the residue was partitioned between ether and water. Alumina (ca. 6 g) was added to the dried ether solution, the ether was evaporated, and the residue was added to a column of silica gel (20 g). After eluting with petroleum ether, the ketone **1** (0.11 g, 28%) was obtained by elution with 10% ether in petroleum ether.

The reaction was repeated with a twofold excess of the phosphorane with no increase in the yield of **1**.

The products of the two reactions (0.21 g) were combined and rechromatographed on silica gel to give an analytical sample: ir 1716 cm^{-1}; NMR δ 2.0 (s, CH_3CO), 0.83 (*t*-CH_3).

Anal. Calcd for $C_{31}H_{62}O$: C, 82.59; H, 13.86. Found: C, 82.82; H, 13.77.

Registry No.—**1**, 53623-10-2; **2**, 2009-84-9; **3**, 33803-59-7; **4**, 34335-17-6; (*E*)-**5**, 55590-31-3; (*Z*)-**5**, 55590-32-4; **6**, 55590-33-5; **7**, 55590-34-6; **8**, 55590-35-7.

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(10) Mention of a trade name or proprietary product does not constitute a USDA endorsement.
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Cephem-*N*-methylnitrones

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Our interest in the synthesis of 2-C–3-C-tricyclic cephalosporins,[1] of cephem-3-*C*-carboxamides,[2] and in the synthesis of cephalosporins with ring substituents attached directly at 3-C vs. 3-C′ [3a,3b] led us to explore some of the chemistry of the *C*-3-*C*-cephem-*N*-methylnitrones. Thus aldonitrones are known to undergo rearrangement with a variety of reagents (acetic anhydride, acetyl chloride, sulfur dioxide, etc.) to give amides and to undergo inter- and intramolecular cycloaddition reactions to give heterocyclic ring systems.[4]

Treatment of the Δ^2-3-*C*-formyl derivative (**1**) with *N*-methylhydroxylamine followed by chromatography on silica gel gave the *N*-methylnitrone (**2**) in moderate yield (Scheme I). Sulfur oxidation with *m*-chloroperbenzoic acid