A Convenient Preparation of Alkanoylmethylenetriphenylphosphoranes

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Received March 28, 1975

Various alkanoylmethylenetriphenylphosphoranes (**2**), versatile Wittig reagents, can be conveniently prepared[1] on a small scale from the corresponding acyl chlorides through the diazo ketone (Scheme I). To avoid undesirable use of diazomethane, an alternate route (Scheme II) to the chloro ketone had been developed.[2] Carboxylic acid esters containing no active hydrogen can be converted to the phosphorane (**2**, R = C_6H_5, R = H) upon treatment with methylenetriphenylphosphorane (Scheme III).[3,4] Various phosphoranes (**2**) can also be prepared[4] by treatment of an appropriate acyl chloride with excess methylenetriphenylphosphorane (Scheme IV). However, poor yields in our hands[2] made this procedure unattractive. Recently Taylor and coworkers[5] and Cooke[6] have discovered that various alkanoylmethylenetriphenylphosphoranes (**3**) could be prepared by alkylation of lithiotriphenylphosphinioacetonide (Scheme V).

Scheme I[1]

$$\mathrm{RCOCl} \xrightarrow{CH_2N_2} \mathrm{RCOCHN_2} \xrightarrow{HCl} \underset{\mathbf{1}}{\mathrm{RCOCH_2Cl}} \xrightarrow{Ph_3P}$$

$$\mathrm{RCOCH_2\overset{+}{P}Ph_3\overset{-}{Cl}} \xrightarrow{Na_2CO_3} \underset{\mathbf{2}}{\mathrm{RCOCH{=}PPh_3}}$$

Scheme II[2]

$$\mathrm{RCOCH_3} \xrightarrow[NaH]{(CH_3O)_2CO} \xrightarrow[H_2O]{KOH} \mathrm{RCOCH_2CO_2H} \xrightarrow{SO_2Cl_2} \xrightarrow{\text{distillation}} \underset{\mathbf{1}}{\mathrm{RCOCH_2Cl}}$$

Scheme III[3,4]

$$\mathrm{RCO_2C_2H_5} + \mathrm{Ph_3P{=}CH_2} \longrightarrow \underset{\mathbf{2}}{\mathrm{RCOCH{=}PPh_3}} + \mathrm{C_2H_5OH}$$

Scheme IV[4]

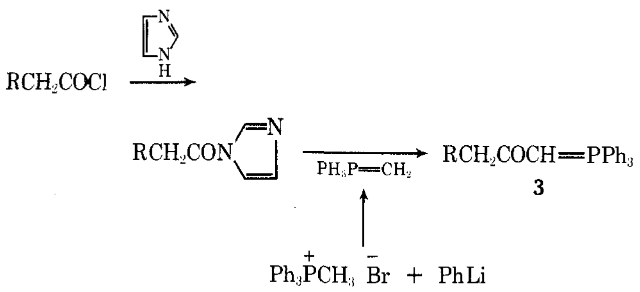
$$\mathrm{RCOCl} + 2\mathrm{Ph_3P{=}CH_2} \longrightarrow \underset{\mathbf{2}}{\mathrm{RCOCH{=}PPh_3}} + \mathrm{Ph_3\overset{+}{P}CH_3\overset{-}{Cl}}$$

Scheme V[5,6]

$$\mathrm{CH_3COCH_2\overset{+}{P}Ph_3\overset{-}{X}} \xrightarrow{2n\text{-BuLi}} \mathrm{\overset{-}{C}H_2COCH{=}PPh_3} \xrightarrow{RX} \underset{\mathbf{3}}{\mathrm{RCH_2COCH{=}PPh_3}}$$

In this communication we report a preparation of **3** from acyl imidazolide (Scheme VI) which affords a significant advantage over Schemes III and IV. Contrary to Scheme III, Scheme VI could be applied to imidazolides of weak acids having α hydrogens. Only an equivalent amount of methylenetriphenylphosphorane was required in Scheme VI, in contrast with 2 equiv in Scheme IV. The overall yield of phosphoranes via Scheme VI was usually 50–60%, superior to yield of phosphoranes via Scheme IV. Since the basic fraction of reaction products included no phosphorus-containing by-product, the work-up was easy. The major by-product was a ketone **5**, presumably formed by a Claisen-type condensation (**4**).

Scheme VI



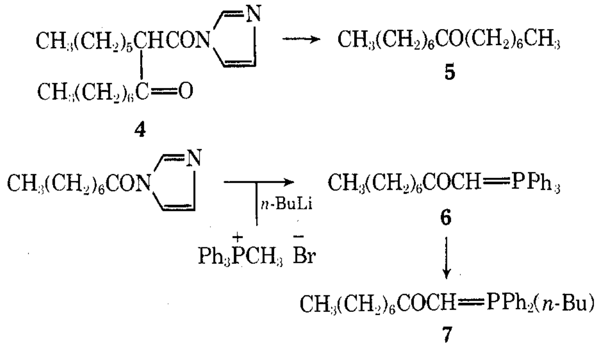
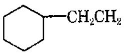
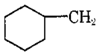
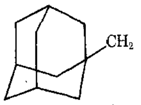
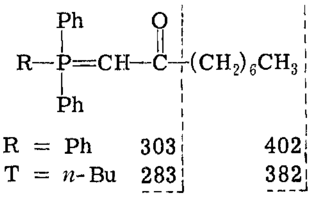
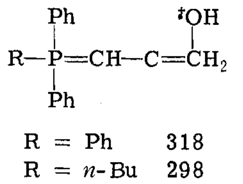


Table I
New Alkanoylmethylenetriphenylphosphoranes Prepared by Imidazole Procedure

R	RCOCH=PPh3						Registry no.
	Yield, %	Mp, °C	Calcd, %		Found, %		
			C	H	C	H	
$n\text{-}C_4H_9(CH_3)CH$	55	83-85	80.38	7.53	80.41	7.57	41692-76-6
	56	84-86	81.13	7.54	80.87	7.64	55759-57-4
	53	133-135	80.97	7.30	80.97	7.40	55759-58-5
$n\text{-}C_7H_{15}$	52	81-83	80.56	7.76	80.61	7.58	41693-09-8
$CH_3OCH_2CH_2CH_2$	31	75-78	76.57	6.42	76.10	6.61	55759-59-6
	45	224-225	82.21	6.91	81.95	7.18	55759-60-9

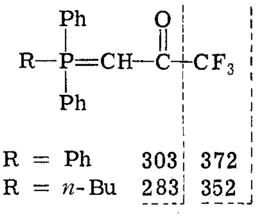
Methylenetriphenylphosphorane used in this reaction had to be generated with phenyllithium. If n-butyllithium was used, significant amounts of n-butyldiphenylphosphorane (**7**) were formed, drastically decreasing the yield of crystalline **6**. Although **7** could not be isolated in a pure state and was an oil, m/e 382 (molecular ion), 298, and strong 283 peaks afforded convincing evidence for structure **7**. A few precedents for similar alkyl–aryl exchange have been recorded in the literature. Seyferth,[7] for instance, showed that benzene (26%) was formed when methyltriphenylphosphonium bromide was treated with methyllithium.





Trifluoroacetylmethylenetriphenylphosphorane (**8**) was obtained accompanied by trifluoroacetylmethylene-n-butyldiphenylphosphorane (**9**) when ethyl trifluoroacetate was treated with methylenetriphenylphosphorane generated by n-butyllithium. When **8** was treated with an equimolecular amount of n-butyllithium in ether at 25°, approximately 70% of **8** was converted into **9** within 30 min. On the other hand, treatment of **9** with phenyllithium did not afford any recognizable (by TLC) amount of **8**.

$$\underset{\mathbf{8}}{F_3CCOCH{=}PPh_3}\ \underset{\text{PhLi}}{\overset{n\text{-BuLi}}{\rightleftarrows}}\ \underset{\mathbf{9}}{F_3CCOCH{=}P(n\text{-Bu})Ph_2}$$



Experimental Section

Melting points were determined on a Fisher-Johns melting point apparatus and were not corrected.

Acyl chlorides were prepared from the corresponding acids by thionyl chloride in hexane or benzene and were purified by distillation.

General Procedure for Preparation of Alkanoylmethylenetriphenylphosphorane (3). A solution of imidazole (0.2 mol) in 250 ml of tetrahydrofuran–ether (50:50) was stirred at 5° under nitrogen as an ethereal solution of acyl chloride (0.1 mol) was slowly added over 15 min. The resulting slurry was stirred for an additional 30 min and filtered under a nitrogen atmosphere. The cake of imidazole hydrochloride was washed with ether. A slurry of methyltriphenylphosphonium bromide (0.1 mol) in 1 l. of ether was treated with 0.1 mol of phenyllithium in benzene–ether (Ventron) at 25° for 1.5 hr. The ethereal acyl imidazolide solution was added to the methylenetriphenylphosphorane solution at −70° over 30 min. The mixture was allowed to warm to 25°, poured into 2 l. of dilute hydrochloric acid, and shaken with 1 l. of ether. The aqueous phase containing a heavy oil which was soluble in neither phase separated. The insoluble oily substance was the hydrochloride of **3** and often crystallized during the work-up. The aqueous phase was made alkaline (pH 10) with potassium carbonate and the oil which separated was extracted with toluene or benzene. The organic extract was washed[8] and evaporated in vacuo. The residue was recrystallized from hexane or ether–hexane.

Isolation and Identification of Pentadecan-8-one (5) as Byproduct. The preparation of **6** was carried out according to the general procedure except that methylenetriphenylphosphorane was generated with n-butyllithium. The ethereal phase was separated from the aqueous hydrochloric acid layer and concentrated. The residue was dissolved in benzene, washed,[8] and concentrated. The residue was recrystallized from hexane to give **5**: mp 43° (lit.[9] mp 43°); ir ($CHCl_3$) 1715 cm^{-1}; mass spectrum (70 eV) m/e 127 [$CH_3(CH_2)_6C(OH){=}CH_2$].

Anal. Calcd for $C_{15}H_{30}O$: C, 79.59; H, 13,36. Found: C, 79.30; H, 13.39.

The aqueous phase containing the heavy oil gave **6** and **7**.

Trifluoroacetylmethylenetriphenylphosphorane (8) and Trifluoracetylmethylene-*n*-butyldiphenylphosphorane (9). To a solution of methylenetriphenylphosphorane (prepared from 0.22 mol of methyltriphenylphosphonium bromide and 0.2 mol of n-butyllithium) in 1 l. of ether was added 0.2 mol of ethyl trifluoroacetate at −70° under nitrogen. The reaction mixture was stirred at −70° for 1 hr, brought to 25°, then stirred with 1.5 l. of 2% hydrochloric acid and filtered to collect a colorless precipitate (A). The ethereal phase was worked up in the usual manner[8] (B). The aqueous acidic layer was made alkaline with potassium carbonate and extracted with methylene chloride[8] (C). The crystalline precipitate (A) was dissolved in methylene chloride, washed, and dried[8] (D). Extracts B and D gave totally 30.3 g of crude **8** whereas extract C gave 42.3 g of a mixture of **8** and **9**. Pure **8** of mp 233° was obtained (~30 g) by recrystallization from benzene: ir ($CHCl_3$) 1590 (C=O), 1575 cm^{-1} (C=C); NMR ($CDCl_3$) δ 4.27 (d, 1, J = 20 Hz).

Anal. Calcd for $C_{21}H_{16}OF_3P$: C, 67.74; H, 4.33. Found: C, 67.81; H, 4.49.

Pure **9** (~15 g) was obtained by chromatography of a mixture of **8** and **9** on silica gel using 1% ethyl acetate–methylene chloride and recrystallization from ethyl acetate: mp 138°; ir ($CHCl_3$) 1587 (C=O), 1572 cm^{-1} (C=C); NMR ($CDCl_3$) δ 4.07 (d, 1, J = 19 Hz), 2.73 (m, 2), 1.47 (m, 4), 0.90 (m, 3).

Note Added in Proof. A preparation of benzoylmethylene triphenylphosphorane from benzoylimidazole and 2 mol of methylenetriphenylphosphorane was recorded in the literature, but no example of an imidazolide having an α H was given: H. J. Bestmann, N. Sommer, and H. A. Staab, *Angew. Chem.*, **74**, 293 (1962).

Registry No.—**5**, 818-23-5; **8**, 55759-55-2; **9**, 55759-56-3; methyltriphenylphosphonium bromide, 1779-49-3; phenyllithium, 591-51-5; methylenetriphenylphosphorane, 3487-44-3; ethyl trifluoroacetate, 383-63-1.

References and Notes

(1) (a) A. Michaelis and E. Köhler, *Ber.*, **32**, 1566 (1899); (b) see also F. Ramirez and S. Dershowitz, *J. Org. Chem.*, **22**, 41 (1957), for the correct structure.
(2) M. Miyano and C. R. Dorn, *J. Org. Chem.*, **37**, 1818 (1972).
(3) G. Wittig and U. Schöllkopf, *Chem. Ber.*, **87**, 1318 (1954).
(4) S. Trippett and D. M. Walker, *J. Chem. Soc.*, 1366 (1961).
(5) J. D. Taylor and J. F. Wolf, *J. Chem. Soc., Chem. Commun.*, 876 (1972).
(6) M. P. Cooke, Jr., *J. Org. Chem.*, **38**, 4082 (1973).
(7) D. Seyferth, J. K. Heeren, and W. B. Hughes, Jr., *J. Am. Chem. Soc.*, **84**, 1764 (1962).
(8) Washed first with 2% aqueous sodium carbonate and then with 1% sodium chloride, and dried over sodium sulfate.
(9) L. Ruzicka and J. B. Buijs, *Helv. Chim. Acta*, **15**, 10 (1932).

Metal–Hexamethylphosphoramide Reduction. IV. Birch-Like Reduction of 2,6- and 2,7-Dimethoxynaphthalenes[1]

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Received March 17, 1975

Recently we reported[2] preliminary results on the reduction of β-substituted dimethoxynaphthalenes with lithium in hexamethylphosphoramide (HMPA)–tetrahydrofuran (THF) with or without a proton donor (ethanol). We demonstrated that in the absence of an alcohol reductive cleavage of the type naphth–OMe and naphthO–Me is the major reaction pathway. In the presence of ethanol reduction of