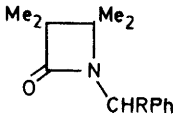
α-(4,6-Diphenyl-2-oxo-1-pyridyl)benzyl-lithiums and their Reactions with Electrophiles

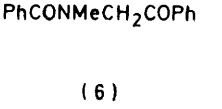
By **Alan R. Katritzky,*§ John Arrowsmith, Zakaria bin Bahari, Chandra Jayaram, Tayyaba Siddiqui,** and **Socrates Vassilatos,** School of Chemical Sciences, University of East Anglia, Norwich, NR4 7TJ

1-Benzyl-4,6-diphenyl-2-pyridone is lithiated by $LiNPr^i_2$ at the methylene carbon to form a carbanion which reacts with various electrophiles to give the corresponding 1-(α-substituted-benzyl)-4,6-diphenyl-2-pyridones. Potassium dimsylate converts 1-benzyl-4,6-diphenyl-2-pyridone into the 3-methyl derivative. The anion derived from 1-(α-methylbenzyl)-4,6-diphenyl-2-pyridone rapidly rearranges to the azepinone (18).

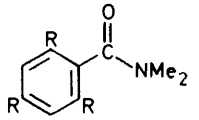
HYDROGEN atoms on sp^3-carbon attached to nitrogen are rendered acidic if the nitrogen also carries a carbonyl group as demonstrated by Durst,[1] who lithiated (1) to give (2) as shown by the formation of (3) on rapid quenching with D_2O. Beak [2] similarly lithiated (4), but the product isolated was ketone (6) arising from rapid reaction with more (4). Such self-condensation was prevented by Seebach [3] in the anion (7) of the isopropyl derivative (5) or in *NN*dimethyltriphenylacetamide. *NN*Dibenzyl-benzamide [4] and *N*-benzylbenzamide [5] have also been successfully lithiated (the latter requiring two equivalents of base) and all these carbanions reacted to give the expected products with electrophiles such as alkyl halides, aldehydes, ketones, and esters. Seebach and Schlecker [6] have metallated *N*-methylsuccinimides at the methyl group, but considerable steric hindrance around the carbonyls by *C*-substituents is required to reduce dimer formation.



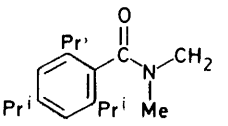
(1) R = H
(2) R = Li
(3) R = D



(6)

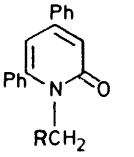


(4) R = H
(5) R = Pr^i

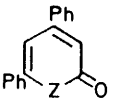


(7)

We reasoned that *N*-alkylated heteroaromatic carbonyl compounds should also be capable of α-metallation and that the considerable aromatic stabilisation of compounds such as pyridones [7] could be advantageous. Our initial experiments centred on compounds of type (8) which were prepared [8] in fair to good yield from the corresponding amine and 4,6-diphenyl-2-pyrone (9) itself available [9] in one moderate-yield step from commercial benzoylacetic ester. Alternatively, 1-substituted 4,6-diphenyl-2-pyridones can be prepared *via* the corresponding 1-substituted 2-methyl-4,6-diphenylpyridinium cations.[10] In compounds of type (8) the phenyl groups should discourage nucleophilic attack at ring-



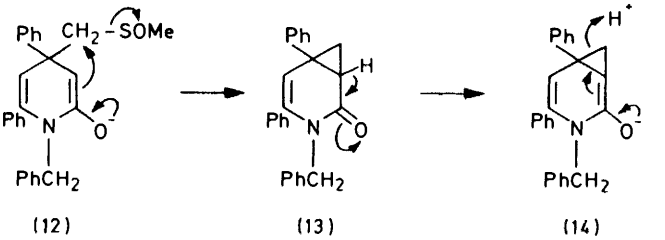
(8)
a ; R = Ph
b ; R = *o*-ClC_6H_4
c ; R = *p*-$MeOC_6H_4$
d ; R = *p*-MeC_6H_4



(9) Z = O
(10) Z = N-O$^-$
(11) Z = N-CH$^-$-Ar

carbon and the anions (11) resemble their oxygen analogues (10) which can readily be alkylated.[11]

Metallation Techniques.—Potassium t-butoxide in dimethylformamide and sodium hydride in tetrahydrofuran did not react with 1-benzyl-4,6-diphenyl-2-pyridone (8). Treatment with potassium dimsylate in dimethyl sulphoxide at 60 °C formed a highly coloured reaction mixture, indicative of anion formation, but subsequent treatment with an electrophile, such as 4-toluoaldehyde, gave as the only product identified 1-benzyl-3-methyl-4,6-diphenyl-2-pyridone (24%, unoptimised). We suggest that this product is formed by initial reagent addition to give (12) followed by the pathway (12)→(13)→(14). The nearest heterocyclic analogies we have found are the methylation of quinoline



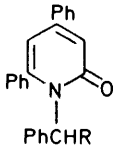
(12) (13) (14)

and isoquinoline [12] in the 4- and 1-position respectively (see also ref. 13). Walling [14] found the dimsylate anion will react with alkenes to form cyclopropane rings [*cf.* (12)→(13)].

§ *New permanent address*; Department of Chemistry, University of Florida, Gainesville, Florida, U.S.A.

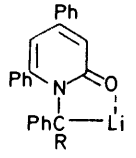
However, lithium di-isopropylamide (LDA) in tetrahydrofuran reacts rapidly at −78 °C with (8a) to generate a deep-purple solution of the corresponding carbanion. Treatment of this solution with deuterium oxide gave (15a) with quantitative mono-deuteriation (from n.m.r.) at the α-carbon, and, as discussed later, a variety of other electrophiles also reacted with (16) to give products of type (15). The 1-(substituted benzyl) analogues (8b) and (8c) also gave similar highly coloured solutions of their anions, which reacted with electrophiles without rearrangement.

Although 1-(α-methylbenzyl)-4,6-diphenyl-2-pyridone

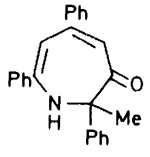


(15)

a ; R = D
b ; R = Me
c ; R = Et
d ; R = PhCO
e ; R = *p*-MeC_6H_4CO
f ; R = *o*-MeC_6H_4CO
g ; R = *p*-$MeOC_6H_4CO$
h ; R = *p*-ClC_6H_4CO
i ; R = PhCH(OH)
j ; R = *p*-$MeC_6H_4CH(OH)$
k ; R = *p*-$MeOC_6H_4CH(OH)$
l ; R = *p*-$ClC_6H_4CH(OH)$
m ; R = *m*-$ClC_6H_4CH(OH)$
n ; R = $Ph_2C(OH)$
o ; R = $Me_2C(OH)$
p ; R = cyclo-$C_6H_{10}(OH)$
q ; R = CO_2Et
r ; R = CO_2H



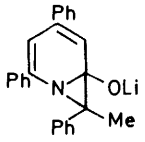
(16) R = H
(17) R = Me



(18)

(15b) also reacted with LDA in tetrahydrofuran at −78 °C to give a deeply coloured anion, this anion rapidly rearranged: on quenching with H_2O, 2-methyl-2,5,7-triphenylazepin-3-one (18) was formed as shown by microanalysis and i.r. [ν(NH): 3 360 cm^{-1} broad; ν(C=O) of divinylogous amide: 1 655 cm^{-1}]. The structure was confirmed by n.m.r. spectral data. The ^1H n.m.r. spectrum shows outside the aromatic region a sharp singlet at δ 2.36 p.p.m. for the 2-methyl and doublets appear at δ 6.98 and δ 6.74 (*J* 1.6 Hz) for 4-H and 6-H positions, respectively. The ^{13}C n.m.r. coupled and decoupled spectra (Table 1) show the expected peaks and further support the structure.

We believe that the instability of carbanion (17) is a consequence of steric crowding which reduces effective co-ordination of the lithium by the oxygen atom as



(19)

compared to that in (16). Consequently, (17) collapses to (19) which then gives (18) following Cope rearrangement and protonation.

Reaction of Lithium Derivatives with Electrophiles.—Organolithium (16) [and its analogues derived from (8b) and (8d)] react rapidly at −78 °C with many electrophiles: consumption of the anion is assessed by the colour discharge. Thus, substituted benzoyl chlorides gave the α-benzoylated products (15d—h, Table 2) in fair to good yield. Methyl benzoate gave the same product as benzoyl chloride (15d) but double the reaction time was required. The benzoylated products showed ν(C=O) at 1 700—1 715 cm^{-1} (benzoyl) and at 1640—1 650 cm^{-1} (pyridone). The remaining benzyl proton was shifted downfield to δ 6.1—6.3 p.p.m.

The ethoxycarbonyl group was readily introduced with ethyl chloroformate (15q); subsequent acid hydrolysis gave the corresponding carboxylic acid (15r) (100%) also available, in poor yield, by direct reaction of (16) with carbon dioxide.

Aromatic and aliphatic aldehydes and ketones added (16) across the carbon–oxygen double bond to give good yields of the hydroxy-products (15i—p) which showed ν(OH) at 3 100—3 250 cm^{-1} (broad) and ν(C=O) at 1 640 cm^{-1} (pyridone). The single remaining benzylic proton absorbed at δ 5.0—5.5. The aldehyde products (15i—m) contain two asymmetric centres. Compound (15j) was separated into the two diastereoisomers (4 : 1) by fractional crystallisation. The i.r. spectra were superimposable and the n.m.r. spectra merely showed slight differences in the aromatic region.

TABLE 1

^{13}C N.m.r. spectral data for compound (18)

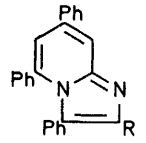
Shift (δ)	22.07	97.91	116.98	129.19	138.12	139.82	147.82	149.57	152.15	161.43
Multiplicity	4	2	2	1	1	1	1	1	1	1
						[a]				
Assignment	CH_3	C-6	C-4	C-2	C-5	C-7	*i*2Ph [b]	*i*5Ph [b]	*i*7Ph [b]	C-3

[a] Unambiguous assignment of individual carbons was not possible. [b] *i* = *ipso*.

The anion (16) reacted rapidly with methyl iodide to give compound (15b) in good yield. Attempted reactions with benzyl, n-propyl, isopropyl, or n-butyl bromide failed; however, (15c) was obtained by adding LDA to a mixture of (16) and ethyl iodide (Procedure B) at −78 °C (*i.e.* reverse addition).

Benzonitrile and toluonitrile reacted with (16); how-

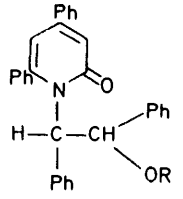
ever, in place of the expected Schiff bases, the isolated products were the 2,3,5,7-tetra-arylimidazo[1,2-*a*]pyridines (20a) and (20b) resulting from the further reaction of the *N*-lithio-Schiff base with the pyridone carbonyl. The



(20)

a ; R = Ph

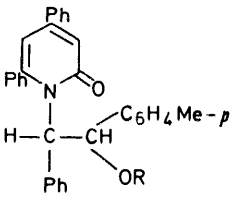
b ; R = *p*-MeC_6H_4



(21)

a ; R = Ac

b ; R = *p*-MeC_6H_4CO



(22)

a ; R = Me

b ; R = Ac

structures of (20a) and (20b) were determined by microanalysis, and i.r., ^1H n.m.r., and ^{13}C n.m.r. spectroscopy.

The alcohols (15i) and (15j) from the addition of (16) Some benzyl 4-tolyl ketone (8%) was obtained by reduction under Clemmensen conditions of (15e). Although 30% C–N bond cleavage occurred (as determined by isolated 4,6-diphenyl-2-pyridone) no further products were identified.

EXPERIMENTAL

M.p.s were measured on a Reichert ' Hot Stage ' melting-point apparatus and are uncorrected. I.r. spectra were recorded in bromoform on a Perkin-Elmer 297 spectrophotometer, ^1H n.m.r. spectra at 60 MHz on a Perkin-Elmer R12 spectrometer, and ^{13}C n.m.r. spectra at 25.05 MHz on a JEOL FX-100 Fourier transform spectrophotometer.

Materials.—Tetrahydrofuran (THF) was refluxed over and distilled from lithium aluminium hydride. Commercial n-butyl-lithium (1.6M solution in hexane, Aldrich Chemical Co. Ltd.) was standardised by titration.[15] Diisopropylamine was distilled from solid potassium hydroxide and stored over molecular sieves, type 4A. Aldehydes and ketones were kept over fused $CaCl_2$ and fractionally distilled.

4,6-*Diphenyl-2-pyrone*[9] (9).—Ethyl benzoylacetate (500 g) was stirred with sulphuric acid (500 g) for three weeks at 20 °C and poured onto ice. The 4,6-diphenyl-2-pyrone was washed with MeOH and recrystallised from Me_2CO to give pale yellow prisms (82.3 g, 31%), m.p. 137—139 °C [lit.,[9] m.p. 139—140 °C].

1-*Benzyl*-4,6-*diphenyl*-2-*pyridones*.—4,6-Diphenyl-2-pyrone (39.7 g) and benzylamine (85.6 g) in absolute EtOH (200 ml) were heated under reflux for 48 h. Volatiles were evaporated off at 90 °C at 20 mmHg to give a yellow oil which solidified when triturated with light petroleum (b.p. 40—60 °C). 1-Benzyl-4,6-diphenyl-2-pyridone crystallised from EtOH as needles (37.4 g, 70%), m.p. 137—137.5 °C [lit.[16] 133—134 °C]; $\nu_{max.}$ ($CHBr_3$) 1640 cm^{-1} (C=O); δ($CDCl_3$) 7.30 (15 H, m), 7.01 (1 H, d, *J* 2.6 Hz), 6.49 (1 H, d, *J* 2.6 Hz), and 5.29 (2 H, s).

4,6-Diphenyl-2-pyridone (3.97 g) and 2-chlorobenzylamine (4.25 g) in EtOH (45 ml) heated under reflux for 72 h similarly gave 1-[2-*chlorobenzyl*]-4,6-*diphenyl*-2-*pyridone* (4.1 g, 72%) as needles, m.p. 162—163 °C from EtOAc

TABLE 2

Preparation of 1-(α-substituted benzyl)-4,6-diphenyl-2-pyridones

Reagent	Compd. no.	Alpha substituent	Procedure	Reaction time (h)	Yield (%)	M.p. (°C)	Recryst. solvent	Cryst. form	Formula	Found (%) C	Found (%) H	Found (%) N	Required (%) C	Required (%) H	Required (%) N
MeI	(15b)	Me	A	1.5	76	147—148	EtOAc	Prisms	$C_{25}H_{21}NO$	85.3	6.0	4.0	85.4	6.0	4.0
EtI	(15c)	Et	B	3	20	105—106	Et_2O–light petroleum	Prisms	$C_{26}H_{23}NO$	85.3	6.3	3.9	85.5	6.3	3.8
PhCOCl	(15d)	PhCO	A	3	71	193	95% EtOH	Prisms	$C_{31}H_{23}NO_2$	84.4	5.4	3.1	84.4	5.2	3.2
$PhCO_2Me$	(15d)	PhCO	B	6	12										
p-MeC_6H_4COCl	(15e)	*p*-MeC_6H_4CO	A	3	67	183—185	EtOH	Needles	$C_{32}H_{25}NO_2$	84.2	5.3	2.9	84.4	5.5	3.0
o-MeC_6H_4COCl	(15f)	*o*-MeC_6H_4CO	A	3	39	210—215	EtOH	Needles	$C_{32}H_{25}NO_2$	84.1	5.7	3.0	84.4	5.5	3.1
p-$MeOC_6H_4COCl$	(15g)	*p*-$MeOC_6H_4CO$	A	3	56	185—187	EtOH	Needles	$C_{32}H_{25}NO_3$	81.3	5.3	3.0	81.5	5.3	3.0
p-ClC_6H_4COCl	(15h)	*p*-ClC_6H_4CO	A	3	38	187—189	EtOH	Prisms	$C_{31}H_{22}ClNO_2$ [a]	77.9	4.7	2.8	78.2	4.6	2.9
PhCHO	(15i)	PhCH(OH)	A	2.5	78	186—187	EtOAc	Needles	$C_{31}H_{25}NO_2$	84.1	5.6	3.2	84.0	5.6	3.2
p-MeC_6H_4CHO	(15j)	*p*-$MeC_6H_4CH(OH)$	A	2.5	85 [b]	183—184.5 237—239	EtOH EtOH	Prisms	$C_{32}H_{27}NO_2$ $C_{32}H_{27}NO_2$	84.2 84.1	6.0 6.0	3.0 3.1	84.0 84.0	6.0 6.0	3.1 3.1
p-$MeOC_6H_4CHO$	(15k)	*p*-$MeOC_6H_4CH(OH)$	A	2.5	50	166—168	EtOH	Needles	$C_{32}H_{27}NO_3$	81.0	5.8	2.9	81.2	5.7	3.0
p-ClC_6H_4CHO	(15l)	*p*-$ClC_6H_4CH(OH)$	A	2.5	65	168—170	EtOAc	Prisms	$C_{31}H_{24}ClNO_2$	77.7	5.1	2.9	77.9	5.0	2.9
m-ClC_6H_4CHO	(15m)	*m*-$ClC_6H_4CH(OH)$	A	2.5	60 [c]	234—235	EtOAc	Needles	$C_{31}H_{24}ClNO_2$	77.6	5.1	2.9	77.9	5.0	2.9
Ph_2CO	(15n)	Ph_2COH	A	2.5	72	220	EtOAc	Prisms	$C_{37}H_{29}NO_2$	85.4	5.8	2.7	85.5	5.6	2.7
Me_2CO	(15o)	Me_2COH	A	2.5	60	197—198	EtOH	Needles	$C_{27}H_{25}NO_2$	82.0	6.4	3.5	82.0	6.4	3.5
cyclo-$C_6H_{10}O$	(15p)	cyclo-$C_6H_{10}OH$	A	2	75	203	EtOH	Prisms	$C_{30}H_{29}NO_2$	82.6	6.8	3.2	82.7	6.7	3.2
$ClCO_2Et$	(15q)	CO_2Et	A	4	84	171—172	95% EtOH	Prisms	$C_{27}H_{23}NO_3$	79.3	5.7	3.4	79.2	5.7	3.4
Me_2CO	*d*	CMe_2OH	A	3	78	140—141	EtOH	Plates	$C_{28}H_{27}NO_2$	82.0	6.5	3.4	82.1	6.6	3.4
PhCHO	*e*	PhCHOH	A	2.5	68	208—209	EtOH	Plates	$C_{31}H_{24}ClNO_2$ [f]	77.9	5.0	2.9	77.7	5.0	2.9

[a] Found: Cl, 7.5. Required: Cl, 7.5%. [b] Two diastereoisomers in ratio 4 : 1 which were separated by fractional crystallisation from ethanol. [c] Isolated by column chromatography (silica gel eluted with diethyl ether). [d] Compound analogous to (15o) but derived from (8d). [e] Compound analogous to (15i) but derived from (8b) [f] Found: Cl, 7.6. Required: Cl, 7.6%

(Found: C, 77.3; H, 4.9; N, 3.8. $C_{24}H_{18}ClNO$ requires C, 77.5; H, 4.8; N, 3.8%); $\nu_{max.}$ ($CHBr_3$) 1 660 cm^{-1} (C=O); δ($CDCl_3$) 7.8—6.95 (15 H, m), 6.45 (1 H, d, *J* 2.65 Hz), and 5.22 (2 H, s).

Similarly 4,6-diphenyl-2-pyrone (4 g) and 4-methoxybenzylamine (4.37 g) in EtOH (50 ml) were heated under reflux for 16 h to afford 1-(*4-methoxybenzyl*)-4,6-*diphenyl*-2-*pyridone* (3.08 g, 51%) as needles, m.p. 115—117 °C from EtOH (Found: C, 81.7; H, 5.8; N, 3.8. $C_{25}H_{21}NO_2$ *requires* C, 81.7; H, 5.8; N, 3.8%); $\nu_{max.}$ (KBr) 1 650 cm^{-1} (C=O); δ($CDCl_3$) 7.98—7.11 (12 H, m), 6.88 (1 H, d, *J* 2.5 Hz, pyridone 3-H), 6.77 (2 H, d, *J* 3.5 Hz, protons *ortho* to OMe group), 6.33 (1 H, d, *J* 2.5 Hz, pyridone 5-H), 5.13 (2 H, s), and 3.68 (3 H, s). Similarly 4,6-diphenyl-2-pyrone (4 g) and 4-methylbenzylamine (4 g) in EtOH (30 ml) were heated under reflux for 36 h to afford 1-(*4-methylbenzyl*)-4,6-*diphenyl*-2-*pyridone* (4.2 g, 75%) as long needles, m.p. 173—173.5 °C from EtOH (Found: C, 85.4; H, 6.0; N, 3.9. $C_{25}H_{21}NO$ requires C, 85.4; H, 6.0; N, 3.9%); $\nu_{max.}$ ($CHBr_3$) 1 650 cm^{-1} (C=O); δ($CDCl_3$) 7.08—7.82 (14 H, m), 6.96 (1 H, d, *J* 2.66 Hz, pyridone 3-H), 6.48 (1 H, d *J* 2.66 Hz, pyridone 5-H), 5.18 (2 H, s), and 2.29 (3 H, s).

Alkylation of 1-*Benzyl*-4,6-*diphenyl*-2-*pyridone*.—*Procedure A*. To LDA (3.0 mmol) in dry THF (10 ml) [prepared by adding dropwise n-butyl-lithium in hexane (3.1 ml, 3.0 mmol of 0.96M) to di-isopropylamine (0.3 g, 3.0 mmol) in dry THF (7 ml) at −76 °C under N_2] cooled to −76 °C was added dropwise 1-benzyl-4,6-diphenyl-2-pyridone (1.0 g, 3.0 mmol) in dry THF (10 ml). After 0.5 h at −76 °C, the electrophile (3.0 mmol) in dry THF was added. Stirring was continued for 1 h at −76 °C and for a further 0.5—5 h at 20 °C. Water (1 ml) was then added and the solvent removed at 40—50 °C/20 mmHg. The residue in CH_2Cl_2 (75 ml) was washed with saturated aqueous NaCl (30 ml), water (30 ml), dried ($MgSO_4$), and evaporated at 40—50 °C/20 mmHg to give the product as a yellow or orange oil which usually crystallised slowly when kept under EtOAc and was recrystallised from the appropriate solvent (see Table 2).

Procedure B. To 1-benzyl-4,6-diphenyl-2-pyridone (1.0 g, 3.0 mmol) and electrophile (3.0 mmol), stirred in dry THF (25 ml) at −76 °C under N_2, was added dropwise LDA (3.0 mmol) in dry THF (10 ml) [prepared as described in Procedure A]. The products were isolated as in Procedure A.

1-*Benzyl*-3-*methyl*-4,6-*diphenyl*-2-*pyridone*.—To potassium dimsylate (363 mg, 3.1 mmol) in dry Me_2SO [prepared by adding powdered potassium t-butoxide (350 mg, 3.1 mmol) to dry Me_2SO (10 ml) heated to 60 °C under N_2] was added with stirring 1-benzyl-4,6-diphenyl-2-pyridone (1.0 g, 3.0 mmol). The immediate purple colour slowly diminished to red over 3 h. The solution was quenched with saturated aqueous NaCl (30 ml) and extracted with $CHCl_3$ (3 × 25 ml). The combined organic extracts were washed with water (2 × 25 ml), dried ($MgSO_4$), and evaporated at 30—40 °C/20 mmHg to leave a pale yellow oil which was separated by preparative layer chromatography [silica gel, EtOAc–light petroleum (b.p. 40—60 °C), 2 : 1]. The band of R_F 0.70 gave the 3-*methyl*-2-*pyridone* (248 mg, 24%) as prisms, m.p. 150.5—151.5 °C from EtOH (Found: C, 85.3; H, 6.0; N, 3.9. $C_{25}H_{21}NO$ requires C, 85.5; H, 6.0; N, 4.0%); $\nu_{max.}$ ($CHBr_3$) 1 642 cm^{-1} (C=O); δ($CDCl_3$) 7.87—7.23 (15 H, m), 6.04 (1 H, s), 5.20 (2 H, s), and 2.18 (3 H, s).

2-*Methyl*-2,5,7-*triphenylazepin*-3-*one* (18).—To LDA (2.2 mmol) in dry THF (10 ml) [prepared as in procedure A] cooled to −76 °C under N_2 was added *N*-(α-methylbenzyl)-4,6-diphenyl-2-pyridone (15b) (750 mg, 2.1 mmol) in dry THF (10 ml). Stirring was continued for 1 h at −76 °C and for a further 1 h at 20 °C. Water (1 ml) was added and the solvent removed at 30—40 °C/20 mmHg. The residue in CH_2Cl_2 (50 ml) was washed with water (2 × 25 ml), dried ($MgSO_4$), and evaporated at 30—40 °C/20 mmHg to afford a brown oil, which was separated by preparative layer chromatography (silica gel, Et_2O). The band of R_F 0.42 gave 2-*methyl*-2,5,7-*triphenylazepin*-3-*one* (117 mg, 16%) as microcrystals, m.p. 92—94 °C, from ether (Found: N, 3.9. $C_{25}H_{21}NO$ requires N, 4.0%); $\nu_{max.}$ ($CHBr_3$) 3 360 (NH, broad) and 1 655 cm^{-1} (C=O); δ($CDCl_3$) 7.88—7.07 (15 H, m), 6.98 (1 H, d, *J* 1.7 Hz), 6.74 (1 H, d, *J* 1.7 Hz), and 2.36 (3 H, s); *m/e* 351 (100%).

2,3,5,7-*Tetraphenylimidazo*[1,2-a]*pyridine* (20a).—*Following Procedure A*. Benzonitrile (0.31 g, 3.0 mmol) in dry THF (5 ml) was added under N_2 to (1b) (3.0 mmol) in dry THF (20 ml) at −76 °C. Stirring was continued at −76 °C for 2 h and a further 0.5 h at 20 °C. Water (1 ml) was added and the solvent removed at 40—50 °C/20 mmHg. The residue in CH_2Cl_2 (75 ml) was washed with water (30 ml), dried ($MgSO_4$), and evaporated at 40—50 °C/20 mmHg to give, as an orange oil which crystallised slowly under toluene, 2,3,5,7-*tetraphenylimidazo*[1,2-a]*pyridine* which crystallised from EtOAc–light petroleum (b.p. 40—60 °C) (1 : 3) as needles (0.56 g, 45%), m.p. 227—229 °C (Found: C, 87.7; H, 5.2; N, 6.5. $C_{31}H_{22}N_2$ requires C, 88.1; H, 5.3; N, 6.6%); $\nu_{max.}$ (Nujol) 1 600 cm^{-1}; δ($CDCl_3$) 8.05—6.65 (m).

Similarly (16) (3.0 mmol) and 4-toluonitrile (0.35 g, 3.0 mmol) afforded 2-(*4-methylphenyl*)-3,5,7-*triphenylimidazo*[1,2-a]*pyridine* (20b) (40%) as pale yellow needles, m.p. 229—231 °C from EtOAc–light petroleum (b.p. 40—60 °C) (1 : 3) (Found: C, 87.6; H, 5.6; N, 6.3. $C_{32}H_{24}N_2$ requires C, 88.0; H, 5.5; N, 6.4%); $\nu_{max.}$ (Nujol) 1 600 cm^{-1}; δ($CDCl_3$) 8.08—6.84 (21 H, m) and 2.3 (3 H, s).

1-[2-*Methoxy*-2-(*4-methylphenyl*)-1-*phenyl*]*ethyl*-4,6-*diphenyl*-2-*pyridone* (22a).—To LDA (6 mmol) in dry THF (10 ml) [prepared as in procedure A] cooled to −76 °C under N_2 was added 1-benzyl-4,6-diphenyl-2-pyridone (2.0 g, 6.0 mmol) in dry THF (30 ml). After 0.5 h at −76 °C 4-toluoaldehyde (0.71 g, 6.0 mmol) in dry THF (5 ml) was added. Stirring was continued at 20 °C for 2 h before MeI (0.84 g, 6.0 mmol) was added and stirring continued for a further 2 h. Water (1 ml) was added, the solvent removed at 40—50 °C/20 mmHg, and the residue taken up in CH_2Cl_2 (100 ml), washed with water (50 ml), and dried ($MgSO_4$). The CH_2Cl_2 solution was evaporated at 40—50 °C/20 mmHg to give the product as a yellow oil which crystallised from EtOH on cooling. Recrystallisation from EtOAc gave the *methoxy-derivative* (1.96 g, 70%) as plates, m.p. 208—210 °C (Found: C, 83.8; H, 6.1; N, 3.0. $C_{33}H_{29}NO_2$ requires C, 84.0; H, 6.2; N, 3.0%); $\nu_{max.}$ (Nujol) 1 660 cm^{-1} (C=O); δ($CDCl_3$) 7.75—6.88 (20 H, m), 6.45 (1 H, d, *J* 2.6 Hz), 3.16 (3 H, s), and 2.10 (3 H, s).

Similarly the reaction between LDA (1.5 mmol), 1-benzyl-4,6-diphenyl-2-pyridone (500 mg, 1.5 mmol), and benzaldehyde (160 mg, 1.5 mmol) was treated with 4-toluoyl chloride (230 mg, 1.5 mmol) to afford 1-[2-(*4-toluoyloxy*)-1,2-*diphenyl*]*ethyl*-4,6-*diphenyl*-2-*pyridone* (21b) (177 mg, 56%) as prisms, m.p. 195—196 °C from EtOH (Found: C, 83.0; H, 5.3; N, 2.4. $C_{39}H_{31}NO_3$ requires C, 83.4; H, 5.6; N, 2.5%); $\nu_{max.}$ (Nujol) 1 670 (C=O) and 1 640 cm^{-1} (C=O); δ($CDCl_3$) 7.25—6.89 (24 H, m), 6.75

(1 H, d, *J* 2.6 Hz), 6.32 (1 H, d, *J* 2.6 Hz), 5.86 (1 H, d, *J* 9.2 Hz), 5.33 (1 H, d, *J* 9.2 Hz), and 3.21 (3 H, s).

1-(2-*Acetoxy*-1,2-*diphenylethyl*)-4,6-*diphenyl*-2-*pyridone* (21a).—1-(2-Hydroxy-1,2-diphenylethyl)-4,6-diphenyl-2-pyridone (200 mg, 0.45 mmol) in Ac_2O (6 ml) was heated at reflux temperature for 6 h. Upon cooling a crystalline solid separated which was collected by filtration and recrystallised from MeOH to give 1-(2-*acetoxy*-1,2-*diphenylethyl*)-4,6-*diphenyl*-2-*pyridone* (153 mg, 70%) as needles, m.p. 115—116 °C (Found: C, 82.0; H, 5.6; N, 3.0. $C_{33}H_{27}NO_3$ requires C, 81.7; H, 5.6; N, 2.9%); $\nu_{max.}$ (Nujol) 1 710 (C=O) and 1 640 cm^{-1} (C=O); $\delta(CDCl_3)$ 7.96—6.72 (20 H, m), 6.53 (1 H, d, *J* 2.6 Hz), and 2.12 (3 H, s).

Similarly 1-[2-hydroxy-1-phenyl-2-(4-tolyl)ethyl]-4,6-diphenyl-2-pyridone (200 mg, 0.44 mmol) and Ac_2O (6 ml) when heated under reflux for 6 h gave 1-[2-*acetoxy*-1-*phenyl*-2-(4-*tolyl*)*ethyl*]-4,6-*diphenyl*-2-*pyridone* (109 mg, 50%) as needles from MeOH, m.p. 183—184 °C (Found: C, 81.4; H, 5.7; N, 2.7. $C_{34}H_{29}NO_3$ requires C, 81.7; H, 5.9; N, 2.8%); $\nu_{max.}$ (Nujol) 1 750 (C=O) and 1 640 cm^{-1} (C=O); $\delta(CDCl_3)$ 7.70—6.90 (20 H, m), 6.67 (1 H, d, *J* 2.6 Hz), 6.05 (1 H, d, *J* 2.6 Hz), 5.22 (1 H, d, *J* 8.4 Hz), 2.28 (3 H, s), and 1.73 (3 H, s).

Reduction of 4,6-*Diphenyl*-1-[α-(4-*toluoyl*)*benzyl*]-2-*pyridone* (15e).—4,6-Diphenyl-1-[α-(4-toluoyl)benzyl]-2-pyridone (750 mg, 2.1 mmol) in hot toluene (10 ml) was added to zinc amalgam (730 mg) [prepared as described in ref. 17] and 10M-HCl (5 ml) and heated at reflux temperature for 9 h. The reaction mixture was poured into water (50 ml) and extracted with CH_2Cl_2 (2 × 25 ml). Combined organic extracts were dried ($MgSO_4$) and evaporated at 30—40 °C/20 mmHg to afford a brown oil which was triturated with Et_2O (3 × 15 ml). The solid material (600 mg) (a mixture of starting material and 4,6-diphenyl-2-pyridone) was removed by filtration. The filtrate was evaporated and the residue was taken up in 95% EtOH; the product crystallised upon cooling. The crystalline material was recrystallised from 95% EtOH to give 4-methyl-α-phenylacetophenone (40 mg, 8%) as flakes, m.p. 110—111 °C (lit.,[18] m.p. 109 °C); $\nu_{max.}$ ($CHBr_3$) 1 680 cm^{-1} (C=O); $\delta(CDCl_3)$ 7.96 (2 H, d, *J* 9.1 Hz), 7.47—7.12 (7 H, m), 4.24 (2 H, s), and 2.40 (3 H, s).

We thank the Universiti Teknologi Malaysia and the British Council for Scholarships to Z. B. and T. S. respectively, and Dr. A. Prout for help with experimental work.

[9/1954 *Received*, 10*th December*, 1979]

REFERENCES

[1] T. Durst, R. van den Elzen, and M. J. Le Belle, *J. Amer. Chem. Soc.*, 1972, **94**, 9261.
[2] P. Beak and R. Farney, *J. Amer. Chem. Soc.*, 1973, **95**, 4771.
[3] R. Schlecker, D. Seebach, and W. Lubosch, *Helv. Chim. Acta*, 1978, **61**, 512.
[4] R. R. Fraser, G. Boussard, I. D. Postescu, J. J. Whiting, and Y. Y. Wigfield, *Canad. J. Chem.*, 1973, **51**, 1109.
[5] A. N. Tischler and M. H. Tischler, *Tetrahedron Letters*, 1978, 3.
[6] R. Schlecker and D. Seebach, *Helv. Chim. Acta*, 1977, **60**, 1459.
[7] M. J. Cook, A. R. Katritzky, P. Linda, and R. D. Tack, *J.C.S. Perkin II*, 1972, 1295.
[8] J. A. Leben, *Ber.*, 1896, **29**, 1673.
[9] F. Arndt and B. Eistert, *Chem. Ber.*, 1925, **58**, 2318.
[10] A. R. Katritzky and M. Shanta, *J.C.S. Chem. Comm.*, 1979, 552; A. R. Katritzky, R. C. Patel, and M. Shanta, *J.C.S. Perkin I*, 1980, 1888.
[11] A. R. Katritzky, M. J. Cook, S. B. Brown, R. Cruz, and G. H. Millet with A. Anani, *J.C.S. Perkin I*, 1979, 2493.
[12] H. Nozaki, Y. Yamamoto, and R. Noyori, *Tetrahedron Letters*, 1966, 1123.
[13] Y. Hamada, K. Morishita, I. Ozawa, I. Takeuchi, and M. Hirota, *Chem. Pharm. Bull.*, 1979, **27**, 1535.
[14] C. Walling and L. Bollyky, *J. Org. Chem.*, 1963, **28**, 256.
[15] S. C. Watson and J. F. Eastham, *J. Organometallic Chem.*, 1967, **9**, 165.
[16] J. Faust, G. Speier, and R. Mayer, *J. prakt. Chem.*, 1969, **311**, 61.
[17] L. F. Fieser and M. Fieser, 'Reagents for Organic Synthesis,' Wiley, New York, 1967, vol. 1, p. 1287.
[18] H. Strassman, *Chem. Ber.*, 1889, **22**, 1229.