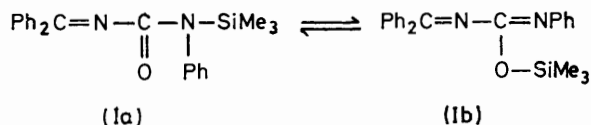


## Formation of Heterocyclic Compounds by Use of *N'*-Diphenylmethylene-*N*-phenyl-*N*-trimethylsilylurea

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The reactions of *N'*-diphenylmethylene-*N*-phenyl-*N*-trimethylsilylurea (I) with variety of acceptor molecules have been studied. Imidazolidinone, triazinone, and pyrimidinone derivatives were obtained *via* [4 + 1] or [4 + 2] cyclizations with cyclohexyl isocyanide, methyl isocyanate, dimethyl acetylenedicarboxylate, and trichloroacetonitrile, followed by desilylation with methanol. Dimethylcyanamide reacts with the urea (I) to give 3-diphenylmethylene-1,1-dimethyl-2-phenylguanidine (VIII) *via* the thermal decomposition of the intermediate 1,4-dihydro-2-dimethylamino-6-trimethylsilyloxy-1,4,4-triphenyl-1,3,5-triazine. Linear products of insertion into a silicon-nitrogen bond of the urea (I) are obtained, possibly *via* a common intermediate, in the reactions with diphenylketen and with chloral. 2,3-Dihydro-6-methyl-2,2-diphenyl-3-phenylcarbamoyl-1,3-oxazin-4-one is formed from diketene (4-methyleneoxetan-2-one).

1,3,5-TRIAZINEDIONE derivatives have been obtained in the reactions of *N*-trimethylsilyl- and *N*-trimethylstannyl-diphenylmethyleamine with two equivalents of isocyanate.<sup>1,2</sup> The reaction was shown to proceed in a stepwise fashion, *i.e.* with formation of a 1:1 insertion product (I) followed by reaction with another molecule of isocyanate. The insertion product (I) is considered to exist as an equilibrium of the urea (Ia) and the imidate (Ib), interconvertible through an intramolecular 1,3-migration of the trimethylsilyl group.<sup>1,3,4</sup>



A [4 + 1] or [4 + 2] cyclization reaction would be expected from the interaction of compound (I) with dienophiles, involving the C=N-C=N linkage of the

<sup>1</sup> I. Matsuda, K. Itoh, and Y. Ishii, *J.C.S. Perkin I*, 1972, 1678.

<sup>2</sup> H. Suzuki, K. Itoh, I. Matsuda, and Y. Ishii, *Bull. Chem. Soc. Japan*, 1974, **47**, 3131.

form (Ib). The present paper describes two types of reaction of compound (I) with various acceptor molecules to give heterocyclic compounds or linear insertion products, *via* a common intermediate.

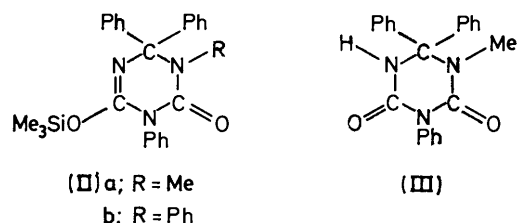
### RESULTS AND DISCUSSION

[4 + 2] Cyclizations.—The reaction of *N'*-diphenylmethylene-*N*-phenyl-*N*-trimethylsilylurea (I) with 1 equiv. of methyl isocyanate gave the triazinone (IIa) in 89% yield, identified on the basis of the elemental analysis and comparison of i.r. and n.m.r. spectra with those of the 3-phenyl analogue (IIb).<sup>1</sup> Methanolysis of the product (IIa) gave the triazinedione (III) identical with an authentic sample.<sup>2</sup>

Dimethyl acetylenedicarboxylate reacted with the urea (I) to give the pyrimidine (IVa) and its pyridone tautomer (IVb) in 35% yield. Methanolysis of the product gave the pyrimidinone (V) quantitatively. The interconversion between the tautomers (IVa) and (IVb)

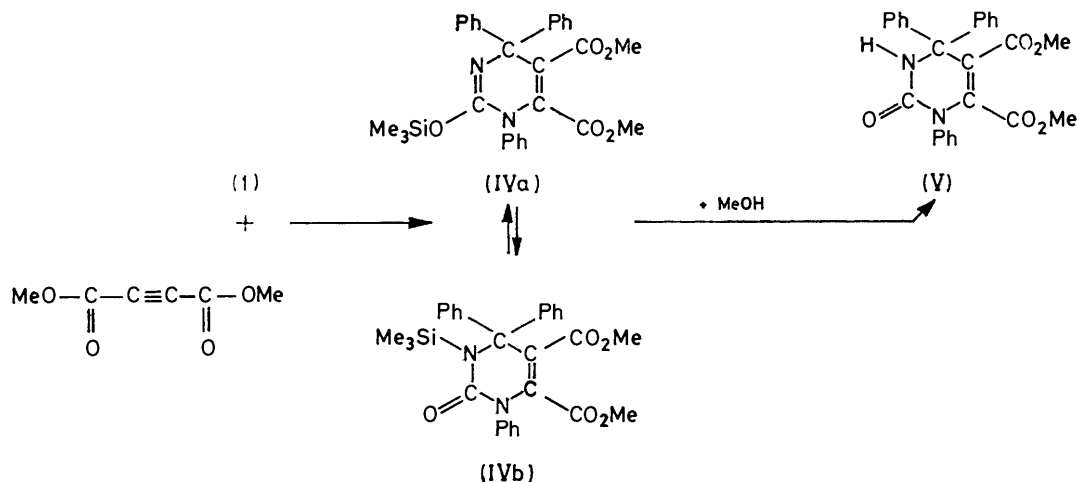
<sup>3</sup> J. Pump and E. G. Rochow, *Chem. Ber.*, 1964, **97**, 627.

<sup>4</sup> K. Itoh, M. Katsuda, and Y. Ishii, *J. Chem. Soc. (B)*, 1970, 302.

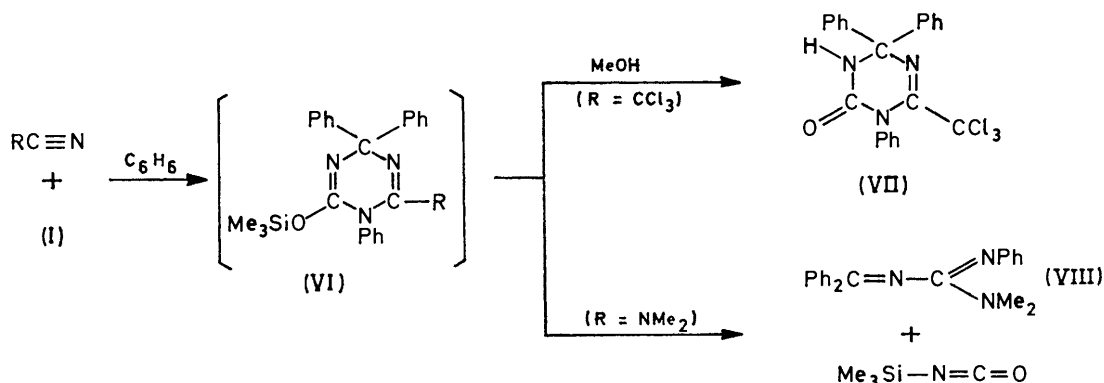


was observed by  $^1\text{H}$  n.m.r. spectroscopy at various temperatures. A set of three singlets at  $\tau$  10.02, 6.51,

electron-withdrawing substituent and the latter an electron-donating one. A high temperature and a long time (45 days at  $105^\circ\text{C}$ ) were necessary. No pure product was obtained in the reaction of trichloroacetonitrile, but methanolysis of the reaction mixture gave the triazinone (VII) in 7% yield, identified by analysis and i.r. ( $\nu_{\text{C=O}}$  1 679  $\text{cm}^{-1}$ ) and u.v. spectra (no absorption at *ca.* 250 nm, suggesting the absence of a  $\text{Ph}_2\text{C}=\text{N}-\text{C}=\text{N}$  linkage). The reaction of dimethylcyanamide (28 days) gave the guanidine (VIII) and trimethylsilyl isocyanate.



SCHEME 1

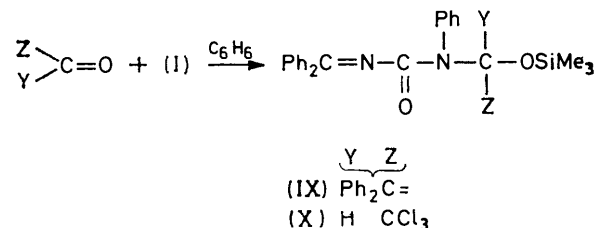


SCHEME 2

and 6.25 which appeared above room temperature are ascribed to the  $\text{SiMe}_3$  and the two  $\text{CO}_2\text{Me}$  groups respectively. However the spectrum at  $-30^\circ\text{C}$  showed two sets of three singlets, at  $\tau$  10.00, 6.55, and 6.24 and  $\tau$  10.13, 6.50, and 6.29 (intensity ratio 2 : 1). This can be explained in terms of an intramolecular 1,3-migration of the trimethylsilyl group, as reported for amides<sup>3,4</sup> and for ureas.<sup>5</sup>

A carbon-nitrogen triple bond is relatively unreactive in Diels-Alder reactions. However the reactions of the urea (I) with trichloroacetonitrile and with dimethylcyanamide, were investigated. The former has an

The former was identified by analysis ( $\text{C}_{22}\text{H}_{21}\text{N}_3, 0.5\text{-H}_2\text{O}$ ) and the n.m.r. spectrum [ $\tau$  7.05 (6 H, s,  $\text{NMe}_2$ ), 5.55br

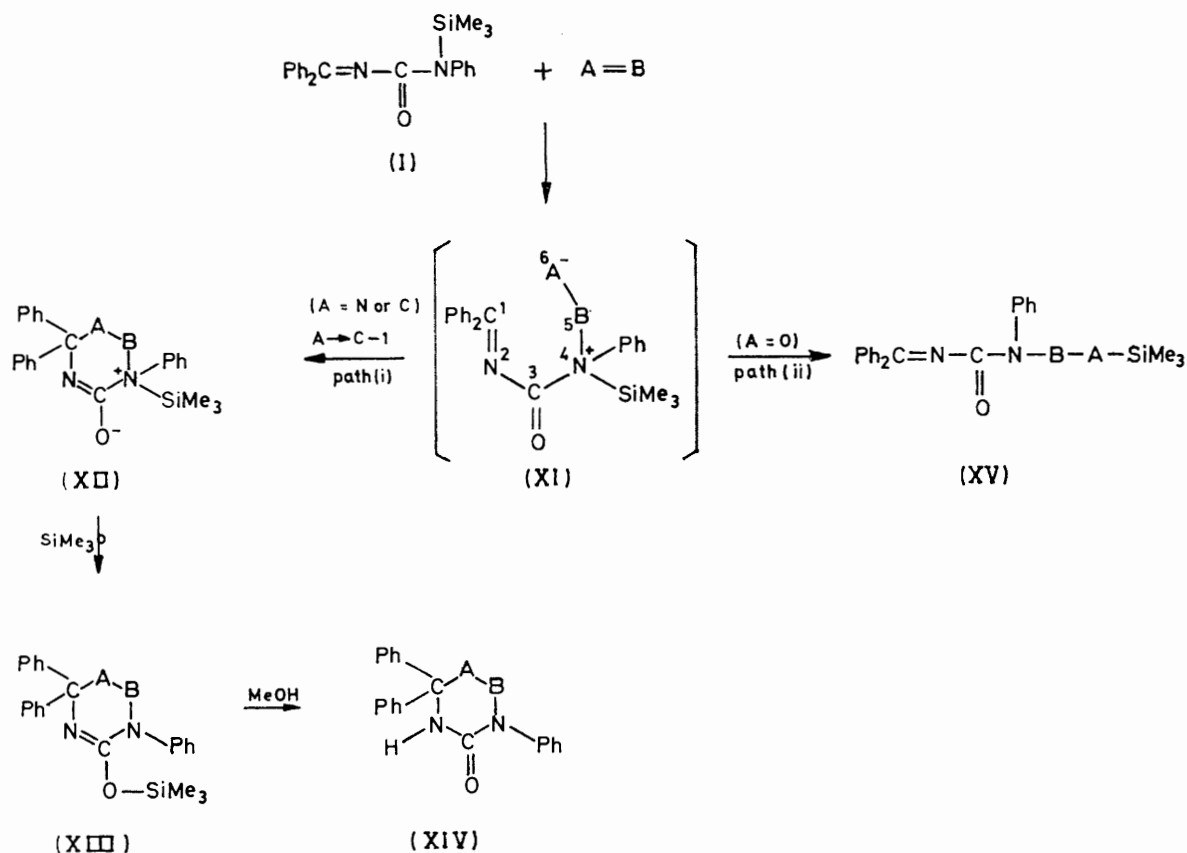


(1 H, s, OH), and 2.8–3.5 (15 H, 3 Ph)]. These reactions are explained in terms of the intermediate (VI) derived from [4 + 2] cyclization. The electron-donating di-

<sup>5</sup> I. Matsuda, K. Itoh, and Y. Ishii, *J. Chem. Soc. (C)*, 1969, 701.

methylamino-group lowers the stability of this intermediate, resulting in its decomposition in the latter case (Scheme 2).

C-1 in the intermediate (XI), followed by N  $\rightarrow$  O migration of the trimethylsilyl group [path (i)]. However migration of the trimethylsilyl group from N to the

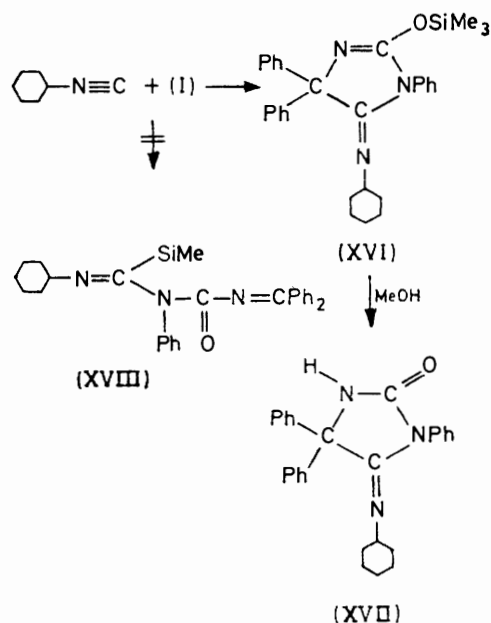


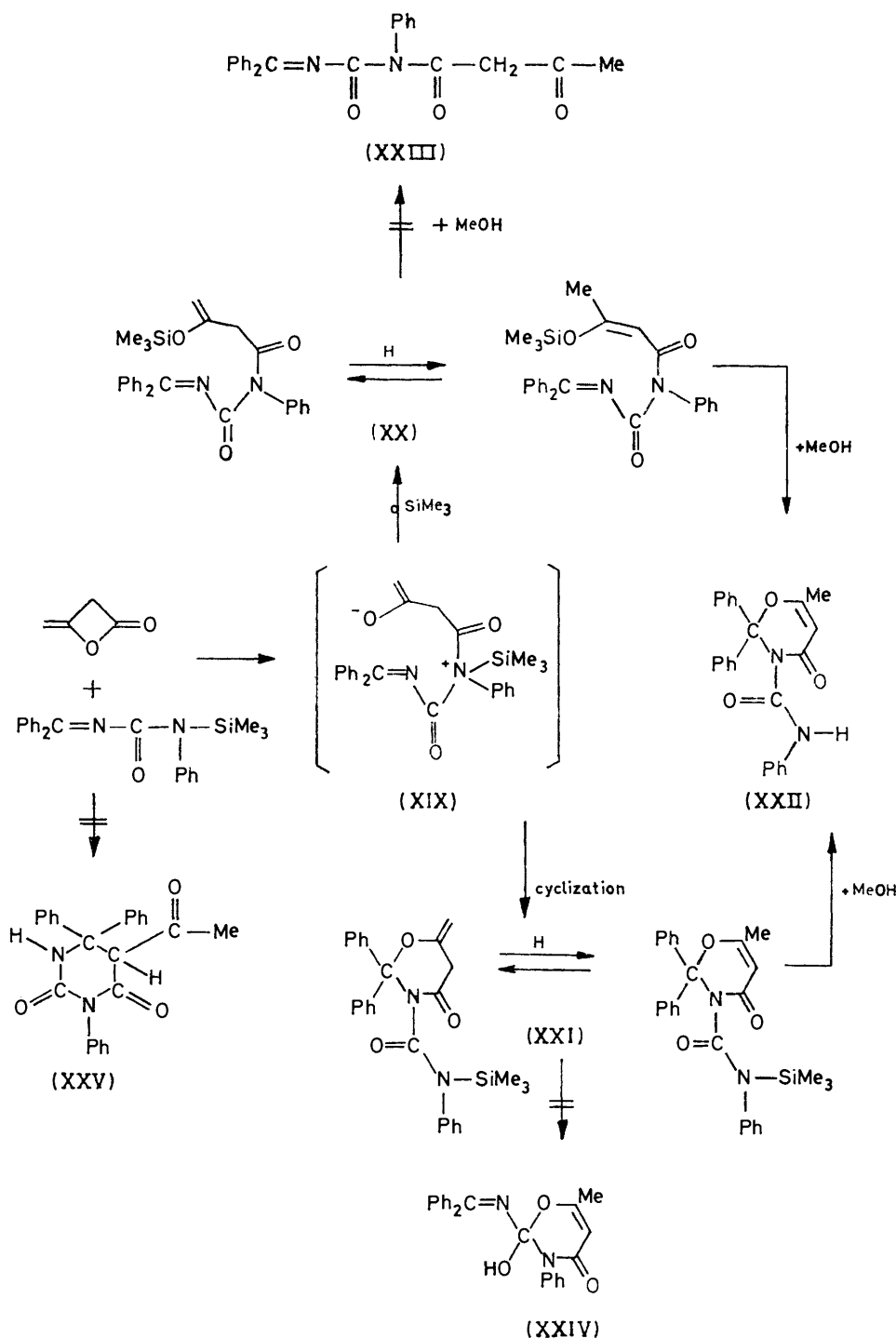
SCHEME 3

The reaction of the urea (I) with 1 equiv. of diphenylketen proceeded smoothly even at room temperature and the product (IX) was stable in moist air and to protic solvents. It was identified by analysis and i.r., n.m.r., and u.v. spectra [strong absorption due to  $\pi \rightarrow \pi^*$  transition at 258.5 nm ( $\log \epsilon$  4.66 in EtOH) characteristic of  $\text{Ph}_2\text{C}=\text{N}-\text{C}=\text{O}$ ].

Chloral also reacted with the urea (I) to give the linear adduct (X), identified by analysis and spectral data. The carbon-oxygen double bonds in diphenylketen and chloral and the carbon-carbon double bond in diphenylketen can undergo [4 + 2] cyclization; however, only linear insertion products were obtained in the foregoing reactions. Thus there are two different types of reaction with the urea (I), depending upon the character of the dienophile: (i) [4 + 2] cyclization, observed with methyl isocyanate, dimethyl acetylenedicarboxylate, and trichloroacetonitrile; and (ii) linear consecutive insertion, giving (IX) and (X), observed with diphenylketen and chloral (Scheme 3). Initial nucleophilic attack of the amino-nitrogen atom in (Ia) on a dienophile gives a zwitterionic intermediate (XI), and this is followed by the product-determining step. The heterocycle (XIII) is formed by the attack of the anionic terminal A<sup>-</sup> on

anionic terminal A<sup>-</sup> may be preferred to the attack of A<sup>-</sup> on C-1 when the terminal atom is oxygen (which has a





SCHEME 4

strong affinity for a silicon atom<sup>6</sup>), giving a linear insertion product (XV) [path (ii)]. Semiempirical SCF-LCAO MO calculations (CNDO/2) support such a stepwise product formation.<sup>7</sup>

[4 + 1] Cyclizations.—The reaction of the urea (I) with 1 equiv. of cyclohexyl isocyanide proceeded almost

<sup>6</sup> K. Itoh, T. Katsuura, I. Matsuda, and Y. Ishii, *J. Organometallic Chem.*, 1972, **34**, 63.

quantitatively to give the imidazoline (XVI), which afforded the imidazolidinone (XVII) upon methanolysis. Although a 1,1-insertion product (XVIII) might have been expected in view of Lappert's result,<sup>8</sup> it is excluded

<sup>7</sup> H. Suzuki, H. Kato, I. Matsuda, K. Itoh, and Y. Ishii, unpublished work.

<sup>8</sup> M. F. Lappert and B. Prokai, *Adv. Organometallic Chem.*, 1967, **5**, 225.

by the n.m.r. spectrum and by the absence of a  $\pi \rightarrow \pi^*$  transition (at *ca.* 250 nm;  $\text{Ph}_2\text{C}=\text{N}-\text{C}=\text{O}$ ) and the existence of an exchangeable amino-proton ( $\tau$  *ca.* 3.95;  $\nu_{\text{max}}$ . 3 280  $\text{cm}^{-1}$ ) in the methanolysis product (XVII). The formation of (XVI) can be explained in terms of a [4 + 1] cyclization following path (i) in Scheme 3.

*Reaction of the Urea (I) with Diketen.*—Treatment of the urea (I) with 1 equiv. of diketen (4-methyleneoxetan-2-one) gave a brownish oil which showed two trimethylsilyl groups ( $\tau$  9.92 and 9.91) in the n.m.r. spectrum. It resembled the product of the reaction of *N*-trimethylsilyl-(diphenylmethylene)amine with diketen, which gave three isomeric 1 : 1 adducts, each of which was desilylated to the same oxazinone.<sup>9</sup> Accordingly, the reaction mixture was desilylated with methanol directly, giving the oxazinone (XXII) in good yield, identified from analysis and spectral data. Of the three other possible structures (XXIII)—(XXV), the linear structure (XXIII) was excluded because of the absence of a  $\pi \rightarrow \pi^*$  transition ( $\text{Ph}_2\text{C}=\text{N}-\text{C}=\text{O}$ ) in the u.v. spectrum. The methyl protons in structure (XXV) should resonate at  $\tau$  *ca.* 8.0<sup>10</sup> rather than at  $\tau$  8.37 as observed. An olefinic proton signal at  $\tau$  5.17 also excludes structure (XXV). Structure (XXIV) is excluded by the absence of O-H and C=N stretching vibrations in the i.r. spectrum; in fact N-H and C=O stretching bands were observed, at 3 230 and at 1 734 and 1 673  $\text{cm}^{-1}$ , respectively. The first step of the reaction is presumably nucleophilic attack of the amino-nitrogen atom in (I) on the carbonyl atom to form a zwitterionic intermediate (XIX). This may be followed either by the formation of (XX), as a result of N  $\rightarrow$  O migration of the trimethylsilyl group, or by direct cyclization to (XXI); the product (XXII) would be formed by desilylation of either precursor as shown in Scheme 4. In this reaction compound (I) plays the role of a dienophile in a different type of [4 + 2] cyclization from those recorded above. The reaction of 6-methyl-2,2-diphenyl-1,3-oxazin-4-one<sup>9</sup> with phenyl isocyanate did not give the oxazinone (XXII), which means that the presence of a trimethylsilyl group is necessary for the synthesis of (XXII).

#### EXPERIMENTAL

M.p.s were determined for samples in sealed tubes filled with argon. I.r. spectra were recorded with a JASCO IR-403G and IR-S instruments. A JEOL C-60 HL instrument was utilized to record <sup>1</sup>H n.m.r. spectra, with tetramethylsilane as internal standard. Mass spectra were obtained with a JEOL JMS-01SG spectrometer at an ionizing voltage of 75 eV. A Hitachi 124 spectrophotometer was used for the measurement of u.v. spectra. *N*-Trimethylsilyl(diphenylmethylene)amine,<sup>1</sup> *N'*-diphenylmethylene-*N*-phenyl-*N*-trimethylsilylurea,<sup>1</sup> diphenylketen,<sup>11</sup> and cyclohexyl isocyanide<sup>12</sup> were prepared according to the literature. All reactions were carried out in an atmosphere of argon.

*Reactions of the Urea (I) with One Equivalent of Acceptor.*—

<sup>9</sup> H. Suzuki, I. Matsuda, K. Itoh, and Y. Ishii, *Bull. Chem. Soc. Japan*, 1974, **47**, 2736.

<sup>10</sup> H. Toda, *Yakugaku Zasshi*, 1967, **87**, 1351.

(a) *Methyl isocyanate.* A mixture of the urea (I) (2.15 g, 5.77 mmol), methyl isocyanate (0.336 g, 5.89 mmol), and benzene (3 ml) was heated for 6 days at 90–95 °C in a sealed tube. The yellow oily product obtained by evaporation of volatile materials was recrystallized from benzene-*n*-hexane (1 : 7) to give white needles of 3,4-dihydro-3-methyl-1,4,4-triphenyl-6-trimethylsilyloxy-1,3,5-triazin-2(1H)-one (IIa) (89%), m.p. 131–132 °C (Found: C, 70.1; H, 6.3.  $\text{C}_{25}\text{H}_{27}\text{N}_3\text{O}_2\text{Si}$  requires C, 69.9; H, 6.3%),  $\nu_{\text{max}}$ . ( $\text{CCl}_4$ ) 1 698s (C:O) and 1 668s  $\text{cm}^{-1}$  (C:N),  $\tau$  ( $\text{CDCl}_3$ ) 9.88 (9 H, s,  $\text{SiMe}_3$ ), 7.32 (3 H, s, NMe), and 2.7–3.1 (15 H, m, 3 Ph). Desilylation with an excess of methanol gave 3-methyl-1,4,4-triphenylperhydro-1,3,5-triazine-2,6-dione (III) quantitatively. White prisms were obtained by recrystallization from benzene-*n*-hexane (2 : 1) in 69% yield; m.p. 265–266 °C (Found: C, 73.8; H, 5.1; N, 11.7.  $\text{C}_{22}\text{H}_{19}\text{N}_3\text{O}_2$  requires C, 73.9; H, 5.4; N, 11.8%),  $\nu_{\text{max}}$ . (KBr) 1 730s and 1 658s  $\text{cm}^{-1}$  (C:O),  $\tau$  ( $\text{CDCl}_3$ ) 7.26 (3 H, s, NMe), 3.01br (1 H, s, NH), and 2.7–3.1 (15 H, m, 3 Ph).

(b) *Dimethyl acetylenedicarboxylate.* A mixture of the urea (I) (2.25 g, 6.05 mmol), dimethyl acetylenedicarboxylate (0.835 g, 5.88 mmol), and benzene (3 ml) was heated for 22 days at 90–95 °C in a sealed tube. The oily residue obtained by evaporation was recrystallized from benzene-*n*-hexane (1 : 8) to give the pyrimidine diester (IV) as a brownish-yellow powder (0.74 g, 35%), m.p. 148–149.5 °C (Found: C, 67.9; H, 5.8; N, 5.6. Calc. for  $\text{C}_{20}\text{H}_{30}\text{N}_2\text{O}_5\text{Si}$ : C, 67.7; H, 5.9; N, 5.4%),  $\nu_{\text{max}}$ . (KBr) 1 735s and 1 680s  $\text{cm}^{-1}$  (C:O),  $\tau$  ( $\text{CDCl}_3$ ) 10.02br (9 H, s,  $\text{SiMe}_3$ ), 6.51 (3 H, s, OMe), 6.25 (3 H, s, OMe), and 2.5–3.0 (15 H, m, 3 Ph).

Desilylation with an excess of methanol (3 ml) at room temperature gave dimethyl 1,2,3,6-tetrahydro-2-oxo-3,6,6-triphenylpyrimidine-4,5-dicarboxylate (V) as a white powder (89%), m.p. 239–240 °C [benzene-*n*-hexane (3 : 1)] (Found: C, 70.8; H, 5.2; N, 6.3.  $\text{C}_{26}\text{H}_{22}\text{N}_2\text{O}_5$  requires C, 70.6; H, 5.0; N, 6.3%),  $\nu_{\text{max}}$ . (KBr) 1 750s, 1 722s, and 1 690s  $\text{cm}^{-1}$  (C:O) *m/e* 442 ( $M^+$ , 15%), 411 ( $M - \text{MeO}$ , 4), 398 ( $M - \text{H} - \text{HN}=\text{C}=\text{O}$ , 9), 383 ( $M - \text{CO}_2\text{Me}$ , 35), 366 ( $M - \text{Ph} + \text{H}$ , 27), 365 ( $M - \text{Ph}$ , 100), and 340 ( $M - \text{CO}_2\text{Me} - \text{HNCO}$ , 9),  $\tau$  ( $\text{CDCl}_3$ ) 6.62 (3 H, s, OMe), 6.57 (3 H, s, OMe), 3.88br (1 H, s, NH), and 2.5–3.1 (15 H, m, 3 Ph).

(c) *Trichloroacetonitrile.* A mixture of the urea (I) (2.17 g, 5.82 mmol), trichloroacetonitrile (1.34 g, 9.25 mmol), and benzene (3 ml) was heated for 45 days at 100–110 °C in a sealed tube. Volatile materials were evaporated off under reduced pressure and the resulting oil, which was difficult to purify, was desilylated directly with an excess of methanol (5 ml). Evaporation, washing the residue with ether, and recrystallization from benzene-*n*-hexane (2 : 1) gave 3,4-dihydro-1,4,4-triphenyl-6-trichloromethyl-1,3,5-triazin-2(1H)-one as a yellow powder (VII) (4%), m.p. 220–221.5 °C (Found: C, 59.4; H, 3.7; N, 9.4.  $\text{C}_{22}\text{H}_{16}\text{Cl}_3\text{N}_3\text{O}$  requires C, 59.4; H, 3.6; N, 9.5%),  $\nu_{\text{max}}$ . (KBr) 1 679s (C:O) and 1 640sh  $\text{cm}^{-1}$  (C:N),  $\tau$  ( $\text{CDCl}_3$ ) 2.7–3.2 (15 H, m, 3 Ph) and 1.82br (1 H, s, NH).

(d) *Dimethylcyanamide.* A mixture of the urea (I) (2.05 g, 5.53 mmol), dimethylcyanamide (0.38 g, 5.38 mmol), and benzene (3 ml) was heated for 28 days at 100–110 °C in a sealed tube. Volatile materials were then evaporated

<sup>11</sup> E. C. Taylor, A. McKillop, and G. H. Hawks, *Org. Synth.*, 1972, **52**, 36.

<sup>12</sup> I. Ugi, R. Meyr, M. Lipinski, F. Bodesheim, and F. Rosen-dahl, *Org. Synth.*, Coll. vol. V, 1973, p. 300.

off under reduced pressure. Trimethylsilyl isocyanate was detected in the volatile fraction by its i.r. ( $\nu_{\text{N}=\text{O}}=0$ , 2 260  $\text{cm}^{-1}$ ) and  $^1\text{H}$  n.m.r. spectra [ $\tau$  9.74 ( $\text{SiMe}_3$ )]. Recrystallization of the yellow oily residue gave white prisms of hydrated 3-diphenylmethylene-1,1-dimethyl-2-phenylguanidine (VIII), m.p. 76.5–78 °C [from ethanol–n-hexane (4 : 1)] (72%) (Found: C, 78.4; H, 6.7; N, 12.5.  $\text{C}_{22}\text{H}_{21}\text{N}_3 \cdot 0.5\text{H}_2\text{O}$  requires C, 78.5; H, 6.6; N, 12.5%),  $\nu_{\text{max}}$  (KBr) 1 613m and 1 570  $\text{cm}^{-1}$  (C:N),  $\tau$  7.05 (6 H, s,  $\text{NM}_2$ ), 5.55br (1 H, s, OH), and 2.7–3.4 (15 H, m, 3 Ph). Picric acid (0.044 g, 0.19 mmol) was added to an ethanolic solution (4 ml) of the hydrated guanidine (VIII) (0.064 g, 0.19 mmol). The mixture was heated for 10 h under reflux. Evaporation, and recrystallization of the residue from ethanol–n-hexane (3 : 1) gave yellow prisms of the *picrate* (0.057 g, 60%), m.p. 263–265.5 °C (Found: C, 60.5; H, 4.1; N, 15.1.  $\text{C}_{22}\text{H}_{21}\text{N}_3 \cdot \text{C}_6\text{H}_3\text{N}_3\text{O}_7$  requires C, 60.4; H, 4.4; N, 15.1%),  $\nu_{\text{max}}$  (KBr) 1 660s and 1 630m  $\text{cm}^{-1}$  (C:N).

(e) *Diphenylketen*. When diphenylketen (0.35 g, 1.82 mmol) was added dropwise to a solution of the urea (I) (0.74 g, 2.0 mmol) at room temperature, an exothermic reaction ensued with change of colour from pale yellow to orange. The mixture was stirred for 1 h at room temperature and evaporated to leave a yellowish orange residue. This was recrystallized twice from benzene–n-hexane (1 : 5) to give *N'*-diphenylmethylene-*N*-(2,2-diphenyl-1-trimethylsilyloxyvinyl)-*N*-phenylurea (IX) as a white powder (0.66 g, 70%), m.p. 152–153.5 °C (Found: C, 78.7; H, 5.9; N, 4.9.  $\text{C}_{37}\text{H}_{34}\text{N}_2\text{O}_2\text{Si}$  requires C, 78.4; H, 6.1; N, 4.9%),  $\nu_{\text{max}}$  (KBr) 1 656s (C:O) and 1 631s  $\text{cm}^{-1}$  (C:N),  $\lambda_{\text{max}}$  (EtOH) 258.5 nm ( $\log \epsilon$  4.66)  $\tau$  9.99 (9 H, s,  $\text{SiMe}_3$ ) and 2.6–3.5 (25 H, m, 5 Ph).

(f) *Chloral*. A mixture of the urea (I) (2.57 g, 6.94 mmol), chloral (1.02 g, 6.90 mmol), and benzene (5 ml) was heated for 13 days at 110 °C in a sealed tube. Evaporation, followed by recrystallization from cyclohexane, gave *N'*-diphenylmethylene-*N*-phenyl-*N*-(2,2,2-trichloro-1-trimethylsilyloxyethyl)urea (X) (solvated) as a white powder (76%), m.p. 81.5–84 °C (Found: C, 59.7; H, 5.8; N, 5.0.  $\text{C}_{25}\text{H}_{25}$ -

$\text{Cl}_3\text{N}_2\text{O}_2\text{Si} \cdot 0.5\text{C}_6\text{H}_{12}$  requires C, 59.9; H, 5.6; N, 5.1%),  $\nu_{\text{max}}$  (KBr) 1 667s (C:O) and 1 637m  $\text{cm}^{-1}$  (C:N),  $\lambda_{\text{max}}$  (EtOH) 255.8 nm ( $\log \epsilon$  4.01),  $\tau$  9.77 (9 H, s,  $\text{SiMe}_3$ ), 8.59 (6 H, s, 3  $\text{CH}_2$ ), 3.38 (1 H, s, CH), and 2.6–2.8 (15 H, m, 3 Ph).

(g) *Cyclohexyl isocyanide*. A mixture of the urea (I) (1.02 g, 2.75 mmol), cyclohexyl isocyanide (0.36 g, 3.0 mmol), and benzene (3 ml) was heated for 16 days at 100–110 °C in a sealed tube. Benzene was evaporated off to leave the imidazoline (XVI) (1.32 g, 96%),  $\nu_{\text{max}}$  ( $\text{CCl}_4$ ) 1 730m (C:O) and 1 678s and 1 653s  $\text{cm}^{-1}$  (C:N),  $\tau$  9.78 (9 H, s,  $\text{SiMe}_3$ ), 8.0–9.4 (11 H, m, cyclohexyl), and 2.3–3.0 (15 H, m, 3 Ph). Desilylation with an excess of methanol and recrystallization from benzene–n-hexane (2 : 1) gave 4-cyclohexylimino-3,5,5-triphenylimidazolidin-2-one (XVII) (30%) (Found: C, 79.4; H, 6.6; N, 10.3.  $\text{C}_{27}\text{H}_{27}\text{N}_3\text{O}$  requires C, 79.2; H, 6.7; N, 10.3%), m.p. 165–166 °C,  $\nu_{\text{max}}$  (KBr) 1 720w (C:O) and 1 665s and 1 655sh  $\text{cm}^{-1}$  (C:N),  $\tau$  7.5–8.9 (11 H, m, cyclohexyl), 4.91br (1 H, s, NH), and 2.8–3.2 (15 H, m, 3 Ph), *m/e* 409 ( $M^+$ , 10%), 408 ( $M - \text{H}$ , 20), 327 ( $M - \text{cyclohexyl} + \text{H}$ , 100), 326 ( $M - \text{cyclohexyl}$ , 70), and 182 ( $\text{Ph}_2\text{C}=\text{NH}_2^+$ , 50).

(h) *Diketen*. A mixture of the urea (I) (1.59 g, 4.28 mmol), diketen (0.38 g, 4.54 mmol), and benzene (3 ml) was heated for 3 days at 120–130 °C in a sealed tube, then evaporated under reduced pressure; the residue showed trimethylsilyl proton resonances at  $\tau$  9.92 and 9.91, suggesting a mixture of isomers. The residue was desilylated with an excess of methanol (5 ml); recrystallisation of the product from ethanol gave 2,3-dihydro-6-methyl-2,2-diphenyl-3-phenyl-carbamoyl-1,3-oxazin-4-one (XXII) as yellow needles (0.85 g, 57%), m.p. 271–273 °C (Found: C, 74.9; H, 5.4; N, 7.1.  $\text{C}_{24}\text{H}_{20}\text{N}_2\text{O}_3$  requires C, 75.0; H, 5.2; N, 7.3%),  $\nu_{\text{max}}$  (KBr) 1 734s and 1 673s  $\text{cm}^{-1}$  (C:O),  $\tau$  8.37 (3 H, s, CMe), 8.29br (1 H, s, NH), 5.17br (1 H, s, CH), and 2.6–3.2 (15 H, m, 3 Ph), *m/e* 384 ( $M^+$ , 17%), 265 ( $M - \text{PhNCO}$ , 22), 249 ( $M - \text{PhNCO} - \text{Me} - \text{H}$ , 28), 207 ( $M - \text{PhNCO} - \text{Me} - \text{H} - \text{NCO}$ , 49), and 180 ( $\text{Ph}_2\text{C}=\text{N}^+$ , 100).

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