Aust. J. Chem., 1975, **28**, 133–41

Pyrazolidine-3,5-diones with Heterocyclic Substituents. II* Acylation of 5-Hydrazino-3-phenyl-1*H*-1,2,4-triazoles

Maneerat Woodruff and John B. Polya

Department of Chemistry, University of Tasmania,
P.O. Box 252C, Hobart, Tas. 7001.

Abstract

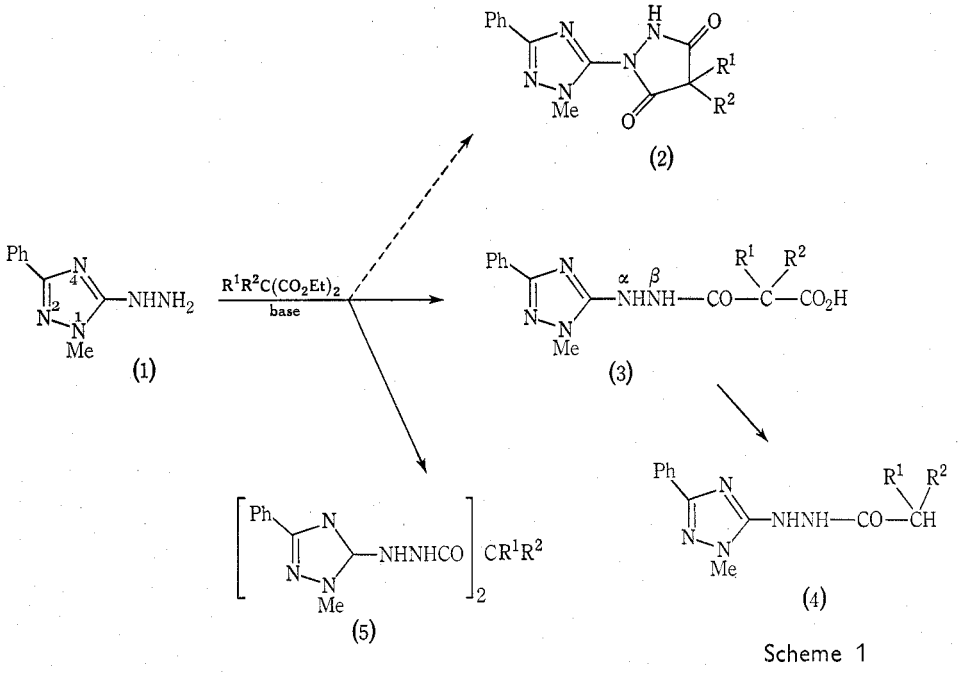
Basic condensation of 5-hydrazino-1-methyl-3-phenyl-1*H*-1,2,4-triazole with diethyl malonates gives *β*-hydrazides of malonic acids, their decarboxylated products and dihydrazides as the main products in low yields; diethyl monophenylmalonate and diethylmalonate also afford the expected pyrazolidinediones in poor yield. The corresponding *β*-benzoyl derivative resists pyrazolidinedione formation. N^1-Benzoyl derivatives of hydrazinotriazoles transacylated to the more basic hydrazine nitrogen. The 4-phenylamino derivative of 6,6-diethyl-2-phenyl-*s*-triazolo[1,5-*a*]pyrimidine-5,7(4*H*,6*H*)-dione rearranges to the corresponding pyrazolidinedione but the analogous 4-benzoylamino compound is demalonylated under the same conditions. Catalytic hydrogenation of the 4-(2′-propylideneimino) analogue fails and attempted reduction by sodium borohydride cleaves the pyrimidine ring.

Condensation of hydrazinotriazoles with substituted malonic esters or malonyl halides to triazolylpyrazolidinediones, triazolopyrimidines and related by-products[1] implies competition for two acyl groups between the two nucleophilic centres of the hydrazine group and three such centres of the nuclear tautomers of triazole. If all the possible rival reactions occurred at comparable rates, the separation of 30 or more compounds of similar molecular weights in two or three functional subclasses would present great difficulties. Fortunately, only few products are obtained and then in fair to good yields; this encourages one to probe the nature of selective features that simplify the course of the reactions under study.

Paradoxically, *N*-substitution of the 1,2,4-triazole nucleus, which restricts malonylation to the hydrazine NH groups, increases the complexity of the reaction mixture and depresses yields. When 5-hydrazino-1-methyl-3-phenyl-1*H*-1,2,4-triazole (1)[2] is made to react with a range of diethyl malonates in the presence of base, only diethylmalonate and monophenylmalonate afford pyrazolidine-3,5-dione (2) as a minor product occurring in low yield (Scheme 1). In general the *β*-hydrazide malonic acids (3), their decarboxylated derivatives (4) and dihydrazides (5) are obtained. Monoalkyl (including cyclohexyl and benzyl) malonates afford only (3), monophenylmalonate forms (4) as the main product; dialkyl and methylphenyl malonates gave (5), accompanied by a little (3), (4) or (2), the last two in one instance each.

* Part I, *Aust. J. Chem.*, 1974, **27**, 2447.

[1] Woodruff, M., and Polya, J. B., *Aust. J. Chem.*, 1974, **27**, 2447.
[2] Gehlen, H., and Segeletz, H., *Z. Chem.*, 1968, **8**, 271; *J. Prakt. Chem.*, 1971, **313**, 294.



Scheme 1

Table 1. Products of condensation of 5-hydrazino-1-methyl-3-phenyl-1*H*-1,2,4-triazole with diethyl esters of malonic acid in presence of base

The use of *italics* for melting points indicates melting with vigorous decomposition and evolution of gas

R^1	R^2	Crude yield (%)	M.P. (°C)	Molecular formula	Found (%) C	H	N	Required (%) C	H	N
				Diones (2)						
H	Ph	12	233–235[A]	$C_{18}H_{15}N_5O_2,0{\cdot}25H_2O$	64·0	4·4	20·5	64·0	4·6	20·7
Et	Et	8	94–100[B]	$C_{16}H_{19}N_5O_2,H_2O$	58·0	6·1	21·4	58·0	6·3	21·2
				Acids (3)						
H	Et	53	*189–190*[C]	$C_{14}H_{17}N_5O_3$	55·6	5·9	23·4	55·4	5·6	23·1
H	Et[F]	90	217–219	$C_{14}H_{16}N_5NaO_3$	51·4	5·1	22·0	51·7	4·9	21·5
H	Pr	35	*181–184*[C]	$C_{15}H_{19}N_5O_3$	56·4	5·8	22·3	56·8	6·0	22·1
H	Bu	60	*180–182*[C]	$C_{16}H_{21}N_5O_3$	58·0	6·2	21·4	58·0	6·3	21·2
H	n-C_5H_{11}	67	*186–187*[C]	$C_{17}H_{23}N_5O_3$	58·9	7·0	20·2	59·1	6·7	20·3
H	c-C_6H_{11}	64	*207–208*[D]	$C_{18}H_{23}N_5O_3$	60·6	6·6	19·5	60·5	6·4	19·6
H	$PhCH_2$	58	*200–201*[C]	$C_{19}H_{19}N_5O_3$	62·5	5·4	19·3	62·5	5·2	19·2
H	$PhCH_2$[G]	95	192–194	$C_{19}H_{18}N_5NaO_3$	58·9	4·4	17·5	58·9	4·7	18·1
Me	Me	7	*184–185*[A]	$C_{14}H_{17}N_5O_3$	55·7	5·7	23·1	55·4	5·6	23·1
Me	Bu	11	*160–161*[A]	$C_{17}H_{23}N_5O_3$	58·9	6·4	19·9	59·1	6·7	20·3
Bu	Bu	7	*163–165*[A]	$C_{20}H_{29}N_5O_3$	62·4	8·1	17·8	62·0	7·5	18·1
Me	$PhCH_2$	6	*163–164*[A]	$C_{20}H_{21}N_5O_3$	63·4	5·4	18·4	63·3	5·5	18·5
				Hydrazides (4)						
H	Ph	36	228–230[B]	$C_{17}H_{17}N_5O$	66·3	5·6	22·9	66·5	5·5	22·8
Me	Ph	9	177–179[E]	$C_{18}H_{19}N_5O$	67·2	6·0	22·0	67·3	5·9	21·8
				Hydrazides (5)						
Me	Me	32	150–155[E]	$C_{23}H_{26}N_{10}O_2,0{\cdot}5H_2O$	57·5	5·4	28·7	57·1	5·6	29·0
Et	Et	24	247–249[E]	$C_{25}H_{30}N_{10}O_2$	59·9	6·0	27·9	59·8	6·0	27·9
Me	Bu	19	218–221[E]	$C_{27}H_{32}N_{10}O_2,0{\cdot}5H_2O$	59·7	6·2	26·6	60·3	6·1	26·1
Me	$PhCH_2$	42	149–151[E]	$C_{29}H_{30}N_{10}O_2,0{\cdot}5H_2O$	61·6	5·5	24·9	61·3	5·6	24·7

[A] From ethanol–ether. [B] Not recrystallized. [C] From ethanol. [D] From methanol. [E] From chloroform–ether. [F] Monosodium salt. Found Na, 22·4. Required Na, 21·9%. [G] Monosodium salt. Found Na, 18·1. Required Na, 18·4%.

The yields, even those of the main products, are low in every case. Reaction times extended from 6 to 22 h do not affect results.

Table 1 lists yields and analytical characteristics of malonylated derivatives of (1). Some of the structures require evidence beyond synthesis and elementary analyses.

The structure of (2; $R^1 = R^2 = Et$) obtained as a monohydrate (after drying over P_2O_5), hence isomeric with the corresponding (3), follows from its n.m.r. spectrum that lacks evidence for acidic protons characteristic of (3) but has a signal at δ 5·7 ($CDCl_3$, 20°) integrated for 2H and exchanged with D_2O.

Compounds (3) are soluble in sodium bicarbonate with evolution of carbon dioxide and melt with vigorous decomposition. Their infrared spectra include features in the region 2800–1800 cm^{-1} associated with very strong hydrogen bonding,[3–6] and not seen when either the triazole nucleus is replaced by phenyl[1] or when the monosodium salts are studied. Imide–imine interaction between triazole nuclei can be disregarded in this case since (3) lacks the triazole NH required for such an effect. Absence of such bands in phenyl analogues of (3)[1] shows that the hydrazine NH groups do not act as basic centres, hence the methylated nitrogen of triazole and the carboxylic acid must be regarded as the basic and acidic centres respectively.

The β-hydrazide structure of (4) and (5) follows from the spectroscopic distinction between –NHNH– and $-NH_2$.[1]

Disinclination of (3), or of its possible ester precursor, to cyclize to (2) appears greater than in analogous cases involving phenyl or unmethylated triazole. In the latter case the triazolate anion should increase the nucleophilic character of the α-NH. Alternatively steric hindrance (admittedly on one side only) presented by the triazole *N*-methyl to acylation of the α-NH may contribute to the difficulty of cyclization.

Monosubstituted malonates in a basic medium form carbanions that reduce the polarity of adjoining C=O bonds and thus lessen nucleophilic attack on the latter. Dispersal of the negative charge through phenyl reverses this tendency and enhances the formation of (2) but at the same time decarboxylation to (4) is also enhanced. Slight inductive deactivation of the carbonyl groups in dialkyl malonates allows some acylation, but only the more basic β-NH_2 reacts to afford (5); decarboxylation is inhibited, of course. Such electronic arguments do not fully account for the behaviour of diethyl diethylmalonate which forms a small amount of (2) while other dialkylmalonates with both greater and smaller inductive effects give (3) as the observable minor product.

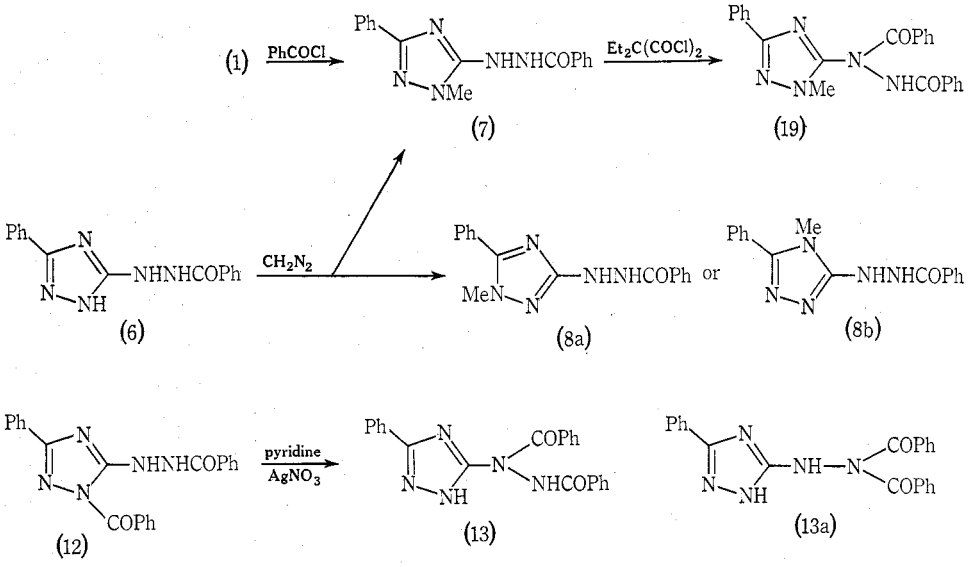
It was hoped to extend these experiments to N^2-methylated and N^4-methylated analogues of (1): in either case electronic effects should be similar to those exerted by the triazole moiety of (1) but N^2-methylation would avoid steric effects associated with N^1- and N^4-methylation.

Action of diazomethane on 5-benzoylhydrazino-3-phenyl-1*H*-1,2,4-triazole (6)* affords the N^1-methyl compound (7) and one other product (8) (Scheme 2). The

* This compound, and its analogues, are here named in conformity with other compounds in the reaction sequence. The correct name for (6) under IUPAC rules is *N'*-(3-phenyl-1*H*-1,2,4-triazol-5-yl)benzohydrazide.

[3] Browne, E. J., and Polya, J. B., *J. Chem. Soc. C*, 1968, 824; 1969, 1056.
[4] Hadzi, D., Klofutar, C., and Oblak, S., *J. Chem. Soc. A*, 1968, 905.
[5] Claydon, M. F., and Sheppard, N., *Chem. Commun.*, 1969, 1431.
[6] Hadzi, D., *Chimia*, 1972, **26**, 7.

structure of (7) follows from its synthesis by benzoylation of (1). A further synthesis by alkaline cyclization of 1,5-dibenzoyl-2-methyldiaminoguanidine does not yield (4) but its isomer 5-(1′-methyl-2′-benzoylhydrazino)-3-phenyl-1*H*-1,2,4-triazole,[2] not



Scheme 2

identical with (8), which lacks the triazole NH present in the former. For the same reason, methylation on the hydrazino β-nitrogen can be excluded. The parent compound (6) has three n.m.r. signals ($(CD_3)_2SO$, 20°) for the two hydrazine NH groups: δ 10·86 (1H), 9·36 (2/3H) and 8·51 (1/3H). Corresponding signals for (7) are δ 11·03 (1H) and 9·23 (1H), for (8) 10·71 (1H) and 8·51 (1H). In either case the most acidic signal is preserved and may be assigned to the β-NH, which cannot interact with the triazole nucleus and thus should not be affected much by nuclear methylation. On the other hand the α-NH may be subject to amidine prototropy, e.g.

$$N^4\text{–}C(=N^1)\text{–}NH^\alpha \rightleftharpoons N^4\text{–}CNH^1\text{=}N^\alpha$$

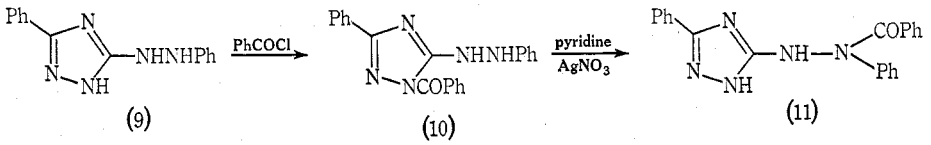
possible in cases (8a) and (8b) or

$$N^4\text{=}C(\text{–}N^1)\text{–}NH^\alpha \rightleftharpoons NH^4\text{–}C(\text{–}N^1)\text{=}N^\alpha$$

possible in case (7). Both prototropic equilibria are possible in (6), but N^1-methylation excludes the former equilibrium, to which the signal δ 8·51 is then ascribed. Structures (8a) and (8b) both exclude the second equilibrium, to which the signal at δ 9·23–9·36 is related. The argument does not distinguish between (8a) and (8b) but provides a structural diagnostic in other cases. If one may compare (7), (8a) and (8b) with 1-methyl-3-phenyl-, 1-methyl-5-phenyl- and 4-methyl-5-phenyl-1*H*-1,2,4-triazoles respectively, (8) may be identified tentatively as (8a) since its ultraviolet spectrum is closely similar to that of (7) as are those of the corresponding methylphenyltriazoles,[7] while the remaining methylphenyltriazole corresponding to (8b) absorbs about 30 nm further towards the red and has a much lower extinction coefficient than the other two.

[7] Atkinson, M. R., Parkes, E. A., and Polya, J. B., *J. Chem. Soc.*, 1954, 4256.

As this assignment lacks final certainty and (8) could not be prepared in more than analytical quantities, extension of studies on (1) to isomers that could be obtained by the hydrolysis of (8a) and (8b) cannot be carried out at present.



(9) (10) (11)

Scheme 3

The lability of *N*-acyl triazoles and its theoretical reasons are known.[8–12] Having shown the advantages of unsubstituted over *N*-methylated triazole for the preparation of triazolyl-pyrazolidinediones, two other examples may be considered. Benzoylation of 3-phenyl-5-phenylhydrazino-1*H*-1,2,4-triazole (9) affords (Scheme 3) the N^1-benzoyl derivative (10) which rearranges to the β-benzoyl isomer (11) on heating with silver nitrate in pyridine. The same sequence of reactions converts (6) into (12),[1] which is similarly rearranged to the α,β-dibenzoyl derivative (13).

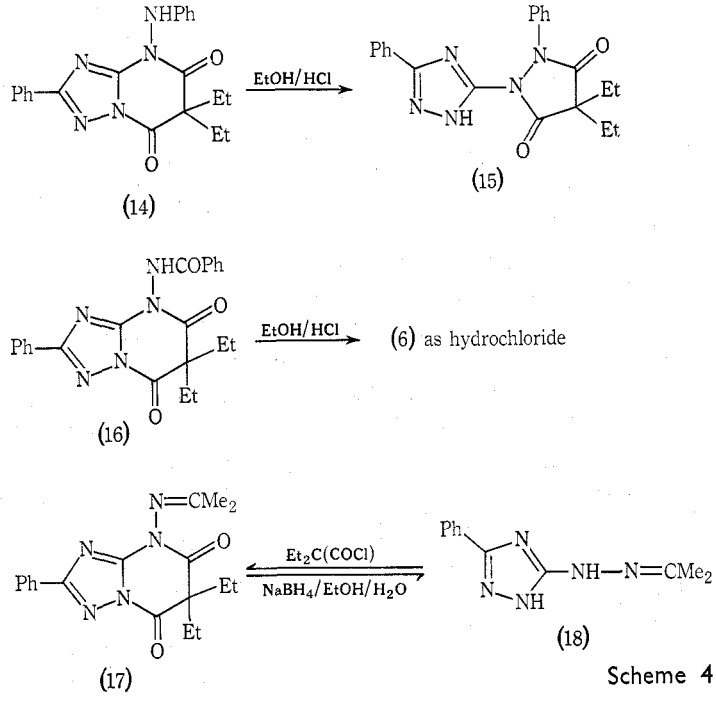
The structure of (11) can be distinguished from the α-benzoyl isomer by n.m.r. spectroscopy (in $(CD_3)_2SO$, 20°). Acidic signals absent in (10) appear and include those due to triazole NH (δ 13·4, 3/7H and 13·93 4/7H); thus the benzoyl has migrated to the hydrazine. Benzoylation of the α-NH group would give rise to a single acidic β-NH signal, instead of which two signals are observed (δ 9·78, 4/7H and 10·48, 3/7H), indicating that the α-NH is free to be involved in tautomeric equilibria with the neighbouring triazole nucleus. The aromatic protons of (11) appear as two sets of multiplets at δ 8·18 (2H) and 7·68 (13H). This pattern is similar to that found in pyrazolidine-3,5-diones with phenyl on nitrogen, the aromatic signal of which appears to be strongly influenced by carbonyl on the same nitrogen. This also argues for the β-acyl structure of (11).

The dibenzoyl derivative (13) produces broad and weak signals at δ 12·3 and 14·9. The latter corresponds to triazole and the former possibly to the β-hydrazide. The interaction of acidic protons, as seen in (11), does not apply and this excludes the β,β-dibenzoyl isomer. The possibility of some stabilization through a H-bridge in a six-membered ring favours (13) over the isomer (13a). Finally it is seen that in these examples of re-acylation the benzoyl group migrates as expected, to the more basic, i.e. more nucleophilic, hydrazine NH.

Triazolopyrimidines obtained from hydrazinotriazoles and malonyl derivatives[1] are N^1-acyl derivatives of triazole and could rearrange by reacylation from N 1 to β-NH to afford pyrazolidinediones. Ring-fusion must have a stabilizing effect as the rearrangement of such triazolopyrimidines calls for more vigorous conditions than those used in the preceding examples. The *N*-phenylamino compound (14) rearranges to pyrazolidinedione (15) when heated with ethanolic hydrochloric acid (Scheme 4). The corresponding *N*-benzoylamino compound (16) lacks a sufficiently

[8] Staab, H. A., and Seel, G., *Chem. Ber.*, 1959, **92**, 1302.
[9] Cipen, G., and Grinstein, V. Ya., *Zh. Obshch. Khim.*, 1962, 460.
[10] Gehlen, H., and Winzer, V., *Justus Liebigs Ann. Chem.*, 1965, **681**, 100.
[11] Potts, K. T., and Crawford, T. H., *J. Org. Chem.*, 1962, **27**, 2631.
[12] Potts, K. T., *Chem. Rev.*, 1961, 61, 87, esp. pp. 114–5.

nucleophilic centre to which the malonyl residue could migrate from the triazole; hence the pyrimidine ring is cleaved without formation of pyrazolidinedione.



Scheme 4

The rearrangement of (14) to (15) appears to be the only known satisfactory method for the preparation of fully substituted triazolylphenylpyrazolidinediones. In order to overcome the difficulty of preparing fully substituted pyrazolidine-3,5-diones[13] a wider generalization of the synthesis of (15) would be desirable. It was planned to prepare unambiguously triazolopyrimidines, e.g. (17)[1] from hydrazones, reduce the Schiff base to provide basic NH and finally rearrange to pyrazolidinedione. Sodium borohydride in ethanol and ether merely removed the malonyl group from (17) and afforded the hydrazone (18). Catalytic hydrogenation of (18) with Pd–C or PtO_2 at room temperature or with Pd–C at 100 atm and 70–100° failed, and the starting material was recovered. The surprising stability of (18) may explain the ready oxidation of 5-benzylhydrazino-3-phenyl-1,2,4-triazole to the corresponding benzalhydrazino compound by exposure to air.[14]

While the role of *N*-acyltriazole intermediates in the formation of pyrazolidinediones cannot be doubted, the contribution of reacylation from hydrazides should not be ignored. Thus one cannot exclude the formation of *gem*-diacyl intermediates such as (13a) which would be a good acylating agent.[15] Some information as to reacylation from the hydrazide was obtained on attempts at forced formation of (2) from (1). The use of malonyl chlorides could be considered for the purpose, provided the NH_2 group was protected so as to avoid the formation of azetidine-

[13] Büchi, J., Ammann, R., Lieberherr, R., and Eichenberger, E., *Helv. Chim. Acta*, 1953, **36**, 75.
[14] Gehlen, H., and Effert, H., *J. Prakt. Chem.*, 1969, **311**, 231.
[15] Dunn, P., Parkes, E. A., and Polya, J. B., *Rec. Trav. Chim. Pays-Bas*, 1952, **71**, 676.

2,4-diones[16] and dihydrazides[17] (5); the protective acyl group can be removed without affecting the pyrazolidinedione.[17] However, the reaction between (7) and diethylmalonyl chloride failed at room temperature, and the starting material was recovered. The only product obtained on heating was 5-(1′,2′-dibenzoylhydrazino)-3-phenyl-1*H*-1,2,4-triazole (19), identified on the n.m.r. criterion for absence of α-NH and presence of β-hydrazide NH. The formation of (19) cannot be explained without assuming an intermolecular migration since the alternatively postulated ring opening and recyclization leads to the triazole, with α-NMe.[2] Formation of the dibenzoyl compound should give rise to some deacylated product (1); failure to detect the latter in the reaction mixture is ascribed to a Heller ring opening[18] of the basic hydrazinotriazole when heated with an acyl chloride. Heating in the absence of diethyl malonyl chloride does not affect (7); thus it appears likely that ring-opening precedes acylation.

Probably one could find conditions to improve yields or to enhance the formation of (2) but the aim of these experiments was to test the importance of unsubstituted triazole NH in the preparation of triazolylpyrazolidinediones: this appears to be considerable but not absolute.

Experimental

Microanalyses were performed by the Australian Microanalytical Service. The melting points are uncorrected.

*(a) Condensation of Monosubstituted Diethyl Malonates $R^1R^2C(CO_2Et)_2$ with 5-Hydrazino-1-methyl-3-phenyl-1*H*-1,2,4-triazole (1; R^1 = H, R^2 = Et, Pr, Bu, pentyl, cyclohexyl, $PhCH_2$)*

The triazole (1)[2] (0·01 mol) and a slight excess of ester were heated in super-dry ethanol (50 ml) containing sodium (0·02 g-atom) with slow removal of the solvent, then kept at 150–160° for 6 h. The residue was dissolved in a small amount of water; extraction with ether removed unchanged ester. Neutralization with CO_2 gave a clear solution in most cases. If the solution turned cloudy, it was filtered before acidification with acetic acid to yield the β-hydrazide carboxylic acid (3). Precipitation of lower homologues was promoted by shaking the acidified solution with chloroform and allowing to stand for a few hours.

Reaction with $PhCH(CO_2Et)_2$.—The reaction was carried out as above. Addition of water to the cold residue left some undissolved solid (4) which was filtered and washed with water and ether. Acidification of the aqueous filtrate with acetic acid afforded the pyrazolidinedione (2) after standing overnight.

Monosodium salts of (*3*; R^2 = *Et or* $PhCH_2$).—These were prepared by dissolving the acid (3) (0·6 g) in ethanol (25 ml) containing sodium (1 g-equiv.). Evaporation of the solution to a small volume gave the salt after a few hours' standing.

(b) Condensation of (1) with Disubstituted Malonates, $R^1R^2(CO_2Et)_2$ (R^1/R^2 = Me/Me, Et/Et, Et/Bu, Bu/Bu, Me/$PhCH_2$)

The triazole (1) (0·01 mol) was made to react with esters as under (*a*). Neutralization with CO_2 yielded the dihydrazide (5). Acidification of the aqueous filtrate with acetic acid and extraction with chloroform removed products to the organic phase, which was then concentrated to a small volume and diluted with ether to afford (3) or (in the case of R^1 = R^2 = Et) the pyrazolidinedione (2).

[16] Ebnoether, A., Jucker, E., Rissi, E., Rutschmann, J., Schreier, E., Steiner, R., Suess, R., and Vogel, A., *Helv. Chim. Acta*, 1959, **42**, 918.

[17] Ebnoether, A., Jucker, E., Rissi, E., Steiner, R., Suess, R., and Vogel, A., *Helv. Chim. Acta*, 1959, **42**, 2013.

[18] Heller, G., *Ber. Deut. Chem. Ges.*, 1907, **40**, 114; cf. Windaus, A., Doerries, W., and Jensen, H., *Ber. Deut. Chem. Ges.*, 1921, **54B**, 2745.

Reaction with Ph(Me)(CO_2Et)$_2$.—A similar procedure gave after neutralization with CO_2 a small amount of pink solid that was taken up in ether. Concentration of the ethereal extract and dilution with light petroleum gave the hydrazide (4). Acidification of the aqueous phase with acetic acid and extraction with chloroform gave a few drops of unidentified brown oil.

(*c*) *3-(2′-Benzoylhydrazino)-1-methyl-5-phenyl-1*H-*1,2,4-triazole* (*8*)

(i) The triazole (1) (2·8 g, 0·015 mol) in dry pyridine (50 ml) was cooled to 0–5° and slowly treated with benzoyl chloride (2·1 g, 0·015 mol) below 0°. The solution was stirred overnight, then freed from solvent under reduced pressure. Treatment of the residue with ice-water (500 ml) gave a brown oil that on trituration turned to a beige precipitate of *5-(2′-benzoylhydrazino)-1-methyl-3-phenyl-1*H-*1,2,4-triazole* (7) (2 g), m.p. 181–182°, recrystallized from ethanol–ether (Found: C, 65·3; H, 5·6; N, 23·5. $C_{16}H_{15}N_5O$ requires C, 65·5; H, 5·1; N, 23·9%).

(ii) 5-(2′-Benzoylhydrazino)-3-phenyl-1*H*-1,2,4-triazole (6)[1] (2·5 g) in methanol (70 ml) was treated with excess diazomethane and the mixture left to stand to allow the excess to decompose. The solvent was removed under reduced pressure and the residue dissolved in a mixture of chloroform and ether from which a white precipitate (0·5 g) fell after standing, m.p. 181–184°, identical with (7) from the preceding preparation. A further crop (0·6 g), m.p. 176–179°, was obtained on dilution of the mother liquor with more ether.

The residue obtained on evaporation of the solvent was separated by t.l.c. on silica gel with chloroform–methanol (100 : 3·5) and gave two components; the bottom one (200 mg) was identical with (7). The top component (400 mg), m.p. 242–245° after recrystallization from chloroform–ether, was the *hydrazide* (8) (Found: C, 65·5; H, 5·1; N, 24·1. $C_{16}H_{15}N_5O$ requires C, 65·5; H, 5·1; N, 23·9%).

(*d*) *Attempted Condensation of* (*7*) *with Diethylmalonyl Chloride*

(i) The hydrazide (7) (1 g, 0·003 mol) in dry pyridine (15 ml) was treated with diethylmalonyl chloride (0·003 mol) as under (*c*)(i). Addition of ice-water (300 ml) resulted in a milky fluid that gave a white precipitate after standing. The precipitate was filtered, washed with water and then with a mixture of ether and light petroleum to afford 0·75 g of the starting material.

(ii) Compound (7) (0·7 g) was treated with diethylmalonyl chloride (0·5 g) as above; the reaction was completed by heating under reflux for 90 min. Addition of ice-water produced a sticky residue that was extracted with chloroform. The organic extract was washed with water and evaporated to dryness under reduced pressure. An ethanolic solution of the residue when treated with water afforded a white solid, *5-(1′,5′-dibenzoylhydrazino)-1-methyl-3-phenyl-1*H-*1,2,4-triazole* (19) (0·35 g), m.p. 220–221°, recrystallized from aqueous ethanol (Found: C, 69·5; H, 5·1; N, 17·5. $C_{23}H_{19}N_5O_2$ requires C, 69·5; H, 4·8; N, 17·5%).

(iii) A repetition of (ii) above without diethylmalonyl chloride recovered starting material, m.p. 182–184°, in almost quantitative yield.

(*e*) *Rearrangement of 1-Benzoyl-3-phenyl-5-phenylhydrazino-1,2,4-triazole* (*10*) *and 1-Benzoyl-5-(2′-benzoylhydrazino)-3-phenyl-1,2,4-triazole* (*12*)

Compound (10) or (12) (0·005 mol) was heated under reflux in pyridine (15 ml) containing a catalytic amount of silver nitrate for 9–11 h, then poured into ice-water (200 ml). A chloroform extract of the mixture was freed from solvent under reduced pressure. Trituration of the residue in water or leaving it standing in ether afforded the rearranged products (11) and (13) in yields of 30 and 53% respectively.

(i) *5-(2′-Benzoyl-2′-phenylhydrazino)-3-phenyl-1*H-*1,2,4-triazole* (11), m.p. 207–209° (dec.), recrystallized from chloroform–ether (Found: C, 71·2; H, 5·1; N, 19·4. $C_{21}H_{17}N_5O$ requires C, 71·0; H, 4·8; N, 19·7%).

(ii) *5-(1′,2′-Dibenzoylhydrazino)-3-phenyl-1*H-*1,2,4-triazole* (13), m.p. 224–226° from chloroform–ether (Found: C, 68·5; H, 4·60; N, 18·4. $C_{22}H_{17}N_5O_2$ requires C, 68·9; H, 4·4; N, 18·3%).

(*f*) *Rearrangement of 4-Phenylamino-* (*14*) *and 4-Benzoylamino-* (*16*) *6,6-Diethyl-2-phenyl-*s*-triazolo[1,5-*a*]pyrimidine-5,7(4*H*,6*H*)-dione*

(i) Method (*e*) applied to (14) or (16) resulted in recovery of starting material in yields of 80 and 90% respectively.

(ii) The dione (14) (0·8 g) was refluxed in a solution of 4M HCl (30 ml) in ethanol (40 ml) for 6 h. The solvent was removed under reduced pressure until precipitation occurred. The white precipitate was filtered and washed with water to afford *4,4-diethyl-1-phenyl-5-(3'-phenyl-1'H-1',2',4'-triazol-5'-yl)pyrazolidine-3,5-dione* (15) (0·3 g), m.p. 200–204°, recrystallized from chloroform–ether (Found: C, 67·0; H, 5·7; N, 18·9. $C_{21}H_{21}N_5O_2$ requires C, 67·2; H, 5·6; N, 18·7%).

(iii) Compound (16) (1·8 g) in a solution of 4M HCl (50 ml) and ethanol (75 ml) was heated under reflux for 13 h. At that stage t.l.c. indicated the presence of unchanged starting material. After heating under reflux for a further 24 h the starting material appeared to have considerably decreased. Concentration of the solution to a small volume afforded a white precipitate (0·3 g), m.p. 178–182° (dec.), readily soluble in water. The substance was found to be identical (by comparison of i.r. spectra) with the hydrochloride of 5-(2'-benzoylhydrazino)-3-phenyl-1*H*-1,2,4-triazole prepared by heating (6) under reflux in methanolic HCl.

(*g*) *Reduction of (17) and (18)*

(i) Compound (17) (1·7 g) (0·005 mol) in ether (30 ml) and ethanol (30 ml) was swirled and treated with sodium borohydride (0·1 g). The solution was left to stand at room temperature for 20 min, warmed in a water bath at 70° for 10 min, then concentrated under reduced pressure. Dilution with ice-water gave, after standing for a few hours, a white precipitate (0·4 g), m.p. 217–222°, recrystallized from chloroform–ether, identical (by comparison of infrared spectra) with the product, m.p. 223–230°, prepared from acetone and 5-hydrazino-3-phenyl-1*H*-1,2,4-triazole.

(ii) The attempted reduction of (18) (2 g) in ethanol (100 ml) with sodium borohydride (0·5 g) in a similar manner allowed recovery of starting material (1·5 g), m.p. 226–228°.

(iii) Catalytical reduction of (18) (1·5 g) over Pd–C at room temperature at 24 p.s.i. afforded only starting material (1·3 g). The same result was obtained with PtO_2 as catalyst.

(iv) Reduction of (18) (5 g) in methanol (300 ml) in the presence of Pd–C at 70–100° under 100 atm pressure gave a purple solution from which starting material was recovered.

Acknowledgments

The authors wish to express their thanks for a University Ph.D. Scholarship (to M.W.), to Smith Kline & French Laboratories for a grant and to Dr E. J. Browne for helpful advice.

Manuscript received 12 August 1974