Allenes. Part 37.[1] The Synthesis of Allenic Barbiturates and Thiobarbiturates.

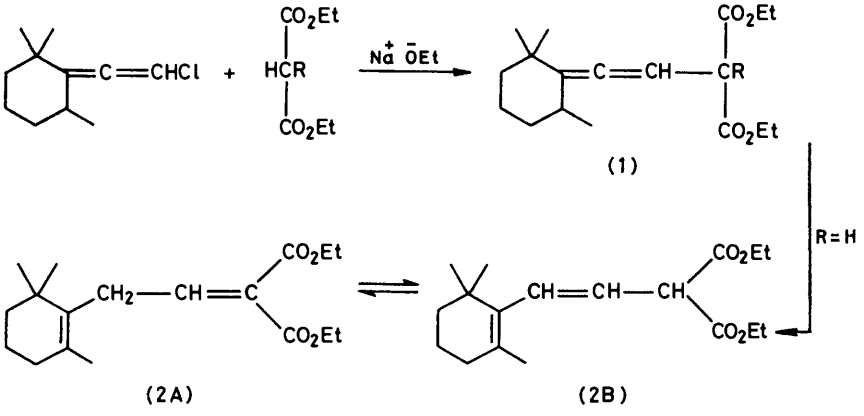
By **Stephen R. Landor,***† **Phyllis D. Landor,** and **Paul F. Whiter,** Chemistry Department, Woolwich Polytechnic, London SE18, and Exeter University, Exeter EX4 4QD

The reaction of allenic halides with malonic esters has been investigated and a number of allenic derivatives of barbituric and thiobarbituric acid have been synthesised from allenylalkylmalonic esters and urea or thiourea.

So far few allenic compounds have been shown to be pharmacologically active, but the recent discovery of the remarkable progestational activity of 17-hydroxy-17α-propadienylestr-4-en-3-one,[2] which is ten times as active as the clinically used acetylenic compound norethindrone, the hypnotic activity of some aliphatic allenic alcohols as well as their carbamates,[3] and the antitubercular activity of some alka-4,5-dien-2-yn-1-ols [4] indicates that other medicinally useful allenes may be discovered. This paper reports the synthesis of barbiturates and thiobarbiturates with allenic side chains. For maximum hypnotic activity in this class of drugs both hydrogen atoms at C-5 should be replaced by alkyl groups and the side chain should contain up to five carbon atoms. A series of 5-alkyl-5-(alka-1,2-dienyl)barbiturates and thiobarbiturates were therefore synthesised.

A preliminary investigation into the synthesis of allenic malonic esters required as starting materials showed that whereas unsubstituted malonic ester (R = H) and 2,2,6-trimethylcyclohexylidenevinyl chloride gave the dienes (2A) and (2B) [$\lambda_{max.}$ 240 (ε 3 000), $\nu_{max.}$ 1 620 cm^{-1}], a monosubstituted malonic ester (R = Bu) gave mainly the required allene (1; R = Bu) ($\nu_{max.}$ 1 950 cm^{-1}), since the prototropic rearrangement was now blocked.

The highly sterically crowded allenic bromide 1-bromo-4,4-dimethyl-3-t-butylpenta-1,2-diene and diethyl malonate gave only the conjugated diene (3) [$\lambda_{max.}$ 290 nm (ε 18,800)], but with diethyl ethylmalonate gave exclusively the allenic ester (4).



Reducing the amount of steric crowding at C-3 of the bromoallene, *i.e.* using 1-bromo-3-methylpenta-1,2-diene (5), gave only the acetylenic ester (6; R = H) with diethyl malonate but with diethyl ethylmalonate gave a mixture of acetylene (6; R = Et) (44%) and allene (7)

† *Present address:* Department of Chemistry, Faculty of Science, University of Lagos, Lagos, Nigeria.

[1] Part 36, P. D. Landor, S. R. Landor, and O. Odyek, *J.C.S. Perkin I*, 1977, 93.

[2] M. Biollaz, R. M. Landeros, L. Cuéllar, P. Crabbé, W. Rooks, J. A. Edwards, and J. H. Fried, *J. Medicin. Chem.*, 1971, **14**, 1190; E. E. Galantay, R. V. Coombs, I. Basco, R. I. Elton, and E. Harrington, *Experientia*, 1972, **28**, 771.

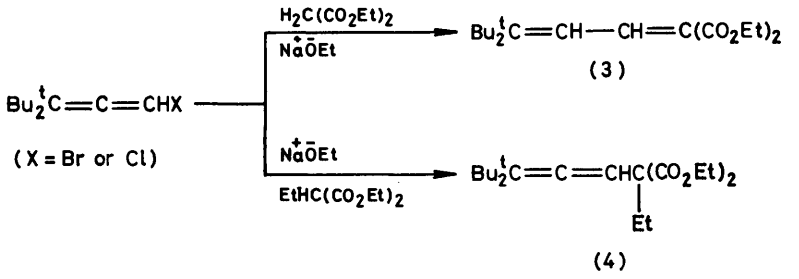
[3] A. Claesson, C. Bogentoft, and B. Danielsson, and L. Paalzow, *Acta Pharm. Saec.*, 1975, **12**, 305.

[4] C. S. L. Baker, P. D. Landor, and S. R. Landor, *J. Chem. Soc.*, 1965, 4659.

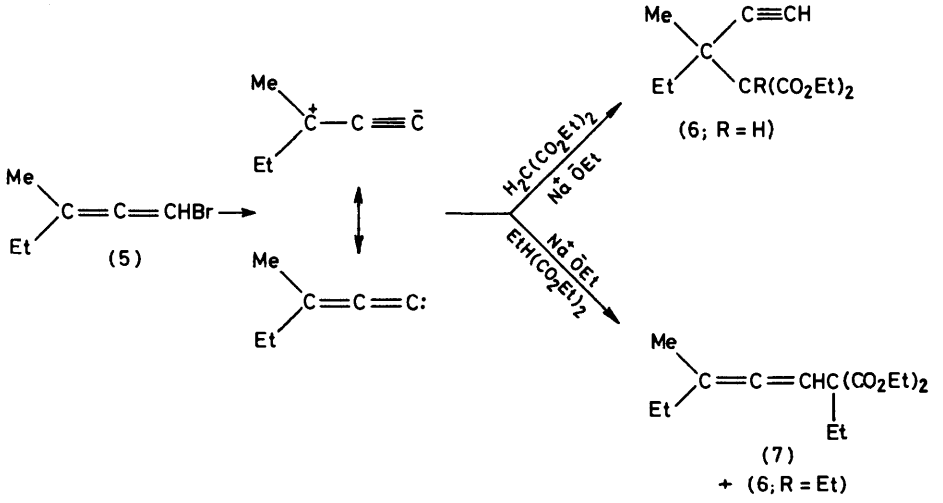
(56%).[5] Since the corresponding acetylenic chloride 3-chloro-3-methylpent-1-yne gave identical ratios and yields of allene and acetylene,[5] the mechanism of this reaction is best explained by the addition of the anion of the malonate to an allenic carbene intermediate. Later it was found that if sodium hydride in benzene was used as base instead of sodium ethoxide when preparing allenic malonates from the less sterically crowded bromoallenes, the allenic malonate was formed exclusively. Apparently sodium hydride does not give the allenic carbene intermediate but only forms the malonate anion, which nucleophilically attacks the 1-bromoallene at C-1. This is the method of choice for the preparation of allenic malonates as intermediates for barbiturate synthesis, and since there are no by-products, the residue from evaporation of the reaction mixture can be used directly for the next stage.

Two malonic esters were prepared in which a terminal allenyl group was separated from C-3 of the malonate by one or two carbon atoms [(8) and (9)]. The allenic malonate (8) was obtained in 66% yield and showed a fairly strong allenic i.r. absorption at 1 950 cm^{-1}, in contrast to the very weak band in that region shown by the non-terminal α-allenyl malonates. The yield of the pentadienyl malonate (9A) depended on the solvent (absolute alcohol gave 26%, ' superdry ' alcohol 56%) and a number of unidentified by-products were formed in various amounts. These are thought to result from homoallenic participation;[6] the main malonate by-product, which could not be separated from the allenic malonate, probably was the diethyl ethyl-(2-methylenecyclobutyl)malonate (9B)[6b] but further work is needed to confirm this.

The barbiturates (10; X = O) and thiobarbiturates



(10; X = S) were prepared by the standard method from the allenic malonates and urea or thiourea, and are listed in the Table. Yields of recrystallised compounds varied from 15 to 52%. Where low yields were obtained the main problem lay in separating the barbiturate from unchanged ester. The spectroscopic data agreed well with the proposed structures. The normal allenic i.r. absorption at 1 950 cm^{-1} of medium intensity was present for the terminal 2,3- and 3,4-dienylbarbiturates but it was extremely weak for the nonterminal 1,2-dienylbarbiturates. The thiobarbiturates (6—8 in the Table) differed from the barbiturates and showed only one N–H stretching and two carbonyl bands at a slightly lower frequency, as well as a band at 2 580 cm^{-1} (SH) indicating the presence of some enethiol forms [(11) and (13)].



The u.v. spectra showed low intensity absorption with $\lambda_{max.}$ 244—250 nm for the three 1,2-dienylbarbiturates (1—3 in the Table) corresponding to a contribution from some enol form, e.g. (12), whereas the 2,3-and 3,4-dienylbarbiturates (4 and 5 in the Table) had end absorption only and must be in the keto form in ethanol solution (*cf.* data for 5,5-diethylbarbituric acid).[7] The three thio-

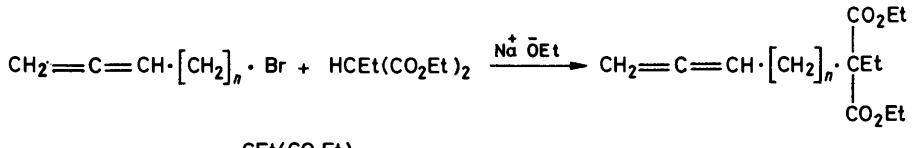
[5] S. R. Landor and P. F. Whiter, *J. Chem. Soc.*, 1965, 5625.

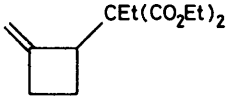
[6] (*a*) M. Hannack and T. Haffner, *Ber.*, 1966, **99**, 1077; (*b*) T. L. Jacobs and R. S. Macomber, *J. Amer. Chem. Soc.*, 1969, **91**, 4824.

[7] J. J. Fox and D. Shugar, *Bull. Soc. chim. belges*, 1952, **61**, 44.

barbiturates (6—8 in the Table) showed high intensity absorption with $\lambda_{max.}$ 239 and 294, suggesting considerable contribution from a di-iminone form (13). All the barbiturates and thiobarbiturates prepared showed n.m.r. signals at τ 4.8—4.9 for the allenic protons.

In view of the importance of the ultrashort-acting barbiturates as general anaesthetics, *e.g.* sodium methohexital (14), it was decided to attempt the condensation of 1,2-dienylbarbiturates with *N*-methylurea. Reaction of diethyl ethyl-(3-ethylpenta-1,2-dienyl)malonate and





(9B)

(8) $n = 1$
(9A) $n = 2$

N-methylurea with sodium ethoxide even after 24 h under reflux gave unchanged *N*-methylurea, and an oily product which was largely the required barbiturate as shown by u.v. and n.m.r. spectra, but which did not crystallise. Further research is being directed towards an alternative synthesis with cyanoacetic acid,[8] and methylation of the allenic barbiturates with methyl iodide.

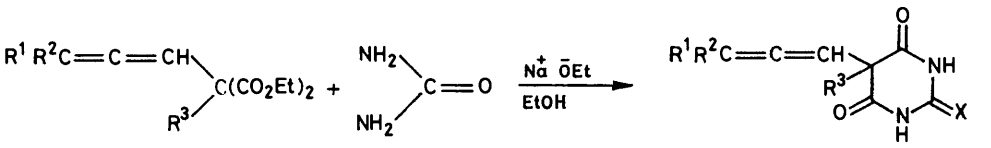
EXPERIMENTAL

I.r. spectra were determined with a Perkin-Elmer Infracord spectrometer. U.v. spectra were obtained for ethanolic solutions with a Bausch and Lomb Spectronic 505 or a Unicam SP 800 instrument. N.m.r. spectra were determined with Perkin-Elmer R12 spectrometer, with tetramethylsilane as internal standard, and for solutions in deuteriochloroform unless otherwise stated. Ethereal solutions were dried over $MgSO_4$. 1-Bromoallenes were prepared from the corresponding prop-2-yn-1-ol and hydrobromic acid.[9] Diethyl ethylmalonate was commercially supplied (Aldrich) or prepared by a phase-transfer reaction [10] with tetrabutylammonium hydrogen sulphate. Purity was checked by g.l.c. on 6ft columns of SE30 on Chromosorb W at 100 °C (carrier gas nitrogen at 2 l h^{-1}).

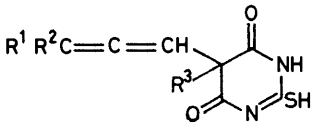
Reaction of 2,2,6-Trimethylcyclohexylidenevinyl Chloride with Diethyl Malonate.—Diethyl malonate (4.8 g, 0.03 mol) was added to a stirred solution of sodium ethoxide [from sodium (0.69 g, 0.03 g atom)] in absolute ethanol (25 ml), followed by 2,2,6-trimethylcyclohexylidenevinyl chloride [11] (4.6 g, 0.025 mol). The mixture was refluxed for 2 h and then alcohol was distilled off. The cooled residue was diluted with ether (15 ml) and water (12 ml) was added. Separation, further extraction with ether, washing with dilute hydrochloric acid and water, and drying, gave after distillation a mixture of starting materials, b.p. 26—32° at 0.0086 mmHg, and a high-boiling residue which was largely diethyl 2-(2,6,6-trimethylcyclohexenyl)ethylidenemalonate (2A) and the prop-2-ene (2B) (3.1 g), $\nu_{max.}$ 1 750 (C=O), and 1 620 and 970 cm^{-1} (C=C), $\lambda_{max.}$ 240 nm (ε 3 000).

Reaction of 2,2,6-Trimethylcyclohexylidenevinyl Chloride with Diethyl n-Butylmalonate.—2,2,6-Trimethylcyclohexylidenevinyl chloride (4.6 g, 0.025 mol) was similarly treated with diethyl n-butylmalonate (6.5 g, 0.03 mol) in sodium ethoxide solution [from sodium (0.69 g, 0.03 g atom) and ethanol (25 ml)]. After work-up, volatile material was distilled off at 0.4 mmHg, leaving diethyl butyl-2-(2,2,6-trimethylcyclohexylidene)vinylmalonate (1; R = Bu) (5.3 g, 58%), $\nu_{max.}$ 1 950 (C=C=C) and 1 730 cm^{-1} (C=O), containing an impurity, $\lambda_{max.}$ 282 nm (ε 750). The crude product was used for barbiturate formation.

Diethyl 4,4-Dimethyl-3-t-butylpent-2-enylidenemalonate (3). —Diethyl malonate (14.5 g, 0.09 mol)was added to a stirred solution of sodium ethoxide [from sodium (1.4 g, 0.06 g atom) and absolute ethanol (35 ml)] and the mixture was heated under reflux for 15 min. 1-Bromo-4,4-dimethyl-3-t-butylpenta-1,2-diene (13 g, 0.06 mol) was added dropwise and the mixture was stirred and heated under reflux for 2 h. After work-up the solvent was evaporated off and distillation gave (*a*) starting materials, b.p. 32—34° at 0.015 mmHg (5.0 g), and (*b*) the malonate (3) (8.4 g, 48%) (Found: C, 68.2; H,



(10)



(11)

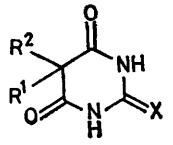
[8] J. Knabe and N. Franz, *Arch. Pharm.*, 1976, 173.
[9] S. R. Landor, A. N. Patel, P. F. Whiter, and P. M. Greaves, *J. Chem. Soc.* (*C*), 1966, 1223.
[10] A. Brändström and V. Junggren, *Tetrahedron Letters*, 1972, 473.
[11] B. L. Bhatia, P. D. Landor, and S. R. Landor, *J. Chem. Soc.*, 1959, 24.

9.1. $C_{18}H_{30}O_4$ requires C, 69.6 H, 9.7%), $\nu_{max.}$ 1 750 (C=O) and 1 620 cm^{-1} (C=C), $\lambda_{max.}$ 290 nm (ε 18,800).

Diethyl 3,4,4-Trimethylpent-2-enylidenemalonate.—Similarly, 1-bromo-3,4,4-trimethylpenta-1,2-diene (18.9 g, 0·1 mol) and diethyl malonate (26 g, 0.16 mol) gave on distillation (a) diethyl (1-methyl-1-t-butylprop-2-ynyl)malonate contaminated with unchanged ester (3%) and 1,3-diene (6%) estimated by g.l.c. (2.8 g, 10%), b.p. 73—78° at 0.03 mmHg, $\nu_{max.}$ 3 300 (C≡CH), 2 100 (C≡CH), 1 760 (C=O) and 1 630 cm^{-1} (C=C), and $\lambda_{max.}$ 284 nm (ε 2 470); (b) *diethyl 3,4,4-trimethylpent-2-enylidenemalonate* (12.4 g, 46%), b.p. 98—140° at 0.02 mmHg (Found: C, 67.0; H, 9.05. $C_{15}H_{24}O_4$ requires C, 67.1; H, 9.0%), $\nu_{max.}$ 1 750 (C=O) and 1 630 cm^{-1} (C=C), $\lambda_{max.}$ 284 nm (ε 11 200). G.l.c. (silicone oil at 186 °C) showed one main peak, t_R 51 min, and 2% of impurity.

Preparation of Allenic Malonates.—*Diethyl ethyl-(3,4,4-trimethylpenta-1,2-dienyl)malonate* (with S. MARKANTONIS). Diethyl ethylmalonate (19.7 g, 0.105 mol) in dry benzene (40 ml) was added slowly to a stirred suspension of sodium hydride (3,8 g, 0.16 mol) in dry benzene (60 ml), and the mixture was refluxed for 10 min. A solution of 1-bromo-3,4,4-trimethylpenta-1,2-diene (18.9 g, 0.1 mol) in dry ether (40 ml) was added dropwise and then the mixture was heated under reflux for 2 h. After cooling, work-up with ether and ice-cold water, and drying, the solvent was evaporated off, finally at 0.1 mmHg for 2 h to give a nearly quantitative yield of the *allenic malonate*, $\nu_{max.}$ 1 980 (C=C=C) and 1 720 cm^{-1} (C=O), τ 9.21 (3 H, t, CH_3·CH_2·C·CH=), 9.05 (9 H, s, Bu^t), 8.84 (6 H, t, CH_3·CH_2·O), 8.40 (3 H, d, CH_3·C=), 8.05 (2 H, q, CH_3·CH_2C·CH), 5.95 (4 H, q, 0·CH_2·CH_3), and 4.55 (1 H, m, C=C=C*H*) [no signal at τ 6.99 showing the absence of *H*C·CH_2·CH_3 (diethyl ethylmalonate)], *m/e* 296. Distillation gave material (14.8 g, 50%) of b.p. 78—81° at 0.0008 mmHg (Found: C, 67.9; H, 10.1. $C_{17}H_{28}O_4$ requires C, 68.9; H, 9.5%); its i.r. and n.m.r. spectra did not differ from those of the undistilled ester, and it showed no absorption in the u.v. above 210 nm. G.l.c. (silicone oil at 182 °C) showed one main peak, t_R 40 min, and 2% impurity.

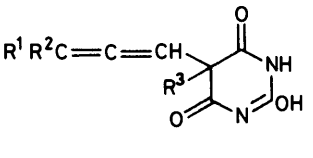
Preparation and physical and spectroscopic data for allenic barbiturates



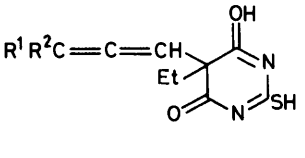
No.	R^1	R^2	X	M.p. (°C)	Yield (%)	$\lambda_{max.}$/nm	ε	$\nu_{max.}$/cm^{-1}	Found (%)	Required (%)
1	TMCV *[a]	Bu	O	159	16	244	3 700	3 200, 3 100, 1 950, 1 770, 1 720	C, 68.9; H, 8.7; N, 8.3	C,68.7; H, 8.5; N, 8.4
2	$Bu^tMeC{=}C{=}CH$	Et	O	142	52	250	2 300	3 200, 3 050, 1 950, 1 750, 1 730, 1 710	C, 64.1; H, 7.6; N, 10.7	C, 63.6; H, 7.6; N, 10.6
3	$Bu_2^tC{=}C{=}CH$ [b]	Et	O	176	41	244	3 850	3 200, 3 100, 1 930, 1 760, 1 740, 1 720	C, 65.4; H, 8.3; N, 8.1	C, 66.7; H, 8.5; N, 9.1
4	$CH_2{=}C{=}CHCH_2$ [c]	Et	O	137	34	(End absorption)		3 200, 3 080, 1 950, 1 770, 1 740, 1 685	C, 58.0; H, 6.0; N, 13.8	C, 57.7; H, 5.8; N, 13.5
5	$CH_2{=}C{=}CHCH_2CH_2$	Et	O	124	22	(End absorption)		3 200, 3 080, 1 950, 1 770, 1 720, 1 685	C, 59.2; H, 6.9; N, 12.7	C, 59.4; H, 6.4; N, 12.6
6	$Pr_2^iC{=}C{=}CH$ [d]	Et	S	150	42	238 294	10 700 29 800	3 150, 2 570, 1 950, 1 750, 1 700	C, 61.2; H, 7.6; N, 9.7; S, 11.0	C, 61.2; H, 7.5; N, 9.5; S, 10.9
7	$Bu^tMeC{=}C{=}CH$ [e]	Et	S	177	24	239 294	9 000 21 000	3 150, 2 570, 1 975, 1 720, 1 680	C, 59.9; H, 7.3; N, 10.0; S, 11.4	C, 60.0; H, 7.1; N, 10.0; S, 11.4
8	$Et_2C{=}C{=}CH$ [f]	Et	S	138	15	239 294	8 000 19 000	3 180, 2 580, 1 980, 1 720, 1 680	C, 58.7; H, 6.8; N, 10.5; S, 11.9	C, 58.6; H, 6.8; N, 10.5; S, 12.0

* 2,2,6-Trimethylcyclohexylidenevinyl.

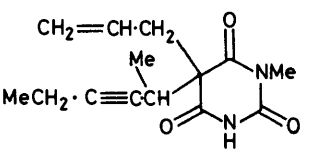
[a] Heated under reflux for 6 h. [b] Recryst. from ethanol–water. [c] First reported by W. H. Carothers and G. J. Berchet [U.S.P. 2,073,363 (*Chem. Abs.*, 1937, **31**, 3503)]. [d] Recryst. from benzene–acetone. [e] Recryst. from light petroleum–ether. [f] The crude solid was boiled with water to remove thiourea and then recryst. from light petroleum–ether.



(12)



(13)



(14)

Diethyl (1-Ethyl-1-methylprop-2-ynyl)malonate.—Similarly 1-bromo-3-methylpenta-1,2-diene (16.1 g, 0.1 mol) and diethyl malonate (26 g, 0.16 mol) gave on distillation the *malonate* (6; R = H) (9.3 g, 38%), b.p. 71° at 0.05 mmHg (Found: C, 65.0; H, 8.5. $C_{13}H_{20}O_4$ requires C, 65.0; H, 8.4%), $\nu_{max.}$ 3 250 (C≡CH), 2 100 (C≡CH), and 1 750 cm^{-1} (C=O), $\lambda_{max.}$ 281 nm (ε *ca.* 101). G.l.c. (silicone oil at 175 °C) showed one main peak, t_R 19 min, and 1% unchanged ester.

In a similar manner, from diethyl ethylmalonate (14.1 g, 0.075 mol), sodium hydride (2.9 g, 0.12 mol), and 1-bromo-3-ethylpenta-1,2-diene (13.1 g, 0.075 mol) was obtained *diethyl ethyl-(3-ethylpenta-1,2-dienyl)malonate* (92%), $\nu_{max.}$ 1 980 (C=C=C) and 1 720 cm^{-1} (C=O), τ 8.5—9.2 [15 H, overlapping t, $(CH_3{\cdot}CH_2)_2C=$, $CH_3{\cdot}CH_2{\cdot}O$, and $CH_3{\cdot}CH_2{\cdot}C{\cdot}CH$], 7.4—8.2 [6 H, m, $(CH_3{\cdot}CH_2)_2C=$ and $CH_3{\cdot}CH_2{\cdot}C{\cdot}CH$], 5.8 (4 H, q, $CH_3{\cdot}CH_2{\cdot}O$), and 4.25 (1 H, m, C=C=C*H*).

Diethyl ethylmalonate (16.8 g, 0.089 mol), sodium ethoxide [from sodium (2.05 g, 0.089 g atom)] and 1-chloro-4,4-dimethyl-3-t-butylpenta-1,2-diene [9] gave *diethyl ethyl-(4,4-dimethyl-3-t-butylpenta-1,2-dienyl)malonate* (4) (15.8 g, 63%), b.p. 96° at 0.0005 mmHg (Found: C, 70.6; H, 10.3. $C_{20}H_{34}O_4$ requires C, 71.0; H, 10.1%), $\nu_{max.}$ 1 930 (C=C=C) and 1 740 cm^{-1} (C=O), no max. in u.v. above 210 nm, τ 8.85 (9 H, s, Me_3C) and 4.40 (1 H, s, C=C=CH).

Diethyl ethylmalonate (37 g, 0.195 mol) sodium ethoxide [from sodium (3.1 g, 0.137 g atom)] and 1-bromo-4-methyl-3-isopropylpenta-1,2-diene (26.3 g, 0.12 mol) gave *diethyl ethyl-(3-isopropyl-4-methylpenta-1,2-dienyl)malonate* (13.0 g, 32%), b.p. 91—92° at 0.05 mmHg (Found: C, 68.7; H, 9.3. $C_{18}H_{30}O_4$ requires C, 69.6; H, 9.7%), $\nu_{max.}$ 1 960 (C=C=C) and 1 760 cm^{-1} (C=O).

Reactions of 5-bromopenta-1,2-diene. (*a*) Diethyl ethylmalonate (18.1 g, 0.096 mol), sodium ethoxide [from sodium (2.2 g, 0.096 g atom) in absolute alcohol (50 ml)], and 5-bromopenta-1,2-diene (11.8 g, 0.08 mol) in absolute alcohol (10 ml) gave after refluxing for 2 h, *diethyl ethyl(penta-3,4-dienyl)malonate* (9A) (5.2 g, 26%), b.p. 70—74° at 0.01 mmHg (Found: C, 65.3; H, 8.7. $C_{14}H_{20}O_4$ requires C, 66.2; H, 8.7%), $\nu_{max.}$ 1 950 (C=C=C), 1 740 (C=O) and 860 cm^{-1} ($C=C=CH_2$), g.l.c. (silicone oil at 176 °C) t_R 23.5 (97%) and 19 min (3%).

(*b*) Similarly diethyl malonate (50 g, 0.27 mol), sodium ethoxide [from sodium (4.15 g) in ' superdry ' alcohol (80 ml)], and 5-bromopenta-1,2-diene (25 g, 0.17 mol) gave the product (9A) (24.1 g, 56%), g.l.c. (silicone oil, 176 °C) t_R 23.5 min (80%), and the cyclobutane (9B), t_R 19 min (20%), $\nu_{max.}$ as given in (*a*) but additional bands at 1 635 (C=C) and 940 cm^{-1} ($C=CH_2$) for (9B).

(*c*) With sodium hydride (1.2 g, 0.05 mol) in dry benzene (40 ml) and dry ether (10 ml) diethylethylmalonate (14.1 g, 0.075 mol) and 5-bromopenta-1,2-diene (7.3 g, 0.05 mol) in ether (20 ml) added dropwise and heated under reflux for 2 h gave the products (9 A and B), (3.8 g, 30%), g.l.c. t_R 23.5 (66%) and 19 min (34%).

Diethyl ethylmalonate (32.9 g, 0.175 mol), sodium ethoxide [from sodium (2.6 g, 0.1 mol)], and 4-bromobuta-1,2-diene (14.6 g, 0.1 mol) gave *diethyl buta-2,3-dienyl(ethyl)-malonate* (8) (17.5 g, 66%), b.p. 60—62° at 0.005 mmHg (Found: 64.6; H, 8.5. $C_{13}H_{20}O_4$ requires C, 65.1; H, 8.3%), $\nu_{max.}$ 1 950 (C=C=C), 1 740 (C=O), and 856 cm^{-1} ($C=C=CH_2$). G.l.c. showed one main peak (98%).

Preparation of Allenic Barbiturates.—*5-Ethyl-5-(3,4,4-trimethylpenta-1,2-dienyl)barbituric acid* (Table, no. 2). Urea (2,4 g, 0.04 mol; dried at 60 °C for 4 h) in hot ' superdry ' ethanol (40 ml) was added to a stirred solution of sodium ethoxide [from sodium (1.84 g, 0.08 g atom) in ethanol (25 ml)] and the mixture was heated under reflux for 10 min. Diethyl ethyl-(3,4,4-trimethylpenta-1,2-dienyl)malonate (11.85 g, 0.04 mol) was added dropwise and the mixture heated under reflux for 3 h, cooled, and evaporated. The residue was acidified with dilute hydrochloric acid at 0 °C, and dilute sodium hydroxide was added to give a clear solution. After extraction with benzene (to remove any unchanged allenic ester) the alkaline water layer was acidified with concentrated hydrochloric acid (Congo Red), and cooled to 0 °C; the crude barbiturate crystallised out. Recrystallisation (EtOH) gave the *barbituric acid*, τ 9.12 (3 H, t, $CH_3{\cdot}CH_2$), 9.0 (9 H, s, Me_3C), 8.33 (3 H, d, $CH_3{\cdot}C=$), 7.8 (2 H, q, $CH_3{\cdot}CH_2$), 4.86 (1 H, m, C=C=CH), and 0.57br (2 H, s, exchanges with D_2O, NH), *m/e* 264. Other data for this compound and for four other allenic barbiturates (nos. 1 and 3—5) prepared as above are given in the Table.

Preparation of Allenic Thiobarbiturates.—*5-Ethyl-5-(3,4,4-trimethylpenta-1,2-dienyl)thiobarbituric acid* (with S. MARKANTONIS) (Table no. 7). Thiourea (2.3 g, 0.03 mol) washed in ' superdry ' ethanol (10 ml) was added to a solution of sodium ethoxide [from sodium (1.4 g, 0.06 g atom) in ethanol (30 ml)] and the mixture was warmed for 20 min. Diethyl ethyl-(3,4,4-trimethylpenta-1,2-dienyl)malonate (8.9 g, 0.03 mol) in ethanol (20 ml) was added dropwise to the stirred solution and the mixture heated under reflux for 2 h, cooled, acidified with dilute hydrochloric acid (Congo Red) and diluted with water to obtain a clear solution. Work-up with ether and evaporation (finally at 0.1 mmHg) gave the crude allenic barbiturate (5.9 g, 70%). Recrystallisation from light petroleum–ether (twice) gave the *thiobarbituric acid*, τ [$CDCl_3$–$(CD_3)_2CO$] 9.1 (3 H, t, $CH_3{\cdot}CH_2$), 9.0 (9 H, s, Me_3C), 8.35 (3 H, d, $CH_3C=$), 7.85 (2 H, q, $CH_3{\cdot}CH_2$), 4.9 (1 H, m, C=C=CH), and −0.7br (s, NH, exchanged with D_2O). Other data for this compound and two other allenic thiobarbiturates (nos. 6 and 8) similarly prepared are given in the Table.

Reaction of Diethyl Ethyl-(3-ethylpenta-1,2-dienyl)malonate and N-Methylurea (with S. MARKANTONIS).—*N*-Methylurea (5.2 g, 0.07 mol) suspended in ' superdry ' ethanol (25 ml) was added to a solution of sodium ethoxide [from sodium (3.2 g, 0.14 g atom) in ethanol (70 ml)] and the mixture warmed for 20 min. The malonate (19.5 g, 0.07 mol) in ethanol (46 ml) was added dropwise to the stirred solution, and the mixture was then refluxed for 24 h. Work-up as above gave an oily product (some solid separated and was shown to be *N*-methylurea), which did not crystallise, but showed $\lambda_{max.}$ 280 nm (ε 9 000) and τ 6.8 (4 H, s, NCH_3) and 4.76 (1 H, m, C=C=CH) and was 5-ethyl-5-(3-ethylpenta-1,2-dienyl)-barbituric acid containing *N*-methylurea (ca. 10%).

We thank Parke Davis and Co. Ltd. for a research fellowship (to P. F. W., 1961—1963, when part of this work was carried out).

[6/2206 *Received*, 2nd *December*, 1976]