Preparation and Properties of Some 1,2-Dihydropyrimidinium Salts

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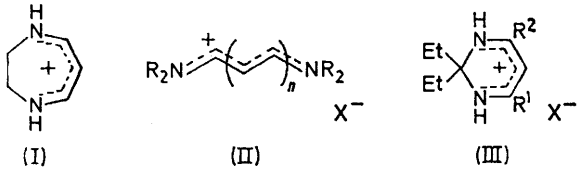
Some 1,2-dihydropyrimidinium salts have been prepared and their spectra and chemical properties compared with those of 2,3-dihydro-1,4-diazepinium salts. They undergo deuteriation, halogenation, and possibly diazo-coupling, at the 5-position. The 5-bromo-derivatives are protodebrominated by thiourea but a 5-chloro-derivative was unaffected by this reagent. The 2,2-diethyl-4-methyldihydropyrimidinium salt reacted at the 6-position with piperidine to give a 1-amino-3-piperidinopropenylium salt and with ethylenediamine and its *N*-methyl- and *NN'*-dimethyl-derivatives to give dihydrodiazepinium salts.

2,3-DIHYDRO-1,4-DIAZEPINIUM ions (I) [1,2] have been studied extensively; they have considerable stabilisation [3] due to a delocalised conjugated system which is not however completely cyclic. Because of this stabilisation they undergo electrophilic substitution and show a great 'tendency to retain the type' [4] or meneidic character.[5] Similar meneidic character has been found in open-chain diazapolymethinium salts (II),[6] but the latter appear to be in general less stable than the dihydrodiazepinium salts. Models suggest that the seven-membered ring in (I) is strain-free and that the molecules exist in a half-chair conformation which is rapidly inverting at room temperature, and in which the whole delocalised portion of the molecule must be effectively coplanar; this has been confirmed by proton n.m.r. studies [7] and *X*-ray crystallography.[8]



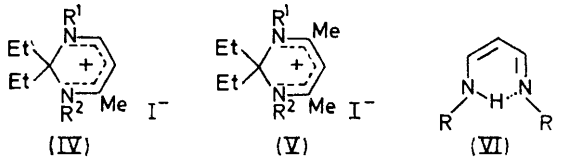
(I) (II) (III)

It seems possible, therefore, that the particular stability of dihydrodiazepinium salts is also associated with their geometry, and the fact that the molecules are held in a favourable conformation. The sp^3-hybridised groups linking the ends of the conjugated chain should play no part in the chemistry of this chain, unless they distort it sterically. To investigate this factor it seemed desirable to incorporate the same diazapolymethinium system into other molecules with different but defined shapes. In the open-chain analogues (II) the shape of the molecules in solution cannot be strictly defined.

As examples of such compounds the 1,2-dihydropyrimidinium salts (III) have now been prepared and examined. Two methods for the preparation of 1,2-dihydropyrimidines had been reported: reduction of a pyrimidin-2-one,[9] and a condensation reaction involving a ketone, an oxo-acetal, and ammonia in the presence of ammonium nitrate.[10]

By the latter method 2,2-diethyl-4-methyl- [10] and 2,2-diethyl-4,6-dimethyl-1,2-dihydropyrimidines were prepared, the latter from pentan-3-one and the mono-acetal of acetylacetone. Both dihydropyrimidine bases were unstable at room temperature but could be kept unchanged for long periods at low temperatures. The chloride and bromide salts of the monomethyl compound were conveniently prepared as crystalline solids by passing the appropriate hydrogen halide through a dry ethereal solution of the base, but the corresponding salts of the dimethyl compound were only obtained as oils. Both compounds gave crystalline picrates on treatment with picric acid in acetone.

Both these dihydropyrimidines were also methylated by methyl iodide to give *N*-methyl derivatives. Methylation of the monomethyldihydropyrimidine might give either of the isomers (IV; R^1 = Me, R^2 = H) and (IV; R^1 = H, R^2 = Me). The n.m.r. spectrum shows that the product is the 1,4-dimethyl derivative (IV; R^1 = Me, R^2 = H), which might be expected on steric grounds. The 5-proton gives rise to a double doublet (J 6.4 and 2.4 Hz) because of coupling with the 6-proton and an NH group, and the 6-proton gives a sharp doublet, J 6.4 Hz, and hence must be adjacent to an *N*-methyl group. The n.m.r. spectrum of this compound in trifluoroacetic acid shows a complex multiplet for the methylene protons of the ethyl groups, and not a simple quartet. INDOR experiments confirm that this is due to non-equivalence of these protons caused by the pseudoasymmetry at C-2 of the ring.



(IV) (V) (VI)

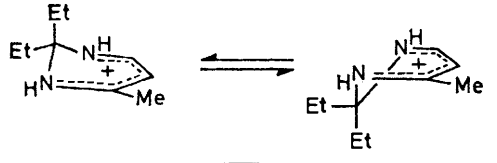
Methylation of the dimethyldihydropyrimidine gave a mixture (3 : 1) of the trimethyl compound (V; R^1 = Me, R^2 = H) and the tetramethyl compound (V; R^1 = R^2 =

[1] D. Lloyd, H. P. Cleghorn, and D. R. Marshall, *Adv. Heterocyclic Chem.*, 1974, **17**, 1; D. Lloyd, *Chimia (Switz.)*, 1975, **29**, 311.
[2] D. Lloyd, H. McNab, and D. R. Marshall, *J.C.S. Perkin I*, 1975, 1260.
[3] D. Lloyd and D. R. Marshall, *Chem. and Ind.*, 1972, 335.
[4] J. W. Armit and R. Robinson, *J. Chem. Soc.*, 1925, **127**, 1604.
[5] D. Lloyd and D. R. Marshall, 'Aromaticity, Pseudo-aromaticity, Anti-aromaticity,' eds. E. D. Bergmann and B. Pullman, Israel Acad. Sci. Humanities, Jerusalem, 1971, p. 85; *Angew. Chem.*, 1972, **84**, 447; *Angew. Chem. Internat. Edn.*, 1972, **11**, 404.
[6] J. Kučera and Z. Arnold, *Coll. Czech. Chem. Comm.*, 1967, **32**, 1704.
[7] D. Lloyd, R. K. Mackie, H. McNab, and D. R. Marshall, *J.C.S. Perkin II*, 1973, 1729.
[8] G. Ferguson and D. Lloyd, unpublished results.
[9] V. P. Mamaev and E. A. Gracheva, *Khim. geterotsikl. Soedinenii*, 1968, 516 (*Chem. Abs.*, 1968, **69**, 96,649s).
[10] S. Hoffmann and E. Muehle, *Z. Chem.*, 1969, **9**, 66.

Me). The trimethyl salt formed first must equilibrate with unchanged dimethyldihydropyrimidine to give some trimethyldihydropyrimidine, which is then further methylated to give the tetramethyl derivative. The ready production of this tetramethyl compound was unexpected in view of the relative difficulty with which the analogous 1,4,5,7-tetramethyldihydrodiazepine is prepared.[11] There may be less crowding of the methyl groups in the case of the dihydropyrimidine consequent upon the smaller internal bond angles of the six- than of the seven-membered ring.

The ^{1}H n.m.r. spectra of dihydropyrimidinium salts closely resemble those of the dihydrodiazepinium salts.[7] In the conjugated chain, protons vicinal to the nitrogen atoms resonate at τ 2.3—2.6, whereas protons at the 5-position, which is electron-rich, do so at τ 4.95—5.05; methyl groups vicinal to the nitrogen atoms also have similar chemical shifts in both sets of compounds. The major differences are in the values of the vicinal coupling constants, which are smaller in the six- ($J_{1,6}$ 6.8; $J_{5,6}$ *ca.* 6) than in the seven-membered ring ($J_{1,7}$ 7.8; $J_{6,7}$ *ca.* 8.25). This is in accord with the change of ring size and hence of a more constrained geometry in the dihydropyrimidinium salts. The values for the dihydropyrimidinium salts are of similar magnitude to those recorded [12] for open-chain diazapentadiene bases in non-polar solvents, in which they take up an all-*cis*-chelate structure (VI). As with dihydrodiazepinium salts,[7] the near identity of the $J_{1,6(3,4)}$ and $J_{5,6(4,5)}$ values provides evidence for the complete delocalisation of the π-electrons in the conjugated portion of the molecule.

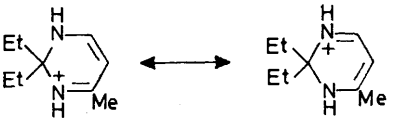
The coupling between the NH and the 5-H indicates that the conjugated portion of the molecule is approximately planar, as in dihydrodiazepinium salts.[7] The 2-position presumably lies out of this plane [*e.g.* (VII)].



(VII)

An attempt was made to observe the possible inversion in this system, but there was no change in the ^{1}H n.m.r. spectrum of (VII) down to −60 °C. Either inversion is very rapid or the molecule is rigid. Similar results were obtained [13] for the 4-methylbenzenium ion, which has some analogy to the present ions.

The NH signals of (VII) in deuteriochloroform consist of a broad singlet at τ − 0.36 and a broad doublet at τ − 0.10. Spin decoupling of the 6-proton causes the doublet to collapse to a singlet. The NH adjacent to the 4-methyl group thus provides the downfield signal despite the inductive effect of the methyl group. A similar position obtains for the 5-bromo-derivative of (VII). It is possible that, because of the electron-donating effect of the methyl group, canonical form (VIIa) is favoured over form (VIIb); hence the 3-position



(VIIa) (VIIb)

would carry more positive charge and its NH signal would appear at lower field.

The ^{13}C n.m.r. data for compounds (III; R^1 = Me, R^2 = H, X = Br or picrate) and (III; R^1 = R^2 = Me, X = picrate) are shown in the Table. The effect of the counter-ion is obviously small. The shifts are similar to those for dihydrodiazepinium cations,[14] and, like the latter, emphasise the large differences in electron density amongst the various sites in the diazapolymethinium chain.

The u.v. spectra of the dihydropyrimidinium salts show pronounced bathochromic shifts in comparison with their dihydrodiazepinium analogues, *e.g.* 27 nm for (III; R^1 = R^2 = Me, X = Cl), and the extinction coefficients are markedly lower. This is presumably attributable to the difference in geometry between the two conjugated systems; the extinction coefficients of all-*trans*-open-chain diazapentamethinium salts are markedly higher than those of either of the cyclic compounds. As with dihydrodiazepinium salts, *N*-methyl groups cause bathochromic shifts in dihydropyrimidinium salts.

The dihydrodiazepinium cations (I) are protonated at the 6-position in concentrated sulphuric acid. Similarly the cation (VII) is protonated, presumably at the 5-position, to give a species which shows weak absorption at 335 and 262 nm. Addition of water regenerates the monocation. The dication is stable in acidic solution,

^{13}C N.m.r. data for dihydropyrimidinium salts (III) [10% solutions in $(CD_3)_2SO$; Me_4Si standard]

R^1	R^2	X	δ(2)	δ(4,6)	δ(5)	δ(Me)	δ(Et)
Me	H	Br	73.86	152.87	90.42	19.72	7.63
				166.55			30.56
Me	H	Picrate	73.34	152.90	90.30	19.54	7.21
				166.31			30.21
Me	Me	Picrate	73.75	164.56	90.95	19.29	7.23
							30.47

[11] C. Barnett, H. P. Cleghorn, G. E. Cross, D. Lloyd, and D. R. Marshall, *J. Chem. Soc.* (*C*), 1966, 93.

[12] E. Daltrozzo and K. Feldmann, *Ber. Bunsengesellschaft Phys. Chem.*, 1968, **72**, 1140.

[13] G. A. Olah, R. H. Schlosberg, R. D. Porter, Y. K. Mo, D. P. Kelly, and G. D. Mateescu, *J. Amer. Chem. Soc.*, 1972, **94**, 2034.

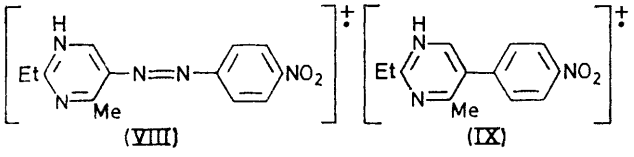
[14] D. Lloyd, R. K. Mackie, H. McNab, and D. R. Marshall, *Tetrahedron*, in preparation.

for the monocation can be regenerated after a solution in sulphuric acid has been kept for 10 days. Protonation of the dihydropyrimidinium ion occurs in less strong acid than is required to protonate dihydrodiazepinium ions. For example the ^{1}H n.m.r. spectrum of (VII) in trifluoroacetic acid shows the 5-H resonance as a broad signal because of equilibration between monocation and dication; the 6-H signal is also broadened since coupling with the NH and 5-H is affected. There is no evidence for such protonation of dihydrodiazepinium monocations in trifluoroacetic acid; the latter cations thus appear to be the preferred species over a wider pH range than is the case for the dihydropyrimidinium ions.

Like dihydrodiazepinium ions, dihydropyrimidinium salts undergo electrophilic substitution, at the 5-position. Thus they are deuteriated in trifluoracetic [^{2}H]acid and brominated by bromine in methanol. *N*-Halogenosuccinimides also react at the 5-position to give 5-chloro-, -bromo-, and -iodo-derivatives. However, the reaction of the bromide (III; R^1 = Me, R^2 = H, X = Br) with *N*-chlorosuccinimide gave, not the 5-chloro-compound, but the 5-bromo-derivative, presumably formed by chlorination of the bromide counter-ion to give a species which acts preferentially as a brominating agent. If the counter-ion was chloride, the 5-chloro-compound was obtained.

Halogenation at the 5-position causes a bathochromic shift of 20—25 nm in the electronic spectrum, which is quantitatively similar to that observed for dihydrodiazepinium salts.[11,15] As expected the presence of a 5-halogeno-substituent causes a downfield shift of the ^{1}H n.m.r. signals due to methyl groups at the 4- and 6-positions.

Attempts to nitrate dihydropyrimidinium cations under a variety of conditions were unsuccessful. Attempted diazo-coupling reactions with *p*-nitrobenzenediazonium tetrafluoroborate gave complex mixtures of products, but the mass spectra of the crude product from the 4-methyl compound (III; R^1 = Me, R^2 = H, X = Cl) indicated that coupling could have taken place: ions derived from the expected breakdown of such products, *e.g.* (VIII) [Found: *m/e* 272.1142. (VIII) requires 272.1147], were identified by high resolution studies. Ion (IX) [Found: *m/e* 244.109 4. (IX) requires



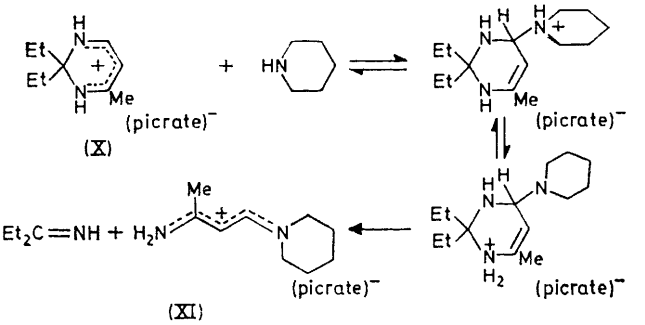
(VIII) (IX)

244.108 5] was also detected and could have arisen either from further breakdown of (VIII) or from a Gomberg-arylation product.

These dihydropyrimidinium compounds thus present an intriguing example of dihydro-'aromatic' compounds which show much greater reactivity towards electrophilic substitution than do the parent 'aromatic systems.

The reactions of 5,7-disubstituted 6-halogenodihydrodiazepines with nucleophiles are complex, with substitution and protodehalogenation as competing reaction paths, the latter tending to predominate only in sterically crowded examples.[15,16] It was surprising, therefore, that the 5-bromo-4-methyldihydropyrimidine was smoothly debrominated by thiourea. The results obtained with the 5-bromo-4,6-dimethyl compound were inconclusive, although the u.v. spectrum of the reactant solution strongly suggested that debromination had occurred, but the 5-chloro-4,6-dimethyldihydropyrimidine was unchanged when heated with thiourea in refluxing ethanol for 5 h. This is in marked contrast to the 6-chloro-5,7-dimethyldihydrodiazepine, which under identical conditions gave a quantitative yield of the 6-isothiouronium salt.[16] This difference may be associated with absence of vicinal crowding in the chlorodihydropyrimidine because of the smaller internal bond angles in the six-membered ring; lack of vicinal crowding of the 6-halogeno-substituent in dihydrodiazepines has been shown to remove the reactivity of the substituent towards nucleophiles.[2]

Dihydrodiazepines which are unsubstituted in the 5- and 7-positions react readily with *N*-nucleophiles at these positions.[2] The dihydropyrimidinium salt (X) reacted with piperidine to give the product (XI). Presumably



(X) (XI)

because of the presence of the hindering methyl substituent at the 4-position, no comparable displacement took place at this site. A possible mechanism for the formation of (XI) is shown. After the initial nucleophilic attack by the piperidine, the driving force is probably the regeneration of the stabilised diazapolymethinium system, which is accomplished by elimination of pentan-3-imine. No related mechanism can be drawn for any analogous reaction involving a dihydrodiazepine, and in fact the 5-methyldihydrodiazepinium ion was unchanged after prolonged heating with piperidine in refluxing methanol.

When the 4,6-dimethyldihydropyrimidinium salt (III; R^1 = R^2 = Me; X = picrate) was heated with piperidine no comparable reaction appeared to take place.

When the salt (X) was heated with ethylenediamine or its *N*-methyl or *NN'*-dimethyl derivative, reaction

[15] D. Lloyd and D. R. Marshall, *J. Chem. Soc.*, 1958, 118; A. M. Gorringe, D. Lloyd, F. I. Wasson, D. R. Marshall, and P. A. Duffield, *J. Chem. Soc.* (*C*), 1969, 1449.

[16] E. M. Grant, D. Lloyd, and D. R. Marshall, *Chem. and Ind.*, 1974, 525.

occurred at both the 4- and the 6-positions, to give, respectively, 5-methyl-, 1,5-dimethyl-, and 1,4,5-trimethyl-dihydrodiazepinium picrates. The 1,5-dimethyl-dihydrodiazepinium salt was formed exclusively, with none of the 1,7-isomer. This can be rationalised as follows. Initial attack will occur at the vacant 6-position, by the MeNH group because of its higher nucleophilicity, and subsequent attack of the NH_2 group at the 4-position is sterically favourable.

In the mass spectra of these dihydropyrimidinium salts the major breakdown pathway involved loss of one 2-ethyl group to give a pyrimidinium ion. This occurred even for 5-halogeno-derivatives. The importance of this breakdown provides an example of 'aromatic' stability (as shown by pyrimidinium ions) not necessarily correlating with 'aromatic' reactivity (shown by the dihydropyrimidinium ions). Further decomposition of the pyrimidinium ion gives only peaks of relatively low intensity, and that due to trivial loss of a methyl group is probably the most important. The breakdown of the ring itself characteristically involves the loss of cyanide molecules. For example the breakdown of (III; $R^1 = R^2 = Me$) proceeds as follows: $M^+ \longrightarrow m/e$ 137.1073 ($C_8H_{12}N_2$ requires 137.1078; m^* found 113; 166 $\longrightarrow$ 137 requires 113.0) $\longrightarrow$ 122 (m^* found 108.7; 137 $\longrightarrow$ 122 requires m^* 108.6).

EXPERIMENTAL

Electronic spectra were recorded for methanolic solutions and i.r. spectra for Nujol mulls.

2,2-Diethyl-1,2-dihydro-4-methylpyrimidinium Salts (III; $R^1 = Me$, $R^2 = H$).—Ammonia was passed for 8 h through a stirred mixture of 2-oxobutyraldehyde 1-(dimethyl acetal) (33 g), pentan-3-one (50 g), and ammonium nitrate (10 g). Aqueous sodium hydroxide (60 g in 60 ml) was then added slowly; the crude dihydropyrimidine base separated as an oil, which was purified by distillation. The fraction of b.p. 80—90° at 1.2 mmHg (lit.,[10] 85—87° at 1.5 mmHg) solidified in the receiver (11.2 g, 30%). When hydrogen bromide was passed through a solution of this base (5.3 g) in ether, the *dihydropyrimidinium bromide* separated immediately as yellow crystals (7.4 g, 91%), m.p. 184.5—185° (from nitromethane) (Found: C, 46.25; H, 7.4; N, 12.0. $C_9H_{17}BrN_2$ requires C, 46.35; H, 7.3; N, 12.0%). The *chloride*, prepared similarly, had m.p. 180—180.5° (from nitromethane), $\lambda_{max.}$ 356 nm (ε 4 550), $\nu_{max.}$ 3 100, 1 630, 1 570, 1 540, 1 260, 1 160, and 820 cm^{-1}, τ ($CDCl_3$) −0.36br(s), −0.10br(d), 2.63 (1H, dd), 5.11 (1H, d), 7.71 (3H, s), 8.01 (4H, q), and 8.93 (6H, t) (Found: C, 57.6; H, 9.5; N, 14.75. $C_9H_{17}ClN_2$ requires C, 57.3; H, 9.0; N, 14.85%). This salt could be made more conveniently but in slightly lower yield from the base and methanolic hydrogen chloride. Addition of a saturated solution of picric acid (wet with ethanol; *ca.* 2.5 g) in acetone to an ethereal solution of the base (1.53 g) provided the *picrate* (2.5 g, 66%), m.p. 123—125° (from ethanol) (Found: C, 47.25; H, 5.0; N, 18.35. $C_{15}H_{19}N_5O_7$ requires C, 47.2; H, 5.0; N, 18.2%).

2,2-Diethyl-1,2-dihydro-4,6-dimethylpyrimidinium Picrate (III; $R^1 = R^2 = Me$; X = picrate).—The base (25.9 g, 63%), made by the same method as the 4-methyl analogue but from acetylacetone monoacetal[17] (38 g), had b.p. 60° at 0.5 mmHg and solidified in the receiver. Picric acid (wet with ethanol; 6.5 g) in acetone was added to a solution of the base (4.15 g) in ether. Evaporation followed by addition of ether gave the *picrate* (6.75 g, 68%), m.p. 138—140° (decomp.) (from propan-2-ol), $\lambda_{max.}$ 352 nm (ε 19 800), $\nu_{max.}$ 3 300, 1 640, 1 560, 1 320, 1 270, and 1 170 cm^{-1}, τ ($CDCl_3$) 1.15 (2 H, s), 1.68br, 5.01 (1 H, s), 7.80 (6 H, s), 8.08 (4 H, q), and 9.01 (6 H, t) (Found: C, 48.65; H, 5.3; N, 17.85. $C_{16}H_{21}N_5O_7$ requires C, 48.6; H, 5.3; N, 17.7%).

2,2-Diethyl-1,2-dihydro-1,4-dimethylpyrimidinium Iodide (IV; $R^1 = Me$, $R^2 = H$).—An excess of methyl iodide (6.3 g) was added to a solution of 2,2-diethyl-1,2-dihydro-4-methylpyrimidine (0.77 g) in ether (20 ml). The mixture was kept overnight at room temperature, and the *iodide* crystallised (0.8 g, 55%) when triturated with a small quantity of acetone; m.p. 153—154° (from propan-2-ol), $\lambda_{max.}$ 374 nm (ε 5 100), $\nu_{max.}$ 3 200, 1 630, 1 570, 1 510, 1 300, 1 160, 1 030, and 780 cm^{-1}, τ ($CDCl_3$) 0.74br (1 H), 2.31 (1 H, d), 5.12 (1 H, dd), 6.75 (3 H, s), 7.62 (3 H, s), 7.89 (4 H, m), and 8.85 (6 H, t) (Found: C, 40.75; H, 6.65; N, 9.7. $C_{10}H_{19}IN_2$ requires C, 40.8; H, 6.45; N, 9.5%).

Reaction of 2,2-Diethyl-1,2-dihydro-4,6-dimethylpyrimidine with Methyl Iodide.—Treatment of this pyrimidine (1.66 g) under the same conditions as the 4-methyl analogue with an excess of methyl iodide (12.0 g) gave a yellow solid (1.89 g), m.p. 162—164° (from propan-2-ol), $\lambda_{max.}$ 366 nm. Its n.m.r. spectrum showed it to be a 3 : 1 mixture of 2,2-diethyl-1,2-dihydro-1,4,6-trimethylpyrimidinium iodide (V; $R^1 = Me$, $R^2 = H$), τ ($CDCl_3$) 0.90br, 5.13 (1 H, s), 6.87 (3 H, s), 7.88 (q), and 8.90 (t), and 2,2-diethyl-1,2-dihydro-1,3,4,6-tetramethylpyrimidinium iodide (V; $R^1 = R^2 = Me$), τ ($CDCl_3$) 5.05 (1 H, s), 6.79 (6 H, s), 7.88 (q), and 8.85 (t). The 4- and 6-methyl groups of the two compounds gave further signals at τ 7.67, 7.71, and 7.74 which could not be assigned specifically (Found: C, 43.35; H, 7.1; N, 8.8. Calc. for the proposed mixture: C, 43.3; H, 6.9; N, 9.0%).

5-Bromo-2,2-diethyl-1,2-dihydro-4-methylpyrimidinium Salts.—(*a*) Bromine (0.70 g) in methanol (3 ml) was added dropwise to a solution of the 5-unsubstituted dihydropyrimidinium bromide (0.92 g) in methanol (3 ml). Addition of ether precipitated the *5-bromodihydropyrimidinium bromide* (0.92 g, 75%), m.p. 114—116° (reprecipitated from propan-2-ol by ether), $\lambda_{max.}$ 379 nm (ε 3 800), $\nu_{max.}$ 3 100, 1 610, 1 520, 1 260, and 1 160 cm^{-1}, τ ($CDCl_3$) −0.14br, 0.13br, 2.42 (1 H, d), 7.51 (3 H, s), 7.96 (4 H, q), and 8.92 (3 H, t) (Found: C, 34.45; H, 5.45, N, 9.1. $C_9H_{16}Br_2N_2$ requires C, 34.6; H, 5.15; N, 8.95%).

(*b*) A mixture of *N*-bromosuccinimide (0.36 g) and the 5-unsubstituted dihydropyrimidinium chloride (0.38 g) in chloroform (5 ml) was shaken until all the solid had dissolved. The solvent was evaporated off and the residue was dissolved in a small quantity of methanol and cooled to −78 °C. The precipitated succinimide was filtered off and the filtrate was concentrated; addition of ether promoted crystallisation of the *5-bromodihydropyrimidinium chloride* (0.4 g, 76%), m.p. 109—110° (reprecipitated from propan-2-ol by ether) (Found: C, 39.3; H, 6.1; N, 9.95. $C_9H_{16}BrClN_2,0.5H_2O$ requires C, 39.05; H, 6.15; N, 10.15%).

5-Bromo-2,2-diethyl-1,2-dihydro-4,6-dimethylpyrimidinium Salts.—(*a*) Bromine (0.16 g) in methanol (2 ml) was added to the 5-unsubstituted dihydropyrimidinium picrate (0.4 g)

[17] L. C. Dorman, *Tetrahedron Letters*, 1966, 459.

in methanol (3 ml). Solvent was evaporated off and addition of ether then precipitated the *5-bromodihydropyrimidinium bromide* (0.29 g, 89%), m.p. 127—129° (from propan-2-ol), $\lambda_{max.}$ 368 nm (ε 4 400), $\nu_{max.}$ 3 100, 1 610, 1 560, 1 290, 1 170, 1 100, 1 040, and 750 cm^{-1}, τ ($CDCl_3$) 0.12br (2 H), 7.53 (6 H, s), 7.96 (4 H, q), and 8.94 (6 H, t) (Found: C, 36.65; H, 5.45; N, 8.6. $C_{10}H_{18}Br_2N_2$ requires C, 36.8; H, 5.5; N, 8.6%).

(*b*) A mixture of the 5-unsubstituted dihydropyrimidinium picrate (0.8 g), *N*-bromosuccinimide (0.36 g), and chloroform (10 ml) was shaken until all the solid had dissolved. After evaporation followed by addition of methanol the solution was cooled to −78 °C. The *5-bromodihydropyrimidinium picrate* which separated was recrystallised from propan-2-ol; yield 0.66 g (70%), m.p. 155—156° (Found: C, 40.7; H, 4.35; N, 14.85. $C_{16}H_{26}BrN_5O_7$ requires C, 40.5; H, 4.2; N, 14.75%).

Reaction of 2,2-Diethyl-1,2-dihydro-4-methylpyrimidinium Bromide with N-Chlorosuccinimide.—The reaction was carried out as for the reaction with *N*-bromosuccinimide but gave the *5-bromodihydropyrimidinium chloride* (0.38 g, 71%), m.p. 110—111° (reprecipitated from propan-2-ol by ether), $\lambda_{max.}$ 378 nm (ε 3 600), M^+ 229/231 (Found: C, 39.2; H, 6.1; N, 9.9. $C_9H_{16}BrClN_2,0.5H_2O$ requires C, 39.05; H, 6.15; N, 10.15%).

5-Chloro-2,2-diethyl-1,2-dihydro-4-methylpyrimidinium Chloride.—When the 5-unsubstituted dihydropyrimidinium chloride (0.76 g) was treated with *N*-chlorosuccinimide (0.52 g) in chloroform (10 ml) by the procedure used with *N*-bromosuccinimide, the 5-chloro-compound was obtained as an oil which could not be crystallised reproducibly; $\lambda_{max.}$ 374 nm, τ ($CDCl_3$) 2.51 (1 H, d), 7.56 (3 H, s), 7.99 (4 H, q), and 8.93 (6 H, t) [Found: *m/e*, 186.0927. $C_9H_{15}{}^{35}ClN_2$ (M − 1) requires 186.0923], *m/e* 99 (succinimide).

2,2-Diethyl-1,2-dihydro-5-iodo-4-methylpyrimidinium Chloride.—When the 5-unsubstituted dihydropyrimidinium chloride was treated with *N*-iodosuccinimide by the procedure used with *N*-bromosuccinimide, the *5-iododihydropyrimidinium chloride* (0.45 g, 66%) was obtained, m.p. 96—96.5° (decomp.) (reprecipitated from methanol by ether), $\lambda_{max.}$ 384 nm (ε 3 500), $\nu_{max.}$ 3 100, 1 610, 1 530, 1 270, 1 160, and 770 cm^{-1}, τ ($CDCl_3$) −0.80br, −0.47br, 2.41 (1 H, d), 7.53 (3 H, s), 8.02 (4 H, q), and 8.93 (6 H, t) (Found: C, 34.05; H, 5.05; N, 8.8. $C_9H_{16}ClIN_2$ requires C, 34.35; H, 5.1; N, 8.9%).

Reaction of 2,2-Diethyl-1,2-dihydro-4-methylpyrimidinium Chloride with p-Nitrobenzenediazonium Tetrafluoroborate.—The dihydropyrimidinium salt (0.38 g) and the diazonium salt (0.54 g) were suspended in water and the mixture was kept overnight. The red precipitate was washed with benzene and ether.

Reaction of 5-Bromo-2,2-diethyl-1,2-dihydro-4-methylpyrimidinium Bromide with Thiourea.—A solution of the dihydropyrimidinium salt (0.16 g) and thiourea (0.04 g) in ethanol (5 ml) was heated under reflux for 20 min. Addition of ether to the cooled solution precipitated the corresponding 5-unsubstituted dihydropyrimidinium salt (0.09 g, 77%), i.r. spectrum identical with that of an authentic sample, m.p. 182—183° (from propan-2-ol), mixed m.p. 180—181°.

Reaction of 5-Bromo-2,2-diethyl-1,2-dihydro-4,6-dimethylpyrimidinium Bromide with Thiourea.—A solution of this salt (0.32 g) and thiourea (0.08 g) in ethanol (10 ml) was heated under reflux for 2 h. The u.v. spectrum of the solution showed $\lambda_{max.}$ 350 nm, consistent with the formation of the corresponding 5-unsubstituted compound. Evaporation followed by addition of ether gave an oil, whose mass and n.m.r. spectra also indicated that protodebromination had taken place.

Reaction of 2,2-Diethyl-1,2-dihydro-4-methylpyrimidinium Picrate with Piperidine.—A solution of the dihydropyrimidinium picrate (0.38 g) and piperidine (0.86 g) in methanol (10 ml) was heated under reflux for 20 min. Solvent was removed *in vacuo* and addition of ether to the residue gave a red oil (0.18 g) which crystallised when the walls of the flask were scratched to provide *1-amino-1-methyl-3-piperidinopropenylium picrate* (XI) (47%), m.p. 142—142.5° (from ethanol), $\lambda_{max.}$ 315 nm (ε 52 100), $\nu_{max.}$ 3 400, 3 100, 1 620, 1 570, 1 350, 1 290, 1 170, 1 090, and 769 cm^{-1}, τ [$(CD_3)_2SO$] 1.16br, 1.40 (2 H, s), 2.10 (1 H, d), 4.59 (1 H, d), 6.42br and 6.60br (4 H, singlets), 7.77 (3 H, s), and 8.37br (6 H, s), M^+ 152 (Found: C, 47.05; H, 5.3; N, 18.05. $C_{15}H_{19}N_5O_7$ requires C, 47.25; H, 5.0; N, 18.35%).

Reactions of 2,2-Diethyl-1,2-dihydro-4-methylpyrimidinium Picrate with Ethylenediamines.—(*a*) A solution of the dihydropyrimidinium salt (1.90 g) and ethylenediamine (1.5 g) in methanol (10 ml) was heated under reflux for 20 min. Methanol was evaporated off *in vacuo* and ether was added. A red-brown solid (1.68 g) separated which was recrystallised from ethanol to give 2,3-dihydro-5-methyl-1,4-diazepinium picrate (0.9 g, 53%), m.p. 127—128°, $\lambda_{max.}$ 330 nm (ε 26 100), $\nu_{max.}$ 3 300, 1 640, 1 560, 1 330, 1 270, and 800 cm^{-1}, τ [$(CD_3)SO$] *ca.* 0.5vbr, 1.40 (2 H, s), 2.57 (1 H, d), 5.06 (1 H, d), 6.40br (4 H, s.), and 7.80 (3 H, s) (Found: C, 42.25; H, 3.7; N, 20.85. Calc. for $C_{12}H_{13}N_5O_7$: C, 42.5; H, 3.85; N, 20.65%). The m.p. (lit.,[18] 146—147°) could not be raised by recrystallisation; samples prepared at a later date had the previously recorded m.p., which was not lowered by admixture with this product.

(*b*) By an identical procedure the dihydropyrimidinium salt (0.38 g) and *NN'*-dimethylethylenediamine (0.45 g) gave *2,3-dihydro-1,4,5-trimethyl-1,4-diazepinium picrate* (0.16 g, 43%), m.p. 118—119° (from ethanol), $\lambda_{max.}$ 343 nm (ε 28 700), $\nu_{max.}$ 1 640, 1 570, 1 340, 1 270, and 800 cm^{-1}, τ [$(CD_3)_2CO$] 1.37 (2 H, s), 2.58 (1 H, d), 4.93 (1 H, d), 6.07br (4 H, s), 6.55 (6 H, s), and 7.67 (3 H, s) (Found: C, 45.6; H, 4.85; N, 19.2. $C_{14}H_{17}N_5O_7$ requires C, 45.8; H, 4.65; N, 19.05%).

(*c*) Similarly the dihydropyrimidinium salt (0.38 g) and *N*-methylethylenediamine (0.37 g) gave *2,3-dihydro-1,5-dimethyl-1,4-diazepinium picrate* (0.25 g, 70%), m.p. 141—142° (from ethanol), $\lambda_{max.}$ 338 nm (ε 28 100), $\nu_{max.}$ 3 200, 1 640, 1 620, 1 530, 1 340, 1 170, 1 090, and 720 cm^{-1}, τ [$(CD_3)_2SO$] 1.39 (2 H, s), 2.53 (1 H, d), 5.13 (1 H, d), 6.37 (4 H, complex), 6.67 (3 H, s), and 7.82 (3 H, s) (no NH signal apparent) (Found: C, 43.85; H, 4.3; N, 19.7. $C_{13}H_{15}N_5O_7$ requires C, 44.2; H, 4.25; N, 19.85%).

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[18] W. W. Paudler and A. G. Zeiler, *J. Org. Chem.*, 1969, **34**, 999.