New Reactions of Polyfluoroaromatic Compounds. Part II.† Polyfluoroaralkyl Amines [1]

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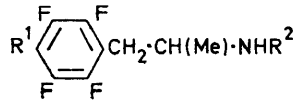
The preparations of the pentafluoro-(1a) and 4-methoxy-2,3,5,6-tetrafluoro-(1b) analogues of (±)-amphetamine and of *N*-methyl-*N*-pentafluorobenzylprop-2-ynylamine (25) are outlined. The synthesis of salts of 1-methyl-2-pentafluorophenylethylhydrazine (10) and (12) and 2-pentafluorophenylcyclopropylamine (19) are described.

THE critical role of the β-phenethylamine skeleton in imparting sympathomimetic effects is well established.[2] The best known member of this class of compounds is 1-methyl-2-phenylethylamine (amphetamine), which exhibits potent central nervous system activity [3] and has served as the focal point for the design of newer antidepressant drugs, including aralkylhydrazine analogues.[4]

Here we describe the synthesis of five analogues of antidepressant drugs which contain a polyfluoroaryl group. The first three analogues are represented by the general structure (1):



a; $R^1 = F$, $R^2 = H$
b; $R^1 = OMe$, $R^2 = H$
c; $R^1 = F$, $R^2 = NH_3^+X^-$ $X = Br[\equiv(10)]$, $Cl[\equiv(12)]$

1-Methyl-2-pentafluorophenylethylamine (1a) was prepared from the known compound 3-pentafluorophenylpropene (2).[5] Pentafluorophenylmagnesium bromide was treated with allyl bromide in ether to give (2) in high yield. Addition of hydrogen bromide to this gave 2-bromo-1-pentafluorophenylpropane which, in the presence of excess liquid ammonia at room temperature afforded *trans*-1-pentafluorophenylpropene as the only isolable product.[6] The relatively high acidity of the methylene protons adjacent to the fluorinated ring [7] facilitates elimination to the exclusion of direct displacement of bromide ion.[8] Nucleophilic aromatic substitution was not observed under the conditions of the reaction.[9] However 2-bromo-1-pentafluorophenylpropane reacted with azide ion to give 2-azido-1-pentafluorophenylpropane in good yield, which upon hydrogenolysis over palladium on charcoal gave (1a).

p-Methoxytetrafluorobromobenzene, obtained by reaction of bromopentafluorobenzene with methoxide ion and separated from its *ortho*-isomer by preparative g.l.c., was similarly converted into 1-methyl-2-(*p*-methoxytetrafluorophenyl)ethylamine (1b).

Compound (1b) could not be isolated as the free amine and attempts to distil it under reduced pressure gave a white solid which was insoluble in water and common organic solvents. In the absence of solvent, the solid precipitated from (1b) within a few minutes. Similar behaviour was observed with (1a), but only after 1 week at room temperature. The solids are probably polymers formed by nucleophilic attack of the amino-group of one molecule on the polyfluorophenyl group of another. Such displacements of fluoride ion from the polyfluoroaryl ring are well known.[9-11]. A ^1H n.m.r. spectrum of a dilute solution of the polymer derived from (1b) in trifluoroacetic acid, revealed that all of the methoxy-groups remained intact.

A second route to (1b) has also been developed. Formylation of 1-lithio-2,3,5,6-tetrafluoroanisole gave *p*-methoxytetrafluorobenzaldehyde in good yield. A Knoevenagel condensation of this with nitroethane gave 1-(p-methoxytetrafluorophenyl)-2-nitropropene which in a one-step reduction of both the double-bond and the nitro-group with lithium aluminium hydride [12] gave (1b).

In our initial approach to the hydrazine salt (10), we investigated the reductive aralkylation of hydrazine.[13] This necessitated the prior preparation of methyl pentafluorobenzyl ketone (5), a compound recently prepared by another route.[14] Attempts to prepare (5) by reaction of pentafluorophenylacetyl chloride with cadmiumdimethyl in benzene, were unsuccessful. Although direct hydration of the double bond in (2) with aqueous sulphuric acid [15] gave 1-methyl-2-pentafluorophenylethanol (4), yields were erratic (25 to 85%). Compound (4) was ultimately obtained in consistently good yield by epoxidation of (2) to give (3), whose epoxy-linkage was smoothly cleaved with lithium alu-

† Part I, R. Filler, N. R. Ayyangar, W. Gustowski, and H. H. Kang, *J. Org. Chem.*, 1969, **34**, 534.

[1] Presented, in part, at the Third Great Lakes Regional Meeting of the American Chemical Society, DeKalb, Illinois, June 1969.

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[6] This compound was characterized by refractive index, boiling point, g.l.c. retention time, and i.r. assignments, as reported by G. M. Birchall, T. Clarke, and R. N. Haszeldine, *J. Chem. Soc.*, 1962, 4977.

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[8] R. Filler, N. R. Ayyangar, W. Gustowski, and H. H. Kang, *J. Org. Chem.*, 1969, **34**, 534.

[9] G. M. Brooke, J. Burdon, M. Stacey, and J. C. Tatlow, *J. Chem. Soc.*, 1960, 1768; G. M. Brooke, J. Burdon, and J. C. Tatlow, *ibid.*, 1961, 802.

[10] A. K. Barbour, M. W. Buxton, P. L. Coe, R. Stephens, and J. C. Tatlow, *J. Chem. Soc.*, 1961, 808.

[11] J. M. Birchall and R. N. Haszeldine, *J. Chem. Soc.*, 1961, 3719.

[12] E. H. P. Young, *J. Chem. Soc.*, 1958, 3493.

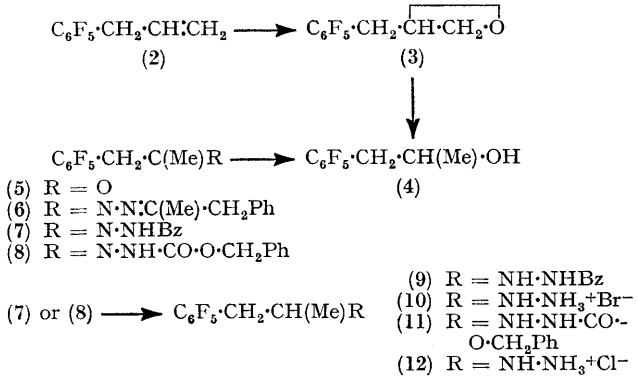
[13] W. S. Emerson, *Org. Reaction*, vol. 4, John Wiley and Sons, New York, N.Y., 1948, 174.

[14] G. M. Brooke, *Tetrahedron Letters*, 1968, **17**, 2029.

[15] B.P. 983,921/1965 (*Chem. Abs.*, 1965, **62**, 14,570a).

minium hydride (Scheme 1). Oxidation of (4) to (5) with chromic acid proceeded smoothly. However all attempts to form the hydrazone of (5) gave instead, the azine (6) as the only isolable product. We turned, therefore, to the hydrazide reductive aralkylation technique of Fox and Gibas.[16] Condensation of benzohydrazide with (5) gave the *N*-benzoylhydrazone (7) the C=N bond of which underwent catalytic hydrogenation to give *N'*-(1-pentafluorobenzylethyl)benzohydrazide (9). Hydrolysis of this with 48% hydrobromic acid gave hydrazinium bromide (10). All attempts to isolate the free base were unsuccessful.

In an alternative approach, benzyloxycarbonylhydrazine hydrochloride[17] was treated with (5) to give compound (8), which failed to undergo catalytic hydrogenation but was reduced with sodium borohydride in aqueous ethanol to form compound (11). The hydrazinium chloride, (12), was then obtained by catalytic hydrogenolysis. The preparation of the hydrazine salts are summarized in Scheme 1.



Scheme 1

The preparation of the fourth member of the series 2-pentafluorophenylcyclopropylamine (19), was initiated by the thermally induced addition of ethyl diazoacetate to pentafluorostyrene to give ethyl 2-pentafluorophenylcyclopropanecarboxylate (13) in good yield. Saponification of this followed by acid work-up gave the acid (14) which was converted into the desired amine in poor yield by a Schmidt rearrangement. Attempts to form the amine by Hofmann rearrangement of the amide of (14) were unsuccessful, but the corresponding acid azide (16) readily underwent Curtius rearrangement to the isocyanate, which was converted into the carbamates (17) and (18) on treatment with ethanol and benzyl alcohol, respectively. Although the ethyl carbamate was slowly hydrolyzed in refluxing hydrochloric–acetic acid,[18,19] the cyclopropylamine was obtained more readily by treating (18) with dry hydrogen bromide in glacial acetic acid.

[16] H. H. Fox and J. T. Gibas, *J. Org. Chem.*, 1952, **17**, 1653.
[17] K. Hofmann, A. Lindenmann, M. Z. Magee, and N. H. Khan, *J. Amer. Chem. Soc.*, 1952, **74**, 470.
[18] A. Burger and W. Yost, *J. Amer. Chem. Soc.*, 1948, **70**, 2198.
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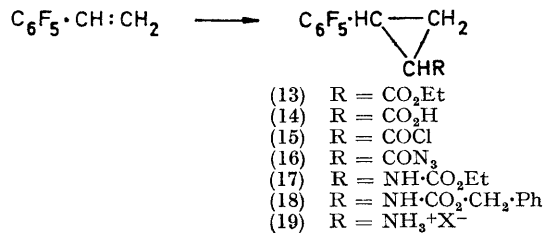
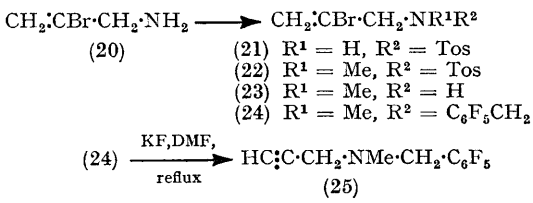
In order to avoid the formation of polymer, the amine was converted directly into its hydrosulphate salt. The reactions are summarized in Scheme 2.

For the synthesis of the fifth member of the series, *N*-methyl-*N*-pentafluorobenzylprop-2-ynylamine (25) (Scheme 3), 2-bromoallylamine (20) was prepared by



Scheme 2



Scheme 3

reaction of 2,3-dibromopropene with hexamethylenetetramine, followed by hydrolysis of the intermediate complex.[20] Compound (20) was converted into its toluene-*p*-sulphonamide (21), which was alkylated with dimethyl sulphate. The toluene-*p*-sulphonate group of (22) was cleaved in refluxing 48% hydrobromic acid–phenol to give (23), which, in turn, was alkylated with 2,3,4,5,6-pentafluorobenzyl toluene-*p*-sulphonate to give the tertiary amine (24) in excellent yield. Pentafluorobenzyl toluene-*p*-sulphonate was prepared from pentafluorobenzyl alcohol and toluene-*p*-sulphonyl chloride or from pentafluorobenzyl bromide and silver toluene-*p*-sulphonate[21] in acetonitrile. Finally, compound (24) underwent smooth dehydrobromination on treatment with anhydrous potassium fluoride in refluxing dimethylformamide to give the desired prop-2-ynylamine (25). The latter reaction[22] is potentially of great utility for the preparation of olefins and acetylenes from substrates which contain polyfluoroaryl or other substituted rings which cannot tolerate strong bases of high nucleophilicity.

Compound (25) is stable at room temperature and forms a silver acetylide. It does not form a picrate or a stable hydrosulphate. The possibility of an intra- or inter-molecular charge-transfer complex between the polyfluoroaryl ring and the π-electrons of the acetylenic bond in (25) is under investigation.

All five final compounds are currently undergoing biological screening.

[20] Obtained in 60% yield by the method of A. Bottini, V. Dev, and J. Klinck, *Org. Synth.*, 1963, **43**, 6.
[21] Obtained in 95% yield by the method of N. Kornblum, W. Jones, and G. Anderson, *J. Amer. Chem. Soc.*, 1959, **81**, 4113.
[22] M. Hauptschein and R. E. Oesterling, *J. Amer. Chem. Soc.*, 1960, **82**, 2868.

EXPERIMENTAL

General.—All ^{1}H n.m.r. spectra were recorded on a Varian A-60 spectrometer. Data are given in δ relative to tetramethylsilane as internal standard, and are for neat liquids unless otherwise specified. I.r. spectra of carbon tetrachloride solutions, unless otherwise specified, were recorded on a Perkin Elmer 257 spectrophotometer. U.v. spectra were recorded on a Cary Model 14 spectrophotometer. V.p.c. was performed on a 5 ft. × 0·250 in. 15% Carbowax (70—80m) on Chromosorb P column on a Varian Aerograph 700 (analytical) instrument and on an 80 in. × 0·750 in. 20% Carbowax (20m) on Chromosorb P column on a Hewlett Packard 776 (preparative) instrument. Percentage composition data were estimated by peak areas and are uncorrected. All m.p.s were determined on a Thomas Hoover 'Unimelt' and are uncorrected. Microanalyses were performed by M–H–W Laboratories, Garden City, Michigan.

3-Pentafluorophenylpropene (2).—Bromopentafluorobenzene (74·1 g., 0·30 mole) in anhydrous ether (200 ml.) was added dropwise during 1 hr. to magnesium turnings (7·2 g., 0·30 g-atom) under a nitrogen atmosphere. The mixture was stirred at 25° for 1 hr. after which freshly distilled allyl bromide (43·6 g., 0·36 mole) in anhydrous ether (100 ml) was added during 20 min followed by anhydrous ether (100 ml). After it had been stirred at 25° overnight, the mixture was poured into a slurry of 4N-hydrochloric acid (250 ml.) and crushed ice (200 g.). The ethereal layer was separated, the aqueous layer was extracted with ether (2 × 75 ml.), and the combined organic phases were washed once with water (100 ml.) and dried ($MgSO_4$). Fractionation of the concentrate through a 10 cm. Vigreux column gave the phenylpropene (2) (53·7 g., 86%), b.p. 148—150°, n_D^{27} 1·4270 (lit.,[6] b.p. 148—149°, n_D^{23} 1·4265), δ 5·89 (1H, m, C*H*=C), 5·10 (2H, m, $C_6F_5CH_2$) and 3·45 (2H, m, C=CH_2).

2-Bromo-1-pentafluorophenylpropane.—20·0 g (96 mmole) of the phenylpropene (2) and 48% aqueous hydrobromic acid (80 ml.) were stirred and heated under reflux for 12 hr. The mixture was cooled and the organic phase was separated; the aqueous layer was extracted with ether (2 × 35 ml.) and the combined organic phases were washed once with water (25 ml.) and dried ($MgSO_4$). Fractionation of the concentrate through a 10 cm. Vigreux column gave the bromopropane (20·2 g., 73%) b.p. 54—56°/3·0 mm., n_D^{24} 1·4615, δ 4·33 (1H, m, C*H*Br), 3·28 (2H, d, CH_2) and 1·82 (3H, d, CH_3).

Reaction of 2-Bromo-1-pentafluorophenylpropane with Liquid Ammonia.—The bromopropane (8·0 g., 28 mmole) and liquid ammonia (1·1 g., 65 mmole) were shaken in a sealed Carius tube at 25° for 4 days, during which time a solid separated. The tube was cooled to −78°, opened, warmed to 25°, and the residual ammonia was removed under gentle vacuum. Water was added to the mixture to dissolve the solid, followed by the addition of ether. The organic layer was separated and the aqueous phase was extracted with ether (2 × 15 ml.), the combined organic extracts were washed with small quantities of water until the wash was neutral after which the extracts were dried (BaO). Fractionation of the concentrate through a 10 cm. Vigreux column gave two fractions: (a) *trans*-1-pentafluorophenylpropene (2·8 g., 49% conversion, 77% yield), b.p. 65—70°/13—14 mm., 160—163°, n_D^{20} 1·4580 [lit.,[7] b.p. 159—160°, n_D^{20} 1·4590]. Analytical v.p.c. showed fraction (a) to be 96—97% pure, contaminated with traces of unchanged bromopropane and a compound thought to be the *cis*-isomer, $\nu_{max.}$ 1626, 1524, 1502, 980, and 800—600 cm.$^{-1}$ (weak bands only), δ 1·95 (3H, d, CH_3) and 6·53 (2H, m, C*H*=C*H*). (b) (3·0 g., 38% recovery) 2-bromo-1-pentafluorophenylpropane b.p. 90—91°/13—14 mm., n_D^{27} 1·4598; i.r. was identical with that obtained for an authentic sample. Concentration of the aqueous phase left ammonium bromide.

2-Azido-1-pentafluorophenylpropane.— 2-Bromo-1-pentafluorophenylpropane (10·5 g., 36 mmole), ethanol (30 ml.), water (75 ml.), and sodium azide (9·75 g., 0·15 mole) were stirred and heated under rapid reflux for 7 days. The mixture was cooled, organic layer was separated, and the aqueous phase was extracted with ether (2 × 35 ml.); the combined organic layers were washed with water (50 ml.) and dried ($MgSO_4$). Fractionation of the concentrate through a 10 cm. Vigreux column gave the azidopropane (6·1 g., 68%), b.p. 60—63°/1·0—1·5 mm., n_D^{20} 1·4541, $\nu_{max.}$ 2105, 1518, 1502, 972 cm.$^{-1}$; δ 3·80 (1H, m, C*H*N_3), 2·95 (2H, d, CH_2), and 1·38 (3H, d, CH_3).

1-Methyl-2-pentafluorophenylethylamine (1a).—2-Azido-1-pentafluorophenylpropane (6·0 g., 24 mmole), ethyl acetate (100 ml.), 10% palladium on charcoal (1 g.) were shaken with hydrogen (60 lb/sq. in. for 1 hr. at 25°. After filtration and concentration of the ethyl acetate solution the residue was fractionated through a 10 cm. Vigreux column to give the ethylamine (1a) (4·5 g., 83%), b.p. 33—35°/0·1—0·2 mm., $n_D^{23.5}$ 1·4419; $\nu_{max.}$ 3378w, 1517, 1500, and 975 cm.$^{-1}$; δ 3·21 (1H, m, C*H*N), 2·75 (2H, d, CH_2), 1·28 (2H, sharp, s, NH_2), and 1·14 (3H, d, CH_3).

The *N*-benzoyl derivative was obtained as needles, m.p. 171—172° (aqueous methanol) (Found: C, 58·4; H, 3·6; N, 4·05. $C_{16}H_{12}F_5NO$ requires C, 58·35; H, 3·65; N, 4·25%).

1-Methyl-2-pentafluorophenylethylamine Sulphate.—The ethylamine (1a) was dissolved in ethanol–ether (25 ml., 1 : 3), a 5% sulphuric acid solution in ethanol was then added dropwise to the stirred solution until it was just slightly acidic. The mixture was worked-up to give a quantitative yield of the amine sulphate, m.p. 290—295° (decomp.) (Found: C, 39·35; H, 3·4; N, 5·0. $C_{18}H_{18}F_{10}N_2O_4S$ requires C, 39·4; H, 3·3; N, 5·1%).

p-Methoxytetrafluorobromobenzene.— Bromopentafluorobenzene (49·2 g., 0·20 mole) was added to a stirred solution of sodium (4·7 g., 0·205 g. atom) in absolute methanol (100 ml.) under anhydrous conditions. The mixture was stirred and heated under reflux for 8 hr., and was then cooled and poured into cold water (500 ml.). The organic phase was separated and the aqueous phase was exhaustively extracted with ether. The combined organic layers were washed successively with brine (2 × 50 ml.) and water (2 × 50 ml.) and then dried (Na_2SO_4). Bulk distillation of the concentrate gave a mixture of *ortho*- and *para*-isomers (46·1 g., 89%) (v.p.c. and ^{1}H n.m.r). Preparative v.p.c. gave the pure *para*-isomer (36·5 g., 70%), b.p. 74—76°/10·0 mm., $n_D^{21.5}$ 1·4799 (lit.,[23] b.p. 79—81°/15·0 mm., n_D^{25} 1·4812); δ 4·21 (t, J_{H-F} 1·5 Hz, OCH_3).

3-(p-Methoxytetrafluorophenyl)propene.—The same procedure as used for the preparation of 3-pentafluorophenylpropene, was employed. *p*-Methoxytetrafluorobromobenzene (30·0 g., 0·117 mole) gave 3-(*p*-methoxytetrafluorophenyl)propene (20·4 g., 80%), b.p. 72—74°/7·0 mm.;

[23] L. A. Wall, W. J. Pummer, J. E. Fearn, and J. M. Antonucci, *J. Res. Nat. Bur. Standards*, 1963, **67A**(s) 481.

$n_D^{21.5}$ 1·4563, δ 5·92 (1H, m, C*H*=C), 5·04 (2H, m, $MeOC_6F_4CH_2$), 4·05 (3H, t, OCH_3), and 3·39 (2H, m, C=CH_2).

2-*Bromo*-1-(p-*methoxytetrafluorophenylpropane*).—A modification of the procedure for the preparation of 2-bromo-1-pentafluorophenylpropane was employed. Following extraction of the reaction mixture, the combined organic phases were washed with 5% sodium hydroxide solution (2 × 20 ml.) and then with water until the aqueous phase was neutral to litmus. Work-up of the ethereal solution gave [based on 22·0 g. (0·10 mole) of the methoxyphenylpropene] the bromopropane (20·0 g., 66%) b.p. 80—82°/0·5—0·6 mm., n_D^{24} 1·5477, δ 4·40 (1H, m, C*H*Br), 4·18 (3H, t, OCH_3), 3·28 (2H, d, CH_2) and 1·78 (3H, d, CH_3).

The reaction mixture was heated on an oil-bath at 100° for 12 hr. to give upon work-up an almost quantitative recovery of unchanged starting material.

2-*Azido*-1-(p-*methoxytetrafluorophenyl*)*propane*.—The same procedure as used for the preparation of 2-azido-1-pentafluorophenyl was employed. Thus, 2-bromo-1-(p-methoxytetrafluorophenyl)propane (13·3 g., 44 mmole) gave the azidopropane (7·7 g., 66%), b.p. 63—66°/0·05—0·10 mm., $n_D^{23.5}$ 1·4734; $\nu_{max.}$ 2108, 1507, 1498, and 975 cm.$^{-1}$; δ 4·06 (3H, t, OCH_3), 3·74 (1H, m, C*H*N_3), 2·86 (2H, d, CH_2), and 1·31 (3H, d, CH_3).

p-*Methoxytetrafluorobenzaldehyde*.— 2,3,5,6-Tetrafluoroanisole (19·5 g., 0·11 mole) in anhydrous ether (150 ml.) was lithiated at −78° under a dry nitrogen atmosphere by the dropwise addition during 1 hr. of n-butyl-lithium (7·1 g., 0·11 mole, *ca.* 55 ml. of 22·3 wt. % in hexane). The reaction mixture was stirred at −78° for an additional 2 hr. after which freshly distilled *N*-methylformanilide (19·0 g., 0·14 mole) in anhydrous ether (50 ml.) was added during 45 min.; the mixture was stirred for an additional 3 hr. at −78° after which it was allowed to warm to 25° overnight. The mixture was poured on to a stirred slurry of 4N-hydrochloric acid (100 ml.) and crushed ice (100 g.). The ether layer was separated off, and the aqueous layer was extracted with ether (2 × 35 ml.), the combined organic layers were washed once with water (50 ml.) and dried ($MgSO_4$). Fractionation of the concentrate through a 10 cm. Vigreux column gave 15·8 g. (69%) of the aldehyde, b.p. 76—78°/0·5 mm., n_D^{25} 1·4934, $\nu_{max.}$ ($CHCl_3$) 2865, 2765w, 1704, and 1495 cm.$^{-1}$; δ (CCl_4) 10·36 (1H, t, C*H*O) and 4·34 (3H, t, OCH_3); the 2,4-dinitrophenylhydrazone had m.p. 231—232° (from ethanol) (Found: C, 43·2; H, 2·4; N, 14·15. $C_{14}H_8F_4N_4O_5$ requires C, 43·3; H, 2·1; N, 14·45%).

1-(p-*Methoxytetrafluorophenyl*)-2-*nitropropene*.—(a) *p*-Methoxytetrafluorobenzaldehyde (7·1 g., 34 mmole), nitroethane (2·8 g., 37 mmole), n-butylamine (0·7 ml.), and benzene (40 ml.) were heated under rapid reflux with removal of water (Dean and Stark separator) until the aldehydic carbonyl group, as monitored *via* i.r. spectroscopy, had disappeared (6—7 days). After concentration of the benzene solution, the residual oil was distilled (short-path micro-still) and chromatographed on silica gel (J. T. Baker No. 3405) with Skelly B–benzene (19 : 1) as eluant. Distillation of the residue (micro-still) gave the nitropropene (4·9 g., 54%), b.p. 91—93°/0·2 mm., n_D^{22} 1·5208, $\nu_{max.}$ 1538, 1508, 1494, 1330, and 993 cm.$^{-1}$; $\lambda_{max.}$ (EtOH) 285 nm. (log ε 4·65); δ 7·70 (1H, s, C*H*=C), 4·25 (3H, t, OCH_3), and 2·33 (3H, s, CH_3).

(b) *p*-Methoxytetrafluorobenzaldehyde (3·0 g., 14·4 mmole) nitroethane (10 ml.), and n-butylamine (0·2 ml.) or ammonium acetate (1·0 g.) were heated under reflux for 48 hr.; the mixture was cooled, taken up in ether (50 ml.), and dried ($MgSO_4$). Concentration and work-up gave 2·6 g. (68%, from n-butylamine) and 2·1 g. (55%, from ammonium acetate) of the nitropropene which was identical with that obtained in procedure (a).

2-(p-*Methoxytetrafluorophenyl*)-1-*methylethylamine Sulphate*.—(a) *From* 2-*azido*-1-*p*-*methoxytetrafluoropropane*. The azidopropane (5·0 g., 19 mmole) in ethyl acetate (80 ml.) was reduced as described in the reduction of the corresponding pentafluorobenzaldehyde. After filtration, the solution was concentrated to *ca.* 40 ml., anhydrous ethanol (110 ml.) was added, and the volume was reduced to *ca.* 25 ml. and readjusted to 100 ml. with anhydrous ether. Sulphuric acid (5% in ethanol) was added until the mixture was just barely acidic and the mixture was chilled in an ice-bath and filtered. The product was washed successively with ice-cold ethanol and ether and then dried *in vacuo*; the amine sulphate (4·5 g., 71%) had m.p. >300° (decomp.); $\nu_{max.}$ (KBr disk) 2940vbr, 1620 m, 1495, and 973 cm.$^{-1}$ (Found: C, 42·2; H, 4·5. $C_{20}H_{24}F_8N_2O_6S$ requires C, 41·95; H, 4·25%).

The *N*-benzoyl derivative had m.p. 140—141·5° (from methanol–water) (Found: C, 59·6; H, 4·55; N, 3·85. $C_{17}H_{15}F_4NO_2$ requires C, 59·85; H, 4·45; N, 4·15%).

The pure, free amine (1b) could not be isolated. Removal of the solvent, following hydrogenolysis of the azide, and attempted vacuum distillation of the residue gave a white polymer which was soluble in ethanol, but insoluble in ether, carbon tetrachloride, ethyl acetate, acetone, and water. The polymer became a glass at *ca.* 95° and melted at 140—145° (decomp.). The amine (1b) began to polymerize and subsequently to precipitate from carbon tetrachloride solution after 15—20 min., and if completely devoid of solvent, almost immediately at 25°.

(b) *From* 1-p-*Methoxytetrafluorophenyl*-2-*nitropropene*. To a stirred refluxing suspension of lithium aluminium hydride (4·4 g., 0·12 mole) in anhydrous ether (190 ml.) was added during 30 min. a solution of the nitropropene (2·65 g., 0·01 mole) in anhydrous ether (30 ml.). The stirred mixture was heated under reflux for 4·5 hr. after which it was cooled; water (25 ml.) was added in small portions to the mixture, which was filtered. The residue was washed with ether (2 × 25 ml.) and the combined ethereal layers were dried (BaO). Addition of ethanolic sulphuric acid gave 1·2 g. (37%, based on the amount of nitropropene employed) of the amine sulphate. The salt gave an *N*-benzoyl derivative identical with that described in method (a).

1,2-*Epoxy*-3-*pentafluorophenylpropane* (3).—A stirred solution of 3-pentafluorophenylpropene (15·0 g., 72 mmole) in methylene chloride (50 ml.) was cooled to 10° in an ice-bath. The bath was removed and a solution of sodium acetate trihydrate (1·5 g.) in commercial 40% peracetic acid (20·5 g.) was added dropwise during 15 min. The resulting mixture was stirred at 25° for 36 hr. and then poured into water (200 ml.). The organic layer was separated and the aqueous phase was extracted with methylene chloride (2 × 75 ml.); the combined organic layers were washed with 10% sodium carbonate solution (2 × 50 ml.), and water (2 × 50 ml.), and then dried ($MgSO_4$). Fractionation of the concentrate through a 10 cm. Vigreux column gave 10·9 g. (68%) of the epoxypropane as an oil, b.p. 54—56°/3·0—4·0 mm., $n_D^{21.5}$ 1·4378; δ 3·1br (3H, s, $C_6F_5CH_2CH$), 2·75 (1H, m, C–C*H*O *cis*) and 2·52 (1H, m, C–C*H*O, *trans*).

1-*Pentafluorophenylpropan*-2-*ol* (4).—To a stirred slurry of lithium aluminium hydride (0·23 g., 6·0 mmole) in absolute ether (25 ml.) was added, under anhydrous conditions, a solution of the epoxypropane (3) (4·5 g., 20 mmole) in absolute ether (15 ml.), as rapidly as the exothermic reaction would allow. The mixture was stirred for an additional 40 min. and hydrolysed by addition of 5% aqueous hydrochloric acid (15 ml.). The organic phase was separated and the aqueous layer was extracted with ether (2 × 25 ml.); the combined organic phases were washed with water (2 × 20 ml.). The residual flocculent solid was concentrated and dried *in vacuo* to give the pure propanol (4·2 g., 91%), m.p. 78—79° [lit.,[16] m.p. 78°], $\nu_{max.}$ 3600m, 3400m, 1517, 1502, and 971 cm.$^{-1}$; δ (CCl_4) 4·05 (1H, m, C*H*), 2·83 (2H, m, $C_6F_5CH_2$), 2·25 (1H, s, O*H*), and 1·25 (3H, d, CH_3).

1-*Pentafluorophenylpropan*-2-*one* (5).—To a stirred solution of chromium trioxide (7·2 g., 72 mmole) in water (10 ml.) and glacial acetic acid (30 ml.) was added during 15 min., a solution of the propanol (15·0 g., 66 mmole) (4) in glacial acetic acid (30 ml.). The solution was stirred at 25° for 1 hr., heated under reflux for 0·5 hr., cooled, and exhaustively extracted with benzene. The combined organic layers were washed until neutral with 10% sodium hydrogen carbonate solution and with water (2 × 50 ml.) and then dried (Na_2SO_4). Removal of benzene and crystallization of the residue from aqueous ethanol gave the ketone as white needles (11·7 g., 79%), m.p. 35—36° [lit.,[15] m.p. 35·5—36·5°], $\nu_{max.}$ 1728, 1518, 1502, and 965 cm.$^{-1}$; δ (CCl_4) 3·87 (2H, s, CH_2) and 2·24 (3H, s, CH_3). The 2,4-dinitrophenylhydrazone had m.p. 145—146° (from ethanol) (Found: C, 44·2; H, 2·3; N, 13·55. $C_{15}H_9F_5N_4O_4$ requires C, 44·55; H, 2·25; N, 13·85%).

1-*Pentafluorophenylpropan*-2-*one Azine* (6).—To a stirred solution of 85% hydrazine hydrate (10·9 g., 0·185 mole) in refluxing methanol (35 ml.) was added a solution of the ketone (5) (13·6 g., 61 mmole) in methanol (20 ml.) during 20 min. The mixture was stirred and heated under reflux for 2 hr., cooled, and concentrated to dryness. The residual solid, washed with several small portions of ice-cold 50% aqueous ethanol, gave, after recrystallization from ethanol–water, the azine (9·2 g., 63%), m.p. 95·5—96·5°; $\nu_{max.}$ 1645br, m, 1500, and 973 cm.$^{-1}$; δ (CCl_4) 3·58 (2H, s, CH_2) and 1·78 (3H, s, CH_3) (Found: C, 48·7; H, 2·25; N, 6·45. $C_{18}H_{10}F_{10}N_2$ requires C, 48·65; H, 2·25; N, 6·3%).

1-*Pentafluorophenylpropan*-2-*one* N-*Benzoylhydrazone* (7).—To a stirred solution of benzohydrazide (7·1 g., 52 mmole) in refluxing methanol (50 ml.) was added during 15 min. a solution of the ketone (5) (11·2 g., 50 mmole) in methanol (25 ml.). The mixture was stirred and heated under reflux for 1·75 hr. and then worked-up as described in the preparation of the azine to give the hydrazone (7) as white plates (12·3 g., 72%), m.p. 138—139° (from aqueous ethanol) $\nu_{max.}$ 1658vbr, 1500, and 976 cm.$^{-1}$; δ [$(CD_3)_2CO$] 7·50 (6H, m, C_6H_5 and N*H*), 3·76 (2H, s, CH_2), and 2·12 (3H, s, CH_3).

N′-(1-*Methyl*-2-*pentafluorophenylethyl*)*benzohydrazide* (9).—The *N*-benzoylhydrazone (12·3 g., 36 mmole) in absolute ethanol (190 ml.) was reduced with hydrogen (60 lb/sq in) with a platinum oxide catalyst (0·1 g.) at 25° until the theoretical amount of hydrogen had been taken up (4—5 hr.). The catalyst was filtered off and ethanol was removed from the filtrate to leave a residue which crystallized from aqueous ethanol to give the benzohydrazide (9) as white flakes, m.p. 137—138°, $\nu_{max.}$ 3420m, 1660br, 1518, 1500, and 972 cm.$^{-1}$; ($CDCl_3$) 7·62 (6H, m, C_6H_5 and CON*H*), 4·52 (1H, m, N*H*), 3·38 (1H, m, C*H*), 2·86 (2H, m, CH_2), and 1·10 (3H, d, CH_3) (Found: C, 55·5; H, 3·65; N, 8·1. $C_{16}H_{13}F_5N_2O$ requires C, 55·8; H, 3·8; N, 8·15%).

1-*Methyl*-2-*pentafluorophenylethylhydrazinium Bromide* (10).—A mixture of the benzohydrazide (9) (5·0 g., 14 mmole) and 48% aqueous hydrobromic acid (35 ml.) was stirred and heated under reflux for 3·5 hr.; the mixture was then cooled slightly and poured over crushed ice. The precipitated benzoic acid was filtered off and washed with several small portions of ice-cold water; the combined aqueous phases were extracted with ether (2 × 15 ml.) and the extracts concentrated. The residual solid was washed with ether and crystallization from methanol–ether gave the hydrazinium hydrobromide as white granules (3·7 g., 82%), m.p. 120—125° (with conversion into a glass), $\nu_{max.}$ (KBr disc) 3230m, 2990vbr, 1583m, 1504, and 973 cm.$^{-1}$ (Found: C, 33·65; H, 3·2; N, 8·5. $C_9H_{10}BrF_5N_2$ requires C, 33·65; H, 3·15; N, 8·75%).

A 20% sodium carbonate solution was slowly added to the aqueous layer to bring the pH to 8; a white flocculent solid separated out and was filtered off. When left on the filter this product decomposed to a moist gum which gradually darkened, and was ultimately drawn through the filter into the filtrate. After exhaustive extraction with ether, the combined extracts were dried (BaO) and anhydrous hydrogen bromide was bubbled through the ethereal solution. When no precipitate formed, the orange solution was concentrated and the small amount of residual oil was 'scrubbed' several times with anhydrous ether. No solid was obtained after 1 week at 0° from the ethereal solution.

1-*Pentafluorophenylpropan*-2-*one Benzyloxycarbonylhydrazone* (8).—Water was added dropwise to a solution of the ketone (5) (3·3 g., 14·5 mmole) in ethanol (33 ml.) until the solution was just faintly turbid. The turbidity was removed by the dropwise addition of ethanol. Benzyloxycarbonylhydrazinium hydrochloride (3·0 g., 14·7 mmole) and sodium acetate trihydrate (5·0 g.) were added to the reaction mixture and the flask was heated for 5 min. on a steam-bath with occasional swirling. After the mixture had been slowly cooled, the crude product was filtered off and washed with several small portions of cold 25% aqueous ethanol. Recrystallization of the product from aqueous ethanol gave the benzyloxycarbonylhydrazone (8) as white plates, m.p. 122·5—124·0°, $\nu_{max.}$ 3230w, 1707, 1503, and 1123 cm.$^{-1}$; δ ($CDCl_3$) 8·13 (1H, m, N*H*), 7·44 (5H, s, C_6H_5), 5·28 (2H, s, CH_2O), 3·75 (2H, s, CH_2), and 1·86 (3H, s, CH_3).

1-*Pentafluorophenyl*-2-*benzyloxycarbonylhydrazine* (11).—A stirred solution of the benzyloxycarbonylhydrazone (8) (3·7 g., 10 mmole) in ethanol (50 ml.) and warmed to 65° and sodium borohydride (1·2 g., 32 mmole) in ethanol (20 ml.) and water (6 ml.) were carefully added. The stirred mixture was warmed (65—70°) for 1 hr., and water was added dropwise until crystallization began; the solution was then boiled. When the mixture was cooled the benzyloxycarbonylhydrazine (11) separated out as white needles, m.p. 92—93·5°; $\nu_{max.}$ 3437m, 1729, 1503, 1122, and 977 cm.$^{-1}$; δ (CCl_4) 7·28 (5H, s, C_6H_5), 6·30 (1H, m, N*H*CO), 5·07 (2H, s, CH_2O), 3·87 (1H, m, N*H*), and 1·02 (3H, d, CH_3) (Found: C, 54·5; H, 4·05; N, 7·6. $C_{17}H_{15}F_5N_2O_2$ requires C, 54·55; H, 4·05; N, 7·5%).

1-*Methyl*-2-*pentafluorophenylethylhydrazinium Chloride* (12).—Hydrogen was bubbled through a stirred solution of the benzyloxycarbonylhydrazine (11) (2·0 g., 5·4 mmole)

and concentrated hydrochloric acid (0·6 ml.) in ethanol (70 ml.) and water (14 ml.), to which 5% palladium on charcoal (0·2 g.) had been added. Passage of hydrogen was continued until the sweep gases gave a negative test with lime water (*ca.* 1—2 hr.). The catalyst was filtered off and washed with several small portions of ethanol; the combined filtrates were concentrated to leave a residual yellow oil which solidified when anhydrous ether was added to it, and the whole was cooled. Recrystallization of the product from methanol–ether gave the chloride (12) as white flakes, m.p. 127—128° (decomp.); $\nu_{max.}$ (KBr disc) 3228m, 2990vbr, 1583m, 1505, and 974 cm.$^{-1}$ (Found: C, 38·8; H, 3·65; N, 10·05. $C_9H_{10}ClF_5N_2$ requires C, 39·05; H, 3·65; N, 10·15%).

Ethyl 2-Pentafluorophenylcyclopropanecarboxylate (13).—2,3,4,5,6-Pentafluorostyrene (10·0 g., 52 mmole) was added dropwise during 30 min. to a stirred solution of freshly prepared ethyl diazoacetate (6·84 g., 60 mmole). The mixture was gradually warmed to 80°; after 1 hr. the temperature was raised to 120—125°. After 4 hr. the mixture was cooled and stirred at 25° overnight. Distillation through a 10 cm. Vigreux column gave the cyclopropyl ester (11·2 g., 77%) as an oil, b.p. 76—79°/0·5—0·6 mm., n_D^{25} 1·4499; $\nu_{max.}$ 1731, 1522, 1502, and 978 cm.$^{-1}$; δ 4·07 (2H, q, CH_2), 2·22 (2H, m, CH–CH·C), 1·37 (2H, m, C–CH_2·C), and 1·26 (3H, t, CH_3).

2-Pentafluorophenylcyclopropanecarboxylic Acid (14).—The ethyl ester (13) and 10% aqueous sodium hydroxide (50 ml.) were stirred and heated under reflux for 2 hr. until the ester layer disappeared. The cooled aqueous system was extracted with ether, (35 ml.), rendered acidic by dropwise addition of concentrated sulphuric acid, and extracted with ether (3 × 30 ml.). The combined ethereal extracts were washed with water (30 ml.), dried ($MgSO_4$), and concentrated to dryness *in vacuo*. The residual solid was washed with several small portions of ice-cold hexane. Sublimation of the product gave the acid (3·8 g., 84%) as white flakes, m.p. 133—134°; $\nu_{max.}$ ($CHCl_3$) 2640w (several bands), 1703, 1523, 1501, and 988 cm.$^{-1}$; δ (CCl_4) 11·62 (1H, s, CO_2H) and 2·03 (4H, m, CH–CH·CH_2) (Found: C, 47·4; H, 2·0. $C_{10}H_5F_5O_2$ requires C, 47·4; H, 2·02%).

2-Pentafluorophenylcyclopropanecarbonyl Azide (16).—The cyclopropylcarboxylic acid (14), (2·52 g., 10 mmole), anhydrous benzene (8 ml.), and thionyl chloride (2·38 g., 20 mmole) were stirred and heated under reflux under anhydrous conditions for 3·5 hr. The mixture was cooled and the volatile liquids were removed *in vacuo* to leave crude 2-pentafluorophenylcyclopropanecarbonyl chloride (15) (2·54 g., 94%) which was used directly in the next step.

Dropwise addition of the acid chloride (1·0 g., 3·7 mmole) to stirred ice-cold 30% aqueous ammonia (15 ml.), gave the 2-pentafluorophenylcyclopropanecarboxamide as pale tan leaflets, m.p. 209·5—211° (from water containing a trace of ethanol). A solution of sodium azide (0·70 g., 11 mmole) in water (2 ml.) was added to a solution of the acid chloride (2·70 g., 10 mmole) in acetone (25 ml.), cooled in an ice-bath during 1 min. The mixture was stirred for 30 min. in the cold, after which water (50 ml.) was added to it; the brown oil which separated was removed and the aqueous phase was extracted with ether (2 × 20 ml.). The combined organic phases were washed with 5% aqueous sodium hydrogen carbonate (2 × 15 ml.) and water (2 × 15 ml.) and dried ($MgSO_4$). Concentration of the solution *in vacuo* gave the crude acid azide (2·50 g., 92%), which was subjected directly to Curtius rearrangement.

Ethyl 2-Pentafluorophenylcyclopropylcarbamate (17).—A stirred mixture of the acid azide (2·50 g., 9·0 mmole) and anhydrous benzene (5 ml.) was heated under reflux for 2 hr.; the mixture was cooled and solvent was removed *in vacuo* to give the crude isocyanate (1·89 g., 86%) which was employed directly in the next step.

2-Pentafluorophenylcyclopropyl isocyanate (2·5 g., 10 mmole) and anhydrous ethanol (15 ml.) were warmed on a steam-bath under anhydrous conditions for 15 min.; the mixture was cooled and concentrated to dryness *in vacuo*. Recrystallization of the residual solid from hexane gave the carbamate (17) (1·55 g., 52%) as small white needles, m.p. 90—91·5°; $\nu_{max.}$ 3438m, 1737, 1525, and 1502 cm.$^{-1}$; δ (CCl_4) 5·80br (1H, s, NH), 4·12 (2H, q, OCH_2), 3·12 (1H, m, C_6F_5CH), 2·02 (1H, m, CHN), 1·33 (2H, m, CH_2), and 1·24 (3H, t, CH_3) (Found: C, 48·55; H, 3·5; N, 4·4. $C_{12}H_{10}F_5NO_2$ requires C, 48·8; H, 3·4; N, 4·75%).

Benzyl 2-Pentafluorophenylcyclopropylcarbamate (18).—A stirred solution of the acid azide (2·70 g., 9·8 mmole), anhydrous benzene (10 ml.), and benzyl alcohol (1·62 g., 15 mmole) (previously dried over anhydrous Na_2CO_3) was heated at reflux under anhydrous conditions for 4 hr. The mixture was cooled and benzene was removed *in vacuo*; the residual oil was triturated in the cold with hexane. (15 ml.) to give a solid which upon crystallization from hexane gave the carbamate (18) as light tan leaflets m.p. 78·5—80°; $\nu_{max.}$ 3437m, 1737, 1523, and 1502 cm.$^{-1}$; δ (CCl_4) 7·24 (5H, s, C_6H_5), 5·70br (1H, s, NH), 5·02 (2H, s, PhCH_2), 3·10br (1H, m, C_6F_5CH), 1·98 (1H, m, CHN), and 1·33 (2H, m, CH_2) (Found: C, 57·35; H, 3·45; N, 3·7. $C_{17}H_{12}F_5NO_2$ requires C, 57·15; H, 3·4; N, 3·9%).

2-Pentafluorophenylcyclopropylammonium Salts (19).—(a) *From the cyclopropylcarboxylic acid.* Sodium azide (0·65 g., 10 mmole) was added in small portions to a stirred solution of the acid (1·26 g., 15 mmole), chloroform (17 ml.), and concentrated sulphuric acid (8·6 ml.) at 45—50°. After 2 hr. at this temperature, ice (15 g.) was added to the mixture, which was made alkaline by the careful addition of solid sodium hydrogen carbonate. The chloroform layer was separated, the aqueous layer was extracted with chloroform (2 × 30 ml.), and the combined organic layers were washed once with water and dried (BaO). Ethanolic sulphuric acid (50%) was added to the cold chloroform solution which was then washed successively with cold ethanol and ether, and worked-up to give the amine hydrosulphate (0·15 g., 8·7% conversion), m.p. 138—143° (converted into a glass); $\nu_{max.}$ (KBr disc) 3080br, 1605m, 1525, 1504 and 972 cm.$^{-1}$ (Found: C, 34·0; H, 2·5; N, 4·25. $C_9H_7F_5N_5O_4$ requires C, 33·75; H, 2·25; N, 4·35%).

The *N*-benzoyl derivative formed needles, m.p. 201—202° (from aqueous methanol) (Found: C, 58·6; H, 3·15; N, 4·1. $C_{16}H_{10}F_5NO$ requires C, 58·75; H, 3·1; N, 4·25%).

The aqueous phase obtained in the preparation of the salt gave 0·81 g. (64% recovery) of unchanged carboxylic acid upon work-up.

(b) *From the ethyl carbamate.* A mixture of the ethyl carbamate (17) (1·0 g., 3·4 mmole), concentrated hydrochloric acid (5 ml.), and glacial acetic acid (2·5 ml.) was stirred and heated under reflux for 3 days. Water (10 ml.) was added to the mixture, which was then extracted with ether (2 × 15 ml.) and made alkaline by the dropwise addition in the cold of 15% aqueous sodium hydroxide. The aqueous solution was extracted with ether (3 × 30 ml.)

and the combined secondary extracts were washed once with water and dried (BaO). Addition of ethanolic sulphuric acid to the solution gave the amine hydrosulphate (0·52 g., 57%). Conversion of a portion of this salt into the *N*-benzoyl derivative gave material which was identical with that obtained *via* Schmidt rearrangement of the cyclopropanecarboxylic acid.

(c) *From the benzyl carbamate.* A mixture of the benzyl carbamate (18) (0·50 g., 1·4 mmole) and dry hydrogen bromide in glacial acetic acid [2·0 g. of 30% (w/w)] was set aside under anhydrous conditions with occasional swirling at 25° for 30 min., during which time all of the solid dissolved. Anhydrous ether (30 ml.) was added with swirling and the mixture was kept in an ice–salt bath for 1 hr. Filtration and washing with ether gave the amine hydrobromide (0·36 g., 85%). The *N*-benzoyl derivative was identical with that obtained from the hydrosulphate [methods (a) and (b)].

N-2-*Bromoallyl*-p-*toluenesulphonamide* (21).—*p*-Toluenesulphonyl chloride (9·17 g., 48 mmole) was added portionwise to a stirred mixture of 2-bromoallylamine [2] (6·12 g., 45 mmole) and 15% aqueous sodium hydroxide (40 ml.) at 0—5° during 5 min. The ice-bath was then removed and the mixture was stirred at 25° for 2 hr., extracted with ether (3 × 25 ml.), and made acidic by the dropwise addition in the cold of concentrated hydrochloric acid. The resulting precipitate was collected, washed with cold water, and gave, upon recrystallization in the cold from hexane–benzene, the sulphonamide (8·1 g., 62%), m.p. 71—72°; δ (CCl_4) 7·50 (4H, q, C_6H_4), 5·95 (1H, m, N*H*), 5·83 (1H, m, CBr=C*H*, *cis*), 5·40 (1H, m, CBr=C*H*, *trans*), 3·76 (2H, d, CH_2), and 2·42 (3H, s, CH_3).

N-2-*Bromoallyl*-N-*methyl*-p-*toluenesulphonamide* (22).—Dimethyl sulphate (3 ml.) in ethanol (5 ml.) was added during 15 min. to a stirred solution of the sulphonamide (26) (6·5 g., 22·3 mmole) and sodium hydroxide (1·5 g., 26·7 mmole) in water (75 ml.). Additional ethanol (20 ml.) was added in one portion and the mixture was stirred and heated at 85—90° for 4 hr.; the mixture was then distilled until 30 ml. of distillate had been collected. The mixture was cooled and the two-phase distillate was extracted exhaustively with ether; the combined organic phases were washed with aqueous sodium hydroxide (25 ml.) and water (25 ml.) and were then dried ($MgSO_4$). Concentration of the ethereal solution and recrystallization of the residual solid from hexane–benzene in the cold gave the sulphonamide (22), m.p. 44—45°; δ (CCl_4) 7·43 (4H, q, C_6H_4), 5·85 (1H, m, CBr=C*H*, *cis*), 5·58 (1H, m, CBr=C*H*, *trans*), 3·78 (2H, s, CH_2), 2·67 (3H, s, CH_3), and 2·38 (3H, s, NCH_3).

N-2-*Bromoallyl*-N-*methylamine* (23).—A stirred mixture of the sulphonamide (22) (13·0 g., 42·8 mmole), freshly distilled 48% aqueous hydrobromic acid (80 ml.), and phenol (13·0 g.) were heated under reflux for 45 min. The mixture was cooled rapidly, extracted with ether (3 × 40 ml.), made alkaline in the cold by the addition of 30% aqueous sodium hydroxide, and extracted again with ether (3 × 40 ml.). The combined extracts were washed with water (30 ml.), dried ($MgSO_4$), and concentrated at atmospheric pressure. Distillation of the residue (short-path condenser) gave the amine (23) as an oil which darkened rapidly with time, b.p. 59—63°/52—53 mm. [lit.,[24] 135°], n_D^{25} 1·4843; δ 5·80 (1H, m, CBr=C*H*, *cis*), 5·54 (1H, m, CBr=C*H*, *trans*), 3·37 (2H, s, CH_2), 2·32 (3H, s, CH_3), and 1·58 (1H, s, N*H*).

2,3,4,5,6-*Pentafluorobenzyl Toluene*-p-*sulphonate*.— (a) *From* 2,3,4,5,6-*pentafluorobenzyl alcohol.* Cold 20% aqueous sodium hydroxide (10 ml.) was added in one portion to a stirred solution of pentafluorobenzyl alcohol (1·98 g., 10 mmole) and toluene-*p*-sulphonyl chloride (2·10 g., 11 mmole) in water (5 ml.) at 0—5°. The mixture was stirred in the cold for 2 hr. after which the product was filtered off, washed with water and crystallized from hexane to give toluene-*p*-sulphonate, blades, m.p. 77—78°; $\nu_{max.}$ 1512, 1388, and 1188 $cm.^{-1}$; δ (CCl_4) 7·53 (4H, q, C_6H_4), 5·08 (2H, t, CH_2), and 2·45 (3H, s, CH_3) (Found: C, 47·35; H, 2·4. $C_{14}H_9F_5SO_3$ requires C, 47·75; H, 2·6%).

(b) *From* 2,3,4,5,6-*pentafluorobenzyl bromide.* 2,3,4,5,6-Pentafluorobenzyl bromide (5·22 g., 20 mmole) was added dropwise in the dark during 5 min. to a stirred solution of silver tosylate [21] (6·98 g., 25 mmole) in anhydrous acetonitrile (70 ml.) at 0—5°. After being stirred for 24 hr. the mixture was warmed to 25° and poured on to ice–water (250 ml.). The mixture was then extracted exhaustively with ether and the combined extracts were washed with water (50 ml.) and dried ($MgSO_4$). Concentration of the extracts and recrystallization of the crude material gave the toluene-*p*-sulphonate (5·35 g., 76%) which was identical in all respects with that obtained in method (a).

N-2-*Bromoallyl*-N-*methyl*-N-2,3,4,5,6-*pentafluorobenzylamine* (24).—A mixture of the secondary amine (23), (3·0 g., 19·8 mmole), absolute ethanol (40 ml.), sodium carbonate (2·2 g.), and the benzyltoluene-*p*-sulphonate (6·95 g., 19·8 mmole) was stirred at 25° for 6 hr. Anhydrous ether (30 ml.) was added to the mixture, which was then filtered; the residual solids were washed with anhydrous ether and the combined organic layers were concentrated *in vacuo*. Distillation of the residual oil (short-path condenser) gave the tertiary amine (24), (5·3 g., 85%), b.p. 76—77°/0·25 mm.; n_D^{20} 1·4807; δ 5·92 (1H, m, CBr=C*H*, *cis*), 5·56 (1H, m, CBr=C*H*, *trans*), 3·72 (2H, t, $C_6F_5CH_2$), 3·35 (2H, d, CH_2), and 2·32 (3H, s, CH_3).

N-*Methyl*-N-*pentafluorobenzylprop*-2-*ynylamine* (25).—A stirred solution of the amine (24) (40 g., 12·1 mmole) and anhydrous potassium fluoride (8·0 g.) in anhydrous dimethylformamide (48 ml.) was heated at reflux under dry nitrogen for 15 hr. The cooled mixture was poured onto ice–water (200 ml.) layered with ether (40 ml.); the aqueous phase was separated, extracted with ether (3 × 30 ml.), and the combined organic layers were washed with brine (25 ml.) and dried (BaO). Concentration and distillation of the residual oil gave the amine (25) (2·15 g., 72%), b.p. 41—43·5°/0·25 mm.; n_D^{20} 1·4549, $\nu_{max.}$ 3301m, no acetylenic C≡C, 2798m, 1522, and 1506 $cm.^{-1}$; δ (CCl_4) 3·68 (2H, t, $C_6F_5CH_2$), 3·34 (2H, d, CH_2), 2·29 (3H, s, CH_3), and 2·17 (1H, m, C*H*) (Found: C, 52·85; H, 3·3; N, 5·25. $C_{11}H_8F_5N$ requires C, 53·0; H, 3·25; N, 5·5%).

This amine formed a gelatinous, unstable hydrosulphate, but failed to give a picrate. Upon treatment with aqueous silver nitrate a solution of (25) in 95% ethanol formed a flocculent white silver acetylide.

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