572. *Dithiols. Part VIII. Polymethoxy-dithiols.*

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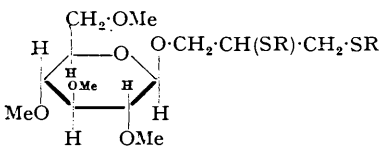
2 : 3 : 4 : 6-Tetramethyl β-(2 : 3-dimercaptopropyl)glucoside (tetramethyl BAL-Intrav), 2 : 3-dimercapto-*n*-propyl 2 : 3-dimethoxy-*n*-propyl ether, 3 : 4-dimethoxybutane-1 : 2-dithiol, and 3 : 4 : 5-trimethoxypentane-1 : 2-dithiol have been synthesised by routes similar to those previously used for the corresponding polyhydroxy-compounds.

The results of *in vivo* tests on many of the dithiols described in this series of papers have been reported by Weatherall (*J. Pharmacy Pharmacol.*, 1949, **1**, 576; Weatherall and Weatherall, *Brit. J. Pharmacol.*, 1949, **4**, 260), and it is clear that, although the presence of several hydroxyl groups in the molecule considerably reduces the toxicity, it also leads to a diminution in anti-arsenical activity, sometimes to a surprising degree. For example, in the series $HO{\cdot}CH_2{\cdot}[CH(OH)]_n{\cdot}CH(SH){\cdot}CH_2{\cdot}SH$, where $n = 0$, 1, 2, or 3, activity becomes zero when $n = 3$. There is also a marked difference between the glucoside (BAL-Intrav) and the mannitol or sorbitol ethers of 2 : 3-dimercaptopropanol (Bladon and Owen, *J.*, 1950, 591); the glucoside has the highest activity/toxicity ratio yet recorded, whereas the ethers show little advantage over 2 : 3-dimercaptopropanol itself. From the preparative point of view, the polyhydroxy-dithiols are difficult to purify; the higher members cannot be distilled and have been isolated only as crude barium salts, and in several instances difficulties have arisen owing to the occurrence of side-reactions, some of which undoubtedly involve the inter- or intra-molecular loss of water or hydrogen sulphide. It therefore appeared of interest to investigate the synthesis of polymethoxy-dithiols, tetramethyl glucose having been found (Weatherall, private communication) to be essentially non-toxic to mice. The increased volatility of such compounds, in comparison with the corresponding polyhydroxy-dithiols, would be expected to lead to easier purification, and the absence of free hydroxyl groups to reduce the possibility of side-reactions. The compounds which have now been prepared are the *O*-methyl ethers of four polyhydroxy-dithiols previously investigated (Fraser, Owen, and Shaw, *Biochem. J.*, 1947, **41**, 325; Evans and Owen, *J.*, 1949, 244; Evans, Fraser, and Owen, *ibid.*, p. 248), and the syntheses were based essentially on those used for the polyhydroxy-compounds themselves, methylation being carried out before formation of the dibromides.

Deacetylation and methylation of 2 : 3 : 4 : 6-tetra-acetyl β-allylglucoside (Fischer, *Z. physiol. Chem.*, 1920, **108**, 3) by stirring it with 30% aqueous sodium hydroxide and methyl sulphate gave 2 : 3 : 4 : 6-tetramethyl β-allylglucoside; an improved yield was obtained by preliminary catalytic deacetylation of the tetra-acetate, and subsequent methylation. Bromination in alcohol-free chloroform proceeded normally, and reaction of the dibromide with potassium thiolacetate in boiling ethanol gave 2 : 3 : 4 : 6-tetramethyl β-(2 : 3-bisacetylthiopropyl)-glucoside (I).



(I; R = Ac.) (II; R = H.)

$MeO{\cdot}CH_2{\cdot}CH(OMe){\cdot}CH_2{\cdot}O{\cdot}CH_2{\cdot}CH(SH){\cdot}CH_2{\cdot}SH$ (III.)

$MeO{\cdot}CH_2{\cdot}[CH(OMe)]_n{\cdot}CH(SH){\cdot}CH_2{\cdot}SH$

(IV; $n = 1$.) (V; $n = 2$.)

A novel method of isolation of the free dithiol was possible in the case of this compound. Addition of methanolic barium methoxide to a solution of (I) in cold methanol resulted in deacetylation, but, unlike the corresponding non-methylated compound (BAL-Intrav), the barium salt remained in solution. It was therefore decomposed *in situ* by carbon dioxide, the precipitated barium carbonate was removed, and evaporation of the filtrate gave tetramethyl β-(2 : 3-dimercaptopropyl)glucoside (II) (tetramethyl BAL-Intrav) in good yield; this could be distilled without decomposition.

Allyl 2 : 3-dihydroxypropyl ether (Evans and Owen, *loc. cit.*) gave allyl 2 : 3-dimethoxypropyl ether in good yield when treated with methyl sulphate and sodium hydroxide. Addition of bromine, treatment with potassium thiolacetate, and deacetylation as above gave 2 : 3-dimercapto-*n*-propyl 2 : 3-dimethoxy-*n*-propyl ether (III).

3 : 4-Dimethoxybut-1-ene was prepared by deacetylation and methylation of 3 : 4-diacetoxybut-1-ene, and its structure proved by ozonolysis to give formaldehyde and 2 : 3-dimethoxypropanal; conversion into 3 : 4-dimethoxybutane-1 : 2-dithiol (IV) was then carried out in the same way.

DL-*erythro*-3 : 4 : 5-Triacetoxypent-1-yne (Raphael, *J.*, 1949, S 44) on deacetylation and methylation gave the corresponding trimethoxy-compound, which on semihydrogenation over a palladium catalyst gave 3 : 4 : 5-trimethoxypent-1-ene, the structure of which was confirmed by ozonolysis to give formaldehyde and 2 : 3 : 4-trimethoxybutanal. It was then converted, through the usual stages, into 3 : 4 : 5-trimethoxypentane-1 : 2-dithiol (V). The trimethoxypentene was also prepared from 3 : 4 : 5-triacetoxypent-1-ene (Evans, Fraser, and Owen, *loc. cit.*; Raphael, *loc. cit.*).

The thiolacetates produced by the long heating of a bromide or toluene-*p*-sulphonate (Chapman and Owen, *J.*, 1950, 579) with potassium thiolacetate are usually contaminated with an orange-red material, not removed by distillation. Measurement of the light absorption of a typical product, 1 : 2-bisacetylthio-3 : 4-dimethoxybutane, revealed two low-intensity maxima at 2810 and 2980 A., $E^{1\%}_{1\,cm.}$ 4·2, probably due to the coloured material. Some dithioacetic esters are known to be orange-red (Schönberg and Asker, *J.*, 1945, 198), but, although dithioacetic acid shows a light absorption maximum at 2910 A. (Bergmann and Samuel, *J. Org. Chem.*, 1941, **6**, 13), no data have been recorded for the esters. Methyl carbethoxydithioacetate ($EtO_2C{\cdot}CH_2{\cdot}CS_2Me$) and methyl dithioacetate ($CH_3{\cdot}CS_2Me$) were therefore prepared (Laakso, *Suomen Kem.*, 1944, **17**, *B*, 1); they showed, however, only one high-intensity maximum at 3050 A., ε = 13,000 and 12,000 respectively.

Simple experiments showed that in ethanolic solution potassium thiolacetate, thiolacetic acid, and air, but not an alkyl thiolacetate, were necessary for the formation of a yellow colour (light absorption, max. 2820 A.), no colour-formation taking place in an atmosphere of nitrogen. The oxidation of thiolacetic acid by iodine, with or without the potassium salt present, gave a colourless liquid (max. 2280 A., ε = 3600). The nature of the orange-red contaminant is therefore still undecided.

Experimental.

2 : 3 : 4 : 6-*Tetramethyl β-Allylglucoside*.—2 : 3 : 4 : 6-Tetra-acetyl β-allylglucoside (40 g.) was dissolved in acetone (100 c.c.), 30% aqueous sodium hydroxide (250 c.c.) was added, and methyl sulphate (80 g.) was run in slowly during 1 hour, the solution being kept at 45° and vigorously stirred. Further quantities of sodium hydroxide solution (100 c.c.) and methyl sulphate (40 g.) were added in the same way. Finally, excess of methyl sulphate was hydrolysed by raising the water-bath to boiling for 30 minutes. Excess of alkali was neutralised with carbon dioxide, and the precipitated salts were filtered off from the cold solution and thoroughly washed with ether. Extraction of the filtrate with the ethereal washings (700 c.c.), drying (Na_2SO_4), and removal of the ether left a pale-yellow oil (20 g.). This was remethylated, using 30% sodium hydroxide (100 c.c.) and methyl sulphate (40 g.), and worked up in the same way. Distillation gave 2 : 3 : 4 : 6-*tetramethyl β-allylglucoside* (15·6 g., 55%), a colourless liquid, b. p. 74°/0·0001 mm., n_D^{20} 1·4483, $[\alpha]_D^{20}$ −31·5° (*c*, 2·8 in chloroform) (Found : C, 56·9; H, 8·9. $C_{13}H_{24}O_6$ requires C, 56·5; H, 8·8%).

Preliminary deacetylation of a solution of the tetra-acetate (80 g.), in dry methanol (250 c.c.) containing *ca.* 0·1 g. of sodium, for 12 hours at room temperature followed by removal of the methanol gave a syrup. Methylation in the same way as before, but without the acetone, gave the tetramethyl allylglucoside in improved yield (33·4 g., 60%).

2 : 3 : 4 : 6-*Tetramethyl β-(2 : 3-Dibromopropyl)glucoside*.—To a solution of the tetramethyl allylglucoside (15·5 g.) in alcohol-free chloroform (50 c.c.), bromine (9 g.) in chloroform (10 c.c.) was added dropwise, with efficient stirring, the temperature being kept below 5° by cooling in ice. Washing with aqueous sodium thiosulphate, sodium hydrogen carbonate, and finally with water, drying ($CaCl_2$), and removal of the chloroform gave 2 : 3 : 4 : 6-*tetramethyl β-(2 : 3-dibromopropyl)glucoside* (21·5 g., 88%). Distillation of a portion gave a pale-yellow liquid, b. p. 120—124°/0·0001 mm., n_D^{20} 1·4940, $[\alpha]_D^{20}$ −8·6 (*c*, 2·9 in chloroform) (Found : C, 36·4; H, 5·9. $C_{13}H_{24}O_6Br_2$ requires C, 35·8; H, 5·6%).

2 : 3 : 4 : 6-*Tetramethyl* β-(2 : 3-*Bisacetylthiopropyl*)*glucoside*.—The dibromo-compound (26 g.), potassium thiolacetate (15 g.), and thiolacetic acid (0·5 c.c.), dissolved in ethanol (100 c.c.), were heated under reflux for 6 hours, with rapid stirring to prevent bumping. The solution was cooled, poured into water (500 c.c.), and extracted with ether (4 × 125 c.c.). Removal of the ether from the dried (Na_2SO_4) extract gave crude 2 : 3 : 4 : 6-*tetramethyl* β-(2 : 3-*bisacetylthiopropyl*)*glucoside* as a red oil (21 g., 85%). A portion was distilled to give an orange liquid, b. p. 180°/0·0001 mm., n_D^{20} 1·4977 (Found : C, 48·4; H, 7·5; S, 14·8. $C_{17}H_{30}O_8S_2$ requires C, 47·9; H, 7·1; S, 15·0%). Light absorption : Max. 2290 A., ε = 8,500.

2 : 3 : 4 : 6-*Tetramethyl* β-(2 : 3-*Dimercaptopropyl*)*glucoside*.—The bisthiolacetate (21 g.) was dissolved under nitrogen in N-methanolic barium methoxide (110 c.c.) and cooled in a carbon dioxide–ethanol bath. After 1 hour a rapid stream of carbon dioxide was passed through the solution for 30 minutes. The precipitated barium carbonate was removed by filtration under nitrogen, and washed with ether; the filtrate was evaporated under reduced pressure. Extraction of the residue with ether, and concentration of the extract, gave a yellow, slightly viscous oil (Found : thiol-S, 15·1%). Short-path distillation of this oil at 120—140° (bath)/0·0001 mm. gave pure 2 : 3 : 4 : 6-*tetramethyl* β-(2 : 3-*dimercaptopropyl*)*glucoside* (10 g., 60%) as a pale yellow liquid, n_D^{20} 1·4967, $[\alpha]_D^{16}$ −12·5 (*c*, 1·9 in chloroform) (Found : C, 45·8; H, 7·6; S, 18·4; thiol-S, 18·4. $C_{13}H_{26}O_6S_2$ requires C, 45·6; H, 7·7; S, 18·7%).

The bis-α-naphthylurethane, m. p. 92—94°, was obtained by heating a portion with α-naphthyl *iso*cyanate for 3 days at 100°, but could not be completely purified (Found : C, 63·9; H, 6·1. Calc. for $C_{35}H_{40}O_3N_2S_2$: C, 61·8; H, 5·9%).

Allyl 2 : 3-*Dimethoxypropyl Ether*.—Glycerol α-chlorohydrin, b. p. 92—95°/3 mm. (75 g.), in allyl alcohol (75 c.c.) was added dropwise to a solution of sodium allyloxide, prepared by dissolving sodium (20 g.) in allyl alcohol (300 c.c.), and the solution was heated under reflux for 2 hours (cf. Evans and Owen, *J.*, 1949, 244). After neutralisation with carbon dioxide, water was added and as much allyl alcohol as possible was removed by distillation. Further dilution, constant extraction with ether, and distillation gave allyl 2 : 3-dihydroxypropyl ether (69·5 g., 77%), b. p. 102°/2 mm., n_D^{20} 1·4630.

To a solution of the above compound (64 g.) in 35% aqueous sodium hydroxide (115 g., 6 moles), maintained at 45°, methyl sulphate (170 g., 3 moles) was added during 2 hours, with vigorous stirring. Excess of methyl sulphate was decomposed by raising the temperature to 95° for 1 hour, the solution was cooled, made just acid with 4N-sulphuric acid, and then continuously extracted with ether. The extract was washed with aqueous sodium hydrogen carbonate, dried (Na_2SO_4), and evaporated to an oil, which was re-methylated in the same way, using three-quarters of the previous quantities of reagents. Distillation gave *allyl* 2 : 3-*dimethoxypropyl ether* (60·8 g., 78%), a colourless liquid, b. p. 95°/30 mm., n_D^{20} 1·4268 (Found : C, 59·9; H, 10·1. $C_8H_{16}O_3$ requires C, 60·0; H, 10·1%).

2 : 3-*Dibromo*-n-*propyl* 2 : 3-*Dimethoxy*-n-*propyl Ether*.—A solution of bromine (60 g.) in dry carbon tetrachloride (60 c.c.) was added dropwise to a well-stirred solution of the allyl ether (60 g.) in carbon tetrachloride (100 c.c.), cooled in ice–salt (1 hour). The solution was then washed with aqueous sodium thiosulphate, sodium hydrogen carbonate, and with water, and dried (Na_2SO_4). Removal of the carbon tetrachloride and distillation gave 2 : 3-*dibromo*-n-*propyl* 2 : 3-*dimethoxy*-n-*propyl ether* (95 g., 80%), a colourless liquid, b. p. 110°/0·5 mm., n_D^{20} 1·4946 (Found : C, 29·8; H, 5·2; Br, 50·0. $C_8H_{16}O_3Br_2$ requires C, 30·0; H, 5·0; Br, 50·0%).

2 : 3-*Bisacetylthio*-n-*propyl* 2 : 3-*Dimethoxy*-n-*propyl Ether*.—The dibromo-compound (5 g.), potassium thiolacetate (4 g.), and thiolacetic acid (0·2 c.c.) in ethanol (25 c.c.) were heated under reflux for 8 hours in a 100 c.c. 3-necked flask, fitted with a mercury-sealed stirrer, in an atmosphere of nitrogen. The cold solution was poured into water, and extracted with ether. The dried ($CaCl_2$) extract was evaporated, and the residual oil distilled to give 2 : 3-*bisacetylthio*-n-*propyl* 2 : 3-*dimethoxy*-n-*propyl ether* (3·5 g., 75%), as an orange-red liquid, b. p. 120°/0·001 mm., n_D^{20} 1·5040 (Found : S, 20·9. $C_{12}H_{22}O_5S_2$ requires S, 20·7%). Light absorption : max. 2280 A., ε = 9,100.

In an earlier preparation, when the reaction mixture had been refluxed for only 6 hours, the product contained an appreciable amount of unchanged bromide. A further 6 hours' reaction with fresh potassium thiolacetate, but in the absence of thiolacetic acid, gave a product containing free thiol. Approx. 30% deacetylation took place.

2 : 3-*Dimercapto*-n-*propyl* 2 : 3-*Dimethoxy*-n-*propyl Ether*.—The bisthiolacetate (20 g.) was dissolved in dry methanol (100 c.c.), and the solution was cooled in carbon dioxide–ethanol, under nitrogen. N-Methanolic barium methoxide (140 c.c.) was added slowly, with stirring, and the solution was allowed to warm to 0° during 2 hours. It was then cooled again, and a stream of carbon dioxide was passed through (below −10°) for 1 hour. After the addition of ether (100 c.c.), which precipitated a further quantity of barium salts, the solution was filtered, and the solids were washed with ether. Evaporation of the filtrate and washings, ether-extraction of the residue, final removal of the ether, and distillation gave 2 : 3-*dimercapto*-n-*propyl* 2 : 3-*dimethoxy*-n-*propyl ether* as a yellow liquid (11·2 g., 77%), b. p. 95°/0·0001 mm., n_D^{15} 1·4995 (Found : C, 43·2; H, 8·2; S, 28·2; thiol-S, 28·2. $C_8H_{18}O_3S_2$ requires C, 42·5; H, 8·0; S, 28·3%).

Reaction with phenyl *iso*cyanate gave a viscous liquid which could not be induced to crystallise. Heating at 100° with α-naphthyl *iso*cyanate and a trace of morpholine for one week gave a *bis-α-naphthylurethane*, which after recrystallisation from chloroform–light petroleum (b. p. 60—80°) had m. p. 152—153° (Found : C, 64·5; H, 5·5. $C_{30}H_{32}O_5N_2S_2$ requires C, 63·8; H, 5·7%).

3 : 4-*Dimethoxybut*-1-*ene*.—Addition of acetic anhydride to butadiene monoxide, ferric chloride being used as catalyst (Raphael, private communication), gave 3 : 4-diacetoxybut-1-ene, in 72% yield. The diacetate (65 g.) was stirred with 35% aqueous sodium hydroxide (170 g.) at 45°, and methyl sulphate (200 g.) was added during 4 hours. Extraction of the product in the usual way gave a somewhat viscous

oil (25 g.), and re-methylation of the concentrated aqueous mother-liquors gave a further 3·5 g. of a more mobile product. Completion of the methylation was achieved by dissolving the oil in methyl iodide (180 g.) and heating the mixture under reflux with silver oxide (100 g.). Filtration, removal of the solvent, and distillation of the residual oil gave 3 : 4-*dimethoxybut*-1-*ene*, as a colourless liquid (18·5 g., 42%), b. p. 110°/765 mm., n_D^{16} 1·4090 (Found: C, 61·7; H, 10·5. $C_6H_{12}O_2$ requires C, 62·0; H, 10·4%).

Ozonolysis. A slow stream of ozonised oxygen was passed through a solution of the dimethoxybutene (0·45 g.) in carbon tetrachloride (10 c.c.), cooled in ice, until ozone could be detected in the exit gases (2 hours). The issuing oxygen was passed through water, which on treatment with dimedone gave the formaldehyde derivative (40 mg.), m. p. and mixed m. p. 189°, after recrystallisation from ethanol.

The carbon tetrachloride solution was concentrated under reduced pressure, and the residue was decomposed by warming it with zinc dust (1 g.) and water (8 c.c.). Filtration, and addition of 1% 2 : 4-dinitrophenylhydrazine in 4N-sulphuric acid (70 c.c.), gave a sticky red solid (0·6 g.) which was extracted with benzene. Chromatography on alumina, and elution with benzene and benzene–chloroform, gave formaldehyde 2 : 4-dinitrophenylhydrazone (250 mg.), m. p. and mixed m. p. 163°, and 2 : 3-*dimethoxypropionaldehyde* 2 : 4-*dinitrophenylhydrazone* (200 mg.); the latter, on recrystallisation from ethanol gave pale orange needles, m. p. 100° (Found: C, 45·4; H, 4·8; N, 19·1. $C_{11}H_{14}O_6N_4$ requires C, 44·3; H, 4·7; N, 18·8%).

1 : 2-*Dibromo*-3 : 4-*dimethoxybutane*.—Treatment of the dimethoxybutene (17 g.) in the usual manner with bromine (25 g.) in carbon tetrachloride gave crude 1 : 2-*dibromo*-3 : 4-*dimethoxybutane* (31 g., 78%), b. p. 108°/10 mm., n_D^{16} 1·5018 (Found: Br, 58·4. $C_6H_{12}O_2Br_2$ requires Br, 57·9%).

1 : 2-*Bisacetylthio*-3 : 4-*dimethoxybutane*.—The dibromide (31 g.), potassium thiolacetate (28 g.), and thiolacetic acid (0·5 c.c.) in ethanol (150 c.c.) were heated under reflux for 8 hours. The addition of ether (100 c.c.) to the cold solution precipitated more potassium bromide, which was filtered off and washed with ether. Concentration of the filtrate, extraction of the residue with ether, and washing it with water, gave an orange ethereal solution which was dried ($CaCl_2$) and evaporated. Distillation of the residual red oil gave 1 : 2-*bisacetylthio*-3 : 4-*dimethoxybutane*, as an orange liquid (21·7 g., 75%), b. p. 110°/0·5 mm., n_D^{20} 1·5098 (Found: S, 23·6. $C_{10}H_{18}O_4S_2$ requires S, 24·1%). Light absorption: max. 2280 A., $\varepsilon = 8{,}100$.

3 : 4-*Dimethoxybutane*-1 : 2-*dithiol*.—(i) The bisthiolacetate (5 g.) was dissolved in 2% methanolic hydrogen chloride (30 c.c.), and the solution was heated under reflux for 4 hours in a stream of nitrogen, the exit gases being passed through 0·1N-iodine (25 c.c.). The iodine reduced (as estimated by back-titration with 0·1N-sodium thiosulphate) amounted only to 4·5 c.c., indicating that very little volatile thiol or hydrogen sulphide was formed during the deacetylation. Removal of the methanol, and distillation of the residue, gave 1·4 g. of a liquid, collected in four fractions, b. p. 83—112°/10 mm., n_D^{15} 1·489—1·506 (thiol-S, 14·1—24·6), and a viscous residue (2·3 g.). The products were not further examined.

(ii) Deacetylation of the same compound (5 g.) with N-methanolic barium methoxide (42 c.c.) as described above in the case of 2 : 3-dimercapto-*n*-propyl 2 : 3-dimethoxy-*n*-propyl ether, and distillation of the product, gave 3 : 4-*dimethoxybutane*-1 : 2-*dithiol* (2·5 g., 73%), as a yellow liquid, b. p. 82°/1·5 mm., n_D^{15} 1·5100 (Found: C, 39·7; H, 7·8; S, 35·5; thiol-S, 33·6. $C_6H_{14}O_2S_2$ requires C, 39·5; H, 7·7; S, 35·2%).

3 : 4 : 5-*Trimethoxypent*-1-*yne*.—DL-*erythro*-3 : 4 : 5-Triacetoxypent-1-yne (Raphael, *loc. cit.*) (10 g.) was deacetylated and methylated in the usual manner, with 35% sodium hydroxide solution (90 c.c.) and methyl sulphate (30 g.). By distillation of the product, 3 : 4 : 5-*trimethoxypent*-1-*yne* was obtained as a colourless liquid (2·8 g., 45%), b. p. 85°/15 mm., n_D^{24} 1·4350 (Found: C, 60·9; H, 8·8. $C_8H_{14}O_3$ requires C, 60·7; H, 8·9%).

3 : 4 : 5-*Trimethoxypent*-1-*ene*.—(i) The acetylenic compound (2·7 g.) was dissolved in ethyl acetate (15 c.c.), and the solution was shaken with hydrogen at atmospheric pressure in the presence of 10% palladium–charcoal (200 mg.) until 1 mole of hydrogen (422 c.c.) had been absorbed (20 minutes). Filtration, evaporation, and distillation furnished 3 : 4 : 5-*trimethoxypent*-1-*ene* (2·45 g., 90%), b. p. 90°/50 mm., n_D^{22} 1·4220 (Found: C, 59·6; H, 10·3. $C_8H_{16}O_3$ requires C, 60·0; H, 10·1%).

(ii) Hydrolysis and methylation of 3 : 4 : 5-triacetoxypent-1-ene (Evans and Owen, *loc. cit.*; Raphael, *loc. cit.*) (20 g.) under the same conditions as those used for the triacetoxypentyne gave the trimethoxypentene (5·7 g., 44%), b. p. 93°/65 mm., n_D^{20} 1·4250.

1 : 2 : 3-*Trimethoxypentane* was obtained by hydrogenation of the ethylenic compound (1·0 g.) in ethyl acetate in the presence of 10% palladium–charcoal (200 mg.). It was a colourless liquid, b. p. *ca.* 90°/50 mm., n_D^{20} 1·4148 (Found: C, 59·0; H, 11·4. $C_8H_{18}O_3$ requires C, 59·25; H, 11·2%).

Ozonolysis of 3 : 4 : 5-*Trimethoxypent*-1-*ene*.—A stream of ozonised oxygen was pased through a solution of the trimethoxypentene (1·0 g.) in dry ethyl acetate (5 c.c.), cooled in ice. After 45 minutes, free ozone was present in the issuing gases. Formaldehyde was precipitated from the wash-water as its dimedone derivative (210 mg.), m. p. 189—190°.

Raney nickel (1 g.) was added to the ethyl acetate solution, which was then shaken with hydrogen until no more was taken up. Filtration and evaporation gave a colourless liquid with a pungent odour. Addition of a solution of 2 : 4-dinitrophenylhydrazine (1·2 g.) in methanol containing sulphuric acid (2 g.), and dilution with water, gave a red viscous gum (1·6 g.), which was extracted with ethyl acetate. Chromatography on alumina, with benzene as developing solvent, separated formaldehyde 2 : 4-dinitrophenylhydrazone (0·5 g.), m. p. and mixed m. p. 163°, and 2 : 3 : 4-*trimethoxybutanal* 2 : 4-*dinitrophenylhydrazone* (0·6 g.), which crystallised from ethanol in pale orange needles, m. p. 106—108° (Found: C, 46·1; H, 5·5; N, 16·7. $C_{13}H_{18}O_7N_4$ requires C, 45·6; H, 5·3; N, 16·4%).

Addition of Bromine to 3 : 4 : 5-*Trimethoxypent*-1-*ene*.—Addition of bromine (32 g.) to the trimethoxypentene (31 g.) in carbon tetrachloride cooled to *ca.* −20° in carbon dioxide–ethanol in the usual manner gave crude 1 : 2-dibromo-3 : 4 : 5-trimethoxypentane (39 g., 62%), which distilled over the range 80—100°/0·5 mm. had n_D^{25} 1·4800—1·4945, and left an involatile residue (11 g.). A considerable amount of hydrogen bromide was formed in the reaction, and no pure dibromide could be isolated.

1 : 2-*Bisacetylthio*-3 : 4 : 5-*trimethoxypentane*.—The crude dibromide (38 g.), potassium thiolacetate (31 g.), and thiolacetic acid (0·5 c.c.) in ethanol (200 c.c.) were allowed to react in the standard manner for 8 hours. Ether (200 c.c.) was added to the cooled solution, potassium bromide was filtered off and washed with ether, and the filtrate was concentrated. Extraction of the residual oil with ether, washing with water, drying (Na_2SO_4), and evaporation of the ethereal solution, followed by distillation, afforded 1 : 2-*bisacetylthio*-3 : 4 : 5-*trimethoxypentane*, as an orange liquid (22 g., 58%), b. p. 90—97°/0·0001 mm., n_D^{22} 1·5045 (Found : S, 20·7. $C_{12}H_{22}O_5S_2$ requires S, 20·7%). Light absorption : max. 2280, 2370 A., $\varepsilon = 7900$.

3 : 4 : 5-*Trimethoxypentane*-1 : 2-*dithiol*.—The bisthiolacetate (13 g.) was dissolved in dry methanol (60 c.c.), and the solution, under nitrogen, was cooled in carbon dioxide–ethanol. Methanolic barium methoxide (65 c.c.; 1·6N.) was run in, with stirring, and the solution was allowed to warm to 0° during 2 hours. A stream of carbon dioxide passed for 1 hour through the solution, again cooled in carbon dioxide–ethanol, precipitated barium carbonate. Addition of ether (100 c.c.), removal and washing of the precipitate, evaporation of the filtrate, and finally extraction with fresh ether gave a clear yellow solution. Removal of the ether and distillation gave 3 : 4 : 5-*trimethoxypentane*-1 : 2-*dithiol* as a yellow, mobile liquid (7·2 g., 76%) b. p. 75°/0·0001 mm., n_D^{20} 1·5020 (Found : C, 42·6; H, 8·0; S, 27·6; thiol-S, 27·3. $C_8H_{18}O_3S_2$ requires C, 42·5; H, 8·0; S, 28·3%).

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