535. *Simple Analogues of Cortisone. Part II.* Some Monocyclic Compounds.*

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The *cis*- and the *trans*-1-ethynyl-2-methyl*cyclo*hexanol (I) were hydrated to the *cis*- and *trans*-1-acetyl-2-methyl*cyclo*hexanols (II). The latter were converted via their bromides (III) into *cis*- and *trans*-1-glycolloyl-2-methyl*cyclo*hexanols (IV). Anionotropic rearrangement of 1-vinyl-2-methyl*cyclo*hexanol (VI) followed by oxidation gave 1-acetoxyacetyl-2-methyl*cyclo*hexanol (VIII) isolated as semicarbazone. Ethyl α-chloro-1-hydroxy-2-methyl*cyclo*hexylacetate (X) was found to be an unsuitable starting material in preliminary experiments as subsequent dehydration probably occurs in the *cyclo*hexane ring in preference to the side chain. The infra-red spectra of 1-glycolloyl*cyclo*hexanol and the *cis*- and *trans*-forms of 1-glycolloyl-2-methyl*cyclo*hexanol are recorded.

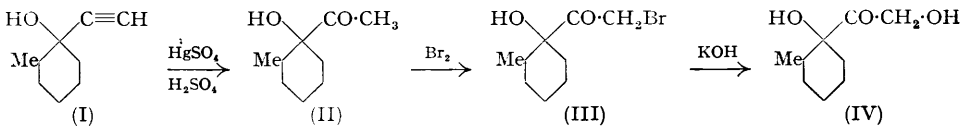
A previous communication * recorded the preparation of 1-glycolloyl*cyclo*hexanol from 1-hydroxy*cyclo*hexanecarboxylic acid. An attempt similarly to obtain 1-glycolloyl-2-methyl*cyclo*hexanol was abandoned because of difficulties in obtaining a stereochemically pure 1-hydroxy-2-methyl*cyclo*hexanecarboxylic acid. 2-Methyl*cyclo*hexanone cyanohydrin, obtained by the action of aqueous potassium cyanide on the hydrogen sulphite adduct of the ketone, gave only ammonium chloride and 2-methyl*cyclo*hexanone on acid hydrolysis. The cyanohydrin also behaved abnormally on treatment with methylmagnesium iodide, yielding a compound $C_8H_{16}O$ (probably 1 : 2-dimethyl*cyclo*hexanol; see Experimental section).

Milas, MacDonald, and Black (*J. Amer. Chem. Soc.*, 1948, **70**, 1829) and Heilbron,

* Part I, *J.*, 1951, 3067.

Jones, Lewis, and Weedon (*J.*, 1949, 2023) have described the preparation of the solid and the liquid isomer of 1-ethynyl-2-methyl*cyclo*hexanol. The *cis*- and *trans*-configurations of these alcohols with respect to the methyl group are unknown, and for convenience the solid isomer and all compounds obtained from it are prefixed (*sol.*), and the liquid isomer and compounds from it correspondingly (*liq.*).

(*sol.*)-1-Ethynyl-2-methyl*cyclo*hexanol on oxidation with potassium permanganate furnished (*sol.*)-1-hydroxy-2-methyl*cyclo*hexanecarboxylic acid only in low yield, but no acidic fraction could be isolated by similar oxidation of the (*liq.*)-alcohol. The alcohols were, however, converted by a more convenient route into the desired keto-alcohols.

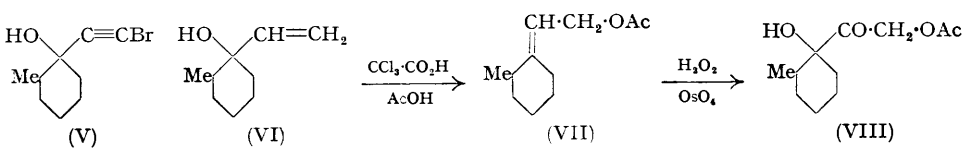


(I) (II) (III) (IV)

The (*sol.*)- and (*liq.*)-alcohols (I) were roughly separated and each was hydrated with mercuric sulphate in aqueous sulphuric acid. The mercury complex which separated during hydration often decomposed violently even at 0°, in nitrogen, but in the presence of carbon tetrachloride this decomposition was avoided. The (*sol.*)- and the (*liq.*)-form of the ketone (II) were completely separated by a fractionation of their semicarbazones from ethanol. Regeneration gave a crystalline (*sol.*)- and a pure liquid (*liq.*)-1-acetyl-2-methyl-*cyclo*hexanol.

Acid-catalysed bromination of the respective ketones gave a solid (*sol.*)-1-bromoacetyl-2-methyl*cyclo*hexanol (III) and a liquid (*liq.*)-bromide (III). Hydrolysis of the (*sol.*)-form directly gave the pure crystalline (*sol.*)-1-glycolloyl-2-methyl*cyclo*hexanol (IV) whereas the corresponding liquid (*liq.*)-compound was obtained only through its semicarbazone. The latter derivatives were formed with difficulty and in low yield whereas the thiosemicarbazones were readily obtained. The bromides (III) gave crystalline quaternary salts with pyridine, the keto-alcohols readily reduced alkaline copper sulphate, and all derivatives of the (*sol.*)-series depressed the m. p. of the corresponding (*liq.*)-compounds.

The (*sol.*)-1-ethynyl compound with aqueous potassium hypobromite readily furnished the (*sol.*)-1-bromoethynyl-2-methyl*cyclo*hexanol (V) but attempts to convert this directly into the bromide (III) were unsuccessful.

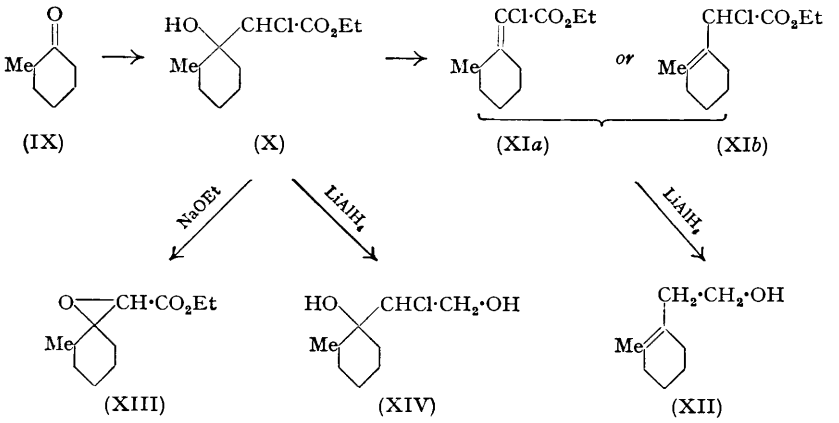


(V) (VI) (VII) (VIII)

Semihydrogenation of (*liq.*)-(I) and treatment of the (*liq.*)-(VI) with trichloroacetic acid in acetic anhydride gave 2-2′-methyl*cyclo*hexylidene-ethyl acetate (VII). Oxidation of this with anhydrous hydrogen peroxide in *tert.*-butanol, catalysed by osmium tetroxide, gave a mixture from which (*liq.*)-1-acetoxyacetyl-2-methyl*cyclo*hexanol (VIII) was isolated in small yield.

2-Methyl*cyclo*hexanone (IX) was further condensed with ethyl dichloroacetate in the presence of magnesium amalgam and a trace of iodine as promoter, to yield ethyl α-chloro-1-hydroxy-2-methyl*cyclo*hexylacetate (X). This with alcoholic sodium ethoxide gave the epoxide (XIII) whilst with lithium aluminium hydride it gave 2-chloro-2-(1-hydroxy-2-methyl*cyclo*hexyl)ethanol (XIV). Further, the α-chloro-ester (X) on dehydration with phosphorus oxychloride in pyridine gave the unsaturated ester (XI*a* or XI*b*). As reduction with lithium aluminium hydride gave chlorine-free, unsaturated alcohol, the material could not be used for further work. Wagner and Moore (*J. Amer. Chem. Soc.*, 1949, **71**, 4160) have reduced methyl 20-bromo-3β-hydroxy-17-pregnen-21-oate (analogous structure to XI*a*) with lithium aluminium hydride to the corresponding unsaturated alcohol

without the loss of the tertiary halogen; the above dehydration product may therefore have the structure (XI*b*), and the reduction product would then be (XII). Further work



on these lines is being pursued. The infra-red spectra * of three keto-alcohols show the following bands:

	C=O, cm.$^{-1}$	Ring OH, cm.$^{-1}$	Ketol OH, cm.$^{-1}$
(*A*) 1-Glycolloyl*cyclo*hexanol	1710 (90)	3400—3200 (90)	2910 (82)
(*B*) (*sol.*)-1-Glycolloyl-2-methyl*cyclo*hexanol	1710 (93)	3500 (82)	2910 (92)
(*C*) (*liq.*)-1-Glycolloyl-2-methyl*cyclo*hexanol	1700 (94)	3575 (70)	2910 (92)

(Values in parentheses are % absorption.)

The ring hydroxy-group and the ketol-hydroxy-groups in (*A*) both show strong hydrogen bonding, whilst in (*B*) and (*C*) this effect is only observed in the ketol-hydroxy-groups. Compounds (*B*) and (*C*) show almost identical bands and their spectra differ mainly in the region 800—1200 cm.$^{-1}$.

Experimental

The microanalyses were carried out by Dr. Sobotka, University of Graz, and in the Microanalytical Laboratory, Organic Chemistry Department, Imperial College (Mr. F. H. Oliver).

2-*Methyl*cyclo*hexanone Cyanohydrin*.—2-Methyl*cyclo*hexanone (10 g.) was added dropwise with vigorous stirring to a saturated aqueous solution of sodium metabisulphite (20 g.), the mixture set aside at 5° for 24 hr., and the crystalline adduct (18 g.; after vacuum drying) then washed thoroughly with water. The material (10·3 g.) was suspended in ether (50 c.c.) and water (10 c.c.), and aqueous potassium cyanide (5 g.) was added with stirring during 15 min. The ether layer was removed, the aqueous layer extracted with ether (5 × 10 c.c.), and the combined extracts (dried with Na_2SO_4) distilled, giving 2-*methyl*cyclo*hexanone cyanohydrin* (4·4 g.) as a viscous oil, b. p. 68°/10^{-6} mm. (bath temp. 120°), n_D^{23} 1·4544 (Found: C, 69·1; H, 9·35; N, 10·1. $C_8H_{13}ON$ requires C, 68·9; H, 9·3; N, 10·2%).

Reaction of the Cyanohydrin with Methylmagnesium Iodide.—The cyanohydrin (10 g.) was added gradually with stirring to an ethereal solution (500 c.c.) of methylmagnesium iodide [from magnesium (4 g.) and methyl iodide (30 g.)], and the solution was refluxed for 1 hr. After solation, the crude compound was heated under reflux (0·5 hr.) with hydrochloric acid (10%; 100 c.c.), extracted with ether, and distilled, giving 1 : 2-dimethyl*cyclo*hexanol (?) (8 g.), b. p. 55°/8 mm., 168°/760 mm., n_D^{21} 1·4622. The authentic compound (Found: C, 75·3; H, 12·5. Calc. for $C_8H_{16}O$: C, 75·0; H, 12·5%) prepared as above from 2-methyl*cyclo*hexanone had the same physical constants (Signaigo and Cramer, *J. Amer. Chem. Soc.*, 1933, **55**, 3330, give b. p. 64°/9 mm., 169°/760 mm., n_D^{20} 1·4620).

(sol.)- *and* (liq.)-1-*Ethynyl*-2-*methyl*cyclo*hexanols*.—The method used was essentially that of Heilbron *et al.* (*loc. cit.*), Nieuwland's catalyst (Vaughn, Vogt, and Nieuwland, *J. Amer. Chem.*

* These will appear in Sadtler's "Catalog of Infra-red Spectrograms," Philadelphia. They were determined on a Baird double-beam instrument, that of 1-glycolloyl*cyclo*hexanol as a melt, those of the 1-glycolloyl-2-methyl*cyclo*hexanols on 10% solutions in chloroform.

Soc., 1934, **56**, 2120) being used for the formation of sodium acetylide. From 2-methyl*cyclo*hexanone (1000 g.), sodium acetylide [from sodium (215 g.)], and liquid ammonia (5 l.), the mixed isomers (1000 g.), b. p. 74—78°/15 mm., were obtained. After purification through the silver salt and regeneration with ammonium thiocyanate at room temperature, the ethynyl compound (900 g.) was kept at 0° for 24 hr. whereupon a portion crystallised and was rapidly separated in a filtration centrifuge. A repetition of this crystallisation gave the solid (225 g., 33%) and the liquid (674 g., 66%) isomer. The yields were reproducible in several experiments. After crystallisation from light petroleum (b. p. 40—60°) the solid form was obtained as needles, m. p. 59—60° (Found: C, 78·3; H, 10·2. Calc. for $C_9H_{14}O$: C, 78·3; H, 10·15%). After redistillation the liquid isomer had b. p. 76°/15 mm., n_D^{22} 1·4689 (Found: C, 78·5; H, 10·2%).

(sol.)-1-*Hydroxy*-2-*methyl*cyclo*hexanecarboxylic Acid*.—(*sol.*)-1-Ethynyl-2-methyl*cyclo*hexanol (10 g.) in acetone (100 c.c.) was treated dropwise with stirring at room temperature with potassium permanganate (13 g.) in water (200 c.c.). After being stirred for 12 hr. the mixture was heated on the steam bath (1 hr.), the filtered solution evaporated, and the residue dissolved in a little ether. This solution was then shaken with saturated aqueous sodium hydrogen carbonate, and from the ether layer unchanged material (5 g.) was recovered.

The aqueous layer was acidified, treated with salt, and re-extracted with ether. Evaporation of the solvent and crystallisation of the residue from benzene gave (sol.)-1-*hydroxy*-2-*methyl*cyclo*hexanecarboxylic acid* (2·5 g.), needles, m. p. 109° (Found: C, 61·0; H, 9·1. $C_8H_{14}O_3$ requires C, 60·8; H, 8·9%).

(sol.)-1-*Bromoethynyl*-2-*methyl*cyclo*hexanol*.—(*sol.*)-1-Ethynyl-2-methyl*cyclo*hexanol (13·8 g.) in light petroleum (100 c.c.; b. p. 40—60°) was shaken for 6 hr. with an aqueous solution (200 c.c.) containing potassium hypobromite (7·4%) and potassium hydroxide (11·2%) (cf. Strauss, Kollek, and Heyn, *Ber.*, 1930, **63**, 1868). The aqueous layer was extracted with light petroleum (4 × 100 c.c.; b. p. 40—60°), and the combined organic layers were dried (Na_2SO_4) and evaporated giving (sol.)-1-*bromoethynyl*-2-*methyl*cyclo*hexanol* (18 g.), needles, m. p. 69—70° [from light petroleum (b. p. 40—60°)] (Found: C, 50·1; H, 6·1; Br, 36·5. $C_9H_{13}OBr$ requires C, 49·8; H, 6·0; Br, 36·9%).

(sol.)-1-*Acetyl*-2-*methyl*cyclo*hexanol*.—(*sol.*)-1-Ethynyl-2-methyl*cyclo*hexanol (100 g.) in carbon tetrachloride (250 c.c.) was added dropwise with stirring to a solution of mercuric sulphate (26·3 g.) in sulphuric acid (70 g.) and water (600 c.c.), and the reaction mixture kept at 15° for 2 hr. The aqueous layer was steam-distilled for 3 hr., the organic layer (which had been kept at 0°) being gradually added. The distillate was treated with salt, the organic layer separated, and the aqueous layer extracted with carbon tetrachloride (5 × 100 c.c.). The combined extracts were dried (Na_2SO_4), the solvent was removed and the residue was distilled, giving the ketone (96 g.), b. p. 81—82°/12 mm. The (sol.)-*semicarbazone* (prepared in pyridine) formed needles, m. p. 229—230° (after 2 crystallisations from ethanol) (Found: C, 56·6; H, 8·9; N, 19·7. $C_{10}H_{19}O_2N_3$ requires C, 56·3; H, 8·9; N, 19·7%). When shaken in light petroleum suspension (500 c.c.; b. p. 40—60°) for 6 hr. with aqueous sulphuric acid (10%) this gave (sol.)-1-*acetyl*-2-*methyl*cyclo*hexanol* (72 g.), b. p. 87°/12 mm. (after purification and distillation), which solidified when cooled at 0° for 4 hr. and then formed needles, m. p. 36° [from light petroleum (b. p. 40—60°)] (Found: C, 69·2; H, 10·3. $C_9H_{16}O_2$ requires C, 69·3; H, 10·3%).

(liq.)-1-*Acetyl*-2-*methyl*cyclo*hexanol*.—This was similarly obtained by the hydration of the (*liq.*)-1-ethynyl-2-methyl*cyclo*hexanol (200 g.) with mercuric sulphate (52·5 g.) in sulphuric acid (140 c.c.) and water (1200 c.c.). After three crystallisations from ethanol the (liq.)-*semicarbazone* was obtained as needles, m. p. 218—219° [depressed to 205° when melted in admixture with the (*sol.*)-semicarbazone] (Found: C, 56·6; H, 8·9; N, 19·7%).

The pure regenerated (*liq.*)-ketone (170 g.) had b. p. 92°/10 mm., n_D^{18} 1·4635 (Found: C, 69·7; H, 10·4%).

(sol.)-1-*Bromoacetyl*-2-*methyl*cyclo*hexanol*.—(*sol.*)-1-Acetyl-2-methyl*cyclo*hexanol (46·8 g.) in chloroform (500 c.c.) was added in one portion to a solution of bromine (16 c.c.) in chloroform (500 c.c.) containing freshly distilled hydrogen bromide in acetic acid (1 c.c. of 30%). After 0·5 hr. the solution was poured into ice–water (1 l.) and neutralised with sodium hydrogen carbonate. The solution was extracted with chloroform (5 × 100 c.c.), the extracts were dried (Na_2SO_4), and the solvent evaporated *in vacuo* (40°). Crystallisation of the residue from light petroleum (b. p. 40—60°) at −30° gave (sol.)-1-*bromoacetyl*-2-*methyl*cyclo*hexanol* (40 g.), as needles, m. p. 68—69° (soon becoming violet on exposure to air at room temperature) (Found: C, 45·7; H, 6·5; Br, 34·1. $C_9H_{15}O_2Br$ requires C, 45·9; H, 6·4; Br, 34·0%).

(liq.)-1-*Bromoacetyl*-2-*methyl*cyclo*hexanol*.—A similar bromination of (*liq.*)-1-acetyl-2-methyl*cyclo*hexanol (30 g.) yielded the liquid (liq.)-*bromide* (27 g.) on evaporative distillation from a wide-bore retort (bath temp. 75—80°) at 10^{-6} mm. (Found: C, 45·8; H, 6·3; Br, 33·7%).

Pyridine Adducts of the Bromides.—A solution of the (*sol.*)-bromide (2 g.) in pyridine (3 c.c.) was diluted with dry ether (10 c.c.) and set aside at 0° for 24 hr. The precipitate (2·6 g.) was dissolved in a little warm methanol, and the solution diluted with ether, the (sol.)-*pyridine adduct* forming flat prisms, m. p. 188—190° (decomp.) (Found: C, 53·6; H, 6·2; N, 4·3; Br, 25·0. $C_{14}H_{20}O_2NBr$ requires C, 53·5; H, 6·35; N, 4·5; Br, 25·4%).

The (liq.)-*adduct*, similarly obtained, had m. p. 202—203°, depressed to 170° on admixture with the (*sol.*)-adduct (Found: C, 53·8; H, 6·2; N, 5·2; Br, 25·7%).

(sol.)- *and* (liq.)-1-*Glycolloyl*-2-*methyl*cyclo*hexanol*.—The (*sol.*)-bromide (23·5 g.) was dissolved in aqueous ethanol (60%; 235 c.c.), and potassium hydroxide (5·8 g.) in aqueous ethanol (60%; 100 c.c.) added under nitrogen with stirring in 5-c.c. portions, at such a rate that the alkali was neutralised (phenolphthalein) before each subsequent addition. After the last addition, the solution was made just acid with a trace of aqueous hydrogen chloride and then evaporated to dryness *in vacuo* (at 40°), and the oily residue dissolved in ether. The ethereal solution was dried (Na_2SO_4), the solvent evaporated, and the crude residue triturated with light petroleum (b. p. 40—60°). (sol.)-1-*Glycolloyl*-2-*methyl*cyclo*hexanol* formed needles (from ether), m. p. 79—80° (Found: C, 63·2; H, 9·5. $C_9H_{16}O_3$ requires C, 62·8; H, 9·3%).

The (*liq.*)-bromide (23·5 g.) on similar hydrolysis gave the crude (*liq.*)-keto-alcohol (11 g.), whose *semicarbazone* (prepared in pyridine–water) was obtained as micro-needles (from methanol) (11 g.), m. p. 199—201° (Found: C, 52·3; H, 8·3; N, 18·4. $C_{10}H_{19}O_3N_3$ requires C, 52·4; H, 8·2; N, 18·1%).

Heating of the semicarbazone (11 g.) with hydrochloric acid (10%; 50 c.c.) on the steam-bath for 15 min. (nitrogen atmosphere), evaporation *in vacuo* at 70°, and evaporative distillation in a high vacuum at 10^{-6} mm. (bath temp. 75°) gave (liq.)-1-*glycolloyl*-2-*methyl*cyclo*hexanol*, $n_D^{21\cdot5}$ 1·4722 (Found: C, 63·0; H, 9·5%).

The thiosemicarbazones. The (*sol.*)-keto-alcohol (1·8 g.), thiosemicarbazide (1 g.), aqueous ethanol (60%; 35 c.c.), and a trace of acetic acid were heated under reflux for 2 hr. On cooling and dilution with a little water the (*sol.*)-thiosemicarbazone separated. This formed pale yellow needles, m. p. 210°, from methanol (Found: C, 49·4; H, 7·7; N, 17·2; S, 13·4. $C_{10}H_{19}O_2N_3S$ requires C, 49·0; H, 7·8; N, 17·1; S, 13·1%). The (liq.)-*thiosemicarbazone* was similarly obtained as yellow needles, m. p. 220°, from aqueous methanol (Found: C, 49·0; H, 7·9; N, 17·1; S, 13·2%).

(liq.)-2-*Methyl*-1-*vinyl*cyclo*hexanol*.—(*liq.*)-1-Ethynyl-2-methyl*cyclo*hexanol (138 g.) in ethanol (500 c.c.) was hydrogenated in the presence of palladium–strontium carbonate (10 g.; containing 2½% of Pd) (22·2 l. of hydrogen were absorbed). The filtered solution was fractionated through a 12″ column, giving (liq.)-2-*methyl*-1-*vinyl*cyclo*hexanol* (119 g.), b. p. 69°/7 mm., n_D^{21} 1·4711 (Found: C, 77·0; H, 11·6. $C_9H_{16}O$ requires C, 77·1; H, 11·4%).

2-2′-*Methyl*cyclo*hexylidene-ethyl Acetate*.—The vinyl*cyclo*hexanol (121 g.), acetic anhydride (450 c.c.), and trichloroacetic acid (150 g.) were heated at 55° for 2 hr., and then poured into ice–water (2000 c.c.). After 3 hr. the mixture was neutralised ($NaHCO_3$) and extracted with ether. Fractionation of the extract through a 12″ column gave 2-2′-*methyl*cyclo*hexylidene-ethyl acetate* (43 g.), b. p. 98—100°/8 mm., n_D^{23} 1·4492 (Found: C, 72·3; H, 10·0. $C_{11}H_{18}O_2$ requires C, 72·5; H, 9·9%).

Oxidation of 2-2′-*Methyl*cyclo*hexylidene-ethyl Acetate*.—An anhydrous solution of hydrogen peroxide in *tert.*-butanol was prepared by dissolving 80% aqueous hydrogen peroxide in the alcohol and adding a calculated quantity of butyl borate.

Osmium tetroxide (0·05 g.) was added to a stirred mixture of 2-2′-methyl*cyclo*hexylidene-ethyl acetate (7 g.) in *tert.*-butanol (40 c.c.) and the hydrogen peroxide solution (11·1 c.c.), and after 36 hr. the solvent was removed under reduced pressure (40°) and the residue boiled with aqueous sodium sulphite (10 g. in 100 c.c.). Extraction with ether gave a liquid (2·5 g.), b. p. 84—88°/10 mm., from which 1-*acetoxyacetyl*-2-*methyl*cyclo*hexanol semicarbazone* was prepared (in pyridine solution). The derivative (0·2 g.) formed needles, m. p. 204° (decomp.) from ethanol (Found: C, 52·9; H, 7·6; N, 15·2. $C_{12}H_{21}O_4N_3$ requires C, 53·1; H, 7·7; N, 15·5%).

Ethyl α-Chloro-1-*hydroxy*-2-*methyl*cyclo*hexylacetate*.—To dry magnesium amalgam [from magnesium (24 g.) and mercury (1200 g.)] ether (1000 c.c.) was addded with vigorous stirring, followed by a portion (20 c.c.) of a mixture of 2-methyl*cyclo*hexanone (112 g.) and ethyl dichloro-acetate (209 g.). Iodine (0·5 g.) was added and then the remainder of the mixture; the temperature was not allowed to exceed 15° (water cooling). After being stirred overnight, the

mixture was poured on crushed ice (500 g.) and acetic acid (250 c.c.), the solution extracted with ether (6 × 1000 c.c.), and the extract washed successively with aqueous sodium hydrogen carbonate, water (2 × 200 c.c.), and saturated aqueous sodium hydrogen sulphite (50 g. in 200 c.c.). Evaporation of the ether, fractionation of the residue through a 12″ column and redistillation of the fraction (143 g.), b. p. 100—105°/0·004 mm., gave *ethyl α-chloro-1-hydroxy-2-methylcyclohexylacetate*, b. p. 78°/0·003 mm., n_D^{20} 1·4702 (Found: C, 55·9; H, 8·1; Cl, 14·8. $C_{11}H_{19}O_3Cl$ requires C, 56·2; H, 8·1; Cl, 15·1%).

Ethyl α-1-Epoxy-2-methylcyclohexylacetate.—The above ester (23·4 g.) in ethanol (50 c.c.) was treated dropwise with sodium ethoxide [from sodium (2·3 g.)] in ethanol (100 c.c.). The solvent was removed *in vacuo*, and extraction with ether followed by distillation of the extract gave the *epoxide*, b. p. 130°/10 mm., n_D^{21} 1·4620 (Found: C, 66·9; H, 9·2. $C_{11}H_{18}O_3$ requires C, 66·7; H, 9·1%).

Reduction of the α-Chloro-ester.—The ester (23·4 g.) dissolved in ether (100 c.c.) was added dropwise to lithium aluminium hydride (3·8 g.) in ether (500 c.c.). The complex was decomposed with 5% hydrochloric acid and extracted with ether. Distillation through a 6″ column gave low-boiling liquid and a fraction, b. p. 120°/0·004 mm., which solidified at 0° and formed flat prisms (9 g.), m. p. 77—78° [from light petroleum (b. p. 60—80)], of *2-chloro-2-(1-hydroxy-2-methylcyclohexyl)ethanol* (Found: C, 56·2; H, 8·9; Cl, 18·0. $C_9H_{17}O_2Cl$ requires C, 56·0; H, 8·8; Cl, 18·4%).

Dehydration of the α-Chloro-ester.—To the chloro-ester (65 g.) in pyridine (66 g.) phosphorus oxychloride (42·5 g.) was added dropwise at 0° with stirring during 1 hr. After 24 hr. at room temperature and 0·5 hr. on the water-bath the solution was poured on crushed ice, made just acid (Congo red), and then extracted with ether. Distillation gave the unsaturated *α-chloro-ester* (37 g.), b. p. 81°/0·003 mm., n_D^{18} 1·4810 (Found: C, 60·9; H, 8·1; Cl, 16·6. $C_{11}H_{17}O_2Cl$ requires C, 70·0; H, 7·9; Cl, 16·3%).

Reduction of the Unsaturated Ester.—The unsaturated ester (21·7 g.) in dry ether (100 c.c.) was added dropwise to lithium aluminium hydride (3·8 g.) in ether (500 c.c.). The chlorine-free unsaturated *alcohol* (13 g.), isolated in the usual manner, had b. p. 62°/0·0035 mm. (Found: C, 77·0; H, 11·4. $C_9H_{16}O$ requires C, 77·1; H, 11·4%).

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