225. *Dicyclic Derivatives of Simple Aliphatic Ketones.*

By Frederick E. King.

The preparation of several ketones, $R\cdot[CH_2]_n\cdot CO\cdot[CH_2]_n\cdot R$, where R represents an alicyclic residue, is described. Contrary to expectation, they do not possess useful odoriferous qualities.

The new ketones were to be obtained by hydrolysis and decarboxylation of esters of the type $R\cdot CH(CO_2Et)\cdot CO\cdot CH(CO_2Et)\cdot R$, that is, condensation products of suitable bromides and the disodio-derivative of ethyl acetonedicarboxylate. *cyclo*Hexyl bromide, however, failed to undergo the necessary condensation, and as the desired substances were obtainable by dry distillation of the lead salts of appropriate acids, this alternative was adopted. Usually the recrystallised semicarbazones were then employed as a source of the pure ketones for comparison with the crude products.

In this way Δ^1-*cyclo*hexenylacetic acid (Wallach, *Annalen*, 1905, **343**, 51) afforded an odorous oil consisting largely of a ketone, probably s-*di*-Δ^1-cyclo*hexenylacetone*, $CO(CH_2\cdot C_6H_9)_2$,* which was isolated as the *semicarbazone*. The preparation was also carried out with the thorium salt of the acid, but gave no great advantage. The unsaturated ketone was catalytically reduced to *s*-di*cyclo*hexylacetone, identified by the semicarbazone obtained by Wallach (*Centr.*, 1907, ii, 53), but in passing to the saturated compound an appreciable diminution in odour was noticeable.

Similarly the ketone [probably s-*di*cyclo*pentenylacetone*, $CO(CH_2\cdot C_5H_7)_2$] obtained *via* the semicarbazone from Δ^1-*cyclo*pentenylacetic acid (Wallach, *Annalen*, 1902, **323**, 159) has an odour decidedly weaker than that of its *cyclo*hexenyl analogue, and this observation also applies to the liquid *di*cyclo*pentyl ketone* derived from it by catalytic reduction.

For the preparation of the intermediates required to form the higher aliphatic ketones with terminal groups of the *cyclo*paraffin series, a method of more general application was chosen, *viz.*, reduction of the corresponding cyclic keto-acids. Thus by means of Clemmensen's process *cyclo*pentanone-2-β-propionic acid (Linstead and Cook, J., 1934, 954) was converted into β-cyclo*pentylpropionic acid*, a liquid forming a well-defined *phenylhydrazide*, and

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* The position of the double bonds in this ketone cannot be stated with certainty. Owing to the possibility of tautomerism the alternative *cyclo*hexylidene structure $CO(CH{:}C_6H_{10})_2$ cannot be excluded, and a similar doubt exists in regard to the ketone derived from the *cyclo*pentenyl acid.

from its lead salt s-*di*-β-cyclo*pentylethyl ketone* was obtained, after purification *via* the *semicarbazone*, as a virtually odourless solid.

EXPERIMENTAL.

cyclo*Hexyl Bromide*.—The following method is based on the general procedure of "Organic Syntheses," Vol. I. A solution containing hydrogen bromide (420 g., *d* 1·5), concentrated sulphuric acid (110 g.), and *cyclo*hexanol (100 g.) was allowed to become hot during the addition of a further quantity of sulphuric acid (200 g.). After a few minutes the mixture was cooled and the reddish oil which had separated was removed, dried over calcium chloride, and distilled, *cyclo*hexyl bromide, b. p. 64°/21 mm., being obtained in more than 90% yield (152 g.) (Found: Br, 49·8. Calc.: Br, 49·1%).

Ethyl acetonedicarboxylate (1 mol.) and *cyclo*hexyl bromide (2 mols.), dissolved in an absolute alcoholic solution of sodium (2 mols.), were refluxed on a steam-bath for 2—3 hours; although quantitative precipitation of sodium bromide occurred, no condensation product was isolated and an appreciable amount of the ester was recovered.

s-*Di*-Δ^1-cyclo*hexenylacetone*.—The addition of Δ^1-*cyclo*hexenylacetic acid (10 g.), dissolved in 30% aqueous sodium hydroxide (30 c.c.), to a solution containing lead acetate (15 g.) gave a sticky solid, which hardened when triturated with water. The dry lead salt was mixed with copper powder and heated under diminished pressure, a plug of glass wool in the neck of the flask preventing the escape of solid into the receiver. Redistillation of the product (3—3·5 g.) gave a greenish-yellow oil, b. p. 160—170°/12 mm., having a sharp but distinctly fragrant odour. The *semicarbazone* formed from it crystallised from alcohol in rhombic leaflets, m. p. 111° (Found: C, 69·6; H, 9·0. $C_{16}H_{25}ON_3$ requires C, 69·8; H, 9·1%). Hydrolysis with warm 25% sulphuric acid gave the unsaturated *ketone* as a yellow oil, b. p. 165°/12 mm., identical in odour with the crude material (Found: C, 82·3; H, 10·1. $C_{15}H_{22}O$ requires C, 82·6; H, 10·1%).

s-*Di*cyclo*hexylacetone*.—A solution of the unsaturated ketone (0·8 g.) in alcohol (10 c.c.) was shaken with palladium chloride (0·1 g.) in hydrogen, 165 c.c. (theo. vol.) of which were absorbed within an hour. The filtered solution on evaporation gave colourless di*cyclo*hexylacetone. Although obtained by Wallach (*loc. cit.*) from calcium *cyclo*hexylacetate, this ketone has not been described. Its odour resembles that of its unsaturated precursor, but is less powerful. The semicarbazone crystallised from light petroleum in colourless prisms, m. p. 149—150° (Wallach, *loc. cit.*, gives 142—145°) (Found: C, 68·9; H, 10·5. Calc. for $C_{16}H_{29}ON_3$: C, 68·8; H, 10·4%).

s-*Di*cyclo*pentenylacetone*.—The action of lead acetate (17 g.) on an aqueous solution containing Δ^1-*cyclo*pentenylacetic acid (10 g.) and sodium hydroxide (3·2 g.), as with the *cyclo*hexenyl acid, gave a viscous lead compound. The new salt was, however, somewhat easily fusible, and no efficient mixing with copper powder before vacuum distillation was required. The bulk of the product (2·8 g.) distilled below 180°/14 mm., and was a yellow liquid with an odour closely resembling that of its counterpart in the *cyclo*hexyl series, although neither so sharp nor intense. The *semicarbazone* crystallised from alcohol in long rectangular plates, m. p. 140° (Found: C, 68·2; H, 8·5. $C_{14}H_{21}ON_3$ requires C, 68·0; H, 8·5%). The ketone liberated from this derivative by warm 25% sulphuric acid was a pale yellow oil, b. p. 139°/12 mm. (bath temp. 155°), retaining the odour characteristic of the unpurified liquid.

s-*Di*cyclo*pentylacetone*.—When shaken in hydrogen in the presence of palladium chloride (0·15 g.), an alcoholic solution (10 c.c.) of the foregoing unsaturated ketone (1 g.) absorbed 236 c.c. of the gas in 50 minutes. After filtration, the solvent was evaporated, and the residue distilled. s-*Di*cyclo*pentylacetone* is a colourless liquid, b. p. 132°/11 mm. (bath temp. 150°), resembling ethyl benzoate in odour (Found: C, 80·2; H, 11·1. $C_{13}H_{22}O$ requires C, 80·4; H, 11·3%). The *semicarbazone* crystallised from light petroleum, containing a little benzene, in colourless needles, m. p. 155—156° (Found: C, 66·8; H, 9·9. $C_{14}H_{25}ON_3$ requires C, 66·9; H, 10·0%).

Ethyl cyclo*Pentanone*-2-*carboxylate*-2-β-*propionate*.—This keto-ester was prepared by the following method shortly before the appearance of Linstead and Cook's paper (J., 1934, 953). The sodium derivative of ethyl *cyclo*pentanone-2-carboxylate (80 g.) was prepared by gentle heating with pulverised sodium (11·5 g.) in toluene (120 c.c.), ethyl β-iodopropionate (J., 1934, 1903) (115 g.) slowly introduced, and the reaction completed by warming at 100° for 30 minutes. After the addition of water, the toluene layer was dried over calcium chloride and distilled, the ester (86 g.) having b. p. 172°/12 mm. (Found: C, 61·0; H, 7·9. Calc. for $C_{13}H_{20}O_5$: C, 60·9; H, 7·9%).

cyclo*Pentanone*-2-β-*propionic Acid*.—When preparing the related acetic acid, Linstead and

Meade (J., 1934, 940) confirmed the observation of Kötz (*Annalen*, 1906, **350**, 238) that relatively long treatment of the intermediate keto-dicarboxylic ester with boiling acid is necessary, and Linstead and Cook (*loc. cit.*) decomposed the foregoing propionic ester by heating with concentrated hydrochloric acid for 9 hours. When it was heated with hydrochloric acid (20 c.c.) and water (15 c.c.) under reflux, however, hydrolysis and decarboxylation were complete in 35 minutes. The clear solution was evaporated to dryness under diminished pressure, and the residual syrup distilled, *cyclo*pentanone-2-β-propionic acid (7·5 g.), b. p. 176—178°/12 mm., forming a solid mass, m. p. 30° (Found: C, 61·2; H, 7·9. Calc. for $C_8H_{12}O_3$: C, 61·5; H, 7·7%).

β-cyclo*Pentylpropionic Acid.*—A mixture of the keto-acid (20 g.), amalgamated zinc (100 g.), and concentrated hydrochloric acid (110 g.) was heated under reflux for 24 hours, a further addition of hydrochloric acid (50 g.) being made after 16 hours. Water and ether were then added, and the extracted oil was distilled under diminished pressure, β-cyclo*pentylpropionic acid* (13 g.) collecting as a colourless liquid, b. p. 135°/15 mm. (Found: C, 67·4; H, 9·8. $C_8H_{14}O$ requires C, 67·6; H, 9·9%). The *phenylhydrazide*, obtained by heating the acid with an equivalent of phenylhydrazine for 10 minutes at 130—140°, crystallised from alcohol in nacreous plates, m. p. 162° (Found: C, 72·3; H, 8·6. $C_{14}H_{20}ON_2$ requires C, 72·4; H, 8·6%).

s-*Di*-β-cyclo*pentylethyl Ketone.*—The addition of lead acetate (20 g.), dissolved in water (100 c.c.), to an aqueous solution of β-*cyclo*pentylpropionic acid (14 g.) and sodium hydroxide (4 g.) precipitated a lead salt, which could be recrystallised from a moderate volume of alcohol. The purified material, mixed with copper powder, was divided into two batches and distilled in the usual manner. By redistillation of the product a colourless liquid (4·5 g.) was obtained, b. p. *ca.* 177°/13 mm., which yielded a *semicarbazone* that crystallised from alcohol in stout prisms, m. p. 91° (Found: C, 68·8; H, 10·6. $C_{16}H_{29}ON_3$ requires C, 68·8; H, 10·4%). The *ketone* recovered from the purified derivative as an almost odourless liquid, b. p. 182°/15 mm., solidified to colourless crystals, m. p. 25°.

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