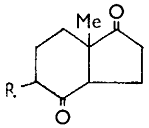
441. *Syntheses of Perhydro-5,8-dimethyl-indane-1,4-dione and -indan-1-one.*

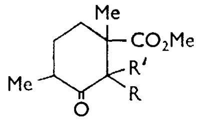
By J. DUTTA and R. N. BISWAS.

The preparation of perhydro-5,8-dimethyl-indane-1,4-dione and -indan-1-one from dimethyl 1,4-dimethyl-3-oxocyclohexane-1,2-dicarboxylate is described. The stereochemistry of the products is unknown.

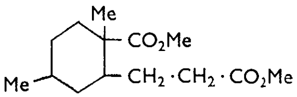
PERHYDRO-8-METHYLINDANE-1,4-DIONE (Ia) was prepared by Banerjee and Shafer[1] and later by Inhoffen and Prinz[2] as a potential intermediate for the synthesis of steroids.[3] The related perhydro-5,8-dimethylindane-1,4-dione (Ib) has now been prepared. The stereochemistry of this product and of the others described in this paper is unknown. Dutta and Biswas[4] recently described the synthesis of dimethyl 1,4-dimethyl-3-oxocyclohexane-1,2-dicarboxylate (IIa). Addition of the β-keto-ester (IIa) to ethyl acrylate in the presence of potassium t-butoxide[5] gave the 2-ethoxycarbonylethyl derivative (IIb) in 83—84% yield; in the presence of potassium ethoxide the adduct was obtained in 62% yield; no adduct was obtained when sodium ethoxide was employed. The adduct (IIb) was hydrolysed and decarboxylated with acetic–hydrochloric acid, yielding a viscous acid whose methyl ester (IIc) was obtained as an oil in 82% yield. Wolff–Kishner–Huang-Minlon reduction[6] then gave a viscous material whose dimethyl ester (III) was also an oil.



(Ia: R = H)
(Ib: R = Me)



(IIa: R = CO_2Me, R' = H)
(IIb: R = $CH_2 \cdot CH_2 \cdot CO_2Et$, R' = CO_2Me)
(IIc: R = $CH_2 \cdot CH_2 \cdot CO_2Me$, R' = H)



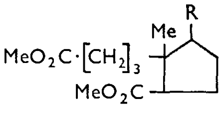
(III)

---

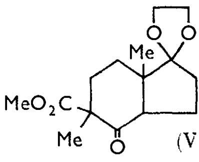
[1] Banerjee and Shafer, *J. Amer. Chem. Soc.*, 1950, **72**, 1931.
[2] Inhoffen and Prinz, *Chem. Ber.*, 1954, **87**, 684.
[3] Inhoffen, *Angew. Chem.*, 1958, **70**, 576.
[4] Dutta and Biswas, *J. Indian Chem. Soc.*, 1961, **38**, 385.
[5] Sukh Dev and Rai, *J. Indian Chem. Soc.*, 1957, **34**, 266.
[6] Huang-Minlon, *J. Amer. Chem. Soc.*, 1946, **68**, 2487.

Dieckmann cyclisation of the keto-diester (IIc) with sodium dust in benzene afforded a β-keto-ester which was directly hydrolysed and decarboxylated with acetic–hydrochloric acid to give perhydro-5,8-dimethylindane-1,4-dione (Ib) as an oil in 50% yield. This gave a crystalline bis-semicarbazone and bis-2,4-dinitrophenylhydrazone.

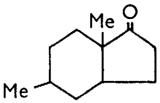
Methyl γ-(1-methyl-2-methoxycarbonyl-5-oxocyclopentyl)butyrate[1] (IVa) was converted into its ethylene ketal (IVb) under Salmi's conditions[7] in about 50% yield. On Dieckmann cyclisation with sodium hydride in benzene, this produced a β-keto-ester which was alkylated *in situ* with methyl iodide. Prolonged refluxing with acetic–hydrochloric acid, hydrolysis, decarboxylation, and removal of the ketal group of the alkylated ester (V) proceeded in one step, to furnish the oily diketone (Ib) which yielded the preceding crystalline bis-semicarbazone and bis-2,4-dinitrophenylhydrazone.



(IVa: R = :O)
(IVb: R = ·O·CH₂·CH₂·O·)



(V)



(VI)

On Dieckmann cyclisation with sodium dust in dry benzene, the ester (III) afforded a β-keto-ester which, on hydrolysis and decarboxylation as above, yielded perhydro-5,8-dimethylindan-1-one (VI) as an oil in 48% yield; this gave a crystalline semicarbazone and 2.4-dinitrophenylhydrazone.

EXPERIMENTAL

Dimethyl 2-2′-*Ethoxycarbonylethyl*-1,4-*dimethyl*-3-*oxocyclohexane*-1,2-*dicarboxylate* (IIb).—To a cooled solution of potassium t-butoxide (from 0·05 g. of potassium and 1 c.c. of t-butyl alcohol) the β-keto-ester (IIa) (14·2 g.) was added; the whole was treated dropwise with ethyl acrylate (5·5 g.). The solution was left for 7 days at room temperature, then acidified with cold acetic acid. After dilution with water, the mixture was extracted with ether. The extract was washed with water and saturated aqueous sodium hydrogen carbonate, dried, and evaporated. The residue was distilled to give unchanged ester (IIa) (6·1 g.), b. p. 110—114°/0·2 mm., and the *adduct* (IIb) (9·5 g., 84%), b. p. 170—174°/0·2 mm., n_D^{33} 1·4717 (Found: C, 59·6; H, 7·85. $C_{17}H_{26}O_7$ requires C, 59·6; H, 7·65%).

Methyl 2-2′-*Methoxycarbonylethyl*-1,4-*dimethyl*-3-*oxocyclohexanecarboxylate* (IIc).—The adduct (IIb) (9·5 g.) was refluxed for 60 hr. with acetic acid (60 c.c.) and 20% hydrochloric acid (36 c.c.). After removal of water and acetic acid at the water-pump, the residue was refluxed for 60 hr. with methanol (60 c.c.) and sulphuric acid (9 c.c.; *d* 1·84). The *keto-ester* (IIc) was worked up in the usual way and distilled as an oil (6·2 g., 82%), b. p. 140—150°/0·4 mm., n_D^{32} 1·4657 (Found: C, 61·8; H, 8·3. $C_{14}H_{22}O_5$ requires C, 62·2; H, 8·2%).

Methyl 2-2′-*Methoxycarbonylethyl*-1,4-*dimethylcyclohexanecarboxylate* (III).—The keto-ester (IIc) (4·5 g.), diethylene glycol (45 c.c.), and 85% hydrazine hydrate (7·5 c.c.) were heated under reflux for 1 hr. at 140°. To the mixture was added a solution of potassium hydroxide (4·5 g.) in diethylene glycol (22·5 c.c.) and refluxing was continued for 1 hr. The condenser was removed, and the temperature of the bath raised slowly to 200° and kept there for 2 hr. The mixture was poured into ice and hydrochloric acid (22·5 c.c.) and extracted with ether. The extract was washed with brine, dried, and evaporated. The crude acid (2·9 g.) was refluxed for 60 hr. with methanol (25 c.c.) and sulphuric acid (3·5 c.c.; *d* 1·84), giving the *diester* (III) (2 g., 47%), b. p. 125—128°/0·5 mm., n_D^{26} 1·4625 (Found: C, 65·2; H, 9·1. $C_{14}H_{24}O_4$ requires C, 65·6; H, 9·4%).

Methyl γ-(2,2-*Ethylenedioxy*-5-*methoxycarbonyl*-1-*methylcyclopentyl*)*butyrate* (IVb).—Methyl γ-(1-methyl-2-methoxycarbonyl-5-oxocyclopentyl)butyrate[1] (IVa) (2·42 g.), freshly distilled ethylene glycol (0·62 g.), toluene-*p*-sulphonic acid (0·04 g.), and dry thiophen-free benzene (60 c.c.) were refluxed under a Dean and Stark separator until no more water separated (8 hr.).

---

[7] Salmi, *Ber.*, 1938, **71**, 1803; Mukherjee, Gandhi, and Vig, *J. Indian Chem. Soc.*, 1956, **33**, 853.

The mixture was cooled, washed with saturated sodium hydrogen carbonate solution, followed by water, then dried (Na_2SO_4), and evaporated. Fractionating the residue gave the ketal (IVb), b. p. 150—160°/0·2 mm.

Perhydro-5,8-dimethylindane-1,4-dione (Ib).—(*a*) Methyl γ-(2,2-ethylenedioxy-5-methoxycarbonyl-1-methylcyclopentyl)butyrate (IVb) (1·25 g.), sodium hydride (0·25 g.), dry thiophen-free benzene (40 c.c.), and a drop of methanol were heated under reflux for 3 hr. in an atmosphere of nitrogen. The mixture (intense violet colour with alcoholic ferric chloride) was cooled in ice and treated with methyl iodide (1 c.c.) with shaking and set aside for 14 hr. at room temperature, then refluxed for 3 hr. The mixture was cooled and diluted with water. The benzene layer was separated and the aqueous layer extracted with ether. The combined organic layers were washed with water, dried (Na_2SO_4), and evaporated. The residue (0·8 g.; no ferric chloride colour) was refluxed for 20 hr. with acetic acid (10 c.c.) and 20% hydrochloric acid (10 c.c.). After dilution with water and extraction with ether, the ether layer was washed with saturated sodium hydrogen carbonate solution. Evaporation of the dried (Na_2SO_4) ether solution gave an oil, which was evaporatively distilled to furnish the *diketone* (Ib) (0·15 g.), b. p. 65—70°/2 mm., n_D^{28} 1·4846 (Found: C, 73·2; H, 9·0. $C_{11}H_{16}O_2$ requires C, 73·3; H, 8·9%). The orange bis-2,4-dinitrophenylhydrazone, prepared in the usual way and crystallised from ethyl acetate–methanol, had m. p. 250—251° (decomp.). The *bis-semicarbazone*, prepared in pyridine and crystallised from methanol, had m. p. 262—263° (decomp.) (Found: C, 53·3; H, 7·6. $C_{13}H_{22}N_6O_2$ requires C, 53·1; H, 7·5%).

(*b*) A mixture of the keto-ester (IIc) (5·4 g.), powdered sodium (0·92 g.), and dry thiophen-free benzene (60 c.c.) was heated under reflux in an atmosphere of nitrogen for 3 hr. The reddish-brown mixture was cooled and acidified with dilute acetic acid. The benzene layer was separated and the aqueous layer extracted with ether. The combined organic layers gave on evaporation an oil (4·7 g.) (deep violet ferric chloride colour) which was refluxed for 23 hr. with acetic acid (30 c.c.) and 20% hydrochloric acid (6 c.c.) and worked up as described in (*a*) above. Distillation gave the diketone (1·8 g., 50%), b. p. 95—100°/4 mm., n_D^{31} 1·4839 (Found: C, 73·0; H, 9·2%). The bis-2,4-dinitrophenylhydrazone and bis-semicarbazone had the same m. p.s as above and undepressed mixed m. p.s.

Perhydro-5,8-dimethylindan-1-one (VI).—Powdered sodium (0·37 g.) in dry benzene (40 c.c.) was refluxed after addition of the dimethyl ester (III) (1·9 g.) in an atmosphere of nitrogen. The brown product was cooled and acidified with cold dilute hydrochloric acid. After working up as described above. the residual oil (intense violet colour with alcoholic ferric chloride) was heated under reflux for 16 hr. with acetic acid (15 c.c.) and 20% hydrochloric acid (3 c.c.), cooled, neutralised with aqueous sodium hydroxide, and extracted with ether. The ether solution was washed until neutral, dried, and evaporated. The residue was distilled to furnish the *ketone* (0·5 g., 40%), b. p. 75—85°/4 mm. (Found: C, 79·0; H, 10·6. $C_{11}H_{18}O$ requires C, 79·5; H, 10·9%). The *semicarbazone*, prepared in pyridine and crystallised from methanol, had m. p. 258—259° (decomp.) (Found: C, 64·7; H, 9·55. $C_{12}H_{21}N_3O$ requires C, 64·5; H, 9·5%). The orange 2,4-dinitrophenylhydrazone had m. p. 235—236° (from ethyl acetate–methanol).

We thank the Council of Scientific and Industrial Research, Government of India, for a research grant and a research assistantship (Senior) (to R. N. B.).

ORGANIC CHEMISTRY RESEARCH LABORATORIES, SIR P. C. RAY BUILDINGS,
JADAVPUR UNIVERSITY, CALCUTTA-32, INDIA.

[*Received, July 9th*, 1962.]