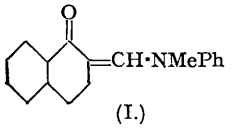
138. *The Direct Introduction of Angular Methyl Groups.*

By Arthur J. Birch and Sir Robert Robinson.

2-*Formyl*-1-*decalone* reacts with methylaniline to give 2-*methylanilinomethylene*-1-*decalone* (I), which on succesive treatment with sodamide and methyl iodide, followed by hydrolysis, gives 9-methyl-1-decalone in good yield.

Cook and Lawrence (J., 1937, 823) attempted to introduce an angular methyl group into 1-decalone by treatment of its sodio-derivative with methyl iodide, but obtained mainly 2-methyl-1-decalone, with only a trace of *cis*-9-methyl-1-decalone. Koebner and Robinson (J., 1941, 566), Johnson (*J. Amer. Chem. Soc.*, 1943, **65**, 1317), and Birch (J., 1943, 661) showed that a methylene group adjacent to a carbonyl can be protected by forming the piperonylidene or benzylidene derivative, and an angular alkyl group introduced by direct alkylation. The only process for the removal of the arylidene group is that of Johnson, which is not entirely satisfactory for several reasons, notably because it involves a chlorination.

The methylanilinomethylene derivatives have now been found to be more satisfactory, since this group is readily removed by hydrolysis. *trans*-1-Decalone condensed with ethyl formate in the presence of sodium to give the 2-*formyl* derivative, and this reacted with methylaniline in boiling benzene to give (I). Treatment of this with sodamide in benzene gave a sodio-derivative, which readily reacted with methyl iodide. The product was hydrolysed by boiling with dilute hydrochloric acid to an oil, mainly soluble in dilute sodium hydroxide solution, which must be 2-formyl-9-methyl-1-decalone, since alkaline hydrolysis produced 9-methyl-1-decalone. The overall yield from 1-decalone to 9-methyl-1-decalone was 55%.



(I.)

The product was a mixture of the *cis*- and *trans*-isomers, the former predominating. Although derivatives of both isomers could be prepared from the mixture, no very satisfactory method of separating them has been found. By taking advantage of the differential rates of reaction with semicarbazide, the *trans*-isomeride reacting the more rapidly as already observed by Johnson, it was possible to effect a partial separation.

The process would appear to be generally useful for blocking a methylene group adjacent to a carbonyl, and should facilitate the preparation of other substances containing angular alkyl groups.

Experimental.

2-Formyl-1-decalone.—In the hydrogenation of α-naphthol (100 g.) and alcohol (50 c.c.) with Raney nickel and hydrogen (100—50 atms.) at 145—150°, the addition of 2 c.c. of 20% aqueous sodium hydroxide reduced hydrogenolysis considerably, and 57 g. of a mixture of stereoisomeric 1-decalols were obtained. Oxidation with chromic acid in the usual manner gave *trans*-1-decalone.

trans-1-Decalone (21 g.) and ethyl formate (25 c.c.) were mixed and slowly added to a stirred suspension of powdered sodium (3·5 g.) in dry ether (100 c.c.), with cooling in water. After 12 hours the yellow, semi-solid mass was decomposed with ground ice and water, the red, aqueous layer separated, extracted several times with ether, and acidified with acetic acid. The product was a very pale-yellow, pleasant-smelling oil (19 g.), b. p. 136—138°/11 mm. (Found: C, 73·0; H, 8·9. $C_{11}H_{16}O_2$ requires C, 73·3; H, 8·9%).

2-Methylanilinomethylene-1-decalone.—The above *formyl* compound (19 g.) was mixed with methylaniline (14 g.) in benzene (150 c.c.), and the benzene slowly removed by distillation from a boiling steam-bath over a period of 2 hours, the water produced going over with it. Distillation gave a pale-yellow oil (26·5 g.), b. p. 195—200°/0·3 mm., solidifying to a yellow crystalline solid. A small portion, recrystallised from light petroleum (b. p. 40—60°), had m. p. 84—85° (Found: C, 79·7; H, 8·25. $C_{18}H_{23}ON$ requires C, 80·3; H, 8·5%). On prolonged contact with solvents the crystals disappeared, and a viscous resin was formed, probably owing to the formation of stereoisomers.

Methylation. The methylanilinomethylene compound (26 g.) was dissolved in dry benzene (150 c.c.) and added to dry sodamide formed by the catalytic decomposition of a solution of sodium (2·5 g.) in liquid ammonia (20 c.c.) with a trace of ferric nitrate. After refluxing for 45 minutes the evolution of ammonia ceased, and some solid sodio-derivative separated. Addition of methyl iodide (17 g.) to the cooled solution produced an exothermic reaction, completed by refluxing for 30 minutes. After the solution had been washed with dilute hydrochloric acid, the benzene was removed by distillation, and the residual brownish-yellow resin hydrolysed by boiling for 30 minutes with a large excess of 10% hydrochloric acid. The product was taken up in ether, and extracted with 5% sodium hydroxide. The ether gave on distillation a colourless oil (1·5 g.), b. p. 245—255°, giving derivatives identical with those from the mixture of isomeric 9-methyl-1-decalones described below. Acidification of the alkaline extract with acetic acid gave a colourless oil (13·5 g.), b. p. 136°/8 mm. Hydrolysis of this by refluxing for 45 minutes with 20% sodium hydroxide solution (75 c.c.) gave a colourless camphoraceous oil, (11 g.), b. p. 240—246° (Found: C, 79·6; H, 10·9. Calc. for $C_{11}H_{18}O$: C, 79·5; H, 10·8%).

The semicarbazone, prepared in the usual manner, was a white, crystalline solid, m. p. 198—204°. Repeated crystallisation from methyl alcohol gave eventually a small amount of material, m. p. 226—228°, undepressed by an authentic sample of *cis*-9-methyl-1-decalonesemicarbazone, kindly prepared by Mr. G. F. Beattie by the method of Elliott and Linstead (J., 1938, 660) (Found: C, 64·7; H, 9·2. Calc. for $C_{12}H_{21}ON_3$: C, 64·6; H, 9·4%). Treatment of the semicarbazone with an alcoholic solution of 2 : 4-dinitrophenylhydrazine sulphate gave a 2 : 4-dinitrophenylhydrazone, m. p. 161—162°, undepressed by an authentic sample of *cis*-9-methyl-1-decalone-2 : 4-dinitrophenylhydrazone, m. p. 162—163°.

Preparation of the benzylidene derivative from the mixed ketones and careful crystallisation from alcohol gave the pure *cis*-derivative as pale-yellow prisms, m. p. 103—104° (Found: C, 84·8; H, 8·7. Calc. for $C_{18}H_{22}O$: C, 85·0; H, 8·7%). The more soluble fraction had m. p. 67—72°, and probably consists mainly of the *trans*-compound.

The mixture of ketones gave an orange-yellow 2 : 4-dinitrophenylhydrazone, m. p. 145—150°, which could not be separated into the components by crystallisation, or chromatographic analysis on alumina in a 3 : 1 light petroleum (b. p. 40—60°)–benzene solvent.

To separate the ketones, the mixture was added to an excess of semicarbazide acetate solution, with sufficient alcohol to produce homogeneity, and warmed to 50°, the precipitate being collected as it appeared in four equal portions. After one recrystallisation from alcohol these had the following m. p.'s: (I) 218—219°, (II) 207—209°, (III) 222—224°, (IV) 224—227°. Fraction (I) depressed the m. p. of the *cis*-semicarbazone, and is therefore probably the *trans*-isomeride (Found: C, 64·3; H, 9·4. Calc. for $C_{12}H_{21}ON_3$: C, 64·6; H, 9·4%). Fractions (III) and (IV) were shown by mixed m. p. to be mainly the *cis*-compound.

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