

245. *Alicyclic Studies. Part VI.* The Synthesis of
2-Phenylcyclooct-2-enone.*

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2-Phenylcyclooct-2-enone has been prepared from 1-phenylcyclooctene *via* the nitrosochloride and the oxime.

2-PHENYLCYCLOOCT-2-ENONE was required as an intermediate for the synthesis of a tricyclic analogue of phenanthrene in which one benzenoid ring is replaced by a cyclooctatetraene ring. Its synthesis followed the preparation of other 2-arylcycloalk-2-enones.¹

1-Phenylcyclooctene nitrosochloride was prepared directly from 1-phenylcyclooctan-1-ol which undergoes dehydration under the conditions of this reaction or from 1-phenylcyclooctene. In this case a base stronger than pyridine is required for the dehydrochlorination. Alcoholic potassium hydroxide was used to convert the nitrosochloride into the oxime of the required $\alpha\beta$ -ethylenic ketone. Acidic hydrolysis of the oxime yielded the ketone. Proof of its structure was obtained by reduction to 2-phenylcyclooctanone.²

Since 40% hydrogen peroxide was not available to us, the authentic specimen of 2-phenylcyclooctanone had to be prepared by a modification of Cope and Smith's method² in which 30% hydrogen peroxide was substituted. The infrared absorption of the mixture obtained after the epoxidation step and acid treatment showed that it contained the allylic alcohol and acetate as stated² but that clearly 2-phenylcyclooctanone was also present in high concentration. Therefore, 2:4-dinitrophenylhydrazine solution was added and immediate precipitation of the 2:4-dinitrophenylhydrazone of 2-phenylcyclooctanone occurred. This product was identical with that subsequently obtained by following explicitly the complete synthetic procedure suggested by Cope and Smith.²

A crystalline by-product was usually obtained during the hydrolysis of 2-phenylcyclooct-2-enone oxime. This was identified as ω -benzoylheptanoic acid and was presumably formed by partial Beckmann rearrangement of the $\alpha\beta$ -ethylenic oxime to a nine-membered unsaturated lactam which upon further hydrolysis to the amino-acid containing a vinylamine function finally gave the keto-acid. Its structure was proved by oxidation of 1-phenylcyclooctan-1-ol which yielded ω -benzoylheptanoic acid identical with the above by-product.

EXPERIMENTAL

1-Phenylcyclooctan-1-ol.—cycloOctanone (76.7 g., 0.6 mole) was added dropwise with stirring at 0° to a Grignard reagent prepared from magnesium (19.5 g.) and bromobenzene (125.6 g., 0.8 mole) in dry ether (800 ml.). After refluxing for 1 hr. the mixture was decomposed with ammonium chloride (250 g.) in water (1 l.). The ether layer was separated and the aqueous

* Part V, preceding paper.

¹ Ginsburg and Pappo, *J.*, 1951, 516; *J. Amer. Chem. Soc.*, 1953, **75**, 1094; Amiel, Loeffler, and Ginsburg, *ibid.*, 1954, **76**, 3625; Bar-Shai and Ginsburg, preceding paper.

² Cope and Smith, *J. Amer. Chem. Soc.*, 1952, **74**, 5136.

layer was extracted twice with ether. The combined ether solutions were distilled under reduced pressure. Light petroleum was added to the residue but crystallisation of the alcohol could be induced by scratching only after water (20 ml.) was added. The crystals were removed and washed until colourless with light petroleum, then having m. p. 41° (90 g.) (Found: C, 75.6; H, 10.0; O, 14.6. $C_{14}H_{20}O \cdot 1H_2O$ requires C, 75.6; H, 10.0; O, 14.4%). On drying, the substance is obtained as an oil. From the mother-liquor, cyclooctanone (19 g.) and 1-phenylcyclooctene (21 g.) were recovered by distillation.

1-Phenylcyclooctene Nitrosochloride.—1-Phenylcyclooctene was obtained in quantitative yield by dehydration of the above alcohol with concentrated phosphoric acid. It had b. p. 106°/5 mm., n_D^{20} 1.5610 (Found: C, 90.2; H, 9.95. $C_{14}H_{18}$ requires C, 90.3; H, 9.7%).

To 1-phenylcyclooctene (21 g.) and isopentyl nitrite (16 ml.) in glacial acetic acid (50 ml.) was added at 0° with stirring a mixture of concentrated hydrochloric acid (16 ml.) and acetic acid (10 ml.). The colourless crystalline nitrosochloride was filtered off, washed with cold ethanol and ether, and dried by suction; it had m. p. 95° (19 g.) (Found: N, 5.5; Cl, 14.0. $C_{14}H_{18}ONCl$ requires N, 5.6; Cl, 14.2%). 1-Phenylcyclooctan-1-ol (22 g.) could be used equally well to yield the nitrosochloride (19 g.). The product is stable for months at 0°.

2-Phenylcyclooct-2-enone Oxime.—The nitrosochloride (10 g.) was added to a solution of potassium hydroxide (10 g.) in ethanol (50 ml.) and heated at 70° for 15–30 min. The resulting solution was poured into water (300 ml.) and after careful acidification with hydrochloric acid was steam-distilled. After removal of the ethanol and some 1-phenylcyclooctene, the residue was cooled and filtered. The oxime forms colourless hexagonal plates, m. p. 150° (from ethanol), after sintering with loss of solvent of crystallisation at 140° (Found: C, 74.0; H, 8.9; N, 5.3. $C_{14}H_{17}ON, C_8H_7OH$ requires C, 73.5; H, 8.9; N, 5.4%).

2-Phenylcyclooct-2-enone.—(a) *From its oxime.* A solution of the oxime (1.8 g.) in ethyl methyl ketone (50 ml.) was added to a mixture of acetone (2 ml.), hydrochloric acid (1 : 1; 12 ml.), and cuprous oxide (2 g.) and the mixture was heated at 80° for 20 hr.³ Water (100 ml.) was added, and the aqueous layer was extracted with ether. The combined organic layers were dried ($MgSO_4$) and evaporated. The residue was dissolved in methylcyclohexane and washed with Claisen's alkali until the latter was colourless. The methylcyclohexane layer was washed with dilute acid and with water and dried (K_2CO_3). After removal of the solvent and distillation, the ketone, b. p. 110°/0.4 mm., was obtained (0.7 g.) and characterised as the 2 : 4-dinitrophenylhydrazone, m. p. 127° (from ethanol).

When the oxime was refluxed with aqueous oxalic acid, ω -benzoylheptanoic acid, m. p. 84–85° (from water), crystallised from the aqueous solution after steam-distillation of volatile material (Found: C, 71.6; H, 7.7. Calc. for $C_{14}H_{18}O_3$: C, 71.8; H, 7.7%). It gave no m. p. depression on admixture with the keto-acid obtained by oxidation of 1-phenylcyclooctan-1-ol.⁴

(b) *From 2-phenylcyclooctanone.* A mixture of 2-phenylcyclooctanone (3 g.), *N*-bromosuccinimide (1.8 g.), and carbon tetrachloride (15 ml.) was refluxed for 90 min. After the usual working up, the residue was set aside at room temperature in collidine (20 ml.). Thence was recovered 2-phenylcyclooct-2-enone (2.8 g.), characterised as the 2 : 4-dinitrophenylhydrazone, yellow needles, m. p. 127° (from ethanol) (Found: C, 63.45; H, 5.3; N, 14.8. $C_{20}H_{20}O_4N_4$ requires C, 63.15; H, 5.3; N, 14.7%). Ultraviolet absorption (in MeOH): λ_{max} 3620 Å (log ϵ 4.37). Infrared absorption (C=O) (in $CHCl_3$): 1695 cm^{-1} .

2-Phenylcyclooctanone.—(a) 2-Phenylcyclooct-2-enone (1 g.) in ethanol (25 ml.) was hydrogenated in the presence of 5% palladised charcoal (0.5 g.) at atmospheric pressure. One mol. of hydrogen was absorbed during 30 min. Removal of the catalyst and solvent followed by distillation of the residue yielded the saturated ketone, b. p. 115°/0.4 mm., characterised as the yellow 2 : 4-dinitrophenylhydrazone, m. p. 146° (from ethanol) (Found: C, 62.8; H, 5.7; N, 14.3. $C_{20}H_{22}O_4N_4$ requires C, 62.8; H, 5.8; N, 14.65%), identical with that obtained by the epoxidation procedure (see below). Ultraviolet absorption (in MeOH): λ_{max} 3510 Å (log ϵ 4.39).

(b) *Epoxidation procedure.*⁵ Hydrogen peroxide (30%; 4.4 g.) was added at 40° to a mixture of 1-phenylcyclooctene (5.5 g.), concentrated sulphuric acid (0.5 ml.), and glacial acetic acid (26 ml.). After being stirred at room temperature for 3 hr. the mixture was poured into hot water (60°; 200 ml.) and was stirred for 5 min., then neutralised with aqueous sodium hydroxide and extracted with ether. Evaporation of the ether followed by distillation yielded an oil, b. p. 100–116°/0.2 mm. This was added to ethanolic (20 ml.) potassium hydroxide

³ Summerford and Dalton, *J. Amer. Chem. Soc.*, 1944, **66**, 1330.

⁴ Fieser and Szmuszkovicz, *J. Amer. Chem. Soc.*, 1948, **70**, 3352.

(1.7 g.), and the mixture was refluxed for 1 hr. and poured into water (300 ml.). Ether-extraction followed by removal of the solvent and distillation gave two fractions, b. p. 80—96°/0.5 mm. and 100—120°/0.5 mm. The latter fraction showed absorption at 1685 cm^{-1} (C=O) and 1725 cm^{-1} (acetate C=O). Addition of 2 : 4-dinitrophenylhydrazine solution to this fraction yielded the 2 : 4-dinitrophenylhydrazone of 2-phenylcyclooctanone, m. p. 146° (from ethanol) (1 g.).

When the Cope-Smith procedure ⁸ was followed in its entirety, 2-phenylcyclooctanone was obtained and was characterised by the identical 2 : 4-dinitrophenylhydrazone, m. p. and mixed m. p. 146° (from ethanol), and as its semicarbazone, m. p. 154°. Cope and Smith ⁸ report m. p. 153.9—154.7° for the latter derivative.

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