of 86 U.S.P. units per mg. as the standard; by this procedure, the synthetic[54c] peptide V was found to possess an ACTH potency of 39.8 U.S.P. units per mg. with a 95% confidence limit for the assay in the range of 32.7–48.5.

The peptide V was also tested for ACTH activity by the adrenal ascorbic acid depletion method,[39] with administration by both intravenous and subcutaneous routes. In each procedure, a six-point design with six hypophysectomized rats per dose was employed. It was found[55] that with intravenous administration, a potency of 34.6 U.S.P. units per mg. was obtained for the nonadecapeptide, with a 95% confidence limit in the range of 22.3 to 55.0; whereas with subcutaneous administration, the nonadecapeptide was found to possess a potency of 74.2 U.S.P. units per mg., with a 95% confidence limit in the range of 50.6 to 100.6.

The melanocyte-stimulating activity of peptide V was determined by the method described by Shizume, *et al.*,[36] with isolated skins of *Rana pipiens;* the unit of activity used is the same as that defined by these investigators. Bioassay also was carried out with hypophysectomized *Rana pipiens* (not more than 4 days after operation) as described by Hogben and Slome.[37]

In vitro lipolytic assay[61] showed that peptide V is highly active as a lipolytic agent. In hypophysectomized rats, peptide V also is capable of eliciting an increased Fe^{59} incorporation[62] into the red cells at a rate comparable to that elicited by the native hormone. In addition, peptide V has been assayed in man and shown to possess the ACTH potency[63] predicted from the results of animal assay. Thus, the synthetic nonadecapeptide V exerts the same biological functions, namely, adrenal-stimulation, melanocyte stimulation, lipolysis and erythropoiesis as the natural ACTH molecule.[27]

Acknowledgment.—This work was supported in part by grants from the National Institutes of Health of the United States Public Health Service (G-2907) and the Albert and Mary Lasker Foundation. E. S. and J. M. wish to thank the conference Board of the Associated Research Councils for Fulbright Grants. T. L. is on leave of absence from the National Taiwan University, Formosa.

(55) We are indebted to Drs. M. L. Pabst, D. A. Harvey and M. Speeter of the Upjohn Co. for these assay data (7/13/60–9/22/60).

(56) In a private communication (11/23/60) Schwyzer and his coworkers[60] also have reported the synthesis of the glutaminyl analog of the nonadecapeptide and found it to possess an ACTH potency of 20–30 I.U. per mg. by the *in vitro* adrenal method.[38]

(57) R. A. Boissonnas, St. Guttmann, J. P. Waller and P. A. Jaquenoud, *Experientia*, **12**, 466 (1956).

(58) K. Hofmann, in *Brook. Symp. Biol.*, **13**, 184 (1960).

(59) K. Hofmann, H. Yajima, N. Yanaihara, T. Y. Liu and S. Lande, *J. Am. Chem. Soc.*, **83**, 487 (1961).

(60) R. Schwyzer, W. Rittle, H. Kappeler and B. Iselin, *Angew. Chem.*, **23**, 915 (1960).

(61) We are indebted to Dr. F. L. Engel of Duke University for the lipolytic assay (11/28/60). For the assay method, see E. Lopez, J. E. White and F. L. Engel, *J. Biol. Chem.*, **234**, 2254 (1959).

(62) We wish to thank Drs. D. C. van Dyke and J. H. Lawrence of this University for the erythropoietic assay (11/22/60). For the assay method, see W. Fried, L. Plzak, L. O. Jacobson and E. Goldwasser, *Proc. Soc. Exp. Biol. Med.*, **92**, 203 (1956).

(63) It is a pleasure to thank Dr. P. Forsham of this University for his coöperation in the clinical tests of our synthetic products (10/29/60).

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, EMORY UNIVERSITY, ATLANTA 22, GA.]

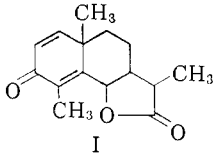
The Synthesis of Dienones Related to Santonin and ψ-Santonin via Aryl Participation

BY LEON MANDELL, DRURY CAINE AND GORDON E. KILPATRICK

RECEIVED JUNE 10, 1961

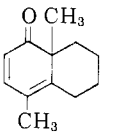
Compound VII has been synthesized and shown to undergo solvolysis with aryl participation leading to the formation of dienones II and XV.

The work of Winstein and his associates[1] has shown the feasibility of utilizing aryl participation as a means of synthesizing dienones having interesting spirane structures. Recently, Masamune[2] has applied Ar_1-5[1] participation to the synthesis of part of the ring skeleton of phyllocladene. A very common type of dienone, typified by santonin (I) has been studied with regard to synthesis[3]

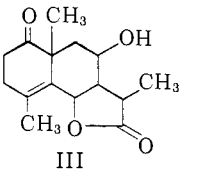


I

and its tendency to undergo the dienone–phenol[4] rearrangement. It was the object of this work to see if the aryl participation reaction could be used for the preparation of non-spirane dienones of the santonin type and also of the related dienone system II, which incorporates features of the ψ-

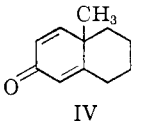


II

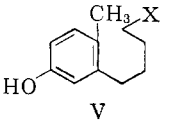


III

santonin ring structure, III. This problem became clearly defined with the failure of recent attempts[5,6] to prepare 3-keto-9-methyl-Δ-1,4-hexahydronaphthalene, IV, utilizing aryl participation. In these efforts compounds of the type V were synthesized and solvolyzed. However, cyclization occurred



IV



V

ortho to the hydroxyl resulting in the formation of a naphthalene of structure VI. It thus became

(1) S. Winstein, R. Heck, S. Lapporte and R. Baird, *Experientia*, **12**, 138 (1956); S. Winstein and R. Baird, *J. Am. Chem. Soc.*, **79**, 756 (1957).

(2) S. Masamune, *ibid.*, **83**, 1009 (1961).

(3) For syntheses of the ring system in santonin see M. Yanagita, S. Inayama, M. Hirakura, and F. Seki, *J. Org. Chem.*, **23**, 690 (1958); M. Yanagita and R. Futaki, *ibid.*, **21**, 949 (1956); P. R. Hills and F. J. McQuillin, *J. Chem. Soc.*, 4060 (1953); F. D. Gunstone and R. M. Heggie, *ibid.*, 1437 (1952).

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(5) W. E. Hill, Doctoral Dissertation, Emory University (1959).

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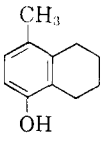
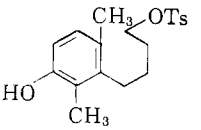
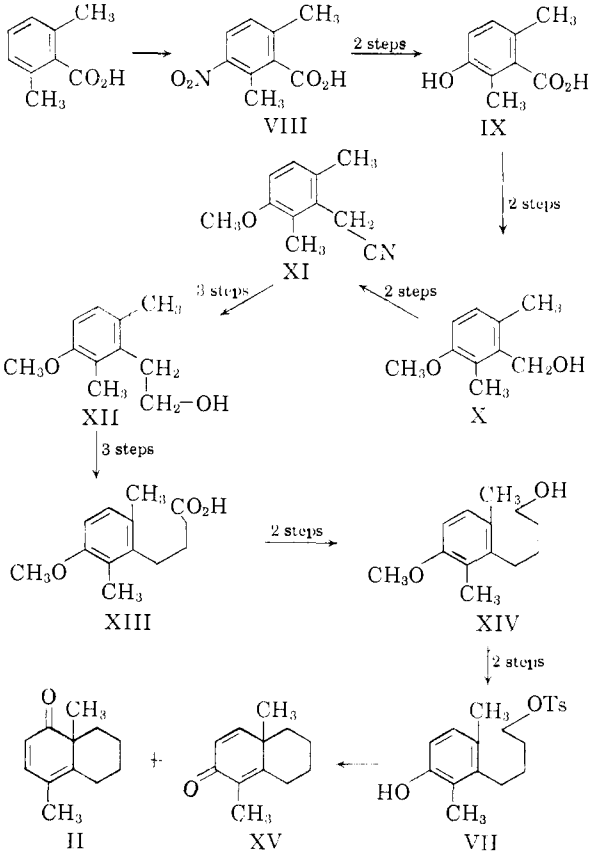

VI

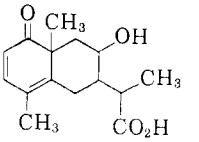

VII

clear that what was needed to demonstrate the possibility of Ar_2-6 participation would be a compound related to V, so modified, however, so that during solvolysis, participation by either the *ortho* (to hydroxyl) or *para* (to hydroxyl) position of the aromatic ring would lead to dienone formation. Such a compound is 4-(2,6-dimethyl-3-hydroxyphenyl)-butyl-*p*-toluenesulfonate, VII, which was synthesized as shown.



2,6-Dimethylbenzoic acid[7] was nitrated to give VIII. The position of the nitro group was proven utilizing n.m.r. spectroscopy which showed clearly the presence of two non-equivalent protons on the benzene ring, thus precluding the alternative symmetrical structure. The nitro group was reduced catalytically to an amine and this followed by diazotization and hydrolysis to afford IX. Methylation of the phenol and acid and subsequent reduction with lithium aluminum hydride gave the alcohol X. This material was converted *via* its chloride to the nitrile, XI, and the nitrile hydrolyzed, esterified and reduced with lithium aluminum hydride to XII. This alcohol was transformed through the agency of phosphorus tribromide to the corresponding bromide to which two carbons were added *via* a malonic ester synthesis ending in decarboxylation of the malonic acid to XIII. Reësterification and reduction with lithium aluminum hydride yielded XIV. The phenolic hydroxyl was demethylated utilizing potassium hydroxide in diethylene glycol[8] and this product converted to the tosylate VII.

The tosylate was solvolyzed under conditions similar to those employed by Winstein and a mixture of the dienones II and XV was obtained. The dienones were separated by chromatography. Dienone II is a new compound and was characterized by analysis of its 2,4-dinitrophenylhydrazone and its spectral properties (reported in the Experimental), which corresponded well with XVI, a derivative of ψ-santonin[9] having the same chromophore as II. The other dienone, XV, is a known


XVI

compound[3] and its properties as well as those of its derivatives were in accord with those reported previously.

This work is thus the first example of Ar_2-6 participation being applied to the synthesis of dienones of the santonin type and the ring system of ψ-santonin.

Experimental[10]

2,6-Dimethyl-3-nitrobenzoic Acid (VIII).—A slurry of 50 g. of 2,6-dimethylbenzoic acid[7] (m.p. 113–115°) in a solution of 91 ml. of glacial acetic acid and 62 ml. of concentrated sulfuric acid was cooled to 5° and, while stirring, maintained as near that temperature as possible during the dropwise addition of 20.8 ml. of concentrated nitric acid in 30.4 ml. of concentrated sulfuric acid. After the addition was complete, the mixture was stirred for 1 hr. at room temperature and poured into ice water. The finely divided solid product was filtered off, washed with cold water and dried in air. Recrystallization from ligroin yielded 55 g. (83%) of VIII, m.p. 111–115° which was depressed below 110° on admixture with starting material; infrared absorption at 6.57 and 7.42 μ; n.m.r. spectrum showing two dissimilar aromatic protons.

Anal. Calcd. for $C_9H_9NO_4$: C, 55.38; H, 4.65; N, 7.18. Found: C 55.17; H, 4.57; N, 7.21.

2,6-Dimethyl-3-hydroxybenzoic Acid (IX).—Thirteen grams of VIII was dissolved in 150 ml. of absolute methanol containing 0.2 g. of platinum oxide catalyst, and the mixture was shaken with hydrogen at approximately 60 p.s.i. until the stoichiometric amount was absorbed. The insoluble amino acid was filtered off and dissolved in 20 ml. of 4.7 *M* sulfuric acid. The solution was filtered to remove the platinum oxide catalyst, the filtrate was cooled to 0°, and an aqueous solution of 2.4 g. of sodium nitrite was added dropwise with stirring until a positive potassium iodide–starch test was obtained. The excess nitrous acid was destroyed by the addition of a little urea, and the cold, clear diazonium salt solution was added dropwise to 100 ml. of refluxing 1.2

(7) H. L. Goering, T. Rubin and M. S. Newman, *J. Am. Chem. Soc.*, **76**, 787 (1954).

(8) M. Gates and G. Tschudi, *ibid.*, **78**, 1380 (1956).

(9) W. Cocker, *Chem. & Ind. (London)*, 1041 (1955); N. M. Chopra, W. Cocker, J. T. Edward, T. B. H. McMurry and E. R. Stuart, *J. Chem. Soc.*, 1828 (1956).

(10) Analyses are by Dr. G. Weiler and Dr. F. B. Strauss, Oxford, England. Infrared spectra were taken on a Perkin-Elmer Model 21, Spectrophotometer, equipped with sodium chloride optics and cells. Ultraviolet spectra were taken on a Beckmann DK-2 Recording Spectrophotometer using silica cells. Melting points were determined by the open capillary method and are uncorrected.

M sulfuric acid. When the addition was complete, the reaction mixture was refluxed for 30 minutes, treated with charcoal and filtered while hot. The hot filtrate was saturated with sodium sulfate, cooled and extracted with four 50-ml. portions of ether. The combined ethereal extracts were dried over anhydrous sodium sulfate, and the solvent was removed under reduced pressure. Recrystallization of the residue from water gave 6.3 g. (56%) of IX which crystallized as the monohydrate, m.p. 101–103°.

Anal. Calcd. for $C_9H_{10}O_3 \cdot H_2O$: C, 58.68; H, 6.56. Found: C, 58.88; H, 6.65.

2,6-Dimethyl-3-methoxybenzyl Alcohol (X).—Dimethyl sulfate (57 ml.) was added slowly with cooling and swirling to a solution of 40 g. of IX in 216 ml. of 20% aqueous sodium hydroxide. The reaction mixture was allowed to stand for 1 hr. at room temperature and then it was refluxed for 2 hr. The reaction mixture was acidified with concentrated hydrochloric acid and extracted with three 200-ml. portions of ether. The ethereal extracts were washed with water, dried and treated with twice the theoretical amount of an ethereal solution of diazomethane. After the mixture had been allowed to stand overnight, the solvent was removed under reduced pressure, 216 ml. of 20% aqueous sodium hydroxide along with 200 ml. of acetone was added to the residue and 57 ml. of dimethyl sulfate was added with swirling and cooling. After being allowed to stand in the cold for 1 hr., the reaction mixture was refluxed for 24 hr. The acetone was removed under reduced pressure and the residue was acidified with concentrated hydrochloric acid and extracted with three 200-ml. portions of ether. The combined ether extracts were washed with water, dried and treated with excess diazomethane overnight. Removal of the ether under reduced pressure and distillation of the residue *in vacuo* gave 36 g. (77%) of methyl 2,6-dimethyl-3-methoxybenzoate, b.p. 93° (0.2 mm.).

The methyl ester (35 g.) was added dropwise with stirring to a slurry of 6.4 g. of lithium aluminum hydride in 460 ml. of anhydrous ether. After the addition was complete, the mixture was stirred and refluxed for 2 hr. and the excess reducing agent destroyed by careful addition of a saturated solution of sodium sulfate. The solid residue was filtered off and washed with anhydrous ether. The filtrate and washings were dried over anhydrous sodium sulfate and the ether evaporated under reduced pressure. Recrystallization of the solid residue from water gave 27.6 g. (92%) of X, m.p. 86–89°.

Anal. Calcd. for $C_{10}H_{14}O_2$: C, 72.26; H, 8.49. Found: C, 72.23; H, 8.24.

2,6-Dimethyl-3-methoxyphenylacetonitrile (XI).—Nineteen ml. of thionyl chloride was added slowly with cooling to a slurry of 29 g. of X in 160 ml. of anhydrous ether. The reaction mixture was allowed to stand for 6 hr. in the cold and poured into ice water. The ether layer was washed with 5% sodium bicarbonate until neutral to litmus, dried and the ether removed under reduced pressure. Recrystallization of the solid residue from aqueous ethanol gave 25.2 g. (78%) of 2,6-dimethyl-3-methoxybenzyl chloride, m.p. 50–51°.

Anal. Calcd. for $C_{10}H_{13}ClO$: C, 65.04; H, 7.09. Found: C, 64.93; H, 7.01.

The benzyl chloride (24 g.) was dissolved in 70 ml. of acetonitrile (freshly distilled from phosphorus pentoxide). Potassium cyanide (33.4 g.) then was added and the mixture was refluxed for 16 hr. under anhydrous conditions. After the solid had been removed by filtration and washed with anhydrous ether, the combined filtrate and washings were washed with four 150-ml. portions of water, 150 ml. of saturated sodium sulfate solution and dried. The residue obtained after evaporation of the solvent was recrystallized from aqueous ethanol to give 19.2 g. (84%) of XI, m.p. 52.6–53.4°; infrared absorption at 4.46 μ.

Anal. Calcd. for $C_{11}H_{13}NO$: C, 75.40; H, 7.48; N, 8.00. Found: C, 74.76; H, 7.25; N, 8.25.

β-(2,6-Dimethyl-3-methoxyphenyl)-ethanol, (XII).—A mixture prepared from 31 g. of the nitrile XI in 100 ml. of 95% ethanol and 70 g. of potassium hydroxide in 100 ml. of water was refluxed for 36 hr. After 50 ml. of the solvent had been removed by distillation, the reaction mixture was cooled, diluted with 400 ml. of water and extracted with ether to remove unchanged nitrile. The aqueous solution then was filtered and acidified with cold, dilute hydrochloric acid. The white precipitate was collected on a filter, dried in air and recrystallized from petroleum ether. The yield was 28 g. (81%) of 2,6-dimethyl-3-methoxyphenylacetic acid, m.p. 123–125°.

Anal. Calcd. for $C_{11}H_{14}O_3$: C, 68.02; H, 7.27. Found: C, 68.39; H, 7.33.

The substituted acetic acid (55 g.) was dissolved in ether and treated with excess ethereal diazomethane. Workup of the reaction mixture in the usual way gave 54.3 g. (92%) of methyl 2,6-dimethyl-3-methoxyphenyl acetate as a colorless liquid; infrared absorption at 5.77 μ.

Lithium aluminum hydride reduction of the crude ester (27 g.) in the usual manner gave 22.2 g. (95%) of XII, m.p. 58–59°, which was obtained as a white solid on recrystallization from *n*-hexane.

Anal. Calcd. for $C_{11}H_{16}O_2$: C, 73.30; H, 8.95. Found: C, 73.36; H, 9.06.

4-(2,6-Dimethyl-3-methoxyphenyl)-butyric Acid (XIII).—To a cooled slurry of 45 g. of XII in 60 ml. of dry benzene was added dropwise 24.4 g. of phosphorous tribromide in 40 ml. of dry benzene. The reaction mixture was allowed to stand for 1 hr. in an ice bath and warmed on a steam-bath (60) for 3 hr. The cooled reaction mixture was poured onto cracked ice, and the benzene layer separated and washed successively with 5% aqueous sodium carbonate, 5% hydrochloric acid and water. Distillation of the colorless liquid obtained after drying of the benzene solution and evaporation of the solvent gave 32.3 g. (53%) of β-(2,6-dimethyl-3-methoxyphenyl)-ethyl bromide, b.p. 113–116° (1 mm.).

Anal. Calcd. for $C_{11}H_{15}BrO$: C, 54.34; H, 6.21. Found: C, 54.52; H, 6.17.

To a cooled solution of ethyl sodio-malonate prepared from 6 g. of sodium, 100 ml. of absolute ethanol and 52 g. of malonic ester, 40 g. of the substituted ethyl bromide was added dropwise with stirring. Sodium bromide began to precipitate after 8 hr. stirring at room temperature, and reflux was begun and continued for 12 hr. before the addition of 120 ml. of 45% aqueous potassium hydroxide solution. After continued reflux for 4 hr., most of the benzene and alcohol was distilled off during a 2-hr. period with water being added occassionally to maintain the volume of the reaction mixture near 200 ml. The mixture then was cooled, extracted with ether and filtered into excess cold, dilute hydrochloric acid. The precipitate of crude β-(2,6-dimethyl-3-methoxyphenyl)-ethylmalonic acid was filtered off and dried in air. The yield was 26.5 g. (60%).

The diacid (24.5 g.) was refluxed for 8 hr. with 125 ml. of 2 *N* hydrochloric acid. The reaction mixture was cooled in an ice bath and extracted with ether. The ethereal solution was washed several times with water and dried over anhydrous sodium sulfate. Evaporation of the solvent yielded 17.2 g. (85% from the diacid) of XIII as a heavy oil which crystallized on cooling. A small amount of this material when recrystallized from *n*-heptane containing a small amount of ether melted at 131–134°.

4-(2,6-Dimethyl-3-methoxyphenyl)-butanol (XIV).—Esterification of 16.6 g. of XIII with excess diazomethane in the usual manner gave 16.5 g. (93%) of methyl-4-(2,6-dimethyl-3-methoxyphenyl)-butyrate as a colorless liquid; infrared absorption at 5.77μ.

Lithium aluminum hydride reduction of 16.4 g. of the methyl ester in the usual manner gave 13.5 g. (93%) of XIV.

A small amount of XIV was converted to its 3,5-dinitrobenzoate derivative which melted at 122.4–124° when recrystallized from 95% ethanol.

Anal. Calcd. for $C_{20}H_{22}N_2O_7$: C, 59.69; H, 5.51. Found: C, 59.42; H, 5.48.

4-(2,6-Dimethyl-3-hydroxyphenyl)-butyl-*p*-toluenesulfonate (VII).—A solution of 13 g. of XIV in 30 ml. of diethylene glycol was added to 290 ml. of diethylene glycol containing 41 g. of potassium hydroxide and 3 ml. of hydrazine hydrate (to serve as an antoxidant). While a slow stream of nitrogen was continuously bubbled through the system, the reaction mixture was heated at 220–224° for 2 hr. The strongly basic solution then was cooled to room temperature, diluted with 450 ml. of water and extracted with ether to remove unchanged starting material. The aqueous solution then was acidified with 70 ml. of concentrated hydrochloric acid containing 100 g. of cracked ice and extracted with three 300-ml. portions of ether. After the ether solution had been dried and the ether removed by evaporation, a heavy oil

which resisted crystallization from several organic solvents was obtained. This oil showed an ultraviolet absorption maximum in 95% ethanol at 282 mμ (log ε, 3.17), but in ethanol which was 0.1 *M* in potassium hydroxide, this maximum was shifted to 300 mμ (log ε, 3.39). This characteristic[11] shift in the B-band absorption to longer wave length and increased intensity in the phenoxide ion as compared to the un-ionized phenol clearly demonstrated that the oil was the desired ether cleavage product, 4-(2,6-dimethyl-3-hydroxyphenyl)-butanol. The yield was 6.2 g. (51%).

An adjusted yield of 80% was obtained when the ethereal solution extracted from the basic solution was shown to contain 5.5 g. of unchanged starting material.

p-Toluenesulfonyl chloride (8.0 g.) was added in one portion to a solution prepared from 5.58 g. of 4-(2,6-dimethyl-3-hydroxyphenyl)-butanol in 55 ml. of dry pyridine which had been cooled to −5°. The reaction mixture was allowed to stand for 2 hr. at 0°, and 6 ml. of water was added in the following portions at 5 minute intervals: 0.6 ml., 0.6 ml., 0.6 ml., 1.2 ml. and 3 ml. The reaction mixture then was diluted with 60 ml. of water and extracted with three 60-ml. portions of chloroform. The combined chloroform extracts were washed successively with cold dilute sulfuric acid, water and 5% aqueous sodium bicarbonate and dried over anhydrous sodium sulfate. Evaporation of the solvent under reduced pressure gave 8.2 g. of a gummy residue.

Although this material could not be recrystallized from a number of organic solvents, its infrared spectrum showed absorption bands at 7.35, 8.41 and 8.50 μ, which are characteristic of the *p*-toluenesulfonate group.[12] Chromatography of the oil on alumina gave only a liquid major fraction, but this material showed infrared absorption bands of exactly the same position and intensity as those of the crude material. This finding demonstrated that the major portion of the crude oil was the desired tosylate VII. The yield of VII was 70%.

Solvolysis of 4-(2,6-Dimethyl-3-hydroxyphenyl)-butyl-*p*-toluenesulfonate (VII).—To a solution of 0.81 g. of potassium in 500 ml. of anhydrous *t*-butanol was added 6.0 g. of VII in 75 ml. of anhydrous *t*-butanol (all alcohol used was dried by reflux over sodium followed by distillation). After 15 hr. reflux the solution was cooled, diluted with 700 ml. of water and extracted with three 250-ml. portions of ether. After the ethereal solution had been dried and the solvent evaporated, chromatography of the residue obtained on alumina (Bio-Rad, Basic Alumina, AG10), eluting with 500 ml. of pure pentane followed by 500 ml. of 2% ether in pentane, gave after evaporation of the solvent 0.48 g. of the *o*-dienone II as an almost colorless oil; λ_{max}^{EtOH} 328 mμ log (ε 3.55); $\lambda_{C=C}^{CmCl_3}$ 6.00μ, $\lambda_{C=C}^{CHCl_3}$ 6.12 and 6.38μ.

The 2,4-dinitrophenylhydrazone of II was prepared from 100 mg. of the dienone, 120 mg. of 2,4-dinitrophenylhydrazone, 8 ml. of absolute methanol and two drops of concentrated hydrochloric acid, with a 2.5 hr. reflux period. This derivative when recrystallized from absolute methanol melted at 129.5–131°.

Anal. Calcd. for $C_{18}H_{20}N_4O_4$: C, 60.66; H, 5.66; N, 15.72. Found: C, 60.12; H, 5.78; N, 16.00.

Continued elution of the chromatographic column with 500 ml. of 10% ether in pentane gave 0.17 g. of a light yellow oil which from its infrared and ultraviolet spectrum appeared to be composed of about equal quantities of the dienone II and the crossed-conjugated dienone XV.

Finally, by eluting the column with 500 ml. of 15% ether in pentane, 0.18 g. of the pure *p*-cyclohexadienone XV was obtained; λ_{max}^{EtOH} 238 mμ (log ε 3.92) and 265 mμ (log *c* 3.72) (inflection); $\lambda_{C=O}^{CHCl_3}$ 6.01μ; $\lambda_{C=C}^{CHCl_3}$ 6.14 and 6.21μ. The reported[3] values for XV are λ_{max}^{EtOH} 241 mμ (log ε 3.95) and 265 mμ (log *c* 3.74) (inflection); $\lambda_{C=O}^{CHCl_3}$ 6.0μ, $\lambda_{C=C}^{CHCl_3}$ 6.11 and 6.195μ.

The 2,4-dinitrophenylhydrazone of XV was prepared in almost quantitative yield when a mixture of 30 mg. of the dienone, XV, 30 mg. of 2,4-dinitrophenyl-hydrazone, 3 ml. of absolute ethanol and 3 drops of concentrated sulfuric acid was allowed to stand overnight at room temperature. This material recrystallized as deep red scales from 1-butanol, m.p. 224–230° (reported[3] 232–234°). It had $\lambda_{max}^{CHCl_3}$ 259 mμ (log ε 4.08), 313 mμ (log ε 3.63) and 407 mμ (log ε 4.40), which are very close to those reported.[3]

The total weight of the three chromatographic fractions obtained was 0.84 g., which amounted to a 27% yield of the dienones II and XV.

(11) L. Doub and J. M. Vandenbelt, *J. Am. Chem. Soc.*, **69**, 2714 (1947).

(12) R. S. Tipson, *ibid.*, **74**, 1354 (1952).

[CONTRIBUTION FROM THE KEDZIE CHEMICAL LABORATORY, MICHIGAN STATE UNIVERSITY, EAST LANSING, MICH].

Multicharged Carbonium Ions. III. Long-lived Ions from Trichloromethylpolymethylbenzenes[1-3]

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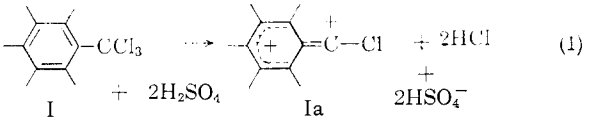
Mesitylene is converted to trichloromethylmesitylene (II) with carbon tetrachloride and aluminum chloride. Under similar conditions, rearrangement occurs with durene, the product being trichloromethylprehnitene (III). Both II and III ionize in 100% sulfuric acid in a fashion analogous to trichloromethylpentamethylbenzene (I), giving long-lived dipositive carbonium ions. The evidence is based on cryoscopy, stoichiometry, conductance measurements, visible, ultraviolet and nuclear magnetic resonance spectroscopy. Ultraviolet spectra of trichloromethylpolymethylbenzenes support the contention that these molecules are strained. Pentamethylbenzoic trifluoracetic anhydride has been prepared from the dipositive ion Ia.

It was recently shown[1] that trichloromethylpentamethylbenzene (I) ionizes in sulfuric acid with the formation of the deep red pentamethylphenylchlorodicarbonium ion (Ia).



I Ia (1)

Evidence included the fivefold freezing point depression, quantitative and rapid sweep of two and only two moles of hydrogen chloride from such solutions (the remaining solution showing a threefold freezing point depression), conductance measurements consistent with the production of two bisulfate ions, and quantitative hydrolysis to pentamethylbenzoic acid (PMBA). Spectra (visi-

(1) For previous papers, see H. Hart and R. W. Fish, *J. Am. Chem. Soc.*, **80**, 5894 (1958); **82**, 5419 (1960).

(2) Presented, in part, before the Organic Chemistry Division of the A.C.S., Symposium on Carbonium Ions, St. Louis, Mo., March 27, 1961.

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(4) Petroleum Research Fund Fellow, 1958–1960. This paper is taken from part of the Ph.D. thesis submitted by R. W. F. to Michigan State University, 1960.