TABLE III

	M.p., °C.	Solvent of cryst.	Analyses,[a] % Found C	H	0.1% HOAc–EtOH $\lambda_{\max}$, mμ (log ε)	$\lambda_{\min}$
XXI[b]	135–136	Water	69.80	7.00		
XXII	101–102	Heptane	69.61	6.91	252.5(4.14), 297.5(3.63)	232.5(3.89), 274(3.31)
XXIII[c]	80–81	Water	69.84	6.80		
XXIV[d]	128–129	Aq. ethanol	69.72	7.16	260(4.37), 287(infl., 3.42) 302.5(infl., 3.17)	226.5(3.51)

[a] Calcd. $C_{12}H_{14}O_3$: C, 69.88; H, 6.84. [b] Prepared from crude *o*-crotylphenol; XXI is the only isomer sparingly soluble in toluene–heptane. [c] Prepared from *p*-crotylphenol, m.p. 39°. [d] Prepared both by alkali isomerization of XXIII and from *p*-1-butenylphenol, m.p. 85–86°.

phenol (VIII) which formed white clusters of soft needles from heptane and melts at 60°. Its infrared spectrum in carbon disulfide shows no bands at 10.0 and 11.0 μ and a strong band at 10.35 μ.

Anal. Calcd. for $C_{16}H_{20}O$: C, 84.16; H, 8.83. Found: C, 83.77, 84.07; H, 8.82, 8.98. $\lambda_{\max}^{\text{EtOH-0.1\% HOAc}}$ 237.5 mμ (log *e* 4.61); 257.5 mμ (infl. log *e* 4.09); 324 mμ (log *e* 3.69). $\lambda_{\min}$ 295 mμ (log *e* 3.30).

2,6-Dipropenylphenol (IX) prepared similarly from 2,6-diallylphenol[12] forms white needles from heptane and melts at 77–78°.

Anal. Calcd. for $C_{12}H_{14}O$: C, 82.72; H, 8.10. Found: C, 82.69; H, 8.67. $\lambda_{\max}^{\text{EtOH-0.1\% HOAc}}$ 237.5 mμ (log *e* 4.60); 255 mμ (infl., log *e* 4.02); 317.5 mμ (log *e* 3.67). $\lambda_{\min}$ 287.5 mμ (log *e* 3.29).

2-Propenyl-3,5-dimethylphenol (XX).—2-Allyl-3,5-dimethylphenol[13] (XIX) was treated with an equal weight of potassium hydroxide in methanol at 110° for 20 hours to form XX in good yield. The product formed soft needles from heptane, m.p. 69–70°.

Anal. Calcd. for $C_{11}H_{14}O$: C, 81.44; H, 8.70. Found: C, 81.17; H, 8.70. XIX: $\lambda_{\max}^{\text{EtOH-0.1\% HOAc}}$ 216 mμ (log *e* 4.04), 277 mμ (infl., log *e* 3.26) 283 mμ (log *e* 3.29). XX: $\lambda_{\max}^{\text{EtOH-0.1\% HOAc}}$ 220 mμ (log *e* 4.38); 254 mμ (log *e* 4.00); 297 mμ (log *e* 3.42). $\lambda_{\min}$ 239 mμ (log *e* 3.87); 279 mμ (log *e* 3.24).

Butenylphenoxyacetic Acids (XXI–XXIV).—When the mixture of I and IV made by the reaction[3] of phenol with butadiene is treated with chloroacetic acid, the *ortho* isomer XXI is easily separated from XXIII through the former's lesser solubility in toluene and heptane. The acids XXI and XXIII were isomerized to XXII and XXIV, respectively, in methanolic potassium hydroxide (110°, 6 hours). The physical constants of the isomers are listed in Table III.

Acknowledgments.—The author is deeply indebted to Professor Martin G. Ettlinger for valuable advice.

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[12] K. v. Auwers, *Ann.*, **422**, 174 (1920).

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[CONTRIBUTION FROM THE CHEMISTRY DEPARTMENT OF BOSTON UNIVERSITY]

2-Acylstyrenes from 3,4-Dihydroisoquinolines[1]

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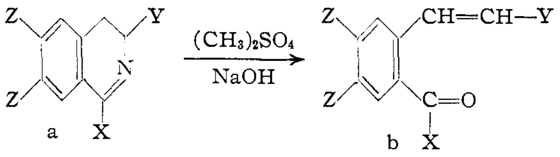
Further examples of 2-acylstyrenes from 3,4-dihydroisoquinolines are reported.

Earlier work showed that aqueous alkali and dimethyl sulfate converted 1-trimethoxyphenyl-6,7-methylenedioxy-3,4-dihydroisoquinoline (Ia) to 2-trimethoxybenzoyl - 4,5 - methylenedioxystyrene (Ib).[3] The present paper describes applications of this reaction to other dihydroisoquinolines. Table I lists the compounds tried, the acylstyrene products, and the yields obtained.

TABLE I

ACYLSTYRENES FROM DIHYDROISOQUINOLINES



	X	Y	Z	Yield, %
I	$(CH_3O)_3C_6H_2$	H	$-OCH_2O-$	98[3]
II	H	H	CH_3O	69
III	CH_3	H	H	70
IV	CH_3	H	CH_3O	49
V	C_6H_5	H	H	54
VI	C_6H_5	H	CH_3O	70
VII	$C_6H_5CH_2$	H	H	55
VIII	C_6H_5	CH_3	H	90
IX	C_6H_5	$COOCH_3$	CH_3O	41

Where there is no substituent on the dihydroisoquinoline 1-position, the product is an aldehyde. For example, 6,7-dimethoxy-3,4-dihydroisoquinoline (IIa) yielded 2-formyl-4,5-dimethoxystyrene (IIb), and cotarnine (Xa) yielded 2-formyl-3-methoxy-4,5-methylenedioxystyrene (Xb).[4] The yields, despite alkaline conditions conducive to Cannizzaro disproportionation, were acceptable. Attempted conversion of the 2-formyl-4,5-dimethoxystyrene to 2-acetyl-4,5-dimethoxystyrene with diazomethane[5] failed. Silver oxide oxidation to 2-carboxy-4,5-dimethoxystyrene, however, proceeded without dif-

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[1] Some of the material in this paper was abstracted from the thesis submitted by Edward M. Healy to the Graduate School of Boston University in partial fulfillment of the requirements for the Doctoral degree, 1953.

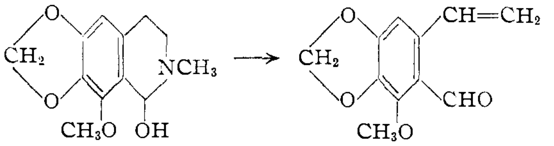
[2] Participant in the Technical Assistance Program of the Mutual Security Agency, 1952–1953.

[3] W. J. Gensler and C. M. Samour, THIS JOURNAL, **73**, 5555 (1951).

[4] W. H. Perkin, Jr., *J. Chem. Soc.*, **109**, 815 (1916).

[5] *Cf.* C. D. Gutsche, Chapter 8 of R. Adams, "Organic Reactions," Vol. VIII, John Wiley and Sons, Inc., New York, N. Y., 1954.

ficulty. Although cotarnine (Xa) is not a dihydroisoquinoline, it corresponds to one of the stages in the multi-step conversion.[6] Consequently, exposure to alkali and dimethyl sulfate in the usual way did generate the expected styrene compound Xb.[7]

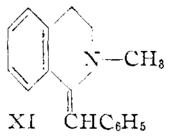


Xa Xb

1-Methyl-3,4-dihydroisoquinoline (IIIa) and 1-methyl-6,7-dimethoxy-3,4-dihydroisoquinoline (IVa) gave the 2-acetylstyrenes IIIb and IVb. On hydrogenation over a palladium-on-carbon catalyst, compound IVb absorbed three instead of the expected one mole of hydrogen[8] to yield 1,2-diethyl-4,5-dimethoxybenzene. Oxidation of compound IVb with bromine in aqueous sodium hydroxide gave 4,5-dimethoxyphthalic acid (metahemipinic acid).

Benzophenone derivatives were obtained from 1-phenyl-3,4-dihydroisoquinoline (Va) and from 1-phenyl-6,7-dimethoxy-3,4-dihydroisoquinoline (VIa). Styrene VIb as an oil polymerized very readily and was difficult to handle. However, once crystals were obtained the compound was reasonably stable. 2-Benzoylstyrene (Vb) is an oil whose distillation resulted in considerable loss by polymerization. Both benzoyl derivatives were converted to the corresponding 2-benzoylbenzoic acids by permanganate oxidation.

1-Benzyl-3,4-dihydroisoquinoline (VIIa) gave 2-phenylacetylstyrene (VIIb). This behavior, as well as that of the two methyl compounds IIIa and IVa, showed that intermediates such as isobase XI[9] do not complicate the process.



XI

3-Substituted-3,4-dihydroisoquinolines lead to ω-substituted styrenes. Thus the carbomethoxy derivative IXa gave 2-benzoyl-4,5-dimethoxycinnamic acid, and the 1-phenyl-3-methyl derivative VIIIa[10,11] gave *o*-propenylbenzophenone (VIIIb). Although we believe the double bond in the propenyl compound to be conjugated with the ring, the point was not proved. Possibly more than one isomer was obtained.

The above examples show that a variety of 2-acylstyrenes can be prepared from the corresponding 3,4-dihydroisoquinoline. The yields, which are not always high, can more than likely be improved, for in this work no effort was made to search for optimal conditions. The method provides a general and—since synthesis of 3,4-dihydroisoquinolines by Bischler–Napieralski cyclization[12] is usually a smooth process—a convenient pathway to 2-acylstyrenes. Aside from nucleophilic addition to the double bond[13] and oxidative cleavage at the double bond to give 2-acylbenzoic acids[3,14–16] or 2-acylbenzaldehydes,[16,17] little is known of the chemistry of these compounds.

Experimental[18]

General Directions for Converting 3,4-Dihydroisoquinolines (a) to 2-Acylstyrenes (b).—A stirred mixture of one mole of 3,4-dihydroisoquinoline, 5–10 moles of dimethyl sulfate and excess 10–20% aqueous sodium hydroxide is heated on the steam-bath under a condenser for three hours. The cooled mixture is extracted with ether, and the ether washed first with dilute (1–5%) hydrochloric acid and then with water to remove all mineral acid. The ether is dried over magnesium sulfate. After removing solvent, the residual crude product is distilled or crystallized.

2-Formyl-4,5-dimethoxystyrene (IIb) from 6,7-Dimethoxy-3,4-dihydroisoquinoline (IIa).—The ring opening experiment was performed with 11.6 g. (0.0605 mole) of dihydroisoquinoline IIa,[19,20] 55 ml. of dimethyl sulfate and 600 ml. of 20% aqueous sodium hydroxide. The crude product was an amber sirup (8.9 g.), which on cooling and scratching crystallized to a yellow powder, m.p. 37–41°. Two crystallizations from petroleum ether (b.p. 30–60°) gave 8.0 g. (69%) of 2-formyl-4,5-dimethoxystyrene (IIb), m.p. 50–51° (reported 54–55°[4]). Excess heating during recrystallization resulted in formation of a tacky insoluble material, presumably polymer.

The oxime of IIb after two crystallizations from methanol melted at 123.5–124.5° (reported 126°).[4] The semicarbazone after crystallization from methanol darkened at 215° and melted at 224° with gas evolution (reported[4] 226° with gas evolution).

2-Carboxy-4,5-dimethoxystyrene by Oxidation of 2-Formyl-4,5-dimethoxystyrene (IIb).—A solution of 0.2 g. of potassium hydroxide in water was added to 0.05 g. (0.26 millimole) of formyl compound IIb and 0.3 g. (1.8 millimole) of silver nitrate dissolved in 2 ml. of ethanol and 2 ml. of water. The gray-black mixture was first swirled by hand and warmed on the steam-bath to 75° for several minutes, and then allowed to stand at room temperature with occasional swirling for 2.5 hr.

Filtration gave a cloudy filtrate, which was clarified with charcoal and passed through a sintered glass filter. Fine white needle-like crystals formed immediately on acidification with 50% nitric acid. The acid mixture, after standing overnight, was chilled and filtered. The solid, washed with cold ethanol, dried (0.052 g., m.p. 178.5–179°), and crystallized twice from methanol, melted at 179–179.5° (reported 184°[21]). This 2-carboxy-4,5-dimethoxystyrene, dissolved in acetone distilled from permanganate, promptly decolorized permanganate.

2-Formyl-3-methoxy-4,5-methylenedioxystyrene (Cotarnone Xb) from 1-Hydroxy-2-methyl-6,7-methylenedioxy-8-methoxy-1,2,3,4-tetrahydroisoquinoline (Cotarnine Xa).—

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[6] W. J. Gensler and C. M. Samour, This Journal, **74**, 2959 (1952).

[7] *Cf.* W. Roser, *Ann.*, **249**, 156 (1888).

[8] *Cf.* J. J. Brown and G. T. Newbold, *J. Chem. Soc.*, 4397 (1952); E. Späth, L. Schmid and H. Sternberg, *Ber.*, **67**, 2095 (1934).

[9] *Cf.* W. J. Gensler, Chapter 2 (pp. 468, 479) of R. C. Elderfield, "Heterocyclic Compounds," Vol. 4, John Wiley and Sons, Inc., New York, N. Y., 1952.

[10] We are indebted to Professor W. H. Hartung, who very kindly furnished a sample of the hydrochloride of 1-phenyl-3-methyl-3,4-dihydroisoquinoline.

[11] W. M. Whaley and W. H. Hartung, *J. Org. Chem.*, **14**, 650 (1949).

[12] W. M. Whaley and T. R. Govindachari, Chapter 2 in R. Adams, "Organic Reactions," Vol. VI, John Wiley and Sons, Inc., New York, N. Y., 1951.

[13] W. J. Dale and L. Levine, Abstracts Am. Chem. Soc. Meeting, Sept., 1955, p. 5-O.

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[15] F. E. King, L. Jurd and T. J. King, *J. Chem. Soc.*, 17 (1952).

[16] W. Reeve and H. Myers, This Journal, **75**, 4957 (1953).

[17] J. Blair and G. T. Newbold, *J. Chem. Soc.*, 1836 (1954).

[18] Temperatures are uncorrected. Analyses were performed by Dr. Carol K. Fitz, 115 Lexington Avenue, Needham Heights, Mass., and by Dr. Stephen M. Nagy and his assistants at Massachusetts Institute of Technology Microchemical Laboratory, Cambridge.

[19] E. Späth and N. Polgar, *Monatsh.*, **51**, 190 (1929).

[20] We are indebted to Monsanto Chemical Co., St. Louis, for a generous sample of the necessary homoveratrylamine.

[21] H. Kondo and T. Kondo, *J. Pharm. Soc. Japan*, **48**, 324 (1928); *C. A.*, **22**, 3414 (1928).

Narcotine[22] was oxidized[23] to cotarnine, m.p. 126–127° dec., in 87% yield. The ring opening was performed with a nitrogen-blanketed mixture of 3.55 g. (0.015 mole) of cotarnine, 12 ml. of dimethyl sulfate and 150 ml. of 20% sodium hydroxide. Benzene was used in place of ether to extract the crude product (2.4 g., m.p. 63°). Two crystallizations from alcohol afforded cotarnone (Xb), m.p. 66–67° (reported 78°[7,17]).

Anal. Calcd. for $C_{11}H_{10}O_4$: C, 64.07; H, 4.9. Found: C, 63.6; H, 4.7.

The oxime melted at 121–122° (reported[7] 130–132°).

Anal. Calcd. for $C_{11}H_{11}O_4N$: C, 59.7; H, 5.0. Found: C, 59.9; H, 5.1.

2-Acetylstyrene (IIIb) from 1-Methyl-3,4-dihydroisoquinoline.—The ring-opening mixture consisted of 11.9 g. (0.065 mole) of 1-methyl-3,4-dihydroisoquinoline hydrochloride,[11] m.p. 195–197°, 48 ml. of dimethyl sulfate, 300 ml. of 40% sodium hydroxide solution and 300 ml. of water. The crude product, distilled under nitrogen in a small Claisen flask, gave 7.2 g. (70%) of almost water-white 2-acetylstyrene (IIIb), b.p. 96–100° (3 mm.), $n^{20}D$ 1.5615. A center cut, b.p. 97–98° (3 mm.), was analyzed.

Anal. Calcd. for $C_{10}H_{10}O$: C, 82.2; H, 6.90. Found: C, 82.05; H, 7.07.

The liquid darkened rapidly on standing even in a carefully stoppered flask. A sample, freshly distilled under nitrogen and sealed under vacuum, set to an amber glass on standing at room temperature. The 2,4-dinitrophenylhydrazone melted at 161–163°.

Anal. Calcd. for $C_{16}H_{14}O_4N_4$: C, 58.9; H, 4.3. Found: C, 59.0; H, 4.2.

2-Acetyl-4,5-dimethoxystyrene (IVb) from 1-Methyl-6,7-dimethoxy-3,4-dihydroisoquinoline (IVa).—The ring opening was run with 2.05 g. (0.01 mole) of the dihydroisoquinoline IVa,[19] 7 ml. of dimethyl sulfate and 80 ml. of 20% sodium hydroxide solution. Crystallization of the crude product (1.6 g., m.p. 61–68°) first from ether and then from methanol afforded 1.01 g. (49%) of styrene IVb, melting constantly at 77–78°.

Anal. Calcd. for $C_{12}H_{14}O_3$: C, 69.9; H, 6.8. Found: C, 69.9; H, 7.0.

2-Acetyl-4,5-dimethoxystyrene gave a positive test for carbonyl with hydroxylamine hydrochloride reagent, but did not reduce Tollens or Fehling reagent. The semicarbazone, m.p. 194–195°, was recrystallized from ethanol.

Anal. Calcd. for $C_{13}H_{17}O_3N_3$: C, 59.3; H, 6.5. Found: C, 59.4; H, 6.7.

Hypobromite Oxidation of 2-Acetyl-4,5-dimethoxystyrene (IVb).—A mixture of 0.5 g. (0.0024 mole) of the styrene IVb with 0.7 ml. (*ca.* 0.014 mole) of bromine in 10 ml. of 3 *N* sodium hydroxide was heated and stirred at 75–80° for 1.5 hr. The cooled mixture, after separation from some dark gummy material by decantation, was extracted with ether to remove non-acidic material. Sulfur dioxide was bubbled through the aqueous solution for five minutes. One milliliter of concentrated hydrochloric acid was added, the mixture was extracted with ether, the extract dried over magnesium sulfate, and the solvent removed. The residual, somewhat tacky, solid was crystallized from water to yield 0.09 g. of crystals, showing a constant melting point of 179–180°. This material when mixed with 2-carboxy-4,5-dimethoxystyrene (m.p. 179–179.5°) obtained from 2-formyl-4,5-dimethoxystyrene, melted at 165–167°. Test for unsaturation with permanganate was negative. It is probable that the hypobromite oxidation product is 4,5-dimethoxyphthalic acid (metahemipinic acid), reported to melt at 174–175° or, with rapid heating, at 179–182°.[24]

Hydrogenation of 2-Acetyl-4,5-dimethoxystyrene (IVb).—A mixture of the acetyldimethoxystyrene (0.40 g. or 0.0019 mole) and 0.1 g. of 10% palladium-on-carbon catalyst[25] in *ca.* 20 ml. of absolute alcohol was stirred under one atmosphere of hydrogen for 70 minutes, at which time 2.97 molar amounts of hydrogen had been absorbed. The hydrogenation mixture was filtered, and the catalyst was rinsed on the funnel with ether and with alcohol. Solvents were removed and the residual oil was distilled in a creased test-tube, 1,2-diethyl-4,5-dimethoxybenzene being collected at a temperature (external) of 128° (1 mm.).

Anal. Calcd. for $C_{12}H_{18}O_2$: C, 74.2; H, 9.3. Found: C, 73.8; H, 9.6.

The hydrogenation product showed a negative test for carbonyl with the hydroxylamine hydrochloride indicator, and showed no hydroxyl or carbonyl absorption in the infrared. 2-Acetyl-4,5-dimethoxyethylbenzene melts at 63°[26]; 1,2-diethyl-4,5-dimethoxybenzene boils at 85° (0.2 mm.).[27]

2-Benzoylstyrene (Vb) from 1-Phenyl-3,4-dihydroisoquinoline (Va).—A mixture of 22.4 g. (0.092 mole) of 1-phenyl-3,4-dihydroisoquinoline hydrochloride,[11,12] m.p. 233–236°, 73.7 ml. of dimethyl sulfate, 460 ml. of 40% sodium hydroxide solution and 460 ml. of water was treated in the usual manner. Distillation of the crude product under nitrogen through an 8-cm. Vigreux column gave 10.4 g. (54%) of pale yellow 2-benzoylstyrene, b.p. 159–161° (2.5 mm.), $n^{20}D$ 1.6182. The yellow glassy residue in the distilling flask was insoluble in ether, and became a powdery solid after standing overnight. This polymer was soluble in benzene and in carbon tetrachloride. Crystallization from benzene and ether gave a solid, m.p. *ca.* 175–185°.

A freshly distilled almost colorless sample of 2-benzoylstyrene, $n^{20}D$ 1.6182, was analyzed.

Anal. Calcd. for $C_{15}H_{12}O$: C, 86.5; H, 5.8. Found: C, 86.4; H, 5.9.

Freshly distilled material, sealed in vacuum, slowly resinified at room temperature.

2-Benzoylbenzoic Acid from 2-Benzoylstyrene (Vb).—A solution of 2.76 g. (0.0175 mole) of potassium permanganate in 150 ml. of acetone, previously distilled from permanganate, was added slowly and with stirring to 1.09 g. (0.0053 mole) of 2-benzoylstyrene dissolved in 5 ml. of acetone. After standing overnight in the refrigerator, the mixture was treated with sodium sulfite and 5% hydrochloric acid. Some of the acetone was distilled from the almost colorless solution, and the concentrated mixture was extracted with chloroform. The chloroform was extracted twice with 5% potassium hydroxide solution, the alkaline solution was acidified with 5% hydrochloric acid, and the brown oil taken up in ether. The ether solution was extracted with 5% potassium hydroxide, and the alkaline solution again acidified. The brown solid deposited from the acid mixture was crystallized twice from alcohol and water and once from benzene and ligroin. Decolorizing carbon was used in the last crystallization. White crystalline *o*-benzoylbenzoic acid (0.4 g.), m.p. 126–127°, was obtained.

2-Benzoyl-4,5-dimethoxystyrene (VIb) from 1-Phenyl-6,7-dimethoxy-3,4-dihydroisoquinoline (VIa).—The dihydroisoquinoline[20,28] (1.0 g. or 0.0037 mole) was exposed to the action of 3.0 ml. of dimethyl sulfate and 30 ml. of 20% sodium hydroxide for four hours. It was noted during the ether extraction that appreciable amounts of gummy material remained insoluble. The crude product after standing at room temperature overnight solidified to a mass of pale yellow crystals, which was washed with 5% hydrochloric acid, with water, and then dried in the air. This material (0.78 g., m.p. 65–66°) on crystallization from ligroin (b.p. 65–90°) furnished white 2-benzoyl-4,5-dimethoxystyrene (0.70 g., 70%) melting constantly at 66–67°.

Anal. Calcd. for $C_{17}H_{16}O_3$: C, 76.1; H, 6.0. Found: C, 75.8; H, 5.9.

2-Benzoyl-4,5-dimethoxybenzoic Acid from 2-Benzoyl-4,5-dimethoxystyrene (VIb).—The styrene (0.3 g. of 0.0011 mole) was treated with the stoichiometric amount of permanganate and with an excess of sodium bicarbonate, using as solvent acetone previously distilled from permanganate. The mixture was allowed to stand at room temperature overnight. Addition of a small amount of sodium sulfite followed by 3 ml. of 5% hydrochloric acid dissolved the pre-

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[22] Drs. A. H. Homeyer and A. E. Ruehle of Mallinckrodt Chemical Works, St. Louis, Missouri, very kindly provided the narcotine used in this work.

[23] G. S. Ahluwalia, B. D. Kochhar and J. N. Rây, *J. Indian Chem. Soc.*, **9**, 215 (1932).

[24] "Dictionary of Organic Compounds," Vol. III, I. Heilbron and H. M. Bunbury, Editors-in-chief, Eyre and Spottiswoode, London, 1953, p. 276.

[25] L. F. Fieser, "Experiments in Organic Chemistry," Second Edition, D. C. Heath and Company, Boston, Mass., 1941, p. 459.

[26] J. Shinoda and S. Sato, *J. Pharm. Soc. Japan*, No. 548, 860 (1927); *C. A.*, **22**, 772 (1928).

[27] K. Fries and H. Bestian, *Ann.*, **533**, 72 (1937).

[28] H. J. Harwood and T. B. Johnson, This Journal, **56**, 468 (1934).

cipitated solids. The almost colorless acid solution was extracted with chloroform; and the chloroform was extracted with 5% potassium hydroxide solution. When this alkaline solution was acidified and allowed to stand two days at room temperature and then two days in the refrigerator, a white solid formed. This was collected, washed with cold ethanol, and dried in the air. The 2-benzoyl-4,5-dimethoxybenzoic acid so obtained (37% yield) melted before as well as after crystallization from alcohol at 193–194° (reported 199–200°).[29]

A convenient derivative for the 2-benzoyl-4,5-dimethoxybenzoic acid was a phthalazone, which was prepared by boiling a solution of 0.4 g. of the acid in 6 ml. of ethanol with approximately 0.02 g. of phenylhydrazine for two hours. The reaction mixture, after standing overnight at room temperature, deposited white crystals, which were collected, washed with cold ethanol and air-dried. 2,4-Diphenyl-6,7-dimethoxyphthalazone, after crystallization from ethanol, melted at 198–198.5° (reported 212°).[29]

Anal. Calcd. for $C_{22}H_{18}N_2O_3$: C, 73.73; H, 5.06. Found: C, 73.52; H, 5.10.

2-Phenylacetylstyrene (VIIb) from 1-Benzyl-3,4-dihydroisoquinoline (VIIa).—The dihydroisoquinoline was formed by cyclizing N-(phenylethyl)-phenylacetamide with phosphorus pentoxide in boiling xylene.[11] Passing dry hydrogen chloride in a benzene solution of the crude undistilled product furnished an oily hydrochloride, which became semisolid on standing overnight. Benzene was removed by decantation and by warming the residue on the steam-bath *in vacuo*. The hydrochloride of 1-benzyl-3,4-dihydroisoquinoline, m.p. 227–228°, was obtained in 31% yield after several crystallizations from isopropanol–ligroin and from methanol–ether. Exposure of the crude dihydroisoquinoline to high temperatures on attempted distillation led to a mixture containing 1-benzylisoquinoline.[30]

The ring opening experiment was carried out under nitrogen with 4 g. (0.016 mole) of 1-benzyl-3,4-dihydroisoquinoline hydrochloride, 12.6 ml. (0.133 mole) of dimethyl sulfate, and 156 ml. of 10% aqueous sodium hydroxide. Distillation of the crude product through a 7-cm. Vigreux column gave 1.89 g. (55%) of pale yellow 2-phenylacetylstyrene (VIIb), b.p. 162–164° (2.5 mm.), $n^{25}\text{D}$ 1.6180. The yield was lower than it should have been, since some of the product was accidentally lost. The 2,4-dinitrophenylhydrazone, recrystallized from alcohol, melted at 137–137.5°.

Anal. Calcd. for $C_{22}H_{18}O_4N_4$: C, 65.66; H, 4.5. Found: C, 65.2; H, 4.7.

o-**Propenylbenzophenone (VIIIb) from 1-Phenyl-3-methyl-3,4-dihydroisoquinoline (VIIIa).**—The dihydroisoquinoline hydrochloride[10,11] (0.35 g., 0.0013 mole) was treated in the usual way with 1.03 ml. of dimethyl sulfate, and 13 ml. of 20% sodium hydroxide solution. The solvent-free, dry product VIIIb (0.26 g.) failed to crystallize after standing four months in the refrigerator. The 2,4-dinitrophenylhydrazone melted at 165–167°.

Anal. Calcd. for $C_{22}H_{18}O_4N_4$: C, 65.7; H, 4.5. Found: C, 65.5; H, 4.6.

2-Benzoyl-4,5-dimethoxycinnamic Acid from Methyl 1-Phenyl-6,7-dimethoxy-3,4-dihydroisoquinoline-3-carboxylate (IXa).—A solution of 20 g. of α-benzamido-3,4-dimethoxycinnamic acid,[31] m.p. 206–207°, in 250 ml. of alcohol containing 8 g. of 10% palladium-on-carbon was stirred in an atmosphere of hydrogen until absorption of hydrogen stopped. α-Benzamido-3,4-dimethoxyhydrocinnamic acid, m.p. 179.5–181°, after crystallization from alcohol and from alcohol-water, was obtained in 94% yield. The methyl ester of the hydrocinnamic acid was formed according to the general procedure of Galat[32] in 97% yield. Two grams of the methyl ester, m.p. 103–104°,[28,33] was boiled with 6 ml. of phosphorus oxychloride for 1.25 hr.[33] The reaction mixture was quenched on ice and made basic. The precipitated product, after washing with water and drying, weighed 1.17 g. and melted at 119–120°. Recrystallization from methanol, after treatment with decolorizing carbon, furnished methyl 1-phenyl-6,7-dimethoxy-3,4-dihydroisoquinoline-3-carboxylate,[28,33] m.p. 119.5–121°.

The ring-opening was run with 0.33 g. (0.001 mole) of the dihydroisoquinoline IXa, 1.04 ml. of dimethyl sulfate and 13 ml. of 20% sodium hydroxide solution. Acidification of the reaction mixture precipitated a pale-yellow solid, which was collected, washed with cold water and dried. This crude product (0.27 g.) was treated with decolorizing carbon in methanol, and then crystallized twice from the same solvent. 2-Benzoyl-4,5-dimethoxycinnamic acid (0.13 g.), m.p. 227–228° dec., was obtained in 41% yield. Further crystallizations did not change the melting point.

Anal. Calcd. for $C_{18}H_{16}O_5$: C, 69.2; H, 5.2. Found: C, 69.0; H, 5.2.

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[Contribution from Pittsburgh Consolidation Coal Co., Research and Development Division]

Synthesis of *p*-Hydroxybenzylpyrene and Homologs[1]

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Direct condensation of a series of 1-pyrenealkanoic acids $Py(CH_2)_nCOOH$, where $n = 0, 1, 3$, with 2,6-xylenol using BF_3 catalyst produced the corresponding 4-substituted phenolic ketones in good yield. Catalytic hydrogenolysis with copper chromite to the substituted methylene, ethane and butane compounds is described. These compounds are models for bituminous coal, the aliphatic portion representing probable weak linkages.

In connection with a study on the structure of coal being conducted in this Laboratory, it was of interest to synthesize model compounds in which the tetracyclic hydrocarbon, pyrene, is linked to a phenolic nucleus by an aliphatic chain containing 1, 2 and 4 carbon atoms, respectively.

The synthetic procedure involves condensation of pyrenealkanoic acids (I) with 2,6-xylenol to the corresponding ketone (II) using anhydrous BF_3 as a condensing agent as shown

Condensation with 2,6-xylenol should result in a single condensation product in the 4-position of the phenol moiety. The ketones were reduced to the hydrocarbon analogs III by catalytic hydrogenolysis with copper chromite catalyst.

Since the three pyrene derivatives were new compounds, the conditions for the ketone synthesis and reduction were tested on a lower molecular weight acid, 1-naphthaleneacetic acid. BF_3 was bubbled continuously into 1-naphthaleneacetic acid dissolved in a 3–5 fold molar excess of 2,6-xylenol for 5 hours at 70°. The naphthalene-substituted ketone

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