*Anal.* Calcd. for $C_9H_{10}ClNS$: Cl, 17.8. Found: Cl, 17.9.

The **methiodide** was crystallized from a mixture of ethyl acetate and alcohol, m. p. 228–229° dec.

*Anal.* Calcd. for $C_{10}H_{12}INS$: I, 41.7. Found: I, 42.1.

The **picrate** melted at 190–191°, after three crystallizations from alcohol.

*Anal.* Calcd. for $C_{15}H_{12}N_4O_7S$: N, 14.3. Found: N, 13.8.

**Attempted Preparation of Other Thieno(2,3-b)pyridines.**—Similar experiments were made to form other derivatives of thieno(2,3-b)pyridine by treating either 2-aminothiophene stanni-hydrochloride or 2-aminothiophene hydrochloride[7] with (a) benzoylacetone,[8] (b) dibenzoylmethane, (c) the sodium salt of 3-formyl-2-butanone,[9] (d) the benzoate of 3-formyl-2-butanone,[10] (e) 2-formyl-3-pentanone[11] or (f) the benzoate of 2-formyl-3-pentanone[12] in the presence of such condensing agents as concentrated sulfuric acid, fused zinc chloride, hydrogen bromide in glacial acetic acid or phosphorus pentoxide. In every case a tar was obtained as the product of reaction, some of the carbonyl compound being recovered in a few instances. Procedures involving pyrolysis were equally unsuccessful. In the experiments with dibenzoylmethane, benzoic acid was always isolated in good yield.

It was also not found possible to apply the Doebner and v. Miller reaction[13] to 2-aminothiophene. Here the procedure was varied to employ either 2-aminothiophene hydrochloride or 2-aminothiophene stanni-hydrochloride with paraldehyde or crotonaldehyde. Both hydrochloric and sulfuric acids were used as condensing agents.

**4,6-Distyrylthieno(2,3-b)pyridine** was prepared by the methods of Wallach and Wusten,[14] and Jacobsen and Reimer[15] had employed successfully in the quinoline series. One gram of 4,6-dimethylthieno(2,3-b)pyridine and 1.3 g. of benzaldehyde were mixed with a small amount of fused zinc chloride and allowed to stand at 25° for two hours. The reaction mixture was then made basic with ammonium hydroxide and extracted with benzene. The product was isolated by precipitating it from the benzene solution as the hydrochloride and then treating the latter with alkali. After recrystallization from benzene and petroleum ether it melted at 238°.

*Anal.* Calcd. for $C_{23}H_{17}NS$: N, 4.13. Found: N, 4.08.

When hydrogen chloride was passed into a benzene solution of the compound, the hydrochloride precipitated as yellow crystals which turned green on standing. It was crystallized from a mixture of acetone and ether, m. p. 268°.

*Anal.* Calcd. for $C_{23}H_{18}ClNS$: Cl, 9.45. Found: Cl, 9.62.

## Summary

4,6-Dimethylthieno(2,3-b)pyridine has been prepared and characterized. Its methyl groups are active and condense with benzaldehyde in the same manner as the quinoline analog. Attempts to prepare related compounds have so far been unsuccessful.

Urbana, Illinois Received June 11, 1941

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[7] Stadler, *Ber.*, **18**, 2316 (1885).

[8] Claisen, *ibid.*, **38**, 693 (1905).

[9] Tracy and Elderfield, *J. Org. Chem.*, **6**, 63 (1941).

[10] Auwers and Kohlhaas, *Ann.*, **437**, 36 (1924).

[11] Claisen and Meyerowitz, *Ber.*, **22**, 3273 (1889).

[12] M. p. 68–69° after two crystallizations from alcohol. *Anal.* Calcd. for $C_{13}H_{14}O_3$: C, 71.5; H, 6.43. Found: C, 70.9; H, 6.47.

[13] Doebner and v. Miller, *ibid.*, **16**, 2464 (1883).

[14] Wallach and Wusten, *ibid.*, **16**, 2007 (1883).

[15] Jacobsen and Reimer, *ibid.*, **16** 2602 (1883).

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[Contribution from the Division of Physiology and the Division of Fruit Products, University of California]

# Hypericin, the Photodynamic Pigment from St. John'swort

By N. Pace[1] and G. Mackinney

When certain domestic animals graze on St. John'swort (*Hypericum perforatum*) they sicken on exposure to sunlight owing to ingestion of a photodynamic pigment, hypericin, which has been variously described as a porphyrin, a flavone, an anthocyanin, and most recently a *meso*-dianthrone. We believe hypericin to be a partially reduced polyhydroxyhelianthrone. The chemical nature of the pigment is discussed here, but it may be noted that hypericin is a highly active photodynamic pigment, causing in concentrations as low as $10^{-7}$ *M*, hemolysis of red blood cells on exposure to light of suitable wave length.[2]

**Location of Hypericin in the Plant.**—The leaves of the St. John'swort family are covered with pellucid dots and glands. Those of *H. perforatum* exhibit numerous black dots 0.5 to 1 mm. in diameter. The pigment hypericin occurs as a semi-solid mass in these dots which are scattered over the surface of leaves, stems and petals.[3,4]

**Extraction and Isolation of Hypericin.**—Pigments of *Hypericum* species include chlorophyll,

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[1] A grant from the College of Agriculture is gratefully acknowledged.

[2] An observation by Dr. H. F. Blum, who attracted our attention to this problem.

[3] E. Siersch, *Planta*, **3**, 481 (1927).

[4] A. W. Sampson and K. W. Parker, *Calif. Exp. Sta. Bull.*, No. 503 (1930).

carotenoids, hypericin, quercetin[5] and a brownish-red ("residual red") pigment. Our method of preparation involves partition between immiscible neutral solvents, followed by fractional precipitation. The crude hypericin is then chromatographed and separated into at least six components of which the two most abundant are readily isolated in pure form. Previous methods have usually involved the use of alkali, which we have carefully avoided as hypericin is not stable in alkaline media.

Four kilograms of air dried, plant meal (20 mesh) was extracted for twelve hours with petroleum ether containing 10% acetone in an external Soxhlet. Most of the chlorophyll and carotenoids were thereby removed. The petroleum ether was allowed to evaporate from the meal, which was then extracted in the same apparatus for twelve hours with 12 liters of 90% aqueous acetone, which removed virtually all the hypericin. The extract was washed three times with a total of 6 liters of petroleum ether to remove the remainder of the chlorophyll. To the remaining 9 liters of the deep red, strongly red-fluorescing acetone phase was added slowly, with stirring, 0.6 liter of concentrated hydrochloric acid, and after twelve hours, an additional 10 liters of water. After twenty-four hours, a heavy black friable precipitate of hypericin was collected. The addition of more acid resulted in the formation of a copious yellow precipitate (the white acetyl derivative melted at 193°) presumably quercetin.[5] On longer standing, a precipitate of the "residual red" pigment was obtained.

The hypericin precipitate was thoroughly washed with water and subsequently with petroleum ether. The yield was 8.4 g., or 0.21% of the dry weight. Reprecipitated from acetone, it contained neither quercetin nor "residual red" pigment. This reprecipitated hypericin (used in subsequent work, except where chromatographed material is expressly designated) could be resolved on a Tswett column of $MgCO_3 \cdot SiO_2$ into six components: "Top," strongly adsorbed, possibly not homogeneous, and five others designated V to Z. Except for Z, a small weakly adsorbed purplish-red zone, they are blue-green on the adsorbent, but all yield similar cherry-red fluorescent solutions in acetone or alcohol, and spectroscopic differences are very slight. Their solutions in concentrated alkali, sodium hydrosulfite and sulfuric acid are a deep emerald-green. Components X and Y have been studied in greatest detail.

For the initial separation, Merck $MgCO_3$ and $SiO_2$ (Hyflo supercel) were used, 3–2 by weight. This gave effective separation of the two more weakly adsorbed components Y and Z from X.

A typical chromatogram is as follows. One hundred fifty milligrams of reprecipitated crude hypericin was dissolved in 200 cc. of 80% aqueous acetone and adsorbed on a column 4 cm. in diameter, 5 cm. long of the 3:2 mixture. Components Y and Z were completely eluted in two hours. Approximately three hours was required for X to appear in the percolate, and an additional six hours before it became contaminated with W. The various percolates were concentrated under reduced pressure, and the material was precipitated by the addition of a drop of concentrated hydrochloric acid. The yield of pure X was 25.3%, of Y and Z 18.5%. The yield of pure Y after separation on a 5–1 mixture was 16.3%. Several hundred milligrams of components X and Y were prepared in this manner. The components thus purified were homogeneous when readsorbed, and showed no change in properties. When present, quercetin appears in the chromatogram as a bright yellow zone between X and Y, while the "residual red" obscures the zones of V and W, as a dark brown band. Attempts to crystallize fractions X and Y met with little success. On standing, after slow addition of hydrochloric acid to a solution of Y in pyridine, a number of garnet-red platelets could be obtained in a matrix of apparently amorphous material. An X-ray powder pattern of hypericin X (through courtesy of Mr. W. H. Dore) gave three spacings, 6.4, 3.55 (intense) and 3.45 Å. (weak).

Both X and Y samples decomposed on heating, 320–330°, without melting.

**Empirical Formulas.**—Qualitative tests for nitrogen, sulfur, phosphorus and halogens were negative. Hypericin Y fits the formula $C_{29}H_{22}O_8$; calcd.: C, 69.88; H, 4.42; found: C, 69.96, 69.88; H, 4.46, 4.51. The formula for hypericin X is less certain. $C_{31}H_{28}O_9$ appears most probable. Calcd.: C, 68.36; H, 5.19; found: C, 67.82, 68.24, 68.08; H, 5.14, 5.18, 5.25.

**Molecular Weight.**—A determination by the Rast camphor method was unsatisfactory owing to the low solubility of hypericin in camphor. A value below 700 was indicated. An equivalent weight for hypericin X was obtained by dissolving 0.1038 g. in 50 ml. of 0.0984 $N$ sodium hydroxide, and titrating electrometrically with the glass electrode with 0.1010 $N$ hydrochloric acid. An inflection point was found after the addition of 46.87 ml. of acid at $p$H 7.50. This reveals a difference of 0.000186 equivalent due to 0.1038 g. of hypericin, indicating an equivalent weight of 558.

**Spectra.**—The absorption spectrum of hypericin Y in acetone is shown in Fig. 1. The effect of solvents on maxima already has been discussed.[6] Fluorescence is obtained from 590 to 750 m$\mu$ with two intense peaks at 605 and 653 m$\mu$ and a smaller band at 710 m$\mu$. We are indebted to Dr. D. Lipkin for this observation.

**Substituent Groups.**—Hypericin Y (44 mg.) was readily acetylated by refluxing for four hours with acetic anhydride (10 ml.) and concentrated sulfuric (0.1 ml.). The clear, yellow-brown solution, poured into ice water (100 ml.), yielded an orange-brown solid (39 mg.). It was soluble in benzene, alcohol and acetone, insoluble in petroleum ether and 0.1 $N$ sodium hydroxide. Hydrolysis of acetyl hypericin Y (14.3 mg.) yielded acetic acid equivalent to 5.55 ml. of 0.02 $N$ sodium hydroxide, or 0.0047 g. of acetyl. Assuming a molecular weight for hypericin Y of 498, this is equivalent to 5.76 moles of acetyl, and the original compound therefore contained six functional hydroxyl groups. A Zeisel determination for methoxy and ethoxy groups was negative. Carboxyl groups may be assumed absent on the basis of the insolubility of the acetylated product in alkali.

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[5] P. O'Neill and A. G. Perkin, *J. Chem. Soc.* **113**, 40 (1918).

[6] N. Pace and G. Mackinney, THIS JOURNAL, **61**, 3594 (1939).

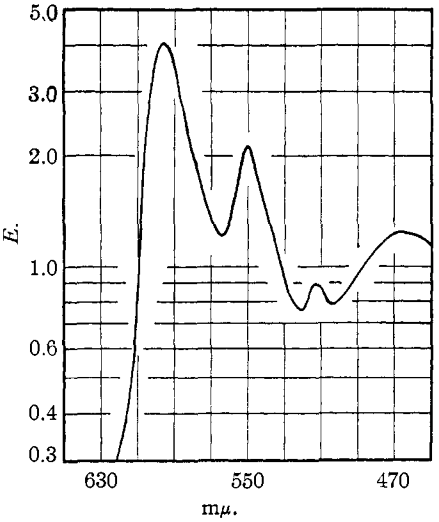

Fig. 1.—The absorption spectrum of hypericin in 80% aqueous acetone. Solid hypericin is sparingly soluble, and the rate of solution very slow. The ordinate, *E*, is a measure of the extinction. The value of the specific extinction or absorption coefficient, at 595 mμ, is approximately 25 (in liters per gram cm.) (for convention, see Brode, "Chemical Spectroscopy," John Wiley and Sons, Inc., New York, N. Y., 1939, p. 4).

**Reduction of Hypericin.**—Zinc dust distillation in hydrogen by the method of Noyes[7] yielded a greenish-yellow oil with a pure blue fluorescence in petroleum ether solution. Yields from crude hypericin (0.992 g.) with 20 g. of zinc dust at 450° in a stream of hydrogen were 0.112 g. oil, and from hypericin Y (0.160 g.), 0.039 g. of oil. The oil could not be crystallized or fractionated. It boiled at 285° (758 mm.). A molecular weight by the Rast camphor method gave a value of 330.

With the assistance of Dr. Oliver H. Emerson hydrogenation with platinum catalyst was attempted. One mole of hydrogen was taken up slowly in the course of twenty-four hours. Hypericin X in glacial acetic acid shows absorption maxima at 582, 568 and 528 mμ. The reduction product showed maxima at 582 and 528 unchanged, but the intensity of the band at 568 was greatly reduced, and new bands at 557 and 541 mμ were observed.

In striking contrast to these results, zinc dust reduction of alizarin and *meso*-dianthrone gave anthracene (m. p. recrystallized 215°, mixed m. p. no depression). In the catalytic hydrogenation of *meso*-dianthrone (0.012 g.) 11.4 moles of hydrogen were taken up in one hour. A small quantity of white, crystalline material (2–3 mg.) melted at 83°. It seems probable the compound was a polyhydroanthracene.

**Oxidation of Hypericin.**—Crude hypericin (1 g.) was treated with 20 ml. of cold nitric acid. An immediate evolution of brown fumes took place. After gentle heating the solution was a clear orange-brown. The volume was then reduced to 10 ml. by boiling, and the solution poured into 100 ml. of water. A slight pale-yellow precipitate was obtained. Extraction of the acid solution with ether yielded a small quantity (5 mg.) of orange crystals, somewhat rod-shaped, insufficient for purification.

**Miscellaneous.**—Alkali fusion of crude hypericin with sodium hydroxide yielded no recognizable products. It was noted that the red fluorescence of a concentrated sulfuric acid solution of hypericin was intensified on standing for some hours. The change in absorption spectrum is appreciable (Fig. 2). The deep-green, concentrated sulfuric acid solution became violet when warmed, or on addition of a small crystal of potassium chromate. Both of these treatments yielded blue-black precipitates when the solutions were poured into water.

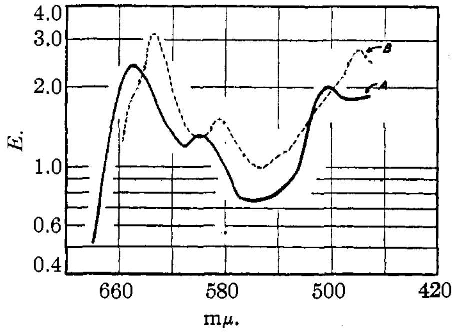

Fig. 2.—Effect of time on hypericin absorption, in concentrated sulfuric acid: A, hypericin in concentrated sulfuric acid; B, the same solution under identical conditions twenty-four hours later.

Crude hypericin and components X and Y all give a slight brownish discoloration with ferric chloride.

## Discussion

The evidence suggesting hypericin may be an anthocyanin or a flavone[3,8] is based on ferric chloride tests where the quercetin has not been completely removed, and on an elementary composition not widely different from that of a flavone. Since the compound contains no nitrogen, it cannot be a porphyrin.[9] The recent suggestion[9a] that hypericin is a hexahydroxy-*meso*-dianthrone seems to us untenable in view of the different behavior of *meso*-dianthrone and hypericin to zinc dust treatment and the Adams catalyst.

Paralleling work on hypericin has been the invaluable study by Oxford and Raistrick[10,11] of pigments from the mold *Penicilliopsis clavariaeformis*. A yellowish-orange pigment (penicilliopsin, $C_{30}H_{24}O_8$) is readily oxidized to oxypenicilliopsin (purple, non-fluorescent, $C_{30}H_{20}O_9$). On irradiation, solutions of oxypenicilliopsin develop a fiery red fluorescence and the irradiated pigment

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[7] W. A. Noyes, "Organic Chemistry for the Laboratory," 2nd ed., Henry Holt & Company, New York, N. Y., 1911, p. 60.

[8] C. Černý, *Z. physiol. Chem.*, **73**, 371 (1911).

[9] J. Wolff, *Pharm. Centralhalle*, **16**, 193 (1875).

[9a] H. Brockmann, M. N. Haschad, K. Maier and F. Pohl, *Naturw.*, **32**, 550 (1939).

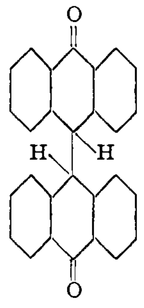
[10] A. E. Oxford, *Chem. and Ind.*, **57**, 975 (1938).

[11] A. E. Oxford and H. Raistrick, *Biochem. J.*, **34**, 790 (1940).

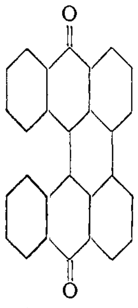
(also $C_{30}H_{20}O_9$) is surprisingly similar to hypericin with respect to absorption and fluorescence spectra and certain color reactions. We have not found any further parallelism between the mold pigments and those of St. John'swort, though we were on watch for similar precursors in the plant. The chlorophyll-containing plant cannot conveniently be grown in the dark, and penicilliopsin could not be anticipated, though the non-fluorescent oxy derivative might. With mature plants, under our conditions, it was not observed. (We note, *Chem. Abstr.*, **35**, 3681[2] (1941), that Betty and Trikojus have identified a purple non-fluorescent precursor, under Australian conditions.)

Oxford and Raistrick have made the important observation that penicilliopsin yields β-methylanthracene, emodin derivatives, and nitrococussic acid. It is believed to be a polyhydroxy derivative of a reduced *meso*-dimethyldianthrone. Oxypenicilliopsin and its irradiated form do not yield such breakdown products, and are thought possibly to be helianthrones or naphthadianthrones.

Too little is known concerning the chemistry of these compounds to enable us to apply the usual degradative methods with success, nor as yet has any massive fragment of hypericin or oxypenicilliopsin been identified. We shall consider briefly a few possibilities on the assumption that the change from penicilliopsin to the oxy derivative is represented by condensation at one set of *peri* positions in *meso*-dianthrone I to give rise to helianthrone II.



I, *meso*-dianthrone



II, helianthrone or benzbianthrone

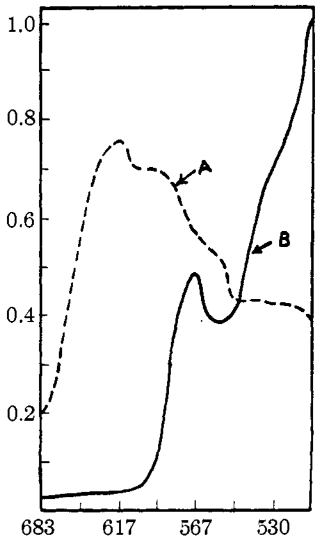


Fig. 3.—A, Helianthrone; B, naphthabianthrone, after Meyer, Bondy and Eckert.[12] For ease of comparison, the wave length, abscissa, has been reversed. The ordinate is labelled Extinktionskoeffizient. It has not seemed wise to attempt re-calculation to fit our scale (Fig. 1 and Fig. 2).

Meyer, Bondy and Eckert[12] measured the absorption spectra of dianthraquinone (bianthrone in their terminology), helianthrone and *meso*-naphthabianthrone in concentrated sulfuric acid, (Fig. 3). Of these, the curve for helianthrone most nearly represents that for hypericin. Interestingly, they also record development of the red fluorescence on standing. Scholl and Seer[13] synthesized 4,4′-dihydroxy *meso*-benzbianthrone. It formed a green vat with sodium hydrosulfite. Scholl and Mansfeld[14] found that helianthrone gave a similar green vat with alkaline $Na_2S_2O_4$ whereas the naphthabianthrone did not. Potschiwauscheg[15] described three of these helianthrone vats which bear much the same relation to helianthrone as does anthrone to anthraquinone, namely, hydrogenation at the *meso* carbons. One of these vats, hexahydro-*meso*-benzdianthrone, is interesting because its empirical formula and known properties agree in a broad sense with those of the hypericin fractions.

Our own work leads us to suspect a similar condensed nucleus in the hypericin molecule. The properties of the oil obtained by zinc dust distillation of hypericin had suggested the presence of a perylene-like substance. The parent hydrocarbon of helianthrone, dibenzperylene, has never been obtained. It was tried apparently unsuccessfully by Potschiwauscheg.[15]

The *meso*-dianthrone used here for comparison purposes was prepared by the method of Dimroth.[16] We have without difficulty repeated syn-

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(12) H. Meyer, R. Bondy and A. Eckert, *Monatsh.*, **43**, 1447 (1912).

(13) R. Scholl and C. Seer, *Ber.*, **44**, 1091 (1911).

(14) R. Scholl and J. Mansfeld, *ibid.*, **43**, 1734 (1910).

(15) J. Potschiwauscheg, *ibid.*, **43**, 1746 (1910).

(16) O. Dimroth, *ibid.*, **34**, 219 (1901).

theses of certain tetramethoxy-dianthraquinones by the method of Attree and Perkin.[17] The conversion to the corresponding helianthrones, supposedly a simple matter of suitable irradiation, has been most uncertain, and no satisfactory yield obtained.

## Summary

Hypericin, the photodynamic pigment from St. John's wort, is composed of at least six fractions. Two of these have the formulas $C_{29}H_{22}O_8$ and $C_{31}H_{28}O_9$. Six of these oxygens are in hydroxyl groups. A pale-yellow oil with a pure blue fluorescence is obtained on zinc dust distillation. Methods of extraction and purification are discussed and hypericin is compared with a group of pigments from the mold *Penicilliopsis clavariaeformis*. Previously suggested structures porphyrin, flavone, anthocyanin, *meso*-dianthrone, are inadequate to explain the properties of hypericin. It is tentatively suggested that hypericin is a partially reduced polyhydroxy derivative of helianthrone. Further synthetic work is obviously needed for final proof, but the observations of Oxford and Raistrick on penicilliopsin, the studies of Meyer and of Scholl and co-workers on helianthrones, together with our comparisons, and our hydrogenation of *meso*-dianthrone, all support the plausibility of the present suggestion.

BERKELEY, CALIFORNIA RECEIVED JUNE 23, 1941

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(17) G. F. Attree and A. G. Perkin, *J. Chem. Soc.*, 144 (1931).

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[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF NORTHWESTERN UNIVERSITY AND UNIVERSAL OIL PRODUCTS COMPANY]

# The Electrolysis of Arylmagnesium Bromides in Ethyl Ether: the Behavior of Short-lived Aryl Free Radicals

BY WARD V. EVANS, RALPH PEARSON AND DAVID BRAITHWAITE

The electrolyses of the simple aliphatic Grignard reagents have been reported.[1] It was found that organic free radicals are liberated at the anode and that these radicals may react (1) by coupling, (2) by disproportionation or (3) by the removal of hydrogen from the ether solvent. The present work presents the electrolyses of aromatic Grignard reagents more fully than was previously reported[2] in an effort to determine the behavior of short-lived aryl radicals. Phenyl, *p*-tolyl, *p*-chlorophenyl, and benzylmagnesium bromides were electrolyzed. The ionization of the Grignards may be represented as being[1c]

$$(RMgX)_2 \longrightarrow Mg^{++} + (R_2MgX_2)^=$$

The corresponding electrode reactions are

$$\text{at the anode: } (R_2MgX_2)^= \longrightarrow 2R\cdot + MgX_2 + 2e$$
$$\text{at the cathode: } Mg^{++} + 2e \longrightarrow Mg^0$$

The symbol R· stands for a free radical.

## Experimental

The same apparatus and general procedure previously described were used,[1b] with platinum electrodes and voltages varying from 100 to 600. The high voltages were necessary because of the lower conductivity of the aromatic Grignards. To make sure that the changes in voltage did not significantly change the course of electrolysis, check runs were made on aliphatic Grignards using 300 volts.

**Phenylmagnesium Bromide.**—Ether solutions of phenylmagnesium bromide about one molar were electrolyzed continuously at different current densities and voltages. The products found by analysis of the hydrolyzed solution after electrolysis were benzene, diphenyl, *p*-terphenyl, styrene, ethyl alcohol and an insoluble, high molecular weight hydrocarbon that formed upon the anode. The results are tabulated in Table I. Samples of the Grignard solution were hydrolyzed and analyzed before electrolysis as blanks. The diphenyl was separated from the *p*-terphenyl by fractional crystallization from hot alcohol. These solids were identified by their melting points. The styrene was identified by its dibromide (m. p. 72–73°) and the ethyl alcohol by its 3,5-dinitrobenzoate. Only small amounts of alcohol were found. The polymer found on the anode was insoluble in all common reagents. It did

TABLE I

PRODUCTS OF ELECTROLYSIS OF PHENYLMAGNESIUM BROMIDE

| Current density, amp./dm. | Voltage | Current efficiency, % | Moles elect. | Moles of phenyl radical found as | | | |
|---|---|---|---|---|---|---|---|
| | | | | Styrene | Diphenyl | Terphenyl | Polymer |
| 0.32 | 300 | 13 | 0.126 | 0.05 | 0.02 | 0.01 | 0.01 |
| .48 | 300 | 14 | .181 | .09 | .01 | .02 | .01 |
| .48 | 400 | 41 | .501 | .09 | .15 | .07 | .01 |
| .48 | 600 | 18 | .143 | .06 | .0 | .02 | .01 |
| .24 | 110 | 66 | .178 | .0 | .12 | .02 | .01 |

Small amounts of ethyl alcohol were found in all cases.

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(1) (a) Evans and Field, THIS JOURNAL, **58**, 720 (1936); (b) Evans and Field, *ibid.*, **58**, 2284 (1936); (c) Evans and Lee, *ibid.*, **56**, 654 (1934); (d) Evans and Braithwaite, *ibid.*, **61**, 898 (1939); (e) Evans, Braithwaite and Field, *ibid.*, **62**, 534 (1940).

(2) Gaddum and French, *ibid.*, **49**, 1295 (1927).