respect to time. The establishment of the conditions for obtaining this relationship is a critical factor in the development of the quantitative aspects of this technique. Fig. 1 shows the results obtained with leucine, phenylalanine and pepsin.

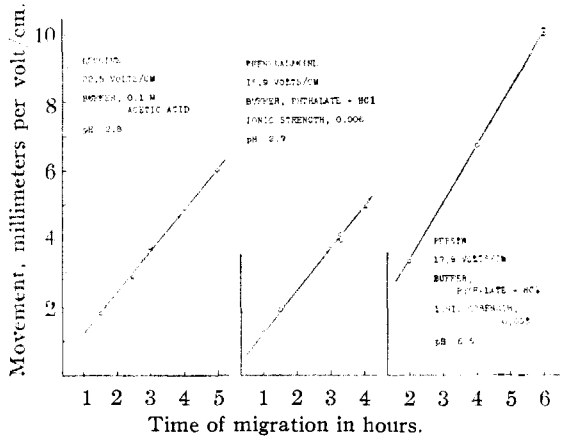


Fig. 1.—Movement of compounds on paper, in an electric field, as a function of time: pepsin, crystallized, of porcine origin, Armour Labs.; temperature, 23–24°.

The experiments were carried out in a modification of the apparatus previously described.[3,4,5] Six paper strips (E. & D. No. 613, 8 mm. wide) stretched across a Bakelite frame, were held in place by plastic draw-bolts actuated by stainless steel coil springs. At each end of the frame, the ends of the strips dipped into common buffer vessels, each containing about one liter of buffer solution. The frame, paper strips and buffer vessels were completely enclosed within a vapor-tight Lucite chamber. The vapor space in the chamber was kept to a minimum by replacing as much of the air as possible with water. Electrical contact with the buffer solutions was made by agar–KCl salt bridges.

The dry paper strips were placed in the Bakelite frame and wetted by immersing the frame in the buffer solution. The excess liquid was allowed to run off, as indicated by the absence of sheen on the paper; the frame was then placed in position in the chamber. When the reading of the milliammeter, in series with the paper strips, became relatively constant, 0.01 ml. of the substance under study (2–8 mg. per ml.) was added to the center point of each horizontal paper strip. The *p*H of the buffers was checked before and after each run to insure against variation. Ninhydrin was used to identify the amino acids, and lead acetate–bromo phenol blue for the pepsin. The displacement of the forward edge of the band on the paper, from the initial point of application of the migrating substance, was measured in each case.

DEPARTMENT OF BIOCHEMISTRY
THE GRADUATE SCHOOL AND
STRITCH SCHOOL OF MEDICINE
LOYOLA UNIVERSITY
CHICAGO 12, ILL.

HUGH J. MCDONALD
MATTHEW C. URBIN
MARTIN B. WILLIAMSON

RECEIVED FEBRUARY 10, 1950

(3) H. J. McDonald, M. C. Urbin and M. B. Williamson, *Science*, **112**, 227 (1950).

(4) H. J. McDonald, M. C. Urbin, and M. B. Williamson, Absts., Div. Biol. Chem., 118th Meeting, Amer. Chem. Soc., p. 66C (1950).

(5) H. J. McDonald, M. C. Urbin and M. B. Williamson, *J. Colloid Sci.*, in press.

THE EXCHANGE REACTION BETWEEN EUROPIUM(II) AND EUROPIUM(III) IONS IN HYDROCHLORIC AND PERCHLORIC ACID SOLUTIONS

Sir:

In view of current interest in electron transfer exchange reactions, we make this preliminary report of our studies of the measurable exchange rate between europium(II) and europium(III) ions in aqueous solutions of hydrochloric and perchloric acid.

Solutions of europium(II) chloride (perchlorate) and labelled europium(III) chloride (perchlorate) were mixed in the appropriate acid, aliquots removed at definite time intervals, the two oxidation states separated, and the specific activity of the europium(II) fraction determined by counting the solution in a reproducible geometry with a dipping Geiger-Mueller tube, then precipitating the europium and weighing it as $Eu_2(C_2O_4)_3 \cdot 10H_2O$. Sodium chloride or sodium perchlorate was used, as required, to adjust the ionic strength to 2.0 in all runs. Since europium(II) in aqueous solution is easily oxidized by air, and is known[1] to be photochemically oxidized by water, all experiments were carried out in an opaque reaction vessel under nitrogen freed from oxygen by passage through a chromium(II) chloride solution. Runs were made at 39.4 ± 0.1°.

Several chemical separation methods were tried, of which only the precipitation of europium(III) hydroxide from the solution by ammonium hydroxide gave reproducible results. This method led to a small, reproducible induced exchange (approximately 12%).

The tracer used was 5.2-year Eu^{152} produced by the Eu(n, γ) reaction in the Oak Ridge pile.

All runs exhibited the usual exponential time dependence of exchange extent. In perchlorate medium the half-time of exchange was not directly measurable since the europium(II) was completely oxidized by the perchlorate ion before the exchange had proceeded more than a few per cent. However, the exchange rate was found to be much faster in the presence of chloride ion, and experiments showed that the rate constant is proportional to the first power of the chloride ion concentration (varied by substituting perchlorate ion for chloride ion). In the presence of chloride the perchlorate oxidation of europium(II) was not serious since the exchange reaction was considerably faster than the oxidation. A plot of rate constant *vs.* chloride ion concentration gives a straight line extrapolating through zero rate at zero chloride ion concentration, implying that the rate of exchange in perchlorate medium in the absence of chloride is very small relative to the rate in the presence of chloride.

The change in half-time as a function of the europium concentrations showed that the reaction is first order in europium(II) and first order in europium(III). The rate is essentially independent of hydrogen ion concentration in the range 0.3–1.0 *f*, indicating that hydrolyzed species are apparently unimportant in the exchange. The exchange rate, R, is then given by $R = k\,[\mathrm{Eu(II)}][\mathrm{Eu(III)}][\mathrm{Cl^-}]$. Some representative data, including the termolecular rate constant k, are given in Table I.

(1) D. L. Douglas and D. M. Yost, *J. Chem. Phys.*, **17**, 1345 (1949).

TABLE I

Eu(II)–Eu(III) EXCHANGE RATES AT 39.4°. μ = 2.0

Total Eu(II) + Eu(III) concn., f	Eu(II) concn., f	Eu(III) concn., f	H^+ concn., f	Cl^- concn., f	Half-time, minutes	k moles$^{-2.12}$ min.$^{-1}$
0.0653	0.0244	0.0409	1.00	1.86	53	0.108
.0894	.0258	.0636	1.00	1.82	40	.107
.1055	.0683	.0372	1.00	1.84	33	.108
.0677	....	....	1.00	.716	132	.108
.0630	....	....	0.30	1.87	58	.102

The europium used was of 99.9% purity and was loaned to us by Mrs. Ethel Terry McCoy to whom we express our sincere gratitude. We thank Professor Don M. Yost and Dr. David L. Douglas of the California Institute of Technology for the Eu^{152} activity.

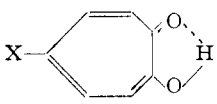
DEPARTMENT OF CHEMISTRY
UNIVERSITY OF CALIFORNIA DALE J. MEIER
LOS ANGELES, CALIFORNIA CLIFFORD S. GARNER

RECEIVED MARCH 5, 1951

ON *p*-AMINOTROPOLONE

Sir:

Very recently, Dewar[1] not only reported a molecular orbital calculation[2] of tropolone (I, X = H) but also predicted that *p*-aminotropolone (II, X = NH_2), which should be obtainable by the reduction of its azo-compound, may show interesting pharmacological properties as a precursor *in vivo* of *p*-aminobenzoic acid.



We have already reported on the syntheses of I[3] (independent of other three laboratories[4]), α-aminohinokitiol,[5] *i.e.*, *p*-amino-*m*-isopropyltropolone (III), *o*-bromo-*p*-aminotropolone[6] (IV) and other various derivatives[3,6] of I. We have also recently synthesized II, a brief account of which is given here.

Catalytic reduction of phenylazotropolone[3] (m.p. 161–161.5°; *anal.* Calcd. for $C_{13}H_{10}N_2O_2$: N, 12.39. Found: N, 12.58) or *p*-tolylazotropolone[3] (m.p. 202.5–203°; *anal.* Calcd. for $C_{14}H_{12}N_2O_2$: N, 11.66. Found: N, 11.42) with Adams catalyst, or their reduction with sodium hydrosulfite, yields yellow scaly crystals (II), m.p. 177–177.5°. *Anal.* Calcd. for $C_7H_7O_2N$: C, 61.32; H, 5.14; N, 10.21. Found: C, 61.09; H, 5.32; N, 10.02; yield, 30–40%. II is also obtained by the similar methods from *p*-nitrosotropolone[7] (X = NO), charring at 180°. (*Anal.* Calcd. for $C_7H_5O_3N$: N, 9.27. Found: N, 9.10) in better yield (70–80%). II is amphoteric and its chemical behaviors are closely analogous to III and IV. Copper complex salt: greenish yellow microcrystals. Picrate: yellow scaly crystals, m.p. 225–226° (dec.); *anal.* Calcd. for $C_{13}H_{10}O_9N_4$: N, 15.30. Found: N, 15.42. Diacetate: colorless scaly crystals, m.p. 180.5–181°; *anal.* Calcd. for $C_{11}H_{11}O_4N$: N, 6.33. Found: N, 6.02.

Application of the Sandmeyer reaction to II yields the following halogen compounds. *p*-Bromotropolone (V, X = Br); m.p. 189–190°, alone or in admixture with β-bromotropolone,[3] obtained as a by-product during the synthesis of I and the position of its bromine atom was later established to be at para,[6] so that the amino group in II is also clearly in the para position. *p*-Chlorotropolone: orange needles, m.p. 147–149°. *p*-Iodotropolone: orange needles, m.p. 169–170°.

Details of the results of our studies will be reported shortly. The effects of I, II, and some of their allied compounds on Yoshida sarcoma have already been published.[8]

We are deeply indebted to Dr. R. Majima (Emeritus Professor of this University) for his unfailing encouragement and to the Ministry of Education of Japan for the financial support.

(1) M. J. S. Dewar, *Nature*, **166**, 790 (1950).

(2) Similar calculation and measurement of dipole moments of I and its related compounds have already been reported; Y. Kurita, T. Nozoe and M. Kubo, *J. Chem. Soc. Japan*, **71**, 543 (1950); *Bull. Chem. Soc. Japan*, in press.

(3) T. Nozoe, S. Seto, Y. Kitahara, M. Kunori and Y. Nakayama, *Proc. Japan Acad.*, **26**, (7) 38 (1950); presented at the Annual Meeting of the Chemical Society of Japan in Kyoto, April 2, 1950.

(4) W. von E. Doering and L. H. Knox, THIS JOURNAL, **72**, 2305 (1950); J. W. Cook and A. R. Gibb, *Chemistry & Industry*, 427 (1950); R. D. Haworth and J. D. Hobson, *ibid.*, 441 (1950).

(5) T. Nozoe and E. Sebe, *Proc. Japan Acad.*, **26**, (9) 45 (1950); T. Nozoe, S. Ebine, S. Itô and A. Konishi, *ibid.*, **27**, 10 (1951).

(6) T. Nozoe, Y. Kitahara, K. Yamane and A. Yoshikoshi, *ibid.*, **27**, 18 (1951); T. Nozoe, S. Seto, T. Ikemi and T. Arai, *ibid.*, **27**, 24 (1951).

(7) T. Nozoe and S. Seto, to be published soon.

(8) S. Katsura, K. Satô, K. Akaishi, T. Nozoe, *et al.*, *Proc. Japan Acad.*, **27**, 31, 36 (1951).

CHEMICAL INSTITUTE TETSUO NOZOE
FACULTY OF SCIENCE SHŪICHI SETO
TÔHOKU UNIVERSITY SEIJI EBINE
SENDAI, JAPAN SHÔ ITÔ

RECEIVED FEBRUARY 28, 1951

ON A NEW TYPE OF AROMATIZATION BY THE DIAZOTIZATION OF *o*-AMINOTROPOLONE DERIVATIVES

Sir:

Tropolone and its allied compounds, the tropoloids, possess a fair degree of aromatic properties in spite of the unsaturated, seven-membered ring structure. On the other hand, it has also been established that these compounds, when heated with highly concentrated alkalies, undergo benzylic rearrangement to carboxylic acids of benzenoid series. According to Raistrick[1] and Dewar,[2] tropolones can be taken as precursors, *in vivo*, of natural benzenoid carboxylic acids, and recently Robinson[3] has also discussed on the assumption of a biogenetic relation between the tropolones and various alkaloids or anthocyanines. These certainly seem attractive suggestions but they must be confirmed by future experimental evidence. In this connection, studies on the aromatization of tropoloid series become of great significance.

Previously, we had encountered a notable fact that when *o'*,*p*-dinitro-*m*-isopropyltropolone is heated with 50% aqueous ethanol for ten minutes at 100°, or with absolute methanol, ethanol or isopropyl alcohol at 50–60° for a few minutes, it undergoes rearrangement to form *o'*,*p*-dinitro-*m*-cumic acid or its respective esters quantitatively.[4]

(1) H. Raistrick, *Proc. Roy. Soc. (London)*, **A199**, 141 (1949).

(2) M. J. S. Dewar, *Nature*, **166**, 790 (1950).

(3) R. Robinson, *ibid.*, **166**, 930 (1950).

(4) T. Nozoe, *Science of Drugs*, **3**, 171 (1949) [English translation, *Sci. Rep. Tohoku Univ.*, I, **34**, in press (1951)].