Anal. Calcd. for $C_{18}H_{14}ClO_4Co$: C, 55.6; H, 3.6; Co, 15.2. Found: C, 55.6; H, 3.8; Co, 15.4.

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DEPARTMENT OF CHEMISTRY
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS

The Vapor Pressure of Naphthalene

BY G. W. SEARS AND E. R. HOPKE

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Bradley and Cleasby[1] have recently reported vapor pressure data for naphthalene which were found by an effusion method. They obtained a linear log p *vs.* $1/T$ plot in disagreement with the measurements of Sears and Hopke,[2] who reported a non-linear log p *vs.* $1/T$ curve.

The Sears and Hopke deviation from linearity has been invalidated by the later spectroscopic detection[3] of an impurity, thionaphthene, which was not removed by the purification procedures used. It has been reported independently[4] that commercially pure naphthalene contains about 1% of thionaphthene. The non-linear vapor pressure data were measured with a Rodebush gage, which is quite sensitive to the presence of volatile impurities.

Sears and Hopke[5] have demonstrated the volatile impurity error is minimized by the effusion method of vapor pressure measurement. The purpose of this note is to report later measurements on the vapor pressure of naphthalene by an effusion method which corroborate the data of Bradley and Cleasby.[1]

From 0–20° the data obey a linear log p *vs.* $1/T$ relation having the same slope as reported by Bradley and Cleasby. The vapor pressures are 6% lower than those of Bradley and Cleasby. This discrepancy is rationalized in direction and magnitude as no correction was made for the orifice thickness. The orifice thickness was non-uniform and consequently no correction was attempted.

(1) R. S. Bradley and T. G. Cleasby, *J. Chem. Soc.*, 1690 (1953).
(2) G. W. Sears and E. R. Hopke, THIS JOURNAL, **71**, 1632 (1949).
(3) Hertha Sponer, private communication.
(4) W. E. Armstrong, A. B. Densham and G. Gough, *J. Chem. Soc.*, 3359 (1950).
(5) E. R. Hopke and G. W. Sears, *J. Chem. Phys.*, **19**, 1345 (1951).

GENERAL ELECTRIC RESEARCH LAOBRATORY
SCHENECTADY, NEW YORK

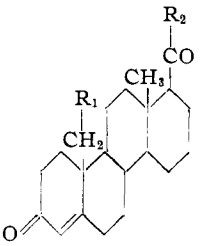
COMMUNICATIONS TO THE EDITOR

19-HYDROXY-11-DESOXYCORTICOSTERONE AND 19-HYDROXYPROGESTERONE[1]

Sir:

One of the aims of work being conducted in this laboratory has been the conversion of the easily accessible cardiac aglycone strophanthidin into analogs of steroid hormones having oxygen in position 19.[2] Recent reports of the isolation from adrenal extracts of electrocortin, a new crystalline hormone having very pronounced sodium-retaining activity, suggest that this product may be an isomer of corticosterone.[3,4] Therefore, we wish to report completion of the synthesis of 19-hydroxy-11-desoxycorticosterone, a new isomer of corticosterone, as well as the two possible monoacetates and the diacetate. We have also prepared 19-hydroxyprogesterone and its acetate.

Successive treatment of the sodium salt of 19-acetoxy-3-oxo-Δ^4-etienic acid (I)[5] with oxalyl chloride and diazomethane produced the non-crystalline 19-acetoxy-21-diazoprogesterone (II).



I, R_1 = Ac; R_2 = OH
II, R_1 = Ac; R_2 = CHN_2
III, R_1 = Ac; R_2 = CH_2OAc
IV, R_1 = Ac; R_2 = CH_2OH
V, R_1 = H ; R_2 = CH_2OH
VI, R_1 = H ; R_2 = CHN_2
VII, R_1 = H ; R_2 = CH_2OAc
VIII, R_1 = H ; R_2 = CH_3
IX, R_1 = Ac; R_2 = CH_3

Heating II with acetic acid gave 19-hydroxy-11-desoxycorticosterone diacetate (III), m.p. 127°, $[\alpha]^{25}D$ +210°, λ_{max}^{EtOH} 239 mμ, ε 13,400. (*Anal.* Found: C, 70.16; H, 8.12). Hydrolysis of III with potassium bicarbonate yielded 19-acetoxy-11-desoxycorticosterone (IV), m.p. 189–190°, $[\alpha]^{25}D$ +215°, λ_{max}^{EtOH} 239 mμ, ε 16,000. (*Anal.* Found: C, 71.06; H, 8.65.) Further hydrolysis with potassium carbonate gave 19-hydroxy-11-desoxycorticosterone (V), which melted at 163–165° after a gradual change in appearance over the range 120–145° and sintering at 153–158°, $[\alpha]^{25}D$ +180°, λ_{max}^{EtOH} 242 mμ, ε 18,500. (*Anal.* Found: C, 72.56; H, 8.70; loss on drying, 2.44.) Hydrolysis of II with potassium bicarbonate gave 19-hydroxy-21-diazoprogesterone (VI), m.p. 166° (*Anal.* Found: C, 70.22; H, 8.21), and reaction of VI with acetic acid produced 19-hydroxy-11-desoxycorticosterone-21-acetate (VII), m.p. 197–199°, $[\alpha]^{24}D$ +178°, λ_{max}^{EtOH} 242 mμ, ε 13,500. (*Anal.* Found: C, 70.86;

(1) This investigation was supported by a research grant from the National Cancer Institute (Grant No. CG757-C2) of the National Institutes of Health, Public Health Service.
(2) M. Ehrenstein, G. W. Barber and M. W. Gordon, *J. Org. Chem.*, **16**, 349 (1951).
(3) S. A. Simpson, J. F. Tait, A. Wettstein, R. Neher, J. von Euw and T. Reichstein, *Experientia*, **9**, 333 (1953).
(4) V. R. Mattox, H. L. Mason and A. Albert, *Proceedings of the Staff Meetings of the Mayo Clinic*, **28**, 569 (1953); THIS JOURNAL, **75**, 4869 (1953).
(5) P. T. Herzig and M. Ehrenstein, *J. Org. Chem.*, **17**, 713 (1952).

H, 8.01.) Treatment of VI with 48% hydriodic acid gave 19-hydroxyprogesterone (VIII), m.p. 171–172°, $[\alpha]^{24}D$ +185°, λ_{max}^{EtOH} 242 mμ, ε 12,900. (*Anal.* Found: C, 75.88; H, 9.11.) Acetylation of VIII produced 19-acetoxyprogesterone (IX), double m.p. 89–95° and 125–126°, $[\alpha]^{25}D$ +212°, λ_{max}^{EtOH} 239 mμ, ε 17,300. (*Anal.* Found: C, 73.45; H, 8.69; loss on drying, 4.26.) All rotations were determined in chloroform.

In bioassays conducted in the laboratory of Dr. John A. Luetscher, Jr., Stanford University School of Medicine, 19-hydroxy-11-desoxycorticosterone (V) produced only a slight sodium-retaining action (approx. 4% that of DOCA). In the Ingle work test, performed by E. H. Morley, W. W. Byrnes and K. J. Olson of the Research Division of the Upjohn Company, V was found to possess less than 2% of the activity of hydrocortisone. 19-Hydroxyprogesterone (VIII) was examined for progestational activity by Dr. Roy Hertz of the National Cancer Institute. Bioassays by the Corner–Allen and Clauberg procedures indicated that VIII is less than 10% as active as progesterone. A detailed report of these findings will appear as "Investigations on Steroids. XXIV" from this laboratory.

DIVISION OF STEROID RESEARCH
THE JOHN HERR MUSSER DEPARTMENT OF RESEARCH MEDICINE
UNIVERSITY OF PENNSYLVANIA G. WINSTON BARBER
PHILADELPHIA 4, PA. MAXIMILIAN EHRENSTEIN

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ENZYMATIC SYNTHESES OF PYRIMIDINE AND PURINE NUCLEOTIDES.[1] I. FORMATION OF 5-PHOSPHORIBOSYLPYROPHOSPHATE

Sir:

In studies on the incorporation of orotic acid into pyrimidine nucleotides, we have observed its conversion to uracil by liver preparations and a requirement for adenosine triphosphate (ATP) and ribose-5-phosphate (R5P) for this reaction.[2] With an enzyme preparation purified about 20-fold from extracts of pigeon liver acetone powder, the following reaction has been observed

$$\text{ATP} + \text{R5P} \longrightarrow \text{5-phosphoribosylpyrophosphate (PRPP)} + \text{adenosine-5'-phosphate (A5P)} \quad (1)$$

With PRPP isolated from reaction (1) and with a partially purified enzyme preparation from yeast, we have been able to show that adenine is converted to A5P and that uridine-5'-phosphate (U5P) is formed from orotic acid. The evidence, to be presented at a later date, suggests the equations

$$\text{Adenine} + \text{PRPP} \rightleftharpoons \text{A5P} + \text{inorganic pyrophosphate (PP)} \quad (2)$$

$$\text{Orotic acid} + \text{PRPP} \rightleftharpoons \text{orotidine-5'-phosphate} + \text{PP} \quad (3a)$$

$$\text{Orotidine-5'-phosphate} \longrightarrow \text{U5P} + CO_2 \quad (3b)$$

(1) This investigation was supported by a research grant from the National Institutes of Health, Public Health Service.

(2) I. Lieberman, A. Kornberg, E. S. Simms, and S. R. Kornberg, *Federation Proc.*, in press. B. Karger and C. E. Carter have also obtained evidence for the conversion of orotic acid to uracil by liver extracts with uridylic acid as an intermediate (personal communication).

The further metabolism of U5P leading to the production of uracil and, in the presence of ATP, to the formation of uridine diphosphate (UDP) and uridine triphosphate (UTP) has been demonstrated with enzyme preparations from yeast and liver. These reactions, the mechanisms of which are now under investigation, are summarized in equations (4) and (5).

$$\text{U5P} \longrightarrow \text{uracil} \quad (4)$$

$$\text{U5P} \longrightarrow \text{UDP} + \text{UTP} \quad (5)$$

Balance studies in support of equation (1) are given in Table I.

TABLE I

STOICHIOMETRY OF PRPP SYNTHESIS[a]

	Micromoles 0 min.	Micromoles 60 min.	Δ
ATP[b]—Exp.	12.5	1.6(1.8)[e]	−10.9
—Control	13.1	12.5(11.1)[e]	− 0.6
PRPP[c]—Exp.	0.0	10.9(10.0)[e]	+10.9
—Control	0.0	0.0	0.0
A5P[d]—Exp.	0.0	9.8(10.2)[e]	+ 9.8
—Control	0.0	0.0(0.0)[e]	0.0

[a] The experimental (Exp.) incubation mixture (10.0 ml.) contained 0.40 ml. of ATP (0.03 *M*, 2.2 × 10^4 c.p.m./μ mole), 1.00 ml. of R5P (0.025 *M*), 0.20 ml. of reduced glutathione (0.5 *M*), 0.20 ml. of $MgCl_2$ (0.1 *M*), 0.50 ml. of KF (1 *M*), 0.20 ml. of phosphate buffer (1 *M*, *p*H 7.4) and 2.00 ml. of the enzyme preparation (containing 0.72 mg. of protein). The control incubation mixture lacked R5P. Incubation was at 35° for 60 min. [b] Determined spectrophotometrically by the combined action of hexokinase and glucose-6-phosphate dehydrogenase (A. Kornberg, *J. Biol. Chem.*, **182**, 779 (1950)). With added myokinase, the extent of TPN reduction was exactly doubled, indicating the absence of adenosine diphosphate (ADP). [c] Determined spectrophotometrically by the removal of orotic acid (see equation (3)), or the production of A5P (see equation (2)); methods are unpublished. [d] Determined spectrophotometrically by Schmidt's A5P deaminase (H. M. Kalckar, *J. Biol. Chem.*, **167**, 445 (1947)). [e] Values in parentheses were determined by chromatography on Dowex-1 anion exchange resin; ATP and A5P were estimated by optical density measurement at 260 mμ; PRPP was estimated as indicated in footnote (*c*).

ATP labeled with P^{32} in the two terminal phosphate groups was used. In the control sample (R5P absent), ATP was not removed to any significant extent and the production of PRPP and A5P was not detectable. In the presence of R5P, almost all the ATP added disappeared and was matched by the appearance of equivalent molar quantities of PRPP and A5P. No ADP or inorganic orthophosphate was produced from ATP after 30 min. or 60 min., when 65 or 87%, respectively, of the ATP was consumed.

PRPP was isolated by ion-exchange chromatography as a discrete symmetrical zone and estimated spectrophotometrically by enzymatic condensation with adenine (equation (2)), or with orotic acid (equation (3)). Eight fractions selected from this PRPP zone (representing approximately 80% of the PRPP) contained pentose, enzymatically active PRPP (equations 2 or 3), acid-labile P and total P in molar ratios (within 5% of the average value) of 1.00:0.94:2.04:3.08. The average specific radioactivity (c.p.m./μmole) of these fractions was 2.24 × 10^4 as compared with values of 2.27 × 10^4 and 2.14 × 10^4, respectively, for the