TABLE I
ETHYL 4-PHENYLPHENYL CARBONATE AND BROMINE SUBSTITUTED DERIVATIVES

Phenol used	Yield, %	Solvent	M.p., °C.	Formula	Bromine, % Calcd.	Found
4-Phenyl	86.9	Ethanol	75–76	$C_{15}H_{14}O_3$	[a]	
2-Bromo-4-phenyl[b]	38.8	Methanol	31–32.5	$C_{15}H_{13}BrO_3$	24.89	25.12
4-(4-Bromophenyl)[c]	51.3	Methanol	75.5–76.5	$C_{15}H_{13}BrO_3$	24.89	24.95
2,6-Dibromo-4-phenyl[b]	41.0	Methanol	61–62	$C_{15}H_{12}Br_2O_3$	39.95	39.88
2-Bromo-4-(4-bromophenyl)[d]	62.5	Methanol	52.5–54	$C_{15}H_{12}Br_2O_3$	39.95	40.07
2,6-Dibromo-4-(4-bromophenyl)	79.0	Methanol	103.5–105	$C_{15}H_{11}Br_3O_3$	50.5	49.80

[a] Reported m.p. 73.9–75°; see ref. 4. [b] See ref. 9. [c] S. E. Hazlet, *J. Am. Chem. Soc.*, 59, 1087 (1937). [d] See Ref. 1.

refluxed gently, 56.5 g. of bromine (0.353 mole) was added slowly during a period of 2 hr. The mixture was refluxed for an additional 2.5 hr. and cooled; excess bromine was removed by treatment with sodium bisulfite solution. The carbon tetrachloride solution was separated, treated with charcoal, filtered, and evaporated to small volume. Coarse needles separated; m.p. 154–158°, 15.75 g. (0.039 mole, 44% yield). Recrystallization from carbon tetrachloride yielded 11.3 g. (0.028 mole, 31.7%), m.p. 158–159.5° (lit.,[5] m.p. 159°).

Ethyl 4-Phenylphenyl Carbonate and Bromine Substituted Derivatives.—These compounds were prepared by the action of ethyl chloroformate on the appropriate phenol in the presence of a slight excess of pyridine with *p*-dioxane as diluent.[6] Results are shown in Table I.

Bromination of Ethyl 4-Phenylphenyl Carbonate. A. In Glacial Acetic Acid.—The ester (10 g., 0.041 mole) was suspended in 30 ml. of glacial acetic acid in a three-necked flask fitted with a reflux condenser, a stirrer, and a dropping funnel. A trace of iron powder was added, and 6.6 g. (0.041 mole) of bromine dissolved in 5 ml. of glacial acetic acid was introduced slowly during a period of 45 min. During the addition of the bromine and for 5 hr. thereafter, the mixture was stirred and heated in an oil bath (98–100°). The mixture was cooled, poured into 200 ml. of water, and neutralized with sodium bicarbonate solution. The neutral solution was extracted with ether; the ether extract was washed three times with 5% sodium hydroxide solution and then with saturated sodium chloride solution.

The **ether extract** was dried with anhydrous sodium sulfate in the presence of charcoal and filtered. The ether was removed by distillation. The residue[7] was a low-melting solid and weighed 7 g. Repeated fractional crystallizations from ethanol and from *n*-heptane resulted in the separation of two products: (a) 4-(4-bromophenyl)phenyl ethyl carbonate (from *n*-heptane), m.p. 74.5–75.5°, 2.19 g. (0.0068 mole, 16.6% yield); (b) ethyl 4-phenylphenyl carbonate (from *n*-heptane), m.p. 74–75°, 3.3 g. (0.0136 mole, 33% yield).

The **sodium hydroxide extract** was acidified with 5% hydrochloric acid. The precipitate weighed 4.5 g. Repeated fractional crystallizations from chloroform and from *n*-heptane resulted in the separation of three products: (a) 2,6-dibromo-4-(4-bromophenyl)phenol (from *n*-heptane), m.p. 156.5–158°, 1.39 g. (0.0034 mole, 8.3% yield); (b) 2,6-dibromo-4-phenylphenol (from *n*-heptane), m.p. 91–93.5°, 1.3 g. (0.00396 mole, 9.6% yield); (c) 4-(4-bromophenyl)phenol (from chloroform), m.p. 144–145.5° [converted to the benzoic ester (from methanol), m.p. 187.5–188.5°[9]], 0.4 g. (0.0016 mole, 3.9% yield).

B. In Carbon Tetrachloride.—The ester (10 g., 0.041 mole) was suspended in 50 ml. of carbon tetrachloride and treated with bromine (6.6 g., 0.041 mole) dissolved in carbon tetrachloride (10 ml.) in the presence of a trace of iron powder; oil-bath temperature, 115°; time, 3.5 hr. The reaction mixture was cooled and extracted twice with 5% sodium hydroxide solution. (Only a trace of phenolic material was obtained from the sodium hydroxide extract; this was not identified.) The carbon tetrachloride solution was dried with anhydrous sodium sulfate in the presence of charcoal; from it was obtained 11.4 g. of solid product. Recrystallizations from *n*-heptane gave 4-(4-bromophenyl)-phenyl ethyl carbonate, m.p. 72–74°, 8.65 g. (0.027 mole, 65.4% yield).

(6) S. E. Hazlet, L. C. Hensley, and H. Jass, *J. Am. Chem. Soc.*, **64**, 2449 (1942).

(7) In one experiment, the residue (8 g.) was hydrolyzed with 12% potassium hydroxide solution. After acidification of the reaction mixture with sulfuric acid, volatile acid was collected by distillation. On a portion of the distillate, Duclaux numbers were determined: 6.1, 6.6, 6.8.[8] The total volatile acid calculated as acetic acid was 0.0495 g.; this indicated that a small amount, approximately 2%, of the ester fraction following the substitution reaction was acetate.

(8) R. L. Shriner, R. C. Fuson, and D. Y. Curtin, "The Systematic Identification of Organic Compounds," 4th ed., J. Wiley and Sons, Inc., New York, 1956; p. 204; Duclaux numbers for acetic acid: 6.8, 7.1, 7.4.

(9) S. E. Hazlet, G. Alliger, and R. Tiede, *J. Am. Chem. Soc.*, **61**, 1447 (1939).

Benzo[*d*]thiazolo[2,3-*b*]quinazoline-11-one. The Action of Hot Sulfuric Acid on 2-Thio-3-phenyl-1*H*,3*H*-quinazoline-2,4-dione

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Received January 24, 1962

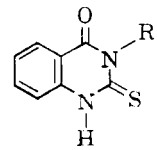
In 1930 Ghosh[1] heated 2-thio-3-phenyl-1*H*,3*H*-quinazoline-2,4-dione (I) with concentrated sulfuric acid at 125–130° for three to four hours and obtained a product to which he assigned the structure II. In the same paper,[1] he also reported that when 2-thio-3-allyl-1*H*,3*H*-quinazoline-2,4-dione (III) was heated with 12 *N* hydrochloric acid the product obtained was 2-allylaminobenzo[*d*][1,3]thiazine-4-one (IV). The latter report has previously been shown to be in error.[2]

As a part of a continuing study of aromatic heterocyclic compounds,[2,3] the author repeated the work of Ghosh.[1] The melting point of the product obtained from the acid-catalyzed rearrangement and oxidation of I agreed, although poorly, with

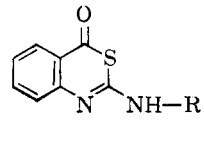
(1) T. N. Ghosh, *J. Indian Chem. Soc.*, **7**, 981 (1930).

(2) R. V. Ohmart, J. E. McCarty, and C. A. VanderWerf, *J. Org. Chem.*, in press. The correct structure was shown to be V.

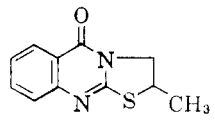
(3) (a) B. A. Carpentier, J. E. McCarty, and C. A. VanderWerf, *ibid.*, **26**, 853 (1960); (b) J. E. McCarty, E. L. Haines, and C. A. VanderWerf, *J. Am. Chem. Soc.*, **82**, 964 (1960).



I. R = C_6H_5
III. R = $CH_2-CH=CH_2$



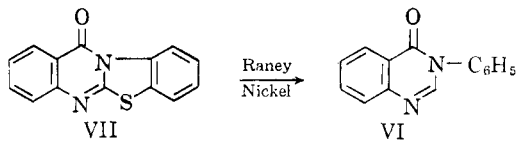
II. R = C_6H_5
IV. R = $CH_2-CH=CH_2$



V

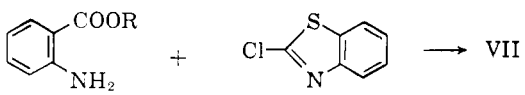
that reported for II by Ghosh, but its properties were not in accord with the assigned structure. The infrared spectrum showed no absorption in the N—H stretching region (3500–3300 cm.$^{-1}$)[4] as would be predicted for II,[4] and desulfurization with Raney nickel[5] afforded 3-phenyl-3*H*-quinazoline-4-one in good yield.

We were led to the tentative conclusion that the product of this reaction has the benzo[*d*]thiazolo-[2,3-*b*]quinazoline-11-one structure (VII). This



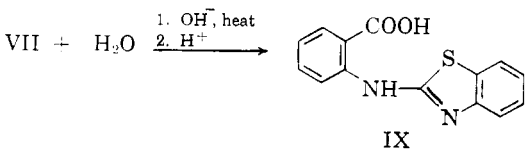
VII VI

compound has previously been prepared by Bose and Pathak[6a] (from anthranilic acid (VIIIa) and 2-chlorobenzothiazole) and by Katz[6b] (from ethyl anthranilate (VIIIb) and 2-chlorobenzothiazole).



VIII a. R = H
b. R = C_2H_5

Katz[6b] has also described the basic hydrolysis of the amide linkage present in VII to form *N*-(2-benzothiazolyl)anthranilic acid (IX).



IX

The Katz preparation[6a] of VII was repeated in a slightly modified form and the product was indistinguishable from the compound prepared by the method of Ghosh.[1] The melting points and mixed melting points were identical, and the infrared absorption spectra were the same. The hydrolysis described by Katz[6b] was performed on the two samples of VII and the melting points and mixed melting points were the same.

(4) F. A. Miller in H. Gilman, "Organic Chemistry, An Advanced Treatise," Vol. III, John Wiley and Sons, Inc., New York, N. Y., 1953, p. 122.

(5)(a) R. Mozingo, D. E. Wolf, W. A. Harris, and K. Folkers, *J. Am. Chem. Soc.*, **65**, 1013 (1943); (b) R. O. Robbins, Jr., J. O. Lampen, J. P. English, Q. P. Cole, and J. R. Vaughn, Jr., *ibid.*, **67**, 290 (1945); (c) J. A. Zderic, W. A. Bonner, and T. W. Greenlee, *ibid.*, **79**, 1696 (1957).

(6)(a) P. K. Bose and K. B. Pathak, *J. Indian Chem. Soc.*, **11**, 463 (1934); (b) L. Katz, *J. Am. Chem. Soc.*, **75**, 712 (1953).

Experimental[7]

Benzo[*d*]thiazolo[2,3-*b*]quinazoline-11-one (VII).—Method 1. This compound was prepared by the method of Ghosh[1] in a 46% yield, m.p. 190–191°, reported[1] 184–185°. 3-Phenyl-1*H*,3*H*-quinazoline-2,4-dione, m.p. 276–277° (reported,[8] 275–277°), was also isolated in a 41% yield.

Method 2. The procedure followed was essentially that of Katz.[6b] To 5.0 g. of methyl anthranilate, 5.0 g. of 2-chlorobenzothiazole was added, and the mixture was heated cautiously until a vigorous exothermic reaction was initiated. Thereafter the reaction vessel was cooled with a jet of air as necessary to keep the reaction under control. When the reaction had moderated, the crude product was powdered and washed with dilute sodium bicarbonate solution. To ensure complete reaction, the air-dried powder was heated above 200° for 10 min. Two crystallizations from isopropyl alcohol gave 6.5 g. of white needles, m.p. 190–191°, reported 189°[6a] and 193°.[6b] A mixed melting point of this compound prepared by method 1 with that prepared by method 2 was 189.5–191°. The infrared spectra of these two were identical, each showing maxima at 1695, 1590, 767, and 750 cm.$^{-1}$.[9]

***N*-(2-Benzothiazolyl)anthranilic Acid (IX).**—This compound was prepared by the method of Katz[6b] in a 72% yield, m.p. 194–195° (reported, 187°[6a] and 195–196°[6b]).

Raney Nickel Desulfurization of Benzo[*d*]thiazolo[2,3-*b*]-quinazoline-11-one (VII).—To a solution of 2.5 g. of VII in 200 ml. of absolute ethanol, 10 g. of W-6 Raney nickel[10] was added. The resulting mixture was heated under reflux for 2 hr. The nickel was removed by filtration, and the ethanol by evaporation, to give 1.6 g. of white needles. Two crystallizations (aqueous ethanol) gave 1.1 g. of 3-phenyl-3*H*-quinazoline-4-one (VI), m.p. 138–139°, reported 139°[11] and 142–142.5°.[3b]

Acknowledgment.—The author is greatly indebted to Dr. J. Allinger for determining the infrared spectra, and to Drs. J. and N. L. Allinger for helpful discussions. The author also wishes to thank the National Science Foundation for financial support of part of this work.

(7) All melting points were determined in capillary melting point tubes and are uncorrected.

(8) B. Pawleski, *Chem. Ber.*, **38**, 130 (1905).

(9) These spectra were determined in carbon disulfide solution and recorded on a Beckman Model IR4 spectrophotometer.

(10) H. R. Billica and H. Adkins, *Org. Syn.*, Coll. Vol. III, 176 (1955).

(11) C. Paul and M. Busch, *Chem. Ber.*, **22**, 2863 (1899).

The Preparation of 16α-Hydroxymethylprogesterone

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Received January 24, 1962

In view of the recent disclosure[1] of the preparation of 16α-substituted methyl corticoids we wish

(1) P. F. Beal and J. E. Pike, *J. Org. Chem.*, **26**, 3887 (1961).