content of acetoxymercury-derivative is 6.2/17.2 or 36.0%, the mercury content of the mixture should be $\frac{36.0 \times 57.8 + 64.0 \times 65.8}{100}$, or 63.0%, a figure in close agreement with that found.

Some of the product was boiled a long time with a large amount of water in an attempt to complete the hydrolysis. No change in the material appeared to take place and the mercury content was not increased, as would have been the case had further hydrolysis taken place. An attempt was made to secure a product free from combined acetic acid by dissolving the material in a 10% solution of sodium hydroxide and precipitating it with sulfuric acid, but this led to considerable decomposition.

Summary.

Two processes of mercuration are described which are applicable to phthaleins. The substitution of mercury is analogous to sulfonation, halogenation or nitration, and the metal enters the phenolic group of the phthalein molecule, in the *ortho* position to the hydroxyl or the quinone oxygen. The number of atoms of mercury entering the molecule is limited by the number of such free *ortho* positions, and if all 4 are occupied no substitution of mercury takes place.

Mercury derivatives containing from one to 4 atoms of the metal have been prepared from the following phthaleins; phenolphthalein, *o*-cresolphthalein, fluorescein, di-bromo-fluorescein and phenolsulfon-phthalein. The methods of substitution differ from those used in the earlier literature on mercurated phthaleins.

It is pointed out that chemical composition alone does not fix the identity of biological behavior or therapeutic effect of compounds of this class, and that samples cannot be considered identical unless they are made in precisely the same way and have the same composition.

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[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF CORNELL UNIVERSITY.]

TETRACHLORO-PHENOLPHTHALEIN.

BY E. T. WHITING.

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As this derivative of phenolphthalein had never been made and as it was desirable to measure its ultra-violet and visible absorption,[1] its preparation was undertaken by the author at the suggestion of Professor W. R. Orndorff and under the direction of Dr. S. A. Mahood.

Numerous attempts to chlorinate phenolphthalein in alkaline solution and in carbon tetrachloride resulted in failure. Tetrachloro-phenolphthalein was finally made by the following method. 50 g. of *pure* phenol-

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[1] See *Phys. Rev.* N. S., **10**, 779 (1917) for the absorption curves.

phthalein (m. p. 253°) was suspended in 500 cc. of *pure* glacial acetic acid and 62 g. of chlorine dissolved in 975 cc. of glacial acetic acid was slowly added, the mixture being stirred vigorously with a mechanical stirrer. The phenolphthalein dissolved completely within $^3/_4$ hour, and on standing overnight some of the tetrachloro product crystallized out. This was filtered off and the solution concentrated by distilling off a large portion of the solvent when most of the material in solution crystallized out in colorless crystals. 45 g. of the *pure* tetrachloro-phenolphthalein, melting at 215°, was obtained. Some of this was recrystallized twice from benzene and found to have the same melting point. The crystals from glacial acetic acid and from benzene contained no solvent of crystallization, as was shown by the very slight loss in weight they sustained when heated to 200°. Analyses for chlorine were made on both products, after heating to constant weight at 150°, by the lime method.[1]

Subs. (from benzene) (I), 0.3040; (II) (0.4290 from glacial acetic acid); (III) 0.1896; (IV) 0.2840: (I) 0.1 *N* $AgNO_3$, 26.59; (II) 37.67; (III) 16.66; (IV) 24.86.

Calc. for $C_{20}H_{10}O_4Cl_4$: Cl, 31.11. Found: (I) 31.01; (II) 31.13; (III) 31.15; (IV) 31.04; average, 31.08.

It will be seen from these analyses that the product was very pure This was the material used in measuring the absorption spectra by Professor R. C. Gibbs and Drs. H. E. Howe and E. P. T. Tyndall, of the Department of Physics, Cornell University.

Tetrachloro-phenolphthalein is soluble in methyl and in ethyl alcohols, in acetone and in ethyl acetate. It is not very soluble in benzene in the cold, but dissolves readily in boiling benzene and crystallizes out on cooling in well-formed colorless crystals. It is also soluble in glacial acetic acid and crystallizes well from this solvent. It is insoluble in petroleum ether and in water. In dil. caustic alkalies, provided they are not used in excess, it dissolves with a violet color, and acids precipitate the phthalein from this solution in colorless, amorphous flocks. Ether shaken with this mixture dissolves the precipitate. In excess of caustic alkalies the phthalein dissolves forming a colorless solution of the salt of the carbinol carboxylic acid, which crystallizes out of the solution in colorless needles when alcohol is added and the mixture allowed to stand for a few days. A *very slight* excess of alkali decolorizes the violet-colored solution of the phthalein in dil. alkali. When heated this colorless solution does not become violet. Alcohol also decolorizes the violet solution of the phthalein in dil. alkalies, and the colorless solution becomes violet when heated. On cooling it again becomes colorless. It dissolves in a 10% solution of sodium carbonate with the same violet color, but the solution is not completely decolorized by an excess of the solvent, although the color becomes much fainter. On warming this solution the color

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[1] *Am. Chem. J.*, 41, 397 (1909).

deepens. In a cold 10% sodium hydrogen carbonate solution the phthalein is almost insoluble, imparting only a faint violet tint to the solution on standing. In excess of a strong solution of ammonia in water it dissolves with a violet color. On boiling the ammonia from this solution the colorless phthalein separates in crystalline form. On shaking the violet-colored sodium carbonate solution several times with ether the color is completely removed, all the phthalein going into the ether. On the other hand, all the phthalein can be removed from an ether solution by shaking it a number of times with sodium carbonate solution. The phthalein dissolves in conc. sulfuric acid with a bright red color, probably forming an oxonium sulfate of the quinoid modification. Water precipitates the unchanged phthalein from this solution in the amorphous condition readily soluble in ether.

The phthalein dissolves in *colorless* nitrobenzene on warming and the solution has no color.

As the tetrachloro-phenolphthalein resembles the tetrabromo-phenolphthalein so closely, both in its chemical and its physical properties, and is made in the same way, it is highly probable that it contains 2 chlorine atoms in each ring *ortho* to the hydroxyl group, a structure analogous to that deduced by Baeyer for the tetrabromo-phenolphthalein.[1]

Tetrachloro-phenolphthalein Diacetate.—This product was made by heating the phthalein with pure acetic anhydride for an hour, cooling and adding absolute ethyl alcohol to remove the excess of acetic anhydride and precipitating with water. It melted sharply at 117°. After drying to constant weight in the water oven it was analyzed for chlorine by the lime method.

Subs., 0.3088, 0.2295: 0.1 N $AgNO_3$, 22.80, 16.86.
Calc. for the diacetate: Cl, 26.26. Found: 26.17, 26.04.

The diacetate is soluble in acetic anhydride, ethyl acetate, alcohol and glacial acetic acid. It is insoluble in caustic alkalies and in the alkaline carbonates. It is saponified on boiling with caustic alkalies, more rapidly and completely with an alcoholic solution of the alkalies. It dissolves in conc. sulfuric acid with a bright red color, exactly like that given by the phthalein itself, and evidently undergoes hydrolysis to the phthalein in this solvent.

ITHACA, N. Y.

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[1] *Ann.*, **202**, 168 (1880).