# SCIENTIFIC SECTION

## DETERIORATION OF CERTAIN MEDICAMENTS UNDER THE INFLUENCE OF LIGHT.*

BY H. V. ARNY, ABRAHAM TAUB AND ABRAHAM STEINBERG.

### I.—INTRODUCTION.

This research is a direct outcome of the creation in 1926 by the Section on Dispensing of the AMERICAN PHARMACEUTICAL ASSOCIATION of a special "Committee on Colored Glass Containers." This committee consisting of Messrs. Becker, Dunning and Arny, reported to the ASSOCIATION in 1927, 1928 and 1929 and the reports will be found in our JOURNAL of these years. Having reported on the available information as found in the chemical and pharmaceutical literature, it became apparent that more extended work, under conditions actually obtaining in present-day American pharmacy should be inaugurated and the senior author of this paper secured a fund of $2000 for this purpose; the subscriptions being obtained through the generosity of the following firms and organizations.

Subscriptions of $100 each from the Dow Chemical Co., Midland, Mich.; Drug Products Co., Long Island City, N. Y.; Hynson, Westcott and Dunning, Baltimore, Md.; Lehn & Fink, Bloomfield, N. J., and New York City; Eli Lilly & Co., Indianapolis, Ind.; William S. Merrell Co., Cincinnati, Ohio; Merck & Co., Rahway, N. J., and New York City; H. K. Mulford Co., Philadelphia, Pa.; Parke, Davis & Co., Detroit, Mich.; Charles Pfizer & Co., Brooklyn and New York City; Perdue Frederick Co., New York; Sharp & Dohme, Baltimore, Md.; Dr. William Jay Schieffelin, New York; E. R. Squibb & Sons, Brooklyn and New York City; Frederick Stearns & Co., Detroit; The Upjohn Co., Kalamazoo, Mich.; and W. R. Warner & Co., New York.

A subscription of $100 from the Proprietary Association.

A grant of $200 from the A. PH. A. Research Fund.

As research fellow, Dr. Arny selected Abraham Steinberg, B.S., who gave to the project his devoted attention during 1929–1930 and 1930–1931 as a student of the graduate course of the College of Pharmacy of Columbia University. Mr. Steinberg was awarded the Columbia degree of Doctor of Pharmacy in June 1931 and submitted in partial fulfilment of the requirements set for the doctor degree an inaugural dissertation embodying the results of the work set forth in this paper. Condensation was essential as Dr. Steinberg's "Arbeit" covers 339 typewritten pages. In connection with the $2000 fund mentioned above, all of it was devoted to the payment of the fellowship held during two years by Dr. Steinberg. Apparatus and routine reagents were available in the laboratories of Columbia University College of Pharmacy. The glass bottles used were donated by the following firms:

Corning Glass Works, Fairmount Bottle Co., Maryland Bottle Co., Owens-Illinois Co., Wheaton Bottle Co. and Whitall Tatum & Co.

The official chemicals and pharmaceuticals employed in the actual tests were kindly furnished by the following firms:

Charles Cooper & Co., Eli Lilly Co., Merck & Co., Parke Davis & Co., Charles Pfizer & Co., Schieffelin & Co., and E. R. Squibb & Sons.

The simpler pharmaceuticals used in the tests were prepared by Mr. Steinberg in our laboratory. The research itself divided naturally into three groups:

(*a*) Study of the light transmission of the commercial glass containers employed.

(*b*) Examination of each chemical studied as to its pharmacopœial quality.

(*c*) Exposure of each medicament under observation to varying degrees of light, with subsequent examination of each sample as to degree of deterioration.

As to "*a*" Professor Taub will report; while "*b*" and "*c*" are discussed by the senior author.

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* Joint Session, Scientific Section and Section on Practical Pharmacy and Dispensing.

## II.—SPECTRAL TRANSMISSION OF COLORED GLASS.

(A. Taub and A. Steinberg.)

An adequate study of the influence of light on chemicals involves not only an examination of the substances affected, but also of the character of the light coming into play. Previous workers have noted some of the effects of isolated portions of the light spectrum by the use of special glass and liquid light filters. The purpose of the present study was to determine how well the commercially available glass containers would protect light-sensitive substances. Upon investigating the market it was found that while many types of glass containers were being manufactured, from the standpoint of light transmission they could all be represented by a selection of eight types. These included 1 flint, 3 green, 1 blue and 3 amber glasses. Of the 3 green, one had only a faint green tint, one was medium dark and one almost black. The three ambers were very similar, differing only slightly in depth of color. In addition to these, five Corning glasses and two special glasses were selected for certain properties which they possessed in cutting out certain parts of the spectrum.

In order to quantitatively determine the transmission of the light through these glasses, the spectrophotometer was employed. Spectrophotometry differs from colorimetry in that the former measures the amount of light energy transmitted at each wave-length. Colorimetry merely measures the sensation produced upon the observer; it is subject to abnormalities of vision. Spectrophotometry is the more accurate and fundamental method. For example, two glasses may appear to the eye as having the same color, yet their spectral transmissions may be quite different. The chemical effects produced are dependent upon the kind of light transmitted and not upon the appearance of the glass to the observer.

For work in the visible spectrum, from 400–800 m$\mu$ we employed the Bausch and Lomb Spectrophotometer that is a part of the equipment of the physics laboratory of the College of Pharmacy. This consists of a constant deviation prism spectrometer and a polarization photometer. A white light source is used. At any wave-length, the per cent of the original light transmitted through an interposed specimen can be read off directly from the scale.

For transmission values in the ultraviolet region, we employed a Hilger quartz spectrograph with sector photometer, kindly placed at our disposal by the Department of Physics of Columbia University. The light source was a high voltage iron arc, permitting readings from 230–500 m$\mu$. The transmission values are obtained by measuring the densities of the images of comparison spectra on a photographic plate.

The thickness of the glass is of course an important factor in the transmission of light. Representative pieces were selected by cutting out the sides of the bottles and grinding them flat when necessary. For converting light transmissions of one thickness to that of another thickness of glass, use was made of a graph worked out by the Bureau of Standards (Technological Paper, No. 148).

The curves on the following three plates (Figs. 1, 2 and 3) represent the transmission values of all the glasses used in the research. In addition, pyrex is included since it was used as the inner container for the chemicals. Window glass

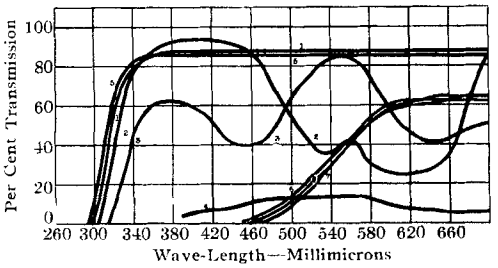
is also included since all light passed through this first, with the intent of simulating the conditions in the pharmacy.

A study of these curves reveals some interesting observations:

(1) Flint No. 1 and bottle green No. 5 allow not only a good percentage of the visible rays but also the ultraviolet rays down to 300 mμ to be transmitted. They are poor preserving glasses.

Spectrophotometric Transmission Curves,
Fig. 1.
COLORED GLASS CONTAINERS.

| | | | |
|---|---|---|---|
| 1—Flint | A 2.8 mm. | 5—Green | C 2.5 mm. |
| 2—Blue | A 2.5 mm. | 6—Amber | A 2.4 mm. |
| 3—Green | A 2.8 mm. | 7—Amber | B 2.5 mm. |
| 4—Green | B 2.5 mm. | 8—Amber | C 2.4 mm. |



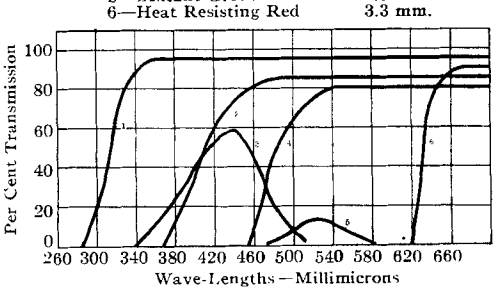

(2) Green No. 3 has a pleasing green color of medium depth. It allows over 40 per cent of all the rays down to 340 mμ to be transmitted. It also is a poor preserving glass.

(3) Green No. 4 is greenish black in appearance. This lets through not more than 13 per cent of light at any wave-length. Yet, the fact that from 2 to 5 per cent of ultraviolet is transmitted, causes it to permit some deterioration. The curve shows that there is such a low total transmission of light that the glass is almost opaque which really defeats the purposes of a glass container.

(4) Ambers Nos. 6, 7 and 8 (or A, B and C) all show marked similarity in their curves. They cut off the light at about 460 mμ. These show a marked protective action even though as much as 60 per cent of light is transmitted at some wave-lengths. In other words, while presenting a fairly transparent ap-

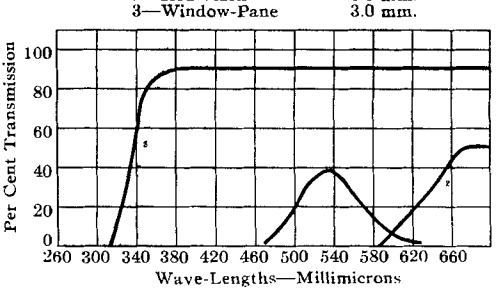
Spectrophotometric Transmission Curves,
Fig. 2.
CORNING COLOR-FILTERS.

| | |
|---|---|
| 1—Pyrex | 2.0 mm. |
| 2—Nultra | 7.4 mm. |
| 3—Lantern Blue | 4.2 mm. |
| 4—Noviol | 6.0 mm. |
| 5—Sextant Green | 4.9 mm. |
| 6—Heat Resisting Red | 3.3 mm. |




Spectrophotometric Transmission Curves,
Fig. 3.
SPECIAL GLASS PLATES.

| | |
|---|---|
| 1—Coeburgh Green | 2.3 mm. |
| 2—Red Flash | 3.0 mm. |
| 3—Window-Pane | 3.0 mm. |




pearance, the fact that they cut off the ultraviolet and deep blue makes them of marked value as protective glasses. Because of the similarity in these three glasses, only "A" and "B" were used in the research described below.

(5) Blue No. 2 is of medium depth of color and high transparency. It transmits light down to about 300 mμ, letting through as much as 90 per cent of ultraviolet at some wave-lengths. It is a very poor protective glass.

It must not be assumed that only ultraviolet rays may produce deterioration

of chemicals, although this is true for most substances. Other wave-lengths of light also affect chemicals. It was for this reason that the Corning glass filters were studied. These are noteworthy for their sharp cut-offs; that is, the sharp transitions between high transmission and strong absorption of light.

Thus, "Nultra" cuts off all waves below 370 mμ, "Noviol" below 450 mμ, and "Heat Resisting Red" all waves below 620 mμ.

"Lantern Blue" cuts off all rays below 340 and above 520 mμ, while "Sextant Green" cuts off all rays below 470 and above 580 mμ.

Of all these glasses, "Noviol" has the greatest interest. It cuts off all ultraviolet and has a very good protective action; yet it is a highly transparent glass of light yellow color. Its cost, however, is at present too high for general bottle use.

Of the special glasses, the Coeburgh green cuts off below 470 and above 630 mμ. It is a good protective glass but not commercially available. The red flashed glass cuts off all rays below 590 mμ. It and the Corning Red are the best protective glasses of those studied. However, its cost prohibits its use for commercial purposes.

Window glass and pyrex of course transmit considerable ultraviolet light, the former down to 320 mμ and the latter down to 290 mμ.

It can readily be seen then that only a spectrophotometric examination can truly indicate the protective value of glass. The visibility and color presented to the unaided eye are no criteria. In general, a better protecting glass is one which cuts off ultraviolet and has a steep ascending curve toward the red end of the spectrum rather than a flat curve throughout. Of course the final test lies in observing the results produced upon the chemical itself when stored in these containers.

### III.—DETERIORATION OF CHEMICALS.

(H. V. Arny and A. Steinberg.)

While excellent work on this subject has been reported by Coeburgh and by Eisenbrand, neither of these investigators studied the chemicals in commercially available glass containers. As the task entrusted by the AMERICAN PHARMACEUTICAL ASSOCIATION to its "committee on glass containers" was specifically a study of deterioration of substances stored in commercial containers, the work now being reported was carefully planned to meet this condition as far as light-influence was concerned. Of course, an important factor in such a study is the effect of chemicals in the glass-batch upon the chemicals stored in the finished container. This disturbing factor we successfully eliminated by the use of pyrex tubes as described hereafter. A second factor demanding consideration was the question of the proper sealing of the container. Due cognizance was taken of the influence of air and of atmospheric moisture and, as outlined below, the influence of various types of sealing (even in gas-filled or evacuated ampuls) was given due attention.

*Experimental Methods.*—Each chemical used was subjected to a complete physical and chemical examination as to its official (U. S. P. or N. F.) quality.

The chemicals as soon as received or made, were placed (in their original containers) in a dark closet in our laboratory "dark room" and there remained throughout the two years of research. Whenever it was necessary to remove portions of the contents for experimental purposes, the containers were opened in the dark room in the presence of an electric light of small intensity. Never

were these chemicals in their original containers exposed to the direct light of the sun. To eliminate the question of the alkalinity of the glass containers as a factor influencing deterioration we secured Pyrex test-tubes of such size to fit into the glass containers under examination. Pyrex glass is generally conceded to be less apt to affect the chemical stored therein than an ordinary glass bottle, since Pyrex is practically free from alkalinity as indicated by our own tests with phenolphthalein and with strychnine nitrate.

In most cases, the Pyrex test-tube containing the chemical was stoppered with an ordinary cork. In some cases where cork was likely to be attacked, rubber stoppers were employed. In still other cases, the stopper (cork or rubber) was covered with tin foil prior to insertion, while in several cases, the stopper was coated with melted paraffin prior to use. Lastly, in special cases, the Pyrex tube was sealed into ampul form either with a pocket of air above the chemical, or evacuated or filled with an inert gas (nitrogen or carbon dioxide).

In a very few cases, where the amount of the medicament (pharmaceutical solution) required for assay was larger than the capacity of the Pyrex tube, this solution was placed into the glass bottle itself. This was done only after experimentation indicated that the particular container was free from substances that might affect the solution studied.

The bottles containing the Pyrex tubes were stoppered either with corks or cotton plugs and were placed in specially constructed panels equipped with panes of window glass. This procedure was followed upon the assumption that bottles behind window panes would more approximate drug store conditions where the light rays pass through glass windows before reaching the bottles. Data given herein indicate, however, that this test was unduly severe. These sets of bottled chemicals in the glass-covered panels were exposed on the roof of the college building where direct sunlight or direct daylight obtained during the daytime hours of exposure of these specimens; one-fifth were exposed continuously over a period of 12 months, one-fifth were exposed during 6 months and the other fifths were exposed 4, 2 and 1 month, respectively. *In the pages which follow, this experimental condition will be called "direct daylight."*

A second group of the same chemicals were arranged in orderly fashion upon the shelves of a bookcase provided with glass doors, situated in the office of the senior author. These batches were designed to simulate average drug store conditions as to heat and light. *On the pages which follow this condition will be called "diffused light."*

A third batch, kept in a dark closet in our "dark room" served as controls giving definite checks on the important question whether deterioration in the chemicals under observation were actually caused by the action of light or by some other factor.

*Chemicals Studied.*—Of the 400 or more light-sensitive chemicals and pharmaceuticals listed in the United States Pharmacopœia and the National Formulary, 35 were given our careful study. Each of these is discussed below. These thirty-five were chosen because of frequent statements in the literature as to their light-sensitivity and it is interesting to note below that several of these do not deserve their bad reputation. These chemicals (or solutions) were stored as mentioned above; 1400 different specimens exposed to direct daylight on the roof; 450

specimens in diffused light in a glass-doored bookcase in the office; and 300 in a dark closet in our "dark room."

In measuring deterioration, various methods had to be followed. Wherever feasible, the official assay process was employed. This seemingly perfect method did not always indicate real deterioration. For instance, diluted hydriodic acid, syrup of hydriodic acid and syrup of ferrous iodide were stable in all types of glass containers under all light conditions to which we exposed them as far as iodide content was concerned, but within 2 to 6 months of direct daylight (according to color of container) these preparations became so dark as to render them unsalable.

In a second group of chemicals under examination (notable examples being ether and chloroform) deterioration was indicated by official tests for specific impurities. In a third and large group, the criterion of deterioration in our work (as well as in commercial practice) was the change in color.

It is unnecessary in this paper to reproduce the wording of the official assays of those chemicals so judged or the official tests of the chemicals in the second group. As to the third group, where color changes are the only practical criterion, Dr. Steinberg expressed those changes in his dissertation in terms of the Ridgeway Color System as presented in that valuable book of standard charts entitled "Color Standards and Nomenclature." For the sake of simplicity, we express color deterioration in the tables which follow in the more elastic terms "considerable darkening," "slight darkening" and "no change." Turning to the tables given below; first gives general findings as to deterioration after exposure during one year.

TABLE IV.—GENERAL FINDINGS AS TO DETERIORATION.

Exposure for 1 Year.

| Stable in all types of glass containers under all conditions. | Stable in all conditions of diffused light. | Unstable in all conditions of light and darkness. |
|---|---|---|
| Hydriodic acid, dilute (as to HI content) | Adrenalin hydrochloride solution | Apomorphine hydrochloride, solution |
| Hydriodic acid, syrup (as to HI content) | Benzoic acid | Phenol (one sample) |
| Hydrobromic acid, dilute | Chloroform | Physostigmine salicylate, solution |
| Mercuric iodide | Ephedrine hydrochloride solution | Solution of arsenic and mercuric iodide |
| Phenol (one sample) | Hydriodic acid, dilute (as to color) | Solution of chlorinated soda |
| Syrup of ferrous iodide (as to $FeI_2$ content) | Hydriodic acid, syrup (as to color) | Spirit of ethyl nitrite |
| Sulphurated potassa | Mercurous chloride | |
| | Pyrogallol | |
| | Resorcinol | |
| | Syrup of ferrous iodide (as to color) | |
| | Thymol iodide | |

Commenting on this table, it will be seen that out of the 20 medicaments reported, 3 were stable under all conditions of exposure, whether in direct daylight or in diffused light, 11 were stable after exposure one year in diffused light resembling conditions obtaining in the average drug store; in one case (phenol) permanence was dependent upon the presence or absence of a stabilizer, while 5

were unstable in all conditions of light and darkness. The latter group will be considered as individuals below.

Table V reports in definite figures the percentage of deterioration shown by actual assay of eleven chemicals (or preparations) exposed during one year in diffused light as described above. It may be stated that our analytical figures indicate that exposure to direct daylight was too severe a test for most of the chemicals studied. Comparing the chemicals exposed in direct light (on the roof) and in diffused light (in a closet with glass doors) it is noted that there is about 3 to 12 times as much deterioration in direct daylight as is noted in samples kept in diffused light. Moreover, other factors, such as evaporation, freezing in winter and explosions in summer rendered our analytic figures as to deterioration in direct daylight less reliable than those obtained from samples maintained under the more normal condition of diffused light. Analytical figures as to each sample exposed to direct daylight are to be found in Dr. Steinberg's dissertation. Moreover, Table No. IV reports upon the effect of direct daylight in general terms.

TABLE V.—DEGREE OF DETERIORATION IN GLASS CONTAINERS AFTER TWELVE-MONTH PERIOD EXPOSURE TO DIFFUSED SUNLIGHT.

Percentage of Deterioration Shown by Actual Assay.

| Chemical. | Flint. A. | Amber. A. | Amber. B. | Blue. A. | Green. [A. | Green. B. | Green. C.] | Control.* |
|---|---|---|---|---|---|---|---|---|
| Hydriodic acid, dilute | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hydriodic acid, syrup | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hydrobromic acid, dilute | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hydrocyanic acid, dilute | 15.7 | 24.7 | 31.1 | 19.7 | 25.9 | 28.7 | 18.7 | 1.7 to 18.7 |
| Solution of arsenic and mercuric iodide | 39.2 | 33.0 | 29.5 | 22.5 | 30.0 | 65.8 | 28.3 | 30.9 |
| Solution of chlorinated soda | 50.6 | 28.0 | 34.4 | 34.3 | 35.4 | 38.3 | 42.9 | 37.6 |
| Solution of chlorine, compound | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Solution of hydrogen peroxide, A | 60.8 | 9.4 | 8.2 | 19.8 | 18.0 | 18.0 | 13.8 | 7.7 |
| Solution of hydrogen peroxide, B | 88.1 | 13.7 | 31.0 | 45.8 | 57.0 | 33.3 | 46.2 | 4.11 |
| Spirit of ethyl nitrite | 43.3 | 57.3 | 61.3 | 60.5 | 86.4 | 100 | 61.3 | 15.8 |
| Sulphurated potassa | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Syrup of ferrous iodide | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

* Samples from same batch kept in darkness for one year.

The next table discusses the degree of deterioration, after one year of exposure in diffused light, of 22 chemicals in which change is best indicated by specific tests or by the darkening of the product.

TABLE VI.—DETERIORATION AFTER ONE YEAR OF EXPOSURE TO DIFFUSED LIGHT AS SHOWN BY COLOR CHANGE OR BY SPECIAL TESTS.

Abbreviations.

C.D.—considerable darkening. S.D.—slight darkening. N.C.—no change. Det.—deterioration shown by chemical tests.

| Chemical. | Flint. A. | Amber. A. | Amber. B. | Blue. A. | Green. [A. | Green. B. | Green. C.] | Control.* |
|---|---|---|---|---|---|---|---|---|
| Adrenaline hydrochloride solution | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Apomorphine hydrochloride solution | C.D. | C.D. | C.D. | C.D. | C.D. | C.D. | C.D. | C.D. |
| Benzoic acid | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Betanaphthol | S.D. | N.C. | N.C. | S.D. | S.D. | N.C. | S.D. | N.C. |
| Chloroform A | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Chloroform B | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Ephedrine hydrochloride solution | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Ether A | Det. | Det. | N.C. | Det. | Det. | Det. | Det. | N.C. |
| Ether B | Det. | N.C. | N.C. | Det. | Det. | N.C. | Det. | N.C. |
| Ferric citrate | C.D. | S.D. | S.D. | C.D. | C.D. | S.D. | C.D. | N.C. |
| Ferric phosphate, soluble | C.D. | N.C. | N.C. | C.D. | C.D. | N.C. | C.D. | N.C. |
| Ferric pyrophosphate, soluble | C.D. | N.C. | N.C. | C.D. | C.D. | N.C. | C.D. | N.C. |
| Ferrous iodide, syrup | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Hydriodic acid, diluted | N.C. | N.C. | S.D. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Hydriodic acid, syrup | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Hydrobromic acid, diluted | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Mercuric iodide, red | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Mercuric oxide, red | C.D. | C.D. | S.D. | C.D. | C.D. | S.D. | C.D. | N.C. |
| Mercuric oxide, yellow | S.D. | S.D. | N.C. | S.D. | S.D. | N.C. | S.D. | N.C. |
| Mercurous chloride | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Mercurous iodide, yellow | C.D. | C.D. | C.D. | C.D. | C.D. | C.D. | C.D. | N.C. |
| Phenol (one sample) | S.D. | S.D. | S.D. | S.D. | S.D. | S.D. | S.D. | S.D. |
| Physostigmine salicylate solution | All erratic. | | | | | | | |
| Pyrogallol | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Resorcinol A | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Resorcinol B | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |
| Santonin | Yellow | N.C. | N.C. | Yellow | Yellow | N.C. | Yellow | N.C. |
| Silver nitrate | S.D. | N.C. | N.C. | S.D. | N.C. | N.C. | S.D. | S.D. |
| Thymol iodide | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. | N.C. |

* Samples from same batch kept in darkness for one year.

We now turn to two tables indicating the speed of deterioration of 33 chemicals (or preparations) stored in containers exposed to (*a*) direct daylight (Table VII) and to (*b*) diffused light (Table VIII). These tables are expressed in terms of the number of months before deterioration was observed. In the case of direct daylight, it will be noted that in several cases deterioration occurred in less than one month of exposure. Obviously, the notation on the tables "−1," "−3," etc., indicate deterioration occurred in less than one month, less than three months, etc.

TABLE VII.—LIMIT OF STABILITY OF THE CHEMICALS IN THE COLORED GLASS CONTAINERS EXPOSED TO DIRECT DAYLIGHT.

(Expressed in Months.)

| Chemical. | Flint. A. | Amber. A. | Amber. B. | Blue. A. | [A. | Green. B. | C.] | Control.* |
|---|---|---|---|---|---|---|---|---|
| Adrenaline hydrochloride (0.1% solution) | − 1 | 1 | 1 | − 1 | − 1 | − 1 | − 1 | +12 |
| Apomorphine hydrochloride (0.5% solution) | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 |
| Benzoic acid | 4 | +12 | +12 | 4 | 4 | +12 | 4 | +12 |
| Betanaphthol | − 1 | 1 | 1 | − 1 | − 1 | 1 | − 1 | +12 |
| Chloroform A | 2 | 6 | 6 | 2 | 2 | 6 | 2 | +12 |
| Chloroform B | 2 | 6 | 6 | 2 | 4 | 6 | 2 | +12 |
| Ephedrine hydrochloride solution | − 1 | 1 | 1 | −1 | − 1 | − 1 | − 1 | +12 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ether A | − 1 | 1 | 1 | − 1 | − 1 | 1 | − 1 | +12 |
| Ether B | − 1 | 1 | 1 | − 1 | − 1 | 1 | − 1 | +12 |
| Ferric citrate | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | +12 |
| Ferric phosphate, soluble | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | +12 |
| Ferric pyrophosphate, soluble | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | +12 |
| Hydriodic acid, diluted: | | | | | | | | |
| (As to HI content) | +12 | +12 | +12 | +12 | +12 | +12 | +12 | +12 |
| (As to color) | 6 | 12 | 12 | 2 | 4 | 4 | 4 | +12 |
| Hydriodic acid, syrup: | | | | | | | | |
| (As to HI content) | +12 | +12 | +12 | +12 | +12 | +12 | +12 | +12 |
| (As to color) | 4 | 4 | 4 | 4 | 4 | 4 | 2 | +12 |
| Hydrobromic acid, diluted | +12 | +12 | +12 | +12 | +12 | +12 | +12 | +12 |
| Hydrocyanic acid, diluted | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 |
| Mercuric iodide | +12 | +12 | +12 | +12 | +12 | +12 | +12 | +12 |
| Mercuric oxide, red | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | +12 |
| Mercuric oxide, yellow | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | +12 |
| Mercurous chloride | − 1 | +12 | +12 | − 1 | − 1 | +12 | − 1 | +12 |
| Mercurous iodide | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | +12 |
| Phenol (one sample) | − 1 | 1 | 1 | − 1 | − 1 | 1 | − 1 | 1 |
| Physostigmine salicylate (0.5% solution) | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 |
| Pyrogallol | − 1 | 6 | 6 | − 1 | − 1 | 6 | − 1 | +12 |
| Resorcinol | − 1 | 2 | 2 | − 1 | − 1 | 1 | − 1 | +12 |
| Santonin | − 1 | 1 | 1 | − 1 | − 1 | − 1 | − 1 | +12 |
| Silver nitrate | 2 | 4 | 4 | 2 | 2 | +12 | 2 | 4 |
| Solution of arsenic and mercuric iodide | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | 1 |
| Solution of chlorinated soda | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | 1 |
| Solution of chlorine, compound | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 |
| Solution of hydrogen peroxide A | − 1 | 1 | 1 | − 1 | − 1 | − 1 | − 1 | 2 |
| Solution of hydrogen peroxide B | − 1 | 1 | 1 | − 1 | − 1 | − 1 | − 1 | 2 |
| Spirit of ethyl nitrite | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 | 4 |
| Sulphurated potassa | +12 | +12 | +12 | +12 | +12 | +12 | +12 | +12 |
| Syrup of ferrous iodide: | | | | | | | | |
| (As to $FeI_2$ content) | +12 | +12 | +12 | +12 | +12 | +12 | +12 | +12 |
| (As to color) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Thymol iodide | − 1 | 4 | 4 | − 1 | − 1 | 4 | − 1 | +12 |

* Samples from same batch kept in darkness for one year.

Table VIII is somewhat incomplete, since our original aim was to use the samples, kept in diffused light only, as a check even as obtained in the case of the samples kept in the dark. Those where deterioration was detected by color change were examined month by month. Those requiring chemical testing or assaying were so treated only at the end of the second or the twelfth month. This explains such large stretches of time such as "+2" and "12" found under solution of hydrogen dioxide.

TABLE VIII.—SPEED OF DETERIORATION IN GLASS CONTAINERS EXPOSED IN DIFFUSED LIGHT.

(Expressed in Months.)

| | Amber. A. | B. | Blue. | Green. B. | Green. A. | Flint. |
|---|---|---|---|---|---|---|
| Adrenalin hydrochloride (0.1% solution) | 12 | 12 | 12 | 12 | 12 | 12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Apomorphine hydrochloride (0.5% solution) | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 |
| Benzoic acid | 12 | 12 | 12 | 12 | 12 | 12 |
| Betanaphthol | 12 | 12 | 6 | 12 | 6 | 6 |
| Chloroform | 12 | 12 | 12 | 12 | 12 | 12 |
| Ephedrine hydrochloride (0.5% solution) | 12 | 12 | 12 | 12 | 12 | 12 |
| Ether | 12 | 12 | −12 | 12 | −12 | −12 |
| Ferric citrate | 6 | 6 | − 3 | 6 | − 3 | − 3 |
| Ferric phosphate | 12 | 12 | − 3 | 9 | − 3 | 3 |
| Ferric pyrophosphate | 12 | 12 | − 3 | 12 | − 3 | − 3 |
| Hydriodic acid, diluted | | | | | | |
| (As to HI content) | 12 | 12 | 12 | 12 | 12 | 12 |
| (As to color) | 12 | 6 | 12 | 12 | 12 | 12 |
| Hydriodic acid, syrup | | | | | | |
| (As to HI content) | 12 | 12 | 12 | 12 | 12 | 12 |
| (As to color) | 12 | 12 | 12 | 12 | 12 | 12 |
| Hydrobromic acid, diluted | 12 | 12 | 12 | 12 | 12 | 12 |
| Hydrocyanic acid, diluted | | Erratic | | | | |
| Mercuric iodide | 12 | 12 | 12 | 12 | 12 | 12 |
| Mercuric oxide, red | − 3 | − 3 | − 3 | − 3 | − 3 | − 3 |
| Mercuric oxide, yellow | − 6 | 12 | − 3 | 12 | − 3 | − 3 |
| Mercurous chloride | 12 | 12 | 12 | 12 | 12 | 12 |
| Mercurous iodide | − 3 | − 3 | − 3 | − 3 | − 3 | − 3 |
| Phenol, liquefied | | Erratic | | | | |
| Physostigmine salicylate, (0.5% solution) | | Erratic | | | | |
| Pyrogallol | 12 | 12 | 12 | 12 | 12 | 12 |
| Resorcinol | 12 | 12 | 12 | 12 | 12 | 12 |
| Santonin | 12 | 12 | − 3 | 12 | − 3 | − 3 |
| Silver nitrate | 12 | 6 | 6 | 12 | 12 | 6 |
| Solution of arsenic and mercurous iodide | | Erratic | | | | |
| Solution of chlorinated soda | 2 | − 2 | − 2 | 2 | 2 | 2 |
| Solution of chlorine, compound | − 1 | − 1 | − 1 | − 1 | − 1 | − 1 |
| Solution of hydrogen dioxide | | | | | | |
| (Sample A) | 12 | 12 | + 2 | + 2 | + 2 | + 2 |
| (Sample B) | 12 | + 2 | + 2 | + 2 | + 2 | + 2 |
| Spirit of ethyl nitrite | − 2 | − 2 | + 2 | + 2 | + 2 | + 2 |
| Sulphurated potassa | 12 | 12 | 12 | 12 | 12 | 12 |
| Syrup of ferrous iodide | | | | | | |
| (As to $FeI_2$ content) | 12 | 12 | 12 | 12 | 12 | 12 |
| (As to color) | 12 | 12 | 12 | 12 | 12 | 12 |
| Thymol iodide | 12 | 12 | 12 | 12 | 12 | 12 |

The foregoing tables report on 33 of the 35 chemicals (or preparations) studied, the others being the two silver proteins which did not satisfactorily fit into tabulations. These are reported below in the discussion of the individual chemicals.

*(To be continued)*

## PUBLICITY FOR PHARMACISTS IN AUSTRALIA.

Victoria has followed the lead of New South Wales in arranging a series of radio talks giving publicity to the professional side of pharmacy—these are being sponsored by the Pharmaceutical Society and are broadcasted every evening. Differences of opinion seem to obtain, some contending that such publicity is detrimental to the dignity of the profession.