SCIENCE

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A Critical Examination of Some Concepts in Rubber Chemistry: DR. THOMAS MIDGLEY, JR. 143

The American Association for the Advancement of Science:

The Twenty-sixth Annual Meeting of the Pacific Division. II: Edited by PROFESSOR J. MURRAY LUCK 146

Obituary:

Raymond L. Ditmars: DR. ALEXANDER G. RUTHVEN. *Henry Francis Nachtrieb:* PROFESSOR D. E. MINNICH. *Recent Deaths* 150

Scientific Events:

The Oxford Institute of Research in Agricultural Engineering; The Hebrew University of Jerusalem; The Handbook of Scientific and Technical Societies and Institutions of the United States and Canada; The Reorganization of the Bureau of Mines; The American Standards Association and the Development of War Standards; In Honor of Dr. Marston Taylor Bogert 151

Scientific Notes and News 154

Discussion:

Swedish Oceanographic Research in 1941: DR. HANS PETTERSSON. *The First Law of Fluorescence:* JACK DE MENT. *Cementing Sino-American Friendship:* WAYNE M. HARTWELL. *Research as Usual:* PROFESSOR ELIOT BLACKWELDER 156

Quotations:

Social Medicine 159

Scientific Books:

The Rat in Laboratory Investigation: DR. C. E. MCCLUNG. *Stellar Dynamics:* PROFESSOR BART J. BOK 160

Special Articles:

Treatment of Experimental Renal Hypertension with Vitamin A: DR. GEORGE E. WAKERLIN and OTHERS. *Renal Hyperlipemia in Dogs:* DR. WALTER HEYMANN. *Association of Tobacco Leaf-spot Bacteria with Roots of Crop Plants:* DR. W. D. VALLEAU and OTHERS 161

Scientific Apparatus and Laboratory Methods:

The Production of Artificial Frost Injury in the Branches of Living Trees: PROFESSOR R. A. STUDHALTER and DR. WALDO S. GLOCK. *The Use of Tertiary Butyl Alcohol in Microtechnique:* DR. R. E. STOWELL 165

Science News 7

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A CRITICAL EXAMINATION OF SOME CONCEPTS IN RUBBER CHEMISTRY[1]

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VULCANIZATION

IT is now over one hundred years since Goodyear discovered vulcanization. Broadly speaking, vulcanization is a process whereby a semi-useless vegetal product is converted into the most amazingly versatile raw material the world of industry has ever known. Need I recite your daily contacts with it? For example, when you take a shower bath, your faucet valve is faced with rubber, the curtain is rubberized cloth, the mat that keeps you from slipping is rubber, and the imitation sponge you use is vulcanized rubber in still another form. And when you play, golf balls, tennis balls, footballs and baseballs all depend on vulcanized rubber for liveliness. Notice that I didn't mention tires. They are almost too sacred to talk about these days. And yet after a century, rubber chemists are in less agreement on the nature of the chemistry of vulcanization than Goodyear's neighbors were that he was crazy. Nor has a Hall of Fame jury yet been selected with brains enough to honor Goodyear's memory as it deserves. It is all most astounding; but also is vulcanization.

If one wished to manufacture some rubber article,

[1] The concluding part of the address made by Dr. Midgley on the occasion of the presentation to him of the Willard Gibbs Medal of the Chicago Section of the American Chemical Society at Chicago on May 27. The presentation of the medal was made by Professor Harry N. Holmes, national president of the society.

use if prolonged exposure to a high concentration of vapors is avoided. TBA is miscible with most reagents in common laboratory use.

TBA was first introduced as a dehydrating agent for tissues by Johansen.[3] Although it has been recommended for plant microtechnique,[4,5] little has been written regarding its use for animal tissues.[6] During the past seven years I have found TBA unusually satisfactory for the dehydration of a large variety of normal and pathological mammalian tissues. A comparative study[7] of dehydrating agents showed that it caused less shrinkage of rabbit kidney than dioxan, xylol or chloroform. After TBA dehydration tissue hardening is comparatively slight and cytological details are well preserved.

Although techniques should be varied to suit the size and type of specimen, the following schedules have been found generally satisfactory. For dehydrating tissues a series of solutions of tertiary butyl-ethyl alcohol (TBEA) should be prepared as indicated in Table 1.

TABLE 1

PERCENTAGES OF TBEA SOLUTIONS

Constituents	50 per cent.	70 per cent.	85 per cent.	95 per cent.	100 per cent.
Distilled water	50 cc	30 cc	15 cc	....	....
95 per cent. ethyl alcohol	40 "	50 "	50 "	45 cc	....
Tertiary butyl alcohol ..	10 "	20 "	35 "	55 "	75 cc
Absolute ethyl alcohol ..	....	....	....	....	25 "

Fixed material dehydrated directly from water or through the lower percentages of ethyl alcohol is transferred to 50 per cent. TBEA for 1–2 hours and material washed in alcohol is placed in the corresponding concentration of the TBEA dehydrating mixture. Leave tissues in (1) 70 per cent. TBEA from 2 hours to several days; (2) 85 per cent. TBEA, 1–2 hours; (3) 95 per cent. TBEA, 1–2 hours; (4) 100 per cent. TBEA, 1–3 hours; (5) pure TBA, three changes in 4 hours to overnight; (6) equal parts of pure TBA and paraffin oil, 1–2 hours; and (7) infiltrate with paraffin. This infiltration is accomplished by filling shell vials three-fourths full of melted parowax or paraffin, allowing the paraffin to solidify and then placing the tissue just covered with TBA-paraffin oil mixture on top of the solid paraffin. The vials are then placed in a well-ventilated oven, the temperature of which is several degrees above the melting point of the paraffin. As the paraffin melts the tissue sinks and is gradually infiltrated with paraffin. Starting at least one hour after the tissue has sunk to the bottom of the vial, the melted paraffin should be changed at hourly intervals, at least until the odor of TBA is no longer detectable, usually 2–6 hours. The used paraffin is discarded. If a special paraffin is used for embedding, it should be used as the last change of melted paraffin in the oven. When necessary, very small pieces of tissue which are in 70 per cent. TBEA one morning may be dehydrated during the day, infiltrated with paraffin overnight and sectioned by noon the next day.

The two most important stages in the technique are the final dehydration with TBA and the infiltration with paraffin. It is essential that the free water be removed completely from the tissue before paraffin infiltration and that the TBA and paraffin oil have diffused from the tissues before they are embedded. Although it is better to discard all solutions after using once, if necessary the same solutions may be used several times.

When celloidin or paraffin-celloidin (double embedding) techniques are being used, after dehydration in 100 per cent. TBEA, tissues may be treated according to the usual schedules with ether-alcohol and infiltrated with celloidin or nitrocellulose. Johansen[4] has suggested the use of equal parts of tertiary butyl, ethyl alcohol and ether instead of the usual alcohol-ether as a solvent for celloidin or nitrocellulose.

Since many stains are less soluble in TBA than in ethyl alcohol, TBA is used in dehydrating stained sections, especially when one is anxious to reduce the extraction of ethyl alcohol soluble stains from the tissues.[8] Slides are mounted with balsam, damar or clarite directly from TBA or preferably after passage through xylol or toluol. Celloidin and nitrocellulose are only slightly soluble in TBA, and stained celloidin sections can be dehydrated directly through TBA or TBA with chloroform into xylol before mounting.

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[3] D. A. Johansen, SCIENCE, 82: 253, 1935.

[4] D. A. Johansen, "Plant Microtechnique," McGraw-Hill Book Company, New York, 1940.

[5] J. E. Sass, "Elements of Botanical Microtechnique," McGraw-Hill Book Company., New York, 1940.

[6] R. E. Stowell, *J. Techn. Methods*, 22 (in press).

[7] R. E. Stowell, *Stain Techn.*, 16: 67, 1941.

[8] N. D. Levine, *Stain Techn.*, 14: 29, 1939.

BOOKS RECEIVED

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