a committee of judges of the American Institute of Nutrition, and the formal presentation will be made at the Cleveland meeting on April 7. The award will be given to the laboratory or clinical research worker in the United States or Canada who, in the opinion of the judges, has published during the previous calendar year January 1 to December 31 the most meritorious scientific report dealing with the field of the B complex vitamins. Further information can be obtained from Dr. Arthur H. Smith, of the College of Medicine of Wayne University, Detroit, who is secretary of the American Institute of Nutrition.

DISCUSSION

THE BACTERIAL OXIDATION OF RUBBER[1]

IN studying the biological oxygen demand of sea water[2] it has been observed that rubber stoppers increase the amount of oxygen consumed. In fact, the small amount of rubber gasket exposed to the water in citrate of magnesia bottles perceptibly increases the amount of oxygen consumed after 5 to 10 days incubation. Heat-sterilized, as well as formaldehyde-preserved, controls prove that the increased oxygen consumption is attributable to biological activity.

One-gram quantities of various kinds of rubber cut in small pieces to give a surface area of approximately 10 sq. cm were placed in 160 ml glass-stoppered bottles. After sterilizing in the autoclave at 120° C. for 20 minutes the bottles were filled with sterile water saturated with oxygen. Half of the bottles were inoculated and the others remained sterile. Duplicate bottles were analyzed for oxygen immediately using the Winkler technique, and the others were incubated in the water bath for one to five days at 22° C. after which the amount of oxygen consumed was determined. It is necessary to decant or siphon the water from the rubber before treating it with the Winkler reagents because free iodine reacts with rubber.

Using samples of rubber stoppers, rubber tubing, pure gum rubber, duprene and neoprene it was found that whereas 0.53 to 0.88 mgm/l of oxygen was consumed in the sterile controls after 5 days incubation, 5.11 to 6.74 mgm/l of oxygen was consumed in the inoculated water. Similar results were obtained when the controls were preserved with 1.0 per cent. formaldehyde. That the increased oxygen consumption is caused by microorganisms is indicated by the fact that the rate of oxygen consumption increases exponentially with time typical of a growth-curve and, more convincingly, by the multiplication of microorganisms.

Realizing that most of the aforementioned rubber products contain sulphur and other oxidizable constituents used as fillers or impurities, the experiments were repeated with several samples of highly purified (non-vulcanized) caoutchouc or latex obtained from the Goodyear Tire and Rubber Company. Small quantities dissolved in C.P. benzene were distributed in bottles which were manipulated to form a thin film of the purified rubber on the inside of the bottles as the benzene evaporated. After driving off all the benzene the bottles were filled with oxygenated water. Following the incubation of inoculated water it was found that 2 to 2.5 mgm of oxygen was consumed in the presence of 1 mgm of purified rubber. This together with the production of carbon dioxide which was estimated manometrically indicated that most of the rubber was oxidized. Considering rubber to be $(C_5H_8)_x$, it would require about 3.3 mgm of oxygen to completely oxidize 1 mgm of rubber. Part of the rubber was converted into bacterial protoplasm as shown by the number of bacteria which appeared. The perforation of thin films of rubber on agar and on glass slides immersed in culture solutions gives further proof that rubber is utilized by microorganisms.

Confirming the observations of Söhngen and Fol[3] and Spence and van Niel[4] most of the rubber oxidizing microorganisms which have been observed belong to the genus *Actinomyces* or *Proactinomyces*. Many of the latter utilize complex hydrocarbons according to Umbreit.[5] Rubber oxidizing *Mycobacterium* and *Pseudomonas* have also been isolated from our enrichment cultures. The aerial mycelium of an unidentified mold virtually enveloped the moist rubber on which it was growing and its substrate mycelium seemed to penetrate the rubber.

Using oxygen consumption with adequate controls as a criterion of their presence, rubber oxidizing bacteria have been found to be quite widely distributed in the sea and in garden soil. Neither in nature nor in the laboratory do the rubber oxidizing microorganisms appear to require rubber or related hydrocarbons for their multiplicaion but old pieces of rubber hose and the cracks in tires found in moist places have proved to be good sources of cultures.

Besides showing that neither synthetic nor pure India rubber is biologically inert and proving that rubber oxidizing microorganisms occur fairly abundantly in nature, the observations suggest that such

[1] Contribution from the Scripps Institution of Oceanography, New Series No. 179.

[2] C. E. ZoBell, *Jour. Mar. Res.*, 3: 211, 1940.

[3] N. L. Söhngen and J. G. Fol, *Centralbl. f. Bakt.*, II. Abt., 40: 87, 1914.

[4] D. Spence and C. B. van Niel, *Ind. and Eng. Chem.*, 28: 849, 1936.

[5] W. W. Umbreit, *Jour. Bact.*, 38: 73, 1939.

microorganisms may play an important role in the deterioration of rubber products. The life of rubber products which come in contact with moisture may be prolonged if ways can be found to retard or prevent the activity of rubber oxidizing microorganisms.

CLAUDE E. ZOBELL
CARROLL W. GRANT[6]
SCRIPPS INSTITUTION OF OCEANOGRAPHY,
UNIVERSITY OF CALIFORNIA, LA JOLLA

STATE BOARD STATISTICS AS A BASIS FOR COMPARISON OF MEDICAL SCHOOLS

A RECENT article in SCIENCE,[1] by Albert E. Casey, compares 15 medical schools with respect to quality of teaching. A definite rank in the group is assigned to each school. Several features of the article appear to deserve comment.

(1) The state board statistics, cited as a basis for the comparison, do not agree with the annual tabulations of such data published in the *Journal* of the American Medical Association.[2] Three of the discrepancies concern the number of graduates listed from individual schools and are too small to be important. But Dr. Casey attributes to Loyola 53 failures, on foreign state board examinations, during the five-year period covered by his study. The annual tabulations in the *Journal* of the American Medical Association list only 32 such failures for Loyola. We have examined each individual state board report, published and indexed in that journal, for the years in question; but have not been able to confirm Dr. Casey's figure.

(2) Any comparison of schools from state board statistics is complicated by two facts. They are (a) that the geographical distribution of graduates is not the same for any two schools, and (b) that the rate of failure, for all candidates examined, is consistently higher in some states than in others. Dr. Casey does not indicate the distribution of candidates or of failures by states. According to the annual tabulations in the *Journal* of the American Medical Association,[2] more than half of all the failures listed by Dr. Casey occurred in two states, New York and Massachusetts. Each of the 15 schools had a higher rate of failure in those two states (taken together) than elsewhere, and for the entire group of schools there were 202 failures out of 986 examinations (20.5 per cent.). In all other states combined (excluding, as Dr. Casey does, candidates locally graduated) there were 154 failures out of 3,974 examinations (3.9 per cent.). The several schools were not represented in New York and Massachusetts by equal quotas of graduates. One school had 5.5 per cent. of its listed graduates examined in those two states, another 35.3 per cent. Quotas for the remaining schools varied between these extremes. For the five schools highest on Dr. Casey's list the average quota was 12.3 per cent.; for the five lowest, 25.6 per cent.

Now the reason for the disparity of failure rates, from state to state, is a matter of opinion. We may assume that examination standards are everywhere uniform; but this logically implies that the weakest graduates from all schools show a conspicuous preference for certain states, a phenomenon which might be difficult to account for. If we assume, alternatively, that examination standards vary from state to state, then obviously the number of failures charged to a given school must be determined largely by the geographical distribution of its graduates. It thus becomes somewhat difficult to compare any two schools, and considerably more so to compare fifteen. Dr. Casey ingeniously avoids these complications by using both assumptions at the same time. He excludes all examinations taken by candidates in the states where they were graduated, and calculates from the remaining data the percentage of failures for each school. If examination standards are uniform, there is no reason to exclude local examinations; if they are not uniform, failure percentages calculated from the remaining data are not fairly comparable.

(3) If all candidates were examined by the same board, variations of failure rate from school to school would no doubt appear. It does not follow, however, that such differences would be due entirely to variations in the quality of teaching, unless it can be shown that the schools are on an equal basis with respect to the quality of classes entering. The applicants annually accepted by the medical schools of the country are, in the judgment of admitting officials, the best available; but Dr. Casey offers no proof that the class entering at Harvard, for example (the first school on his list), is a representative cross-section of the larger group of students admitted to all the schools.

T. E. BOYD
LOYOLA UNIVERSITY

WHAT PRICE GLORY?

IN a recent issue of the *Journal* of the American Medical Association (July 25, 1942, page 1041), Dr. Rendich, of Brooklyn, has stated that the more prominent physicians—those whose death notices head the weekly list in the *Journal*—die on the average 4.7 years earlier in life than do those whose demise receives only a bare mention. This rather markedly shortened life span he infers to be the price of success or prominence in the medical world.

[6] On sabbatical leave from Brooklyn College, New York. Assisted by grant No. 555 from the American Philosophical Society.

[1] Albert E. Casey, SCIENCE, 96: 110, 1942.

[2] *Journal of the American Medical Association*, 98: 1458, 1932; 100: 1240, 1933; 104: 1506, 1935; 106: 1476, 1936; and 108: 1412, 1937.