third going to the support of Rudolph Blaschka and Mrs. Blaschka, whose family made the glass flowers and models; one third to preserve the collection; and one third to pay the salary of officials of the museum in which the objects are housed. The will expresses the wish that the director shall give prominence in the museum to the educational and practical side, and shall endeavor to augment the usefulness of the museum of exploration and investigation. The wish is also expressed that the director have discretionary power under the president and fellows as to expenditures necessary. Other bequests include $40,000 to the Boston Lying-In Hospital; $20,000 to Harvard University for the work of the Cancer Commission; $40,000 to the Boston Athenaeum; $20,000 to the Massachusetts Society for Mental Hygiene; $10,000 to Berea College, Kentucky; $20,000 to the Massachusetts Eye and Ear Infirmary; $70,000 to the Boston Museum of Fine Arts, and $30,000 to Harvard College for the Fogg Museum of Art.

THE *Fondation Scientifique de Lyon et du Sud-Est* is offering a fellowship of 10,000 francs for a period of nine months to a graduate student of chemistry, preferably of industrial chemistry. A fellowship of 18,000 francs for nine months and free transportation in the Tourist Class of the French Line is being offered through the *Office National des Universités et Ecoles Françaises* to an advanced graduate student who has specialized in science, preferably one who has obtained a doctorate in mathematics, physical science, chemistry or biology.

DISCUSSION

HYDROPONICS—CROP PRODUCTION IN LIQUID CULTURE MEDIA

IN the late summer of 1935 a number of large growers of certain vegetables and flowers adopted liquid culture media on a large scale for the growing of crops and have (for two seasons) placed on the market products so grown to compete with those produced by agriculture. Thus further evidence has been established that production of certain crops without soil is practicable and it appears that the introduction into the economic field of a new method of production, essentially another origin of agricultural crops, may well be considered as the birth of a new art and perchance a new science which should be designated by a distinctive name. The first announcement of the probability of the economic feasibility of liquid culture media for production of some agricultural crops was in 1929—"Aquiculture a Means of Crop-Production."[1] This announcement was made about two years after the investigations were started to establish the basis for the use of liquid culture media for the commercial growing of crops. Liquid culture media had been extensively used for nearly three quarters of a century for the growing of plants for study, but until the above reference no mention is found in the literature of investigations designed to apply the principle of water culture in a practical way to grow crops without soil. It was of course evident at the outset of the investigations that cultural techniques had to be designed to establish the physiological basis for the method within the framework of economic feasibility. The physiological basis is the markedly greater productive potentiality of certain crops grown on a per unit area of specially prepared nutrient water surface than that of a similar area soil. It is the manyfold larger production of some crops per unit area of water surface than that of soil which makes water culture economically feasible. A different point of view was required for the organization of the investigations leading to establishment of a method of crop production without soil, than that which prevailed in classical plant physiology using nutrient solutions for growing plants as material for experimental study.

As it is the purpose of this paper to give a name to this new method of production, no discussion will be entered into concerning the physiological basis on which it is founded. In other papers, consideration will be given to this and also to the economic and to the sociological features arising out of the development. However, a brief statement of the historic aspects of water culture experimentation appears in order in considering a name.

While it had been known before modern science took form that certain plants would develop roots and make some growth in water, nevertheless water culture proper dates from those experiments in which the elements found in plants and known to be derived from the soil were added to water to make a nutrient solution. The credit for such experiments is generally accorded to Knop, whose first paper in Landwirtschaftlichen Versuchsstation appeared in 1859. Other names would be mentioned in a complete treatise on the origin and development of water culture experimentation, and cognizance given to the spirit of the day, the methods of the time and the view-point of agricultural chemists and plant physiologists for their part in the development. Knop, an agricultural chemist, conceived water culture as a means of elucidating soil processes in relation to plant growth, and such also has been the

[1] *American Journal of Botany,* 16: 862.

purpose of others who have used it. However, difficulty soon arose in the application of water culture data to soil problems and in time the method became more and more a feature of plant physiology rather than that of soil science.

Plant physiology used water culture as a means for study of plant processes and, as a consequence of the technique found necessary for such studies, data showing the great productive potentiality of liquid culture media were not obtained. The fact that water culture has been known to plant physiology so long, and has not heretofore been applied in a practical way, created the necessity for a name to be given the new development. The name also would draw distinction between two uses of water culture—the strictly scientific and the economic.

Because the term "aquiculture," as used by the author in the first announcement, had previously been used in other connections, being the designation given to the culture of aquatic plants and marine animals, it becomes necessary to select a new word. "Hydroponics," which was suggested by Dr. W. A. Setchell, of the University of California, appears to convey the desired meaning better than any of a number of words considered. Hydroponics has analogy in geoponics—the Greek term by which agriculture was known for several centuries in the middle ages; this word appears to have been in common use before the latinized term "agriculture" obtained universal standing. Furthermore, "hydroponics" (*hydro*, water, and *ponos*, labor) has a strong economic and utilitarian connotation; therefore it is desirable in view of the historic use of water culture in plant physiology. The word has not been used heretofore in a scientific sense, and hence there can be no objection as to prior usage.

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TRANSMISSION OF THE VIRUS OF EQUINE ENCEPHALOMYELITIS BY AEDES TAENIORHYNCHUS

SINCE the initial discovery by the undersigned,[1] in 1933, that the mosquito *Aedes aegypti* is capable of transmitting the virus of equine encephalomyelitis, numerous additional transmission studies have been conducted by different investigators with various other mosquitoes. As a result some five or six additional species have been found capable of transmitting the disease.

During the latter half of the past year transmission experiments were undertaken with *Aedes taeniorhynchus*. These studies have definitely proved the ability of *Aedes taeniorhynchus* to transmit the "Western" type of equine encephalomyelitis from guinea pig to guinea pig.

In one out of a number of positive experiments a single mosquito feeding but once on a guinea pig produced the disease and death of the pig in five days. This was repeated with the same mosquito and another guinea pig, death of this pig from encephalomyelitis occurring in six days.

Transmission tests with *Aedes taeniorhynchus* and the "Eastern" type of virus, in so far as they have gone, have been negative. However, this phase of the study is incomplete and is being pursued further.

Details of the positive transmission experiments with the "Western" type of virus will be published in the near future.

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[1] R. A. Kelser, *Jour. Am. Vet. Med. Asn.*, 35: 5, May, 1933.

VITAMIN C IN PASTEURIZED MILK

SHARP[1] has recently drawn attention to the well-known effect of copper in accelerating the loss of reduced ascorbic acid in milk and has shown that this effect is smaller in milk pasteurized for 10 minutes at 77° C. than in milk pasteurized for 30 minutes at 62°–63° C.

As a result of his observation Sharp concludes that it is commercially feasible to produce copper-free pasteurized milk which will contain as much vitamin C as raw milk of the same age and that the main nutritional objection to pasteurized milk is thereby removed. The second conclusion is open to grave doubt for two reasons. First, cow's milk can not be regarded as an important source of vitamin C on account of low concentration of the vitamin in fresh milk and the uncertainty as to its preservation. Milk pasteurized in the most careful manner contains immediately after pasteurization only about 10 to 20 mg of ascorbic acid per liter. King[2] has estimated the daily human requirement at 25 mg for an infant and 40 mg for an adult, and recommends an estimated dietary allowance well above these minima. Thus an infant must take 2½ liters of the most carefully pasteurized milk in order to ensure ingestion of the mere minimum allowance of vitamin C. On the other hand, this quantity of vitamin C is contained in a relatively small volume of fruit juice.

Secondly, there are other milk constituents of which milk is the only source for infants and an important one for adults: and these may be harmed by pasteurization. For instance, pasteurization of cow's milk by the holder method renders its calcium less available for

[1] SCIENCE, 84: 461, 1936.
[2] *Physiological Reviews*, 16: 238, 1936.