the ash is composed to a very considerable extent of lime, in part deposited as incrustations on the surface of the leaves and stems. In the high-ash samples of *Potamogeton* and *Chara* the lime incrustation was especially marked. It is generally recognized that the cereal grains are deficient in calcium, so a high-lime forage should admirably supplement such feeds.

The "Crude Protein." With the exception of the *Chara* sp. the "crude protein" of all samples compares favorably with the "crude protein" content of legume hays. No great species differentiation is seen in the protein content, neither does the "crude protein" content differ markedly between samples of the same species collected from mud-bottom and sand-bottom lakes. It seems probable that the high "crude protein" content is the resultant of an unusually favorable environment. The best top soil of the vicinity washes into the lake, therefore the lake bottom should possess high fertility. In addition the nitrates from the surrounding lands wash into the lake with the drainage water and provide continuous fertilization. Lastly microscopic forms of life and the lake fauna die and decompose and their nitrogen contributes to the fertilization of the plants.

The "Crude Fiber." The crude fiber represents the cellulose and other supporting elements of the plant. In every instance it is lower than the average analyses of the conventional forage crops. The low fiber content is presumably due to the fact that the lake plants do not need supporting structural elements—the buoyancy of the water serving in place of cellulose strands.

The Feeding Value. Literature on the feeding value of water vegetation is apparently extremely meager. *Elodea canadensis* has been reported by both German[5] and Holland[6] workers to be an excellent food for cattle and swine, being fed either green or as ensilage. Apparently no other forms have been studied. There is, however, no *a priori* reason to suspect that many of the types of lake vegetation will not serve as suitable feeding stuffs. The analyses appear to indicate that they may be superior to much of the forage which is now used on farms in the Great Plains area.

Representative bulk samples have been collected, and their feeding value, including palatability, vitamin content, digestibility, protein quality, nitrogenous constituents, types of carbohydrate present, etc., will be studied in these laboratories during the coming winter. If the drought conditions should continue through another year the lakes of the glaciated region may provide the necessary forage.

In any event, the uniformly high "crude protein" content of lake vegetation suggests the possibility of growing suitable non-leguminous plants in our shallow lakes and preparing therefrom what is essentially a "concentrate" for animal feeding. The high-protein, high-lime, low-fiber meal may well become an article of commerce.

It is generally recognized in the thickly populated areas of Asia that "an acre of water will produce more human food than an acre of land." Aquiculture, in suitable areas, may well become a part of our changing agriculture.

ADDENDUM

Since writing the above the analyses of certain aquatic plants by H. J. Harper and H. A. Daniel (*Bot. Gaz.*, 96: 186 (1934)) has appeared. These authors note that aquatic plants are likely to have a higher nitrogen content than upland vegetation but make no suggestions of the possibility of using aquatic plants as a source of forage.

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[5] F. R. Ferle, *Fühlings. Landw. Ztg.*, 53: 549–58, 1904.
[6] Anon., *Bull. Agr. Intelligence*, 9: 1079–80, 1918; *Jour. Board Agr.* (London), 26: 321–2, 1919.

THE STRUCTURE OF THE CARDIAC AGLUCONES

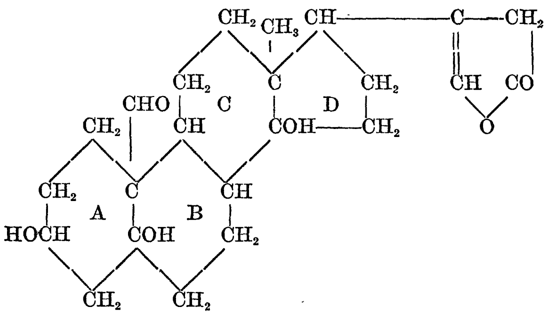
IN our recent preliminary note in SCIENCE[1] we have described the degradation of digitoxigenin to an acid, $C_{20}H_{32}O_2$, which corresponded in properties with aetiocholanic acid obtained by Wieland, Schlichting and Jacobi[2] by the degradation of cholic acid. Through the generous cooperation of Professor Wieland we have been able to make direct comparisons of the melting points of our ethyl and methyl ester with the esters of aetiocholanic acid prepared by the German workers. This comparison as well as mixed melting points has shown their identities. At the end of our previous note we briefly mentioned that "should the identity of these substances be verified, the conclusions are obvious which can be drawn in regard to the structure of the cardiac aglucones." Shortly after our note appeared, the current number of *Angewandte Chemie* reached us, which contains a preliminary article by R. Tschesche[3] on the similar degradation of another cardiac aglucone, uzarigenin. The appearance of the latter requires that we be more explicit in regard to the conclusions which can be drawn from our work.

Tschesche has succeeded in degrading uzarigenin likewise to an acid, $C_{20}H_{32}O_2$, which, however, did not prove to be aetiocholanic acid but appeared from the melting points of the acid and its ester to be identical with aetioallocholanic acid obtained by degradation of hyodeoxycholic acid. These results simul-

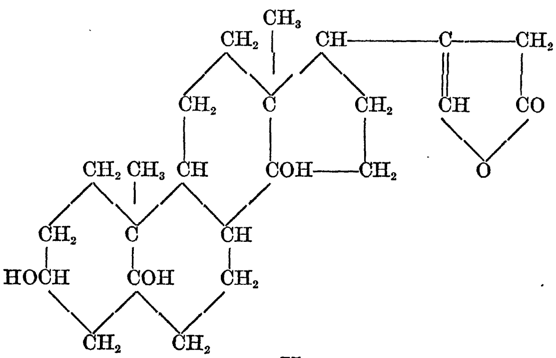
[1] W. A. Jacobs and R. C. Elderfield, SCIENCE, 80: 434, 1934.
[2] *Zeits. physiol. Chem.*, 161: 102, 1926.
[3] *Angewandte Chem.*, 47: 729, 1934.

taneously secured in both laboratories thus complement each other and bring confirmation in regard to the identities of the degradation acids obtained from digitoxigenin and uzarigenin. These observations furnish for the first time conclusive evidence that the cardiac aglucones possess the sterol ring system, a fact already strongly indicated by the production of methyl cyclopentanophenanthrene by selenium dehydrogenation. At the same time it is conclusively shown that the unsaturated side chain of these aglucones is a fragment of the sterol side chain on carbon atom 17.

According to the structure of the sterols now generally accepted, this will require a revision of the partial formulas of strophanthidin and related aglucones which we had tentatively adopted. This structure now requires that the aldehyde group of strophanthidin is situated on a quaternary carbon atom. If this be accepted, the only satisfactory arrangement of the hydroxyl groups in accordance with the interrelationships established by the long investigations of our laboratory requires a formula as given in I for strophanthidin.[4] The formulas of periplogenin, digitoxigenin and gitoxigenin in consequence must be as in II, III and IV. Certain unpublished results add support to this view. Such formulas are now also proposed by Tschesche in the above-mentioned article.

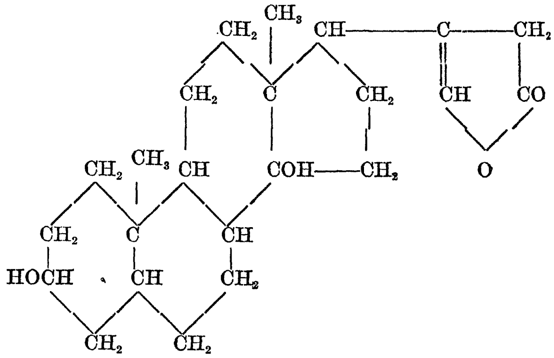


I

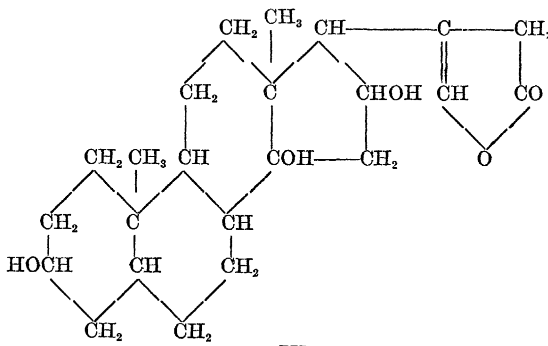


II

[4] Such a formula has already been mentioned among other formulas by Kon in a general theoretical discussion (*Jour. Soc. Chem. Indust.*, 53: 593, 1934).



III



IV

However, there are a number of observations which we have made, both published and unpublished, which appeared to be best explained by the arrangement of the aldehyde group of strophanthidin given in our original formula in which this group is not attached directly to a quaternary carbon atom but to a CH group. Some means of conciliating these observations with the requirements of the new formula will now have to be found.

A complete discussion of these points as well as the presentation of still unpublished work will be left to forthcoming papers in the *Journal of Biological Chemistry*.

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BOOKS RECEIVED

HITCHCOCK, DAVID I. *Physical Chemistry for Students of Biology and Medicine.* Second edition. Pp. xi + 214. 28 figures. Charles C Thomas. $2.75.

SMILEY, DEAN F. and ADRIAN G. GOULD. *A College Textbook of Hygiene.* Revised edition. Pp. xvii + 383. 90 figures. Macmillan. $2.00.

VERDOORN, FR. *Annales Bryologici.* Pp. viii + 231. 31 figures. Martinus Nijhoff, The Hague. Gld. 6.