unquestionable. There is also some basis for questioning the related belief (*2*) that *P. setiferus* normally dies after only one or two spawnings, and without surviving a second winter; since the gray shrimp, like the brown, continues to molt after beginning to spawn; and since a large proportion of adult females, including many nearly ready to spawn again, already show traces of previous spawning in early spring.

King's suggestion (*2*) that nature has failed to make "proper provision for the egress" of the eggs of *P. setiferus*, evidently results from failure to detect ripe eggs left behind in the spawned ovary except when retention was abnormally great. Normally, there is only a sparse scattering of leftover ripe eggs (*1*). For example, among a sample of 67 unripe and ripening hard-shelled North Carolina May adults, most or all of which had spawned previously, such eggs could be detected in 26 by teasing 0.1 ml ovarian samples. The average number of leftover eggs per positive sample was less than two, and the maximum ten.

Remains of spermatophores attached to female gray shrimp offer a second clue to previous spawning. These remains are of two distinguishable types: glutinous remnants grading up to large fragments, and found only in some of the very ripe, which are evidently from recent spermatophores accidentally torn away before spawning; hard traces, never conspicuous, and least frequently detectable in ripe individuals, which are evidently left after normal spermatophore dissolution at spawning. In a sample of 99 unripe and ripening hard-shelled females from the same catch as and including the 67 examined for leftover eggs, 82 bore recognizable spermatophore traces. Since those lacking spermatophore traces bore leftover eggs in about the same percentage as did the whole sample, and vice versa, it appears that even among those not displaying either indicator, most or all had spawned before.

Among very ripe females of the same catch, minute spermatophore traces were detectable in 15 of 31 closely examined. The catch (trawled near shore at Cape Fear in late May, 1949, by Mr. Carter Broad of the Institute of Fisheries Research) included a total of some 130 very ripe, 160 ripening, and 120 unripe adult females. None of this particular catch seemed newly mated or newly spawned. Seven, all unripe, were soft-shelled; of which three had leftover eggs.

It will be seen that the previously misinterpreted distribution of spermatophore traces among female gray shrimp from deepwater catches off Louisiana in March (*1*) suggests the presence of survivors of the preceding season's spawning.

Xiphopeneus kroyeri (Heller), sometimes abundant in Louisiana and a prominent commercial shrimp of Brazil, has not been previously reported from North Carolina. Three ripe females of this species occurred with the catch from Cape Fear, just mentioned.

References

1. Burkenroad, M. D. *Bull. Bingham Oc. Coll.*, 1939, **6**, 4.
2. King, J. E. *Biol. Bull. Woods Hole*, 1948, **3**, 94.
3. Pearson, J. C. *Bull. U. S. Bur. Fish*, 1939, 30.
4. *Rept. Director U. S. Fish Wildlife Serv.*, 1941.

Periodate Oxidation in the Study of the Structure of Dextrans

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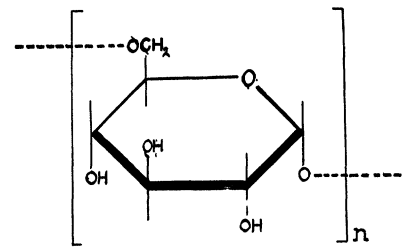
It was predicted by Brown *et al.* (*1*) that pyranoid 1–6 polyglucosans (dextrans) should behave in a distinctive manner toward periodate ion by means of which dextrans may be distinguished from other polysaccharides. Oxidation with potassium *m*-periodate cannot be utilized for the determination of the mean chain length since each 1: 6-glucopyranose residue undergoes oxidation with the liberation of 1 mole of formic acid by virtue of the fact that each such residue possesses hydroxyl groups on three contiguous carbon atoms. Thus, a "straight chain" 1: 6-polyglucose, provided that all the units are pyranose, will behave in a manner analogous to a methyl glucopyranoside as far as the production of formic acid is concerned. It follows that the equivalent weight of such a dextran, i.e., the weight of material yielding 1 mole of acid, will be numerically equal to the equivalent weight of a single glucose residue, viz., 162.



However, any 1–6 glucose residue which is triply linked and thus constitutes a point of branching in the molecule, will not yield formic acid no matter whether the side chain be attached at C_2, C_3, or C_4. (This will also be true for any furanose units or residues linked other than 1: 6-). The presence of numbers of such points of branching will be manifest in an experimental value for the equivalent of a dextran greater than the calculated value. From the difference in these two values it should be possible to determine the ratio of branched residues to straight residues.

A detailed study of the periodate oxidation technique has been carried out by Pacsu *et al.* (*5*) in which the limits of accuracy for the determination of formic acid in the presence of comparatively large amounts of reducing substances have been defined, the best results being obtained by titrating potentiometrically to a given pH. In the case of the dextrans, the total amount of formic acid liberated is considerable (cf. oxidation of starch) and it is not until the end point is reached that interference from other products of oxidation becomes significant; notwithstanding this, the total amount of acid can be determined with considerable accuracy.

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A series of studies were made upon the rate of oxidation, simultaneously and under identical conditions, of α-methyl glucoside, β-methyl gentiobioside, *Leuconostoc mesenteroides* dextran (*7*) and *Leuconostoc dextranicum* dextran (*6*). In all cases the rate of reaction was almost identical and the equivalent for the first two substances agreed closely with the calculated value. *L. mesenteroides* dextran was found to have an equivalent of 204, i.e., 1.25 × theory. Thus from 5 glucose units only four yield formic acid or, in other words, 1 unit in five is engaged in side branching. This evidence indicates a structure:

$$G^1 - {}^6G^1 - {}^6G^1 - {}^6G^1 - {}^6G^1 - \\ {}^4| \qquad \text{(I)}$$

[G represents a glucopyranose unit and the superscripts, the points of attachment] proposed by Fowler *et al.* (*4*) on the basis of methylation studies, by which it was shown that the molecule consists entirely of glucopyranose units. The following partly methylated sugars were isolated: 2 : 3 dimethyl methyl glucoside, (one part 22.6%), 2 : 3 : 4 : trimethyl methyl glucoside (three parts 57.9%) and 2 : 3 : 4 : 6 : tetramethyl methyl glucoside (one part 19.6%).

On the constitution of the dextran from *L. dextranicum*, there has been some divergence of opinion (*2, 3, 6*) concerning the significance of the amounts of tetramethyl and dimethyl methyl glucosides obtained from the hydrolyzed methylated polysaccharide. Evans and Hibbert (*2*) suggested that the quantity of dimethyl sugar was excessive, due to incomplete methylation of the material. Fairhead, Hunter, and Hibbert (*3*) identified in their hydrolyzate, 2 : 3 : 4 : trimethyl methyl glucoside (four parts, 90%), and a dimethyl methyl glucoside (one part, about 10%). Peat, Schlücterer and Stacey (*6*) detected 0.23% of 2 : 3 : 4 : 6 : tetramethyl methyl glucoside in their material in addition to 2 : 3 : 4 : trimethyl methyl glucoside (four parts, 90%) and 2 : 3 : dimethyl methyl glucoside (one part, about 10%).

By periodate exidation, the equivalent of this dextran was 187, i.e., 1.15 × the theoretical value. This would indicate that at least one glucose residue in eight is engaged in branched chain formation, and this is in accord with the structure II proposed from the methylation data.

$$G^6 - {}^1G^6 - {}^1G^6 - {}^1G^6 - {}^1G^6 - {}^1G^6 - {}^1G^6 - {}^1G \\ {}^4| \qquad \text{(II)}$$

References

1. Brown, F. *et al.* *Nature*, Lond., 1945, **156**, 785 and *J. chem. Soc.*, 1947, 1427.
2. Evans, T. H. and Hibbert, H. *Advanced carbohydrate chemistry*. New York: Academic Press, 1946. Vol. III, p. 203.
3. Fairhead, E. C., Hunter, M. J., and Hibbert, H. *Can. J. Res.*, 1938, **B16**, 151.
4. Fowler, L. F. *et al.* *Can. J. Res.*, 1937, **B15**, 486.
5. Pacsu, E. Private communication.
6. Peat, S., Schlücterer, E., and Stacey, M. *J. chem. Soc.*, 1939, 581.
7. Stacey, M. and Swift, G. *J. chem. Soc.*, 1948, 1555.

The Potentiating Effect of Glucose and Its Metabolic Products on Barbiturate Anesthesia

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In July 1944, we studied shock from hemorrhage, using a large number of dogs, most of them anesthetized with pentobarbital sodium (nembutal) given intravenously early in the morning. The dogs were then bled and various procedures carried out on them during the day. Most of these dogs recovered slowly from the anesthetic in the evening. On one occasion, when we were about to inject glucose (10 ml of a solution of 50 g glucose dissolved in 100 ml of water) intravenously, the dog suddenly came out of anesthesia. The animal responded normally when spoken to and tried violently to get off the table. It was with difficulty that the intravenous injection of glucose was made. Instantly the dog relaxed, going into deep sleep and complete anesthesia exactly as after an injection of a barbiturate. The result was so striking that when the dog again recovered suddenly, an hour later, a fresh glucose solution was injected. This produced the same effect, that is, immediate sleep and anesthesia which, however, lasted only 45 min. The dog then went through this cycle of sudden awakening and then immediate sleep and anesthesia after an injection of glucose. The duration of sleep after each glucose injection was 1 hr, 45 min, 30 min, 20 min, 10 min, and 5 min, respectively. Then further injection of glucose produced no sleep, the dog remaining awake and, if anything, hyperexcitable.

In several dogs similar results were seen, but others treated in the same way recovered slowly from the anesthetic and did not go to sleep again after glucose was injected.

This observation was reported to the Office of Scientific Research and Development Committee on Shock, but the work they had been supporting was discontinued and considerable time passed before it was taken up again.

At first we associated this phenomenon with shock, or the extremely high temperatures which occurred in our dogs at this time, when the temperature of our laboratory was well over 100° F. Later, in studying approximately 100 dogs, shock and artificially produced high temperature were eliminated as factors producing the reaction, and it was found that a small percentage of normal dogs given pentobarbital sodium or hexobarbital soluble (evipal) reacted to the subsequent intravenous injection of glucose on awakening, as our shocked dogs did. An occasional dog reacted as strikingly as our first dog. Others reacted little or not at all to the injection of glucose. Because we were unable to reproduce this reaction at will, its study was greatly hindered.

[1] Funds for carrying on this work were kindly supplied by the Mallinckrodt Chemical Works.