This material (pepsinogen or propepsin), which can be converted into pepsin, has been isolated in crystalline form. It is a colorless protein crystallizing in very fine needles from slightly more than 0.4 saturated ammonium sulfate solution at pH 5.2–5.6. Starting with five independent lots of swine gastric mucosae, crystals have been obtained in each instance, and in one case recrystallization was fractionally repeated three times. The optical rotation and specific proteolytic activity[2] were the same for all crystalline preparations.

Pepsinogen does not clot milk at pH 5.0 nor liquefy gelatin at pH 4.7, although pepsin has marked activity under these conditions.

Pepsin prepared by the acidification of pepsinogen has been crystallized twice and its crystalline form is indistinguishable by inspection from pepsin crystallized from commercial pepsin by the method of Northrop.[3] The optical rotation and specific proteolytic activity[2] are nearly the same for the two pepsin preparations.

The conversion of pepsinogen into pepsin at pH 4.6 is an autocatalytic reaction similar to the previously described autocatalytic conversion of trypsinogen into trypsin.[4] Since the conversion is caused by the active enzyme and since no linkage but peptide linkages are known to be split by pepsin, it seems probable that the change involves the rupture of a peptide linkage, although little if any non-protein nitrogen is liberated during the conversion.

The procedure used in crystallizing pepsinogen may be summarized as follows:

(1) Minced swine fundus mucosae extracted with 0.45 saturated ammonium sulfate in M/10 sodium bicarbonate; filtered after the addition of 10 per cent. Filter Cel and 5 per cent. Hyflow Super Cel.[5]

(2) Pepsinogen precipitated from 0.7 saturated ammonium sulfate.

(3) Pepsinogen adsorbed from solution at pH 6.0 by cupric hydroxide suspension and eluted in M/10 pH 6.8 phosphate.

(4) Treatment with cupric hydroxide repeated.

(5) Soluble carbohydrate remaining removed by treatment with Filter Cel at pH 7.0.

(6) Pepsinogen crystallized in fine needles over night at 10° C., 0.4–0.45 saturated ammonium sulfate and pH 5.2–5.6 (orange red to methyl red).

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[2] By "specific proteolytic activity" is meant the activity per milligram of protein nitrogen. The activities were determined by the hemoglobin method.

[3] J. H. Northrop, *Jour. Gen. Physiol.*, 13: 739, 1930.

[4] M. Kunitz and J. H. Northrop, SCIENCE, 80: 505, 1934.

[5] Johns-Manville products.

SELENIUM AND DUCK SICKNESS

SELENIUM in varying concentrations has been known to exist for some time in certain marginal and submarginal areas. It has been found not only in the soil of these areas but also in the vegetation in varying quantities from mere traces to high concentrations.[1] Occurring in grains and grasses in some localities, it has been believed to be a source of chronic and acute disease (formerly known as "alkali disease") among live stock.

Because of the marked similarity of the effects of toxic grains known to contain selenium on experimental animals, as studied by Franke and colleagues,[2] and others,[3] which show symptoms very closely related to those of duck sickness, it is possible to consider selenium as a cause of duck sickness. In general, the range of duck sickness has been confined to regions of alkaline waters of western United States and Canada which are characterized by marshes, mud-flat areas and overflowed lands.[4] Greatest concentrations of selenium have occurred during dry years and in areas identical with those in which great numbers of migratory waterfowl have perished.

Although the evidence for botulinum poisoning as the causative factor[4] is considered valid, it seems desirable in the light of recent work to thoroughly investigate the possibility of another cause, namely, selenium and salts of related metals. Experiments in which tame and decoy ducks were used show that sodium selenite added to drinking water in concentrations of 50 p.p.m. and above, produce lethal results in about ten to twelve hours, depending upon the amount of water consumed. When 20 p.p.m. sodium selenite were added, death usually followed within fifteen to twenty-four hours. Delayed and less severe symptoms resulted when lower concentrations of the toxic element were added to the water.

It is noteworthy that a definite parallelism may exist between selenium poisoning and the syndrome of duck sickness. A difficulty in respiration was first noticed. This was followed by weakness in the legs as a state of unbalance became apparent. The birds showed difficulty in holding their wings in position and, while resting, would support their heads and necks over their backs with bills resting on their breasts. Watery discharges flowed from the eyes and nostrils and in some cases formed encrustations which partly closed the external openings. A characteristic, green, fluid diarrhea was present in all cases. Subnormal body temperatures (100 degrees F.), followed by rapid drop as low as 96 degrees F. just before

[1] H. G. Byers and H. G. Knight, *Ind. and Eng. Chem.*, 27: 902, 1935.

[2] U. S. D. A., Circular 320, August, 1934.

[3] O. A. Beath, J. H. Draize, H. F. Eppson, C. S. Gilbert, and O. C. McCreary, *Jour. Amer. Pharm. Assoc.*, 23: 94, 1934.

[4] U. S. D. A. Bull. 411, May, 1934.

death, accompanied the sickness. The last stage was characterized by complete prostration, in which the neck and head were stretched out flat on the floor of the cage. Post-mortem examinations revealed slight congestion of blood vessels of the small intestine and in some cases an indication of a hemorrhagic condition of the cerebellum.

These experiments show that low concentrations of selenium produce poisoning in ducks in which the syndrome is identical with that produced by *Clostridium botulinum* type C.[4] This would indicate that selenium may be a contributing factor in duck sickness. Further experimental work is in progress and a more detailed paper will appear at a later date.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

OPTICAL DESIGNS FOR OBSERVING OBJECTS IN CENTRIFUGAL FIELDS OF FORCE

HARVEY[1] has described an optical design of a microscope centrifuge employed in investigating the effects of high centrifugal forces on small organisms. The general design, which makes use of two mirrors mounted on the rotor, is applicable to the study of other materials under like conditions. When it is desirable to view the effects from a direction parallel to the axis of rotation and when in addition it is necessary to observe elements of the object more widely separated in that direction than at right angles thereto, the Harvey arrangement is ideal.

Another simpler design employing only one mirror has been found to give greatly improved optical definition when these elements are least widely separated in a direction parallel to the axis. In Fig. 1a, for example, the disk-shaped object O has a diameter large in comparison with its thickness along AB, parallel to the axis of rotation RP. B is a small plane mirror mounted on the rotor. (The same applies to the other figures.) Light from a straight filament lamp is focused upon O so that the image of the filament lies along CD and consequently transverse to the direction of the motion of the object thus illuminated. As O then revolves about RP, it becomes visible to the naked eye or in a microscope only as it passes through the indicated position. Consequently, as viewed from E the virtual image O′ will appear stationary and under apparently continuous illumination when the speed is high enough to prevent flicker. As the light beam passing through O is made wider, the optical definition becomes poorer. Further consideration will show that "perfect" definition is obtained only for points along the line CD in the design described, and only for one point at a time along the line AB in the Harvey design. The reason is that, in the respective designs, these two lines are the only ones whose virtual images in the field of view lie coincident with the axis of rotation.

Fig. 1b illustrates another method that may be used to observe in a radial direction the real image of the filament being vertical here. Furthermore, it will be noticed that B can be placed at any position along RP as long as it is so tilted that the image O′ will lie

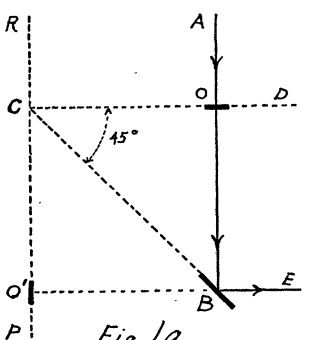

Fig. 1a

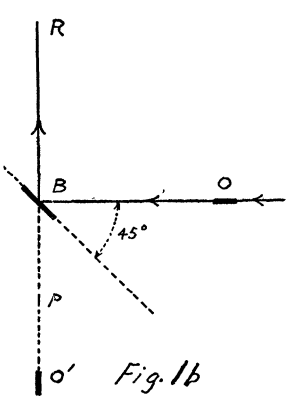

Fig. 1b

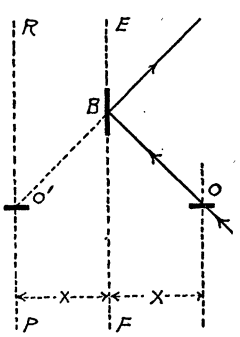

Fig. 1c

somewhere along RP. Fig. 1c shows an arrangement for viewing the object obliquely. In fact, the mirror may be placed anywhere in the plane perpendicular to the plane of the figure intersecting it in EF. In general, there are an infinite number of possible positions for the mirror, the only necessary condition

[1] J. Frank Harvey, *Journal of the Franklin Institute*, 214: 1, 1932.