specifically important features, for use in the departments of vertebrate zoology, entomology, mollusks, botany and geology and mineralogy. The entomological unit is the one with which we are now concerned.

The first point the entomologists faced was to design a case using the same type of glass-top wooden box, size $17\frac{1}{2} \times 13 \times 2\frac{1}{2}$ inches, which we had adopted as the standard box unit a number of years ago, and in which we had an investment of many thousands of dollars. These had been used in Skinner cabinets, and it was our intention to transfer them *in toto* to new cases.

The case as perfected is built of standard automobile body sheet steel, bent over templates and lap-welded, with outside dimensions of $77\frac{5}{8}$ inches high, 40 inches wide and 14 1/16 inches deep, with double hinged doors opening outward, locking into a central division and at top and bottom by bar locks operated by a T handle on each door. The central division is carried the full depth and height of the case, stiffening it and providing on each side its complement of slide shoulders, which with those on the sides of the case itself provide spaced sections for 48 of the standard boxes, 24 on each side. The doors close on felted surfaces, thus providing with the very tight-fitting box lids double protection against insect pests and dust. These felt strips can be poisoned, if it is thought necessary. The finish of the units, both inside and out, is enamel of the desired color, baked on.

A number of these cases are now in constant service at the Academy and have been found satisfactory in every way. In cost they are quite moderate, considering their sturdiness, efficiency, relatively light weight and ease of operation. They possess all the advantages of the old type wooden cabinet, lack the ponderosity of one of the steel cases now in use in some institutions and have numerous advantages when compared with another smaller unit similarly in institutional use elsewhere. Boxes can not stick or jam in the runways, as they are not in contact; guides or boxes can not swell or stick, as the boxes rest on top of a smoothly enamelled metal shoulder and do not quite touch the one above. Pulls are not necessary on the individual boxes, as ample finger space is provided both above and below each.

The cases now in use at the Academy have been furnished by the Peerless Steel Equipment Company, of Philadelphia, which also supplies our other storage steel cases, as well as steel exhibition cases of unique mechanical construction, designed by members of our staff.

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# SPECIAL ARTICLES

## OBSERVATIONS ON ADRENALECTOMIZED, DEPANCREATIZED CATS

OUR attention has just been drawn to a paper by Barnes, Scott, Ferrill and Rogoff in the Proceedings of the Society for Experimental Biology and Medicine (February, 1934). These authors report that if unilateral adrenalectomy is performed in dogs prior to total pancreatectomy, the course of the ensuing diabetes is very mild and comparable to that observed in hypophysectomized, depancreatized animals. Furthermore, unilateral adrenalectomy after total pancreatectomy led in one dog to a reduction to half of the insulin dosage required, while another animal showed only a mild glycosuria with no insulin.

In view of the interest of these results we wish to report our own experiences with cats in which both adrenals and all the pancreas have been removed in stages.

In four cats one adrenal and four fifths of the pancreas were removed at preliminary operations; the remaining portion of the pancreas was grafted under the skin of the abdomen. When the wound was healed and the animal in good health the second adrenal and the pancreatic graft were removed. Administration of liberal doses of a commercial cortical extract were immediately instituted, but at no time was any insulin given. These animals lived 11, 7 and 5 days, while the fourth animal was killed on the seventh day while in good health for liver glycogen determination (2.5 g per cent.).

In another animal (Cat 5) the pancreatic graft became infected. When this was healed it was discovered that the animal was diabetic (fasting blood sugar 180 mgms per cent.). Removal of the graft and the remaining adrenal was carried out as before and the animal lived 11 days.

The behavior of all these animals after the second operation has been identical. They all ate well and did not resemble ordinary depancreatized cats in their clinical course. They died suddenly with convulsions, but for several days before death showed such marked hypoglycemic symptoms that in several instances they had to be resuscitated with glucose. The loss of weight was only moderate and not to be compared with that usually observed in depancreatized animals not treated with insulin.

The most striking findings have been: (a) The fasting blood sugar level. In Cat 1 (lived 11 days) it ranged from 32 to 105 mgms per cent. In Cat 2 (lived 7 days) from 17 to 368 mgms per cent. As well as exhibiting these marked oscillations in blood sugar this animal was resuscitated three times from hypoglycemic convulsions by the administration of glucose. In Cat 3 (lived 5 days) the successive fasting blood sugars were 139, 205, 76, 108 and 190 mgms per cent. In the cat that was sacrificed on the seventh day they ranged from 15 to 180 mgms per cent. (b) The daily glycosuria in all these animals was of a mild nature. The maximum observed in any of them was 4.0 g in one day, while on many days it was completely absent or very slight (0.5 g). When glycosuria was present the $\frac{D}{N}$ ratios were never those of diabetes. Thus with Cat 3, which on one day ingested 20 g pancreas and 134 g of liver and was given 2.5 g of glucose intraperitoneally, the glycosuria was only 0.5 g, which gave a $\frac{D}{N}$ ratio of 0.3. Furthermore, all our animals were in positive nitrogen balance. (c) The administration of glucose gave variable results. In Cat 1, 6 g of glucose by stomach tube led to the excretion of only 0.2 g. In Cat 3, 2.5 g given intraperitoneally caused no glycosuria. On the other hand, intravenous injection of glucose at a rate that normally does not produce glycosuria caused heavy glycosuria in one of the animals (Cat 4). Cat 5 is of especial interest. This is the animal that was diabetic at the time of the second operation. The observations on this cat are recorded in Table I.

We have also made observations on seven cats in which one adrenal was left intact, and the whole pancreas was removed at one operation or in stages. Three of these cats were not treated with insulin after the removal of the graft and died of typical diabetes in 5, 3 and 2 days. The last animal had a severe peritonitis.

The other four were balanced with insulin before the adrenal was removed. In three of these the unilateral adrenalectomy did not reduce the insulin requirement. In the fourth cat all the pancreas and one adrenal were removed at one operation. This animal repeatedly went into shock after two or three units of insulin in spite of the fact that food was given at the time of the injection. To date we have no definite impression that in the cat unilateral adrenalectomy consistently prevents or alleviates the course of pancreatic diabetes. On the other hand, in all our animals complete adrenalectomy has produced a marked amelioration of the usual results of complete pancreatectomy, and this has been observed whether the diabetes had already developed or not.

TABLE I

Cat 5

January 12. Partial pancreatectomy with graft and left adrenalectomy.
January 26. Infection in graft drained.
February 3. Fasting blood sugar 180 mgms per cent.
February 5. Pancreatic graft and right adrenal removed. Weight 2,450 g.

| Date | Weight (g) | Carbohydrate from food (g) | Glucose excreted (g) | Blood sugar (mgms per cent.) a.c. | p.c. | |
|---|---|---|---|---|---|---|
| Feb. 6 | 2400 | 2.6 | 2.4 | 362 | — | |
| " 7 | 2330 | 7.2 | 1.5 | 282 | — | |
| " 8 | 2330 | 7.8 | 0.7 | 176 | — | 3.8 g glucose intraperitoneally |
| " 9 | 2500 | 13.5 | 4.0 | — | 80 | 2.5 g glucose by tube |
| " 10 | 2510 | 4.7 | 1.1 | — | 140 | 2.5 g glucose by tube |
| " 11 | 2450 | 9.1 | 0.0 | 106 | — | 5.0 g glucose by tube; 2.0 g glucose intraperitoneally |
| " 12 | 2530 | 24.0 | 3.2 | 37 | — | 3.0 g glucose by tube; 2.5 g glucose intraperitoneally |
| " 13 | 2320 | 10.1 | 1.9 | — | 208 | |
| " 14 | 2180 | 16.3 | 0.3 | 124 | 158 | |
| " 15 | 2200 | 17.2 | 1.4 | 126 | — | |
| " 16 | 2170 | 13.3 | 0.8 | 66 | — | |
| " 17 | Dead—Blood sugar 11 mgms per cent., Urea N 11.5 mgms per cent. | | | | | |

We are not entirely satisfied that the dosage of cortical extract was adequate, although supposedly ample amounts were given. We mention this because the animals in many respects have resembled those suffering from adrenal insufficiency.

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## MICROORGANISMS AND VITAMIN PRODUCTION IN GREEN PLANTS

EARLY in the history of vitamins, investigators on the sources of these essential factors in the food of animals discovered that the animal world has depended upon the plant world for its supply. Even when vitamins were present in animal tissue, they were shown to have originated elsewhere—usually from a vegetable source. But while the sources were investigated and the quantities occurring in plants were determined, while the effects on the body and functions of the animal were observed, and while numerous attempts were made to isolate the vitamins in a pure state, influences which might lead to the formation of these substances received comparatively little attention. Nevertheless, the possible action of microorganisms, both with regard to their capacity to form vitamins themselves and to their effect on the production in green plants, has been recognized.

Even before Drummond and Zilva[1] showed that Vitamin A was concentrated, rather than formed, in the cod's liver, and traced its production through a series of transfers to its ultimate origin in microscopic marine organisms, the suggestion had been made that green plants might not produce the vitamins, but instead might take them up and concentrate them after their formation by bacteria, molds or other microscopic life. A number of investigators have shown that bacteria are able to form vitamins, and Coward[2] in 1925 found that a freshwater alga (Chorella) synthesized vitamin A. Mockeridge[3] suggested that microorganisms liberated "auximones" (growth-promoting substances) from organic matter, which green plants absorbed and which enabled them to form the vitamins.

Recently, Viswa Nath,[4] from experiments in India, has observed that similar plants are markedly different in their content of vitamins (particularly in regard to B, with some indications of the same phenomenon with A), and this difference seemed to depend upon the amount of organic matter available during the growth of the plant. He concluded that bacteria either produced the vitamins from the organic matter and passed them to the plant, or formed some similar substance which plants could use as a stimulant for the vitamin synthesis, although he did not rule out the possibility that plants might form vitamins without these aids. On the other hand, C. H. Hunt[5] in 1927 had checked the vitamin B content of wheats grown on soils for 35 years under varying fertilizer treatments, and had found little difference due to the fertilizers. The quantity of B varied widely from year to year on the same soils, indicating that climate had a decided influence on its formation.

In 1932 Virtanen and v. Hausen in Finnland published a note—"Die Vitaminbildung in Pflanzen."[6] They grew peas under sterile and non-sterile conditions and determined carotin in the plants. No marked difference was found in the quantity formed. An estimation of vitamin C was also made by Tillman's 2.6 dichlorphenolindophenol solution with similar results.

In these laboratories, one of the duckweeds (*Lemna major* or *Spirodela polyrhiza*) has been grown for five years in the absence of microorganisms. These aquatic plants can produce flowers, but usually propagate asexually. They have been grown under sunlight and artificial light, and with or without organic matter.[7] Each frond puts out a new one, which grows to the size of the parent and later separates. The rate of reproduction under uniform conditions, with ample food supply, is logarithmic.

By feeding rats, a comparison was made of the vitamin A content in Lemna produced in a non-sterile mixture of 5 g of soil with 100 cc water, and those grown, free from microorganisms, in a sterile salt solution. The plants were collected each week, air-dried in the dark, and after being finely ground, were included in the basal ration to the extent of 0.5 per cent. dry weight. A third group of rats was fed daily, by hand, a quarter of a gram each of the undried plants from the soil—this provided approximately the same amount of dry matter from the Lemna as that consumed by those eating the dried plants. A fourth group was fed the basal A-free ration as control.

At the time the rats were put on the Lemna additions to the ration they had ceased to increase in weight for several days and had developed marked xerophthalmia. Three of the four controls died before the end of the experiment and the fourth two days later. The xerophthalmia in the group on the dry sterile Lemna cleared up at once and the rats started to gain weight. The average gain for the 24

[1] *Jour. Soc. Chem. Ind.*, 41: 280, 1922.
[2] *Biochem. Jour.*, 19: 240–1, 1925.
[3] *Biochem. Jour.*, 14: 432–50, 1920.
[4] "Some Aspects of Plant Nutrition," Coimbatore, 1932.
[5] *Ohio Agric. Exper. Sta. Bul.*, 415, 1927.
[6] *Naturwissenschaften*, 20: 905, 1932.
[7] Clark, *Jour. Phys. Chem.*, 29: 935–41, 1925.