8. A. M. Chernukh, P. N. Aleksandrov, and O. V. Alekseev, The Microcirculation [in Russian], Moscow (1975).
9. V. A. Shakhlamov, Capillaries [in Russian], Moscow (1971).
10. E. Allara, Arch. Ital. Anat. Embriol., 80, 37 (1975).
11. A. F. Baradi and D. J. Brandis, Z. Zellforsch., 101, 568 (1969).
12. I. B. Buckvalov (I. B. Buchvalow), E. Unger, W. Schulze, et al., Histochemistry, 44, 1 (1975).
13. J. J. Geuse and C. Poort, J. Cell Biol., 57, 159 (1973).
14. F. Joo, Nature (London), 219, 1378 (1968).
15. K. Kurosumi, Int. Rev. Cytol., 11, 1 (1961).
16. V. T. Marchesi and R. J. Barrnett, J. Cell Biol., 17, 547 (1963).
17. M. Wachstein and E. Meisel, Am. J. Clin. Pathol., 27, 13 (1957).
18. T. Zelander, R. Ekholm, and J. Edlung, J. Ultrastruct. Res., 7, 84 (1962).

ULTRASTRUCTURAL ANALYSIS OF THE EFFECT OF ALLOXAN ON REPTILIAN PANCREATIC CELLS

V. V. Yaglov

UDC 612.34.014.2.014.46:547.854.6+616.379-008.64-092.9-02:547.854.6]-091.8

Intraperitoneal injection of alloxan into terrapins Testudo horsfieldi and Clemmys caspica in a dose of 300 mg/kg caused destructive and metabolic changes in cells of both the endocrine and exocrine parts of the pancreas. The granular cytoplasmic reticulum in the acinar cells and the mitochondria in the centroacinar cells underwent focal destruction. Hydropic degeneration developed in the B cells. Deposition of glycogen was found in all cells and nerve fibers and was abundant in the centroacinar and mucoid cells.

KEY WORDS: pancreas; alloxan; morphological and metabolic changes.

Development of the sensitivity of the insular system of the vertebrate pancreas to diabetogenic substances is a problem in comparative endocrinology that has received little study. A previous investigation [1] showed that injection of alloxan into amphibians leads to a series of morphological changes in the pancreas (degranulation, edema of the secretory granules, activation of the lysosomes) not only in the B cells, but also in the acinar and acino-islet cells. The action of alloxan on the reptilian pancreas, however, has been incompletely studied. Most attention has been paid so far to the B cells [4-6].

The object of this investigation was to continue the study of the effect of alloxan on pancreatic structures.

EXPERIMENTAL METHOD

A 3% solution of alloxan was injected intraperitoneally in a dose of 300 mg/kg into the terrapins Testudo horsfieldi and Clemmys caspica. The pancreas was investigated 1, 2, 3, 5, and 7 days after its injection. Pieces of pancreas for electron microscopy were fixed in 3% gluteraldehyde solution and then postfixed in Millonig's mixture at pH 7.4, dehydrated in alcohols of increasing concentration, and embedded in Durcupan. Sections stained by Reynolds' method were examined in the UÉMV-100K electron microscope.

Department of Histology and Embryology, Faculty of Internal Medicine, N. I. Pirogov Second Moscow Medical Institute. (Presented by Academician of the Academy of Medical Sciences of the USSR A. V. Smol'yannikov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 84, No. 8, pp. 245-247, August, 1977. Original article submitted March 3, 1977.

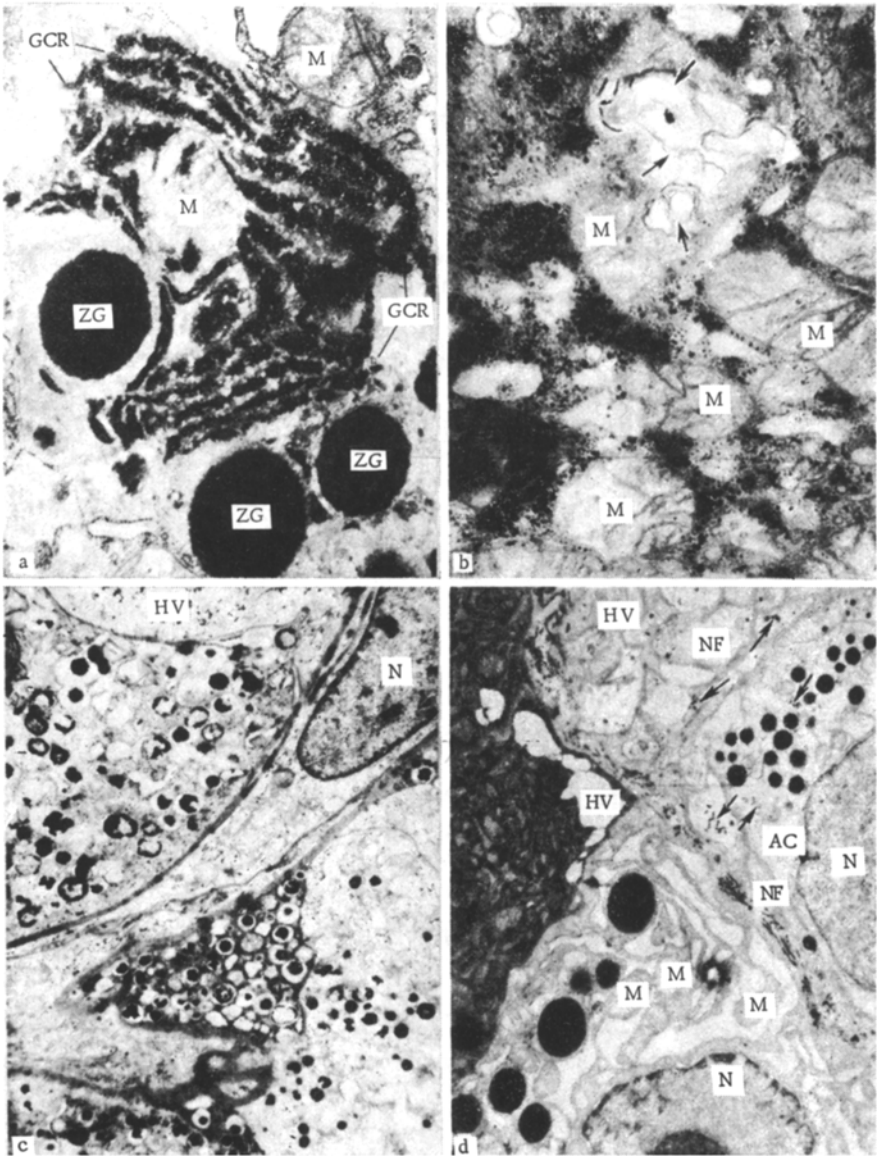

Fig. 1. Ultrastructural changes in pancreatic cells of T. horsfieldi caused by alloxan: a) focal destruction of tubules of cytoplasmic reticulum of an acinar cell (24 h after injection of alloxan; 25,000×); b) myelination of mitochondria (arrow) and marked glycogen infiltration of a centroacinar cell (7 days after injection of alloxan; 40,000×); c) hydropic vacuole and deposition of glycogen in a B cell (7 days after injection of alloxan; 15,000×); d) moderate glycogen deposition (arrows) in cytoplasm of an A cell and neuroplasm of a nerve fiber (7 days after injection of alloxan; 13,000×). GCR) Granular cytoplasmic reticulum; ZG) zymogen granule; M) mitochondrion; HV) hydropic vacuole; AC) A cell; NF) nerve fiber; N) nucleus.

EXPERIMENTAL RESULTS

The pancreas of T. horsfieldi and C. caspica is a compact organ with a lobular structure. Its exocrine part is a complex tubular gland, the terminal portions of which are formed by numerous acinar cells and solitary centroacinar and mucoid cells. The acinar cells have a well developed granular cytoplasmic reticulum and contain comparatively large mitochondria and zymogen granules at different stages of maturity. The mucoid cells differ from the acinar cells in their less well developed cytoplasmic reticulum and their smaller mitochondria and secretory granules. The centroacinar cells have comparatively small mitochondria and poorly developed organelles. The endocrine part of the pancreas is structurally organized in the form of pancreatic islets, consisting of A, B, and D cells. Besides pancreatic islets, bands of A cells or individual cells

are also found in the pancreas. In the periinsular zone acino-islets A and D cells (by the classification of Yaglov and Eletskii, 1975) are frequently found. Details of the ultrastructural organization of the endocrine and acino-islet cells were described previously [2, 3].

Injection of alloxan caused reactive changes in both the exocrine and the endocrine parts of the pancreas. The tubules of the granular cytoplasmic reticulum in the acinar cells were sharply dilated. In some cells local loss of ribosomes in the tubules of the cytoplasmic reticulum as well as their local destruction took place (Fig. 1a). Besides damage to the cytoplasmic reticulum, sometimes pycnosis of the nucleus was observed in the acinar cells, with the appearance of large phagosomes and, less frequently, of glycogen deposits in the cytoplasm. The changes described in the acinar cells were mosaic in character. The morphological changes in the centroacinar and mucoid cells were rather different in character. Death and myelination of some mitochondria and abundant deposition of glycogen in the cytoplasm were observed (Fig. 1b). The most sensitive of the endocrine cells to alloxan were the B cells. At different times of the experiment (1-2 days after injection of alloxan) diffuse pallor of the matrix of the cytoplasm as a result of edema was observed in some B cells, whereas later (after 7 days) only large hydropic vacuoles containing a few clumps of glycogen could be found in the cytoplasm. In this period the intercellular spaces of the B cells were very slightly widened and filled with osmiophilic material of moderate electron density (Fig. 1c). Deposits of glycogen also were found in the A cells, nerve fibers, and their endings (Fig. 1d).

When these data are assessed it must be recalled that writers of all papers published have described changes in the B cells only [4-6]. They showed that these cells responded to injection of alloxan by liberating secretory granules, and in the later stages they developed destructive changes leading to death of the cell. We found, however, that in reptiles not only the B cells but also other pancreatic cells are sensitive to alloxan. However, the changes in these cells varied in character. In the acinar cells destructive changes were found in the protein-synthesizing apparatus (the granular cytoplasmic reticulum). Injury to this structure evidently caused secondary activation of lysosomes with the object of reutilizing the destroyed cell structures. In the centroacinar and mucoid cells there was some damage to the energy system of the cell (mitochondria) and substantial disturbances of carbohydrate metabolism, as shown by the considerable accumulation of glycogen in their cytoplasm. The most pronounced feature in the B cells was hydropic degeneration, whereas the disturbances of carbohydrate metabolism were less severe.

It can thus be concluded from these results that alloxan acts not only on the B cells but also on other structures of the pancreas. Each type of cell is characterized by its own morphologiaal and metabolic changes.

LITERATURE CITED

1. V. V. Yaglov, Probl. Endokrinol., No. 3, 87 (1977).
2. V. V. Yaglov, Arkh. Anat., No. 11, 89 (1976).
3. V. V. Yaglov and Yu. K. Eletskii, Arkh. Anat., No. 12, 20 (1975).
4. P. R. Burton and W. H. Vensel, J. Morphol., 118, 91 (1966).
5. A. Cardeza, Rev. Soc. Argent. Biol., 33, 74 (1957).
6. M. R. Miller and D. H. Wurster, Endocrinology, 58, 114 (1956).