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Normal Histology of Brown Fat of Certain Arkansas Bats

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THE NORMAL HISTOLOGY OF BROWN FAT OF CERTAIN ARKANSAS BATS[1]

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Brown fat, which is found in many species of mammals, has been called the "hibernating gland." It also is known as the interscapular or subscapular gland, multilocular adipose tissue, and lipoid gland. In man, brown fat is present in the embryo, but in the adult it changes into ordinary adipose tissue or is scattered through the common adipose tissue. This tissue is very noticeable in rodents and bats and appears to be especially prominent in those species which undergo long periods of dormancy. The existence of brown fat has been known for many years (Cramer, '20), although it has received relatively little attention until recent years.

The universal occurrence of brown fat in bats (Dalquest and Werner, '51), along with its conspicuous development, suggests that it plays an important role in the periods of dormancy or hibernation that most species of bats undergo. Although the exact function of the interscapular gland is still not certain, there is general agreement that it is a more concentrated source of reserve energy than the common adipose tissue because of its rich store of phospholipids, cholesterol, and glycogen (Lemonde and Timiras, and Selye and Timiras). The relationship of the functional activity of the interscapular gland and the adrenal cortex and thyroid have been pointed out by Lachance and Page, Lemonde and Timiras, and Seifter, Christian and Ehrich.

This study is planned as the groundwork for further studies of the effects of stressor agents on the structure and physiology of the gland, and investigation of possible seasonal changes in the tissue.

MATERIALS AND METHODS

The observations reported here are based on gross examination and histological sections of the interscapular glands of the gray bat *(Myotis grisescens* A. H. Howell), the Indiana bat *(Myotis sodalis* Miller and Allen), the pipistrelle bat *(Pipistrellus subflavus* F. Cuvier), and the lump-nosed bat *(Corynorhinus rafinesquei* [Lesson]). The bats were collected in caves near Fayetteville, Ark., where they were hibernating during the fall of 1951 and the spring of 1952.

The animals were killed by percussion. The interscapular tissue was removed quickly and fixed in Bouin's fluid. The glands subsequently were imbedded in paraffin and sectioned at 10 and 15 micra. All sections were stained with Harris' hematoxylin and counter-stained with eosin. No special fixation or staining for lipoid substances was done.

OBSERVATIONS

Gross Morphology. All interscapular glands collected had the same basic gross structure. All of the glands filled the interscapular fossa and extended posteriorly to the lumbar region (Figure 1). Early dissection indicated that the gland was a single mass of tissue, but when the overlying connective tissue was removed it was seen that the gland consisted of two dorsal interscapular lobes continuous with two lateral or cervical lobes (Figure 1). The cervical lobes extended ventrally around the neck, almost to the base of the ears, where they met the parotid salivary glands. A small encapsulated lymph node was found near the tip of each of the cervical lobes. In freshly killed specimens, the interscapular glands were dark red in color and richly supplied with blood. The shape of the glands apparently depended upon adjacent scapular musculature. The glands were distinctly lobular, as seen grossly (Figure 1). They were not dissected to ascertain the blood and nerve supply. However, it was noted that a large artery entered the ventral side of each interscapular lobe.

Histology. All of the interscapular glands were covered with a fibrous connective tissue capsule which penetrated the gland as septa, dividing it into macro- and micro-lobules (Figure 2). This lobulation is usually characteristic of

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the large tubulo-alveolar glands, such as the salivary glands. This would indicate that perhaps the interscapular gland is an incipient tubulo-aveolar gland.

The connective tissue capsule of the interscapular gland of *Pipistrellus subflavus* was more pronounced than those of the other species. Normal unilocular fat appeared irregularly in the capsule and in the gland.

The white fat cells in the interscapular gland were distinguished easily from gland cells by the typical "signet ring" configuration, containing only one large fat vacuole (Figures 2 and 4). There was a sharp demarcation between the two types of fat, and it was apparent that there was no intergradation between the two types.

The brown fat cells were polygonal. They contained vacuoles of varying size which were occasionally as large or larger than the nucleus (Figure 3). This type of vacuolation usually is considered indicative of lipoidal storage. The intervacuolar cytoplasm was markedly eosinophilic and was filled with granules of varying sizes. The brown fat cells had a delicate cell membrane, with numerous small irregular nuclei on the outside. Presumably, these were reticular cell nuclei. The nuclei of the brown fat cells stained metachromatic and usually were excentrically located. A small nucleolus and fine "powdery" chromatin granules could be seen within the nuclei. Mitotic figures were not seen.

Vascularity was one of the most prominent differences of brown and white fat. Almost without exception, moderately-sized arteries and veins were present in each of the micro-lobules (Figures 2 and 3). Numerous capillary channels next to the gland cells were seen also.

DISCUSSION

The histology and gross structure of the interscapular glands of the bats observed in this study agrees with other reports of different species. No indication of the formation of ducts was observed as was reported by Dalquest and Werner in the interscapular gland of the tropical fruit bat, *Artibeus jamaicensis*. Histologically, the interscapular gland represents a glandular organization comparable with the tubulo-alveolar glands in its vascularity and connective tissue pattern.

Although quantitative data are lacking on the capillary density of brown fat, its blood supply apparently is richer than that of white fat. It has been suggested (Fawcett) that this difference in degree of vascularity is related to a difference in physiological activity. The rich blood supply of the interscapular gland would suggest that it is, perhaps, an endocrine gland. However, recent cytochemical studies (Fawcett) fail to support this suggestion. The vacuolar pattern of the brown fat cells indicates that it is rich in stored lipids. It seems probable that the gland is a concentrated source of energy-rich compounds that enable the animal to survive long periods of fasting. Fawcett believes that some of the dark color of the brown fat is due to phospholipid in the mitochondria and also to compounds produced in the metabolism of the stored fatty acids in the gland.

SUMMARY

The gross and microscopical anatomy of the interscapular gland of several species of bats has been described. The lobulation found in the glands and the blood vascular pattern indicate compound tubular alveolar glands, and suggest that the interscapular gland possibly is an incipient type of compound tubulo-alveolar gland. The vacuolar pattern in the cytoplasm and the numerous cytoplasmic granules indicate lipoid storage.

Fig. 1. The position of the interscapular gland of *Pipistrellus subflavus* F. Cuvier. The superficial connective tissue has been removed to show the gross lobulation. The left hand margin of the gland is slightly pulled away from the scapular masculature (circled).

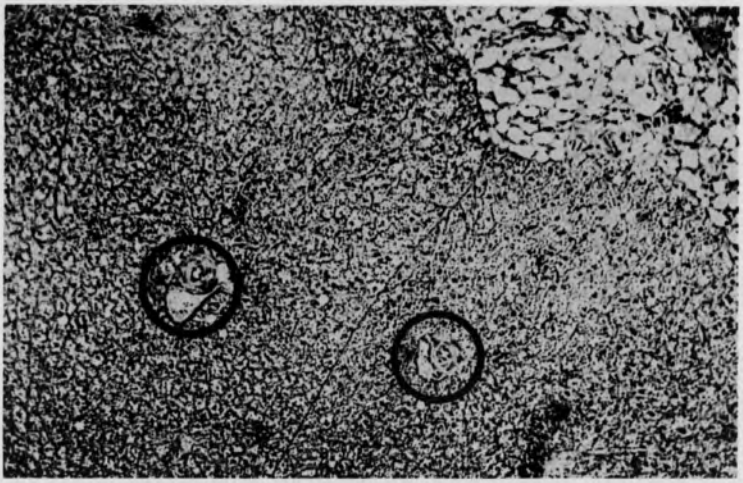

Fig. 2. A cross section of a portion of the interscapular gland of *Myotis grisescens* A. H. Howell. A patch of unilocular fat is visible in the upper right-hand portion of the figure. There is a sharp line of demarcation between the brown fat, below, and the white fat. Also visible are the thin connective tissue septum and the blood vessels to the right (x) and the left (y) of the septum.

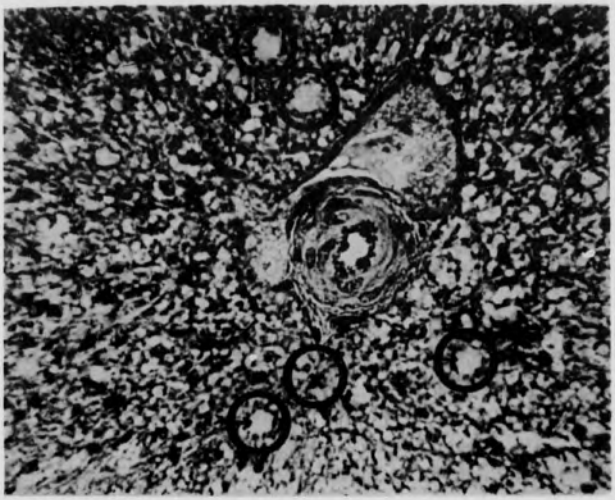

Fig. 3. A high-power photomicrograph of a portion of Figure 2, showing the artery and vein and adjacent brown fat. Visible are the large vacuoles in the cells of the brown fat (circled), and the thin connective tissue septum (x) which extends from the connective tissue sheath surrounding the artery and vein.

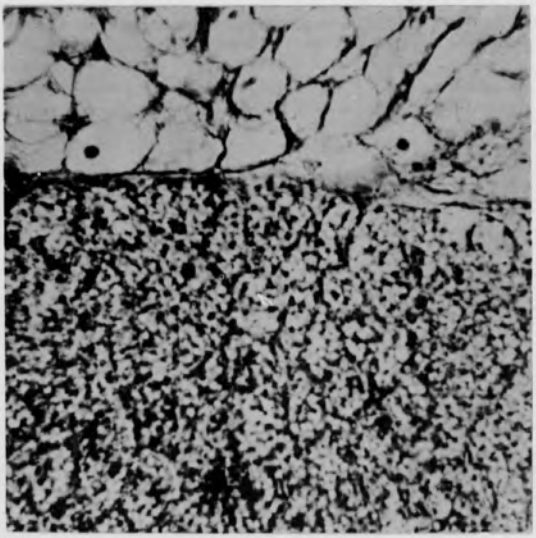

Fig. 4. A high-power photomicrograph of the area of juncture of white fat with brown fat. Visible are the lines between the two types of fat, and the large single vacuole of the white fat above and the many vacuoles of the cells of brown fat below.

REFERENCES

1. Cramer, W. "On Glandular Adipose Tissue, and Its Relation to Other Endocrine Organs and to the Vitamine Problem." *Brit. J. Exp. Path., 1,* pp. 184-196 (1920).
2. Dalquest, W., and Werner, J. "The Interscapular Gland of a Tropical Fruit Bat." *Anat. Rec., 111,* pp. 345-353 (1951).
3. Fawcett, D. W. "A Comparison of the Histological Organization and Cytochemical Reactions of Brown and White Adipose Tissues." *J. Morph., 90,* pp. 363-406 (1952).
4. Lachance, J. P., and Page, E. "Hormonal Factors Influencing Fat Deposition in the Interscapular Brown Adipose Tissue of the White Rat." *Endochrinology, 52,* pp. 57-64 (1953).
5. Lemonde, P., and Timiras, P. S. "Comportement de la Graisse Brune Interscapulaire Chez des Rats Soumis a Divers Agents Nocifs; Effects de l'Ablation de ce Tissu." *Ann. de l'Acfas, 17,* pp. 99-102 (1951).
6. Lemonde, P., and Timiras, P. S. "Extirpation of the Interscapular Brown Fat In Rats and Hamsters." *Rev. Can. Biol., 10,* pp. 222-227.
7. Seifter, J., Christian, J. J., and Ehrich, W. E. "Effect of Cortisone and Other Steroids on the Hibernating Gland of the Pregnant White Rat." *Fed. Proc., 10,* p. 334 (1951).
8. Selye, H., and Timiras, P. S. "On the Participation of 'Brown Fat' Tissues in the Alarm Reaction." *Nature, 164,* p. 745.