INTRODUCTION

Abnormal deposition of fat in organs such as liver and heart under pathological conditions is a well-known phenomenon. Adipose tissue in such cases accumulates enormous quantities of fat, leading to marked obesity. From experimental work on animals, factors such as environmental, genetic, hormonal and psychic, are known to influence the onset of obesity. In muscular dysfunction the adipose tissue is found to encroach upon the muscle fibres and in extreme conditions even replaces them, resulting in the dystrophy of the muscle. In diabetes, however, as opposed to the condition noted in obesity, synthesis and storage of fat is impaired, while oxidation and breakdown are accelerated. Insulin is believed to correct this defect by stimulating the synthesis of fatty acids especially from glucose. Recent *in vitro* studies using surviving adipose tissue slices have shown that insulin markedly accelerates fatty acid synthesis when glucose is present in the medium.

Accumulation of large quantities of fat in the adipose tissue of animals however, is not confined to only pathological conditions. Migratory birds store large amounts of fat in their adipose tissue occurring at many sites in their body, during premigratory period. In locusts also, especially the migratory ones, this appears to be the case. It is also known that most hibernators become enormously fat before entering into the so-called winter sleep. However, the adipose tissue has long been regarded as only a storage form of connective tissue with little or no metabolic activity of its own, and consequently adequate attention was not paid to the study of the physiological activities taking place in this tissue. The histological structure was also studied less extensively than many other

tissues. On account of the growing importance to human life of the problems mentioned earlier, in recent years, more workers have become interested in the study of this tissue and considerable amount of valuable data have come forth. Nevertheless, a proper assessment of the overall metabolic activities and histological structure of the adipose tissue has not been made. The present thesis therefore constitutes a series of investigations on these aspects of the adipose tissue of some vertebrates with special emphasis on that of the pigeon, and for comparison, that of an invertebrate (locust). It should however, be mentioned that the physiology of sustained muscular activity has been the major field of research in our laboratories and it has been shown that fat is the chief fuel in such activity as in flying animals like the birds, bats and insects. So it is only natural that the present work on the adipose tissue has been an attempt to obtain more information regarding this tissue in such animals, indulging in sustained muscular activity such as flight, rather than seeking to make a general study of this tissue in different animals.

It is now more or less an established fact that fat is the chief source of energy in prolonged muscular activity in some birds (George and Jyoti,1957), bats (George and Jyoti,1955), insects (Weis-Fogh,1952) and the heart muscle (Bing,1954). The fat occurring in the muscle alone may not be a sufficient store to supply all the energy that is needed during prolonged exercise. So fat may have to be supplied from extraneous source or sources. Liver can act as one of the suppliers of fat to the muscle. But the adipose tissue could be a better source since it contains larger quantities of fat. In birds this aspect is of especial interest due to the fact that migratory birds are known to accumulate large quantities of fat in

their adipose tissue prior to migration (McGreal and Farner,1956; Odum and Perkinson,1951; Odum and Connell,1956). The synthesis as well as breakdown of such large quantities of fat, mainly in the form of glycerides, requires the enzyme lipase. So my first task was to look for a lipase in this tissue and the enzyme was detected in the adipose tissue of the frog, lizard, pigeon, fowl, rosy pastor, bat and locust by both histochemical and quantitative methods.

In the recent years some authors have, however, expressed doubt as to the occurrence of a 'true lipase' in the adipose tissue. Some are of the opinion that the fat-splitting enzyme present in the adipose tissue is an esterase while according to others it is a lipoprotein lipase. These contentions however, are found to be illfounded and the observations recorded in this thesis strongly indicate beyond any reasonable shadow of doubt, the presence of a 'true lipase' in the adipose tissue.

With the detection of a lipase in the adipose tissue, it was thought desirable to study some of the biochemical properties of the pigeon adipose tissue lipase and compare with that of the pigeon pancreatic lipase. This was done manometrically using the Warburg apparatus.

The in vitro oxygen consumption and oxidation of various metabolites by the adipose tissue of the pigeon was studied according to the Warburg manometric method. In the bat there are two types of adipose tissue, the brown and the yellow. The brown variety of whose function we know very little, is absent in all the other animals studied. The in vitro oxygen consumption of the two varieties of the bat adipose tissue was also studied.

A study of the histological structure of the adipose tissue of the frog, lizard, pigeon and bat and the vascularity of that of the pigeon was conducted. The enzyme alkaline phosphatase was demonstrated histochemically in the adipose tissue of the pigeon, fowl, rosy pastor, bat and locust. Succinic dehydrogenase, lactic dehydrogenase, adenosine triphosphatase, acid phosphatase, phospholipids, cholesterol, neutral fat, sulphydryl groups and water-insoluble aldehydes and ketones in the pigeon and bat adipose tissue were studied. The histochemical method for succinic dehydrogenase was extended to few other dehydrogenases and these studied in the pigeon adipose tissue. The histochemical methods for lipase, alkaline phosphatase, adenosine triphosphatase and acid phosphatase were slightly modified and yielded better results.

The results obtained in the present investigations are discussed in the respective chapters and the salient contributions are reviewed under "Some General Considerations" (Chapter 8). These studies have thrown some new light on the structure and physiology of the adipose tissue. However, it should be pointed out that while stressing the significance of the new information, no claims of solving some of the fundamental problems mentioned earlier, are made.

The following preliminary reports have been published in joint authorship with Dr. J.C.George, my guiding teacher.

1. Certain histochemical and physiological observations on the adipose tissue of the pigeon. J.Anim.Morph.Physiol.,5,49,1958.
2. Histochemical demonstration of certain enzymes in the adipose tissue of the fowl (Gallus domesticus) and rosy pastor (Pastor roseus). Ibid.,5,101,1958.

3. Histochemical demonstration of lipase and alkaline phosphatase activity in the fat body of the desert locust. Nature,183,268,1959.

4. Further histochemical observations on the adipose tissue of the pigeon. J.Anim.Morph.Physiol., 6,30,1959.

5. Lipase activity in the brown and yellow adipose tissue of the bat. Nature,184,59,1959.

6. A histological and histochemical study of the brown and yellow adipose tissue of the bat, Hipposideros speoris. Quart.J.micr.Sci.(in press).

7. Lipase activity in the adipose tissue of vertebrates. J.Anim.Morph.Physiol.(in press).

8. Oxygen consumption and oxidation of various metabolites by the pigeon adipose tissue, in vitro. J.Anim.Morph.Physiol.(in press).