INTRODUCTION

It is well known that the muscles of insects differ from those of vertebrates and they also differ considerably among themselves in structure and function. By virtue of the structural peculiarities associated with the functional diversities of the insect skeletal muscles, the flight muscles in the different groups of insects have been chosen as the material for the present study with a view to achieve a clearer unders-tanding of the relationship between structure and function. Skeletal muscles whether of vertebrates or invertebrates, are used for locomotory and other movements and during activity expend considerable amount of energy particularly when prolonged muscular work is involved. Certain histophysiological aspects of some of the most active skeletal muscles of some vertebrates, such as the flight muscles of birds and bats have been done in our laboratories and it has been shown that these muscles which indulge in long and sustained activity, utilize preferably fat as the chief fuel for energy. Recently some fundamental studies on the biochemistry of insect muscle have been made which also indicate a parallel phenomenon in insects. However, in insects where the duration of flight is short, carbohydrate seems to be the chief fuel. But others which sustain themselves on their wings for a considerably longer period, mobilize chiefly fat, though side by side carbohydrate is also present in their muscles, for energy. Some orthopteran

and lepidopteran insects have been recently shown to utilize fat for energy. If that be so, fat has to be broken down into its component fatty acids and glycerol before the fatty acids could enter the metabolic pathway. The hydrolysis of fat is brought about by lipase, a fat-splitting enzyme. The presence of a lipase in the flight muscles birds, bats and a few insects has been shown in our laboratories by earlier workers. The diverse varieties of insects exhibiting structural and physiological diversity in their flight muscles in relation to their mode of activity, undoubtedly warrant more detailed and extensive investigations. The present thesis comprises studies on certain aspects of the problem in an attempt to reveal some of the dark corners which are hitherto little explored.

It has been found that like vertebrate skeletal muscles particularly the flight muscles of the bird, bat and the cardiac muscle, the insect flight muscles too contain a lipase, indicating the possibility that the fat stored in muscle as the reserve material, is actually the fuel to be utilized for energy. Again, as in the vertebrates it was found that the size and the structure of the muscle fibres of the insect flight muscles have a definite relationship with the concentration of lipase in these muscles. The presence of lipase was studied quantitatively by the manometric method, using the Warburg apparatus. Histochemical techniques were also employed to localize the activity of

lipase in the insect flight muscles. Having thus shown the presence of lipase in the flight muscles of different insects, a study on certain biochemical properties of lipase was conducted manometrically using the Warburg apparatus. To obtain a better understanding of the postulated hypothesis that the size of the muscle fibres has a relationship with the enzymic equipment of the muscles, a quantitative study of one of the oxidizing enzymes (succinic dehydrogenase) was carried out by a calorimetric method. The results obtained in this study also tend to strengthen the above view. Histochemical studies of succinic dehydrogenase, cytochrome oxidase, acid and alkaline phosphatases and adenosine triphosphatase (ATPase), were also carried out on these muscles.

The presence of the slow and fast contracting leg muscles of the chokroach was recorded by some earlier workers and some of the physiological properties of these muscles were also known. In the insect muscles so far examined, no occurrence of the two types of muscle fibres dissimilar in size, structure and the enzyme make-up in the same muscle as found in some birds, has been found, though there do exist different types of individual muscles with considerable differences in their colour, size and structure. In order to obtain a better picture of the presence of these two types of muscles side by side in the same part of the leg, some of the enzymes in these muscles were studied quantitatively as well as histochemically. The results

obtained undoubtedly speak in favour of the suggestion that to indulge in prolonged activity, the muscle should be equipped with a better constitution of metabolites capable of yielding more energy and the related enzymes than the muscles which contract only for a short period. It is also observed that the muscles exhibiting sustained activity possess fibres with lesser diameter than the other type.

Intracellular distribution pattern of the enzymes lipase and succinic dehydrogenase has been studied by isolating the different component particles of the beetle flight muscle, with the aid of the "MSE 25 Superspeed" refrigerated centrifuge. Lipase was found to be concentrated more in the supernatent fraction than the microsomes and the mitochondria. Succinic dehydrogenase was mostly present in the mitochondrial fractions though the other particulate fractions also showed a considerable amount of activity. A study of the <u>in vitro</u> oxidation of fatty acids in the flight muscle homogenate of the honey bee, using the Warburg apparatus, has also been attempted. Due to the histological and morphogenetic diversities of a particular group of flight muscles in the different insect orders, it was thought desirable to undertake a special study of the structure of this group of muscles in relation to certain enzymes present. A few selected representative types of the common insect orders were used as the material in this

study. Finally a discussion on the structural peculiarities in the flight muscles of different insect orders and their possible evolutionary and physiological significance and a relationship is presented.

The following preliminary papers were published with the joint authership of my guiding professor, Dr.J.C.George.

1. A study on the fibre diameter and certain enzyme concentrations in the flight muscles of some butterflies. J.Expt.Biol. 37, 308-315, 1960.

2. Fibre diameter and certain enzyme concentrations in flight muscles of some moths. J. Anim. Morph. Physiol.7, 141-49, 1960.

3. Lipase activity in the thoracic muscles of the beetle (Heliocopris bucephalus. Fabr). Naturwissenschaften. 24, 602-603, 1960.