

S U M M A R Y

CHAPTER 1

The ^Mmorphological and histological studies were carried out on the liver of birds falling into various dietary groups viz., carnivorous, insectivorous, omnivorous, and graminivorous. The liver of insectivore^{ous} birds was found to be the largest as indicated by the liver:body weight ratio (3.0) followed by that of omnivores (2.7), graminivores (2.27) and carnivores (1.8). Histologically, ^{the}livers of omnivores and insectivores were found to be much more advanced as they have simplex muralium (single cell thick liver plates) while those of carnivores and graminivores have duplex muralium (double cell thick plates). It is concluded that evolutionarily, the euryphagous birds ^{are} ~~have taken~~ one step ahead ^{of the} ~~over~~ stenophagous birds. *etc.*

CHAPTER 2

The ^Hhistochemical demonstrations of various lipids were carried out in the livers of carnivorous, insectivorous, omnivorous, frugivorous and graminivorous birds. The livers of carnivorous birds having ^emore phospholipids and lipoproteins than neutral fat. These

^{the} lipids were found to be localized around collecting veins. In the insectivore liver neutral fat which was distributed all over the lobules, was much more ^{what?} than the lipoproteins and phospholipids. The acidic lipids were found mostly around the central collecting veins as in the carnivores. In the liver of omnivorous birds ~~too~~ the neutral fat was the predominant lipid, and was found specifically localized around portal areas. In almost all omnivores, ^a large number of cells of ^{the} reticuloendothelial system were found to be loaded with neutral fat. The livers of graminivores also had ^a high concentration of neutral fat but these were distributed uniformly in the hepatic lobules without showing any specific regional localization.

The quantitative determinations of liver fat (Total lipids) revealed that on an average basis, the insectivorous birds showed ^a very high concentration of it (14.24%) followed by carnivores (11.44%), graminivores (10.75%) and omnivores (09.43%). The average glycogen content of the liver was found to be in an ascending order as follows: carnivores - 0.065%; insectivores - 0.18%; omnivores - 1.72%; and graminivores - 3.53%.

CHAPTER 3

The enzymes concerned with lipid metabolism viz., lipase, esterase, and β -hydroxybutyrate dehydrogenase (BDH), were studied using histochemical techniques in the livers of birds with various dietary preferences.

The lipase was uniformly distributed in the parenchymal cells of the lobular units in the livers of all the groups (carnivores, insectivore, omnivore, frugivore and graminivore) of birds. However, the strength of lipase reactivity was low in carnivores and insectivores compared to that in other groups of birds.

Esterase was found to be very active in the livers of graminivores and insectivores and showed uniform distribution. But, in the carnivores and omnivores it was either found around the portal areas or in the linings of ^{the} vascular sinusoids. Only in omnivores and graminivores, ^{the} Kupffer cells showed esterase activity.

The BDH was distributed uniformly ^{throughout} ~~all over the~~ hepatic lobules in the liver of carnivores while in all the other birds it was more concentrated in the portal areas. The reactivity of BDH was very high in insectivores

and graminivores. Birds of these two groups also exhibited ^ahigh fat content in their livers.

CHAPTER 4

The histochemical localizations and the distribution patterns of various enzymes ^{Sucrose} like α -glycerophosphate (α -GPDH), lactate (LDH), succinate (SDH) and mal^aate (MDH) dehydrogenases were studied in the livers of various birds with different dietary preferences. It is realized that amongst these four dehydrogenases studied, the purely mitochondrial dehydrogenase (SDH) and purely extra-mitochondrial one (LDH) do not show variations in their respective distribution and/or localization in the livers of birds irrespective of their dietary preferences. However, α -GPDH and MDH which are present in both extra-mitochondrial as well as mitochondrial cellular regions, showed variations with respect to their diet. In carnivores and graminivores the extramitochondrial α -GPDH reactivity was more predominant while in insectivores, and omnivores the mitochondrial one had ^aslight edge over the other one. The extramitochondrial MDH was more active in carnivores, whereas other groups had more of mitochondrial MDH. ^{The} Significance of these variations are discussed in relation to the stenophagous and euryphagous adaptations of birds.

CHAPTER 5

The histochemical studies on alkaline and acid phosphatases in the livers of birds representing carnivores, insectivores, omnivores, and frugivores and graminivores diets revealed that their pattern of distribution as well as the concentrations show a correlation with their diets. Carnivores exhibited a moderate alkaline phosphatase but very little acid phosphatase activity whereas insectivores showed higher alkaline phosphatase response and a moderate acid phosphatase activity. Omnivores had higher reactivities of both the phosphatases, while the graminivore liver presented a poor alkaline phosphatase reactivity but that of the acid phosphatase was very strong. The localization of alkaline phosphatase was found to be both peribiliary and periportal in carnivores, insectivores and omnivores while it was uniform in all parenchymal cells of liver lobules in graminivores. The acid phosphatase was confined to Kupffer cells in carnivores and insectivores whereas in omnivores and graminivores it was present in all parenchymal cells. These histochemical differences, with regard to activities of the enzymes in the liver, revealed the fact that these are correlated with the adaptations of the livers to specific type of diet ingested by the birds.

CHAPTER 6

~~The~~ ^{the} comparative studies on histochemical localization of both specific and non specific cholinesterases were conducted ⁱⁿ ~~in~~ the livers of birds with various dietary preferences. The sinusoidal linings, walls of the portal vessels and linings of central collecting veins were found to exhibit both ~~the~~ types of cholinesterases irrespective of dietary variations and differences. The intense reactivity of the enzymes was around the portal areas of the lobules.

While acetylcholinesterase has a specific function of hydrolysis of acetylcholine secreted along the ^{ch}olinergic nerve plexus, the functions of non specific cholinesterases are not clear. However, the presence of both the cholinesterases in high concentration in the periportal areas of the liver lobules where the uptake of metabolites is more than in other regions renders support to the belief that cholinesterases in the liver are in some way involved in the assimilation of various metabolites.

CHAPTER 7

The histochemical demonstration of ATPase in the livers of birds with various dietary habits viz., Carnivorous, Insectivorous, Omnivorous and Graminivorous revealed that, in all ~~the~~ cases, irrespective of ~~their~~ diet, the enzyme was found localized exclusively around bile canaliculi. Nevertheless among all the birds studied the livers of insectivores and omnivores exhibited higher ATPase reactivity. As the ATPase of bile canaliculi is believed to assist the transport of bile components into the lumen of ^{the} bile canaliculi, the higher reactivity of it in these two groups of birds, is suggestive of ^a higher _^ bile production.

CHAPTER 8

The liver of a nectar feeder, the Sun Bird, was studied using histochemical techniques. To a certain extent, this bird's liver shows adaptations peculiar to this bird that could be correlated to its diet. However, the general histochemical patterns of various enzymes and metabolites studied were similar to that observed in the liver of insectivores.

The glycogen content of the liver of this bird was surprisingly lower than that was observed in insectivores. But the lipid content on the other hand was very high, most of which was present as neutral fat. Since the Krebs cycle enzyme like SDH was found to show ^{or} high reactivity while BDH was comparatively low, it could be reasoned that a part of the glucose taken up by the liver is utilized for energy while the major part is utilized for lipogenesis. The lipase and esterase, both of which could figure in the synthesis as well as in the release of lipids, were also quite active in the Sun Bird liver. The hyperlipogenesis is correlated with the high lipid requirement of Sun Bird's pectoralis muscle which is ^{composed} formed of lipid utilizing tonic fibres. The localization and distribution of other enzymes like Alkaline phosphatase, Acid phosphatase, ATPase, cholinesterases and dehydrogenases like MDH, LDH and CC-GPDH were more or less same as in the case of insectivore liver. This fact led to the suggestion that basically the Sun Birds might ^{once} have been insectivorous in ^{its} habits.