

CHAPTER 2

SEASONAL VARIATIONS IN CERTAIN BLOOD
PARAMETERS IN NORMAL AND PINEALECTOMIZED FERAL BLUE
ROCK PIGEON, COLUMBA LIVIA.

For the total body ^{economy} energy is stored in the body in the form of different metabolites. Whenever there is demand for energy, these metabolites are broken down rapidly. Glycogen, from liver and muscle, and often other metabolites are converted to blood glucose to meet increased energy demands by the body. Insulin and glucagon are hormones responsible in maintaining normal blood glucose level in birds and mammals. The effect of insulin on mammalian blood glucose level is known for long. In birds, insulin is reported to play only a secondary role in the control of blood sugar level (Hazelwood, 1973). Thus, mammals are insulin dependent while birds are more glucagon dependent. Recent findings have shown that the effect of insulin on the glucose transport is modified by ^{the} participation of

nervous elements (Mondon and Burton, 1971). A significant hypersecretion of insulin and its interaction with glucose from the pinealectomized rat was demonstrated by Gorry *et al.* (1979). Calcium is essential for blood clotting. Therefore, a change in calcium content in blood will certainly affect its clotting time, which in turn may change erythrocyte sedimentation rate.

The influence of the pineal gland could be better understood by removing the pineal and studying the abnormalities resulting therefrom. In the present study blood glucose level, blood clotting time, erythrocyte sedimentation rate and haemoglobin content are evaluated quantitatively in normal and pinealectomized birds during the three reproductive phases of the feral blue rock pigeon, Columba livia.

MATERIALS AND METHODS

During all the three phases of reproductive cycle, normal, pinealectomized and sham-operated feral pigeons were maintained and segregated as described in chapter 1. The estimation of blood glucose was carried out according to the micro-method of Folin and Malmros (1929). Blood glucose concentration was expressed as mg/100 ml. Studies were conducted on haemoglobin content, blood clotting time and erythrocyte sedimentation rate during the recrudescence

and breeding periods. For estimating the haemoglobin (Hb) content, blood was taken from the brachial vein. The method of Wong as described by Hawk et al. (1954) was used for measuring the Hb content. Blood clotting time was recorded by transferring fresh untreated blood from the wing to two glass capillaries, each with a diameter of 1 mm., at room temperature. The capillaries were broken gently every five seconds and time was recorded for a clot to form which was sufficiently solid. The rate at which erythrocytes settled under the force of gravity alone i.e. erythrocyte sedimentation rate (ESR) was determined by the method of Wintrobe and Landsberg, (1935). Citrate treated blood was allowed to stand in a graduated tube 200 mm long, held absolutely vertical for one hour. The number of millimeters of clear fluid above the settled cellular fraction of the blood was the measure of ESR. ESR in this study was measured only during the recrudescence period as this period was found to be more sensitive to pinealectomy. ESR was expressed as mm/hour at room temperature.

RESULTS

SEASONAL CHANGES IN NORMAL BIRDS:

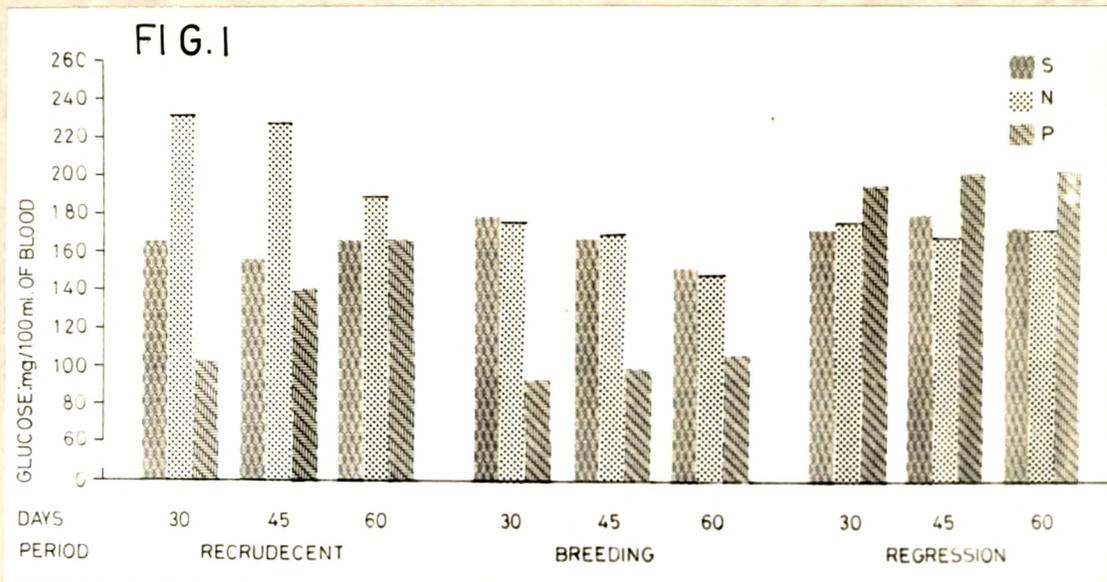
Blood glucose level was highest during the recrudescence period, lowest during breeding and intermediate in the regression phase (table 1 ; Fig.1). It increased with progressing

EXPLANATION FOR FIGURE

Fig. 1. Histogram showing blood glucose level in three different phases of reproductive activity, at three different intervals post-pinealectomy.

Abbreviations:

- S - Sham-operated.
- N - Normal unoperated.
- P - Pinealectomized.



recrudescence, decreased towards late breeding phase and in the regression period remained constant. Erythrocyte sedimentation rate (ESR) which was done only during recrudescence was noted to increase gradually temporally. There was a gradual decrease in clotting time from 20 seconds in early recrudescence, to 9 seconds in early breeding, which was increased to 16 seconds in mid and late breeding periods. Haemoglobin content was high during the recrudescence period and low in the breeding phase with maximal levels being recorded during late recrudescence and early breeding.

CHANGES DUE TO PINEALECTOMY:

Blood glucose, in general, recorded decrease in all PX birds during both recrudescence and breeding. Most significant change was in PX 30 birds. PX 60 birds in recrudescence showed a glucose level more towards the normal while in the breeding phase, it was still subnormal in PX 60 birds. Both recrudescence and breeding periods were marked by identical percentage fall in glucose. In the regression period an opposite pattern of change was noted. Blood glucose level tended to be above normal in all groups of PX birds. Moreover, there was a temporal increase post-pinelectomy. ESR increased after pinelectomy. The change was most significant in PX 30 group and the increase ranged from 170 % to 93 % from PX 30 to PX 60.

Pinealectomy increased the clotting time all throughout recrudescence and early breeding while it was not significantly different during mid and late breeding phases. Hb content had a tendency to fall and was affected only in PX 30 group of the recrudescence and breeding periods. It did not show much change in PX 45 and PX 60 groups.

DISCUSSION

Changes in the plasma glucose level obtained during the recrudescence period in normal wild pigeons reflect more or less the pattern of variations in the glycogen and lipid content of the liver. Apparently, anabolic processes are predominant during this period leading to deposition of various metabolites in the body. Low phosphorylase activity of hepatic tissue (Chapter 3) indicated decreased glycogenolysis. High blood glucose levels with high serum K^+ content in this reproductive phase (chapter 6) could be reasoned as due to increased glucose uptake by blood from sources other than metabolic depots. Only source available is the alimentary canal from which digested carbohydrates in the form of glucose can enter the general blood circulation. Pigeon is among birds consuming a carbohydrate rich diet. Increased intake of dietary carbohydrates could probably account for the increased blood glucose level observed in recrudescence. During the breeding phase, decreased blood glucose along with decrease in hepatic

glycogen (Chapter 3) indicate movement of glycogen out of the liver. Apparently, in wild pigeons, during breeding activities carbohydrate catabolism acquires prime role. The maintenance of low level of blood glucose even during regression together with the corresponding increase in glycogen and lipid contents (Chapters 3 and 6) indicate the utilization of blood glucose for synthesis of glycogen and lipids so as to replenish the exhausted metabolite resources of the body. Pigeon liver is known to divert major part of blood glucose for lipid synthesis (Pilo and Patel, 1978) and the present findings indicate the same to occur during the regression period.

Either glucose uptake by various tissues or reduction in its absorption from the alimentary canal can reduce blood glucose level. If tissue uptake of glucose is increased, tissue glycogen and/or lipid fraction should also be expected to increase concomitantly. However, in the present study, PX birds showed parallel decrement in blood glucose as well as tissue glycogen and lipids during recrudescence and breeding phases (Chapters 3,6). In this context, likelihood of reduced sugar absorption from the alimentary canal due to pineal ablation cannot be overlooked. The hypoglycemic effect might also be suggestive of the probable anti-insulinic and anti-avian pancreatic polypeptide (APP) role of pineal in the wild pigeons.

Both glucagon and APP cause glycogen hydrolysis in liver, however, only glucagon induced hepatic glycogenolysis leads to hyperglycemia; APP is without effect on blood glucose level (Hazelwood et al., 1973). Prevailing hypoglycemic condition during recrudescence and breeding suggests absence of glucagonic effect in PX birds and support the probability of anti-insulinic role of pineal in the control of sugar metabolism. A significant hypersecretion of insulin was demonstrated from the islets of PX rats (Gorry et al., 1979). The rat pineal evidently can exert direct effects upon insulin secretion from islets possibly through a hormonal route. Mihail and Giurgea (1979) reported hypoglycemic effect of pineal gland which partially compensated for the lack of endocrine pancreas in domestic pigeons. Plasma glucose levels were elevated in pinealectomized fish, the degree of increase varying with lighting conditions (Delahunty et al., 1980). Hyperglycemia observed in PX birds during the regression phase suggests that during this period anti-insulinic effect of pineal is decreased. Apparently, pineal is not anti-insulinic in all the phases of reproductive cycle of the birds under investigation. During the breeding phases (i.e. recrudescence and breeding) pineal exerts maximal anti-insulinic effect which decreases in the non-breeding phase (i.e. regression). These observations tend to indicate the presence of some season specific insulinotropic agent in the pineal gland with

season specific involvement in carbohydrate metabolism of wild pigeons.

Many factors such as temperature changes, concentration of various macromolecules such as protein, mucoproteins, lipoproteins etc., affect ESR but no absolute correlation has been established in any avian species. It appears from the present observations, that the normal ESR has a tendency to increase with environmental temperature and increasing reproductive activities, thus showing a parallel relationship. Altered physiological changes associated with breeding activities (other chapters) may also have some correlation with the increase in ESR. Pineal ablation increased ESR significantly. Observed alterations in various physiological parameters and inorganic ions due to pinealectomy might be responsible for the significant increase in ESR in the PX condition. Highly significant shortening of blood clotting time (rapid hemostasis) in normal pigeons with progressive recrudescence indicates its interaction with some plasma factor/s. Various steps of hemostasis are mediated by enzymatic activities and protein substances. The mode of interaction of the factors is not perfectly understood. During breeding, initially, time for hemostasis remained unchanged from that in late recrudescence which ^{later} increased and remained constant throughout breeding. The cause of these changes remains

obscure. Delayed hemostasis after pineal removal throughout recrudescence and early breeding suggests slower conversion of fibrinogen to fibrin. Avian blood lacks platelets and their role is assumed by thrombocytes (Grant and Zucker, 1973). If pineal has direct or indirect influence over thrombocytes' production or check over its destruction, changes in blood clotting time could occur. Slow hemostasis in PX 30 group of birds during breeding indicates short term effect post-pinelectomy; while the near normal hemostasis of PX 45 and PX 60 groups is suggestive of the probable setting up of corrective mechanisms at long term intervals after pineal ablation which established normal hemostasis.

Increment in Hb content in normal birds during recrudescence and early breeding phases indicates the existence of increased oxygen carrying capacity of the blood during these phases of reproductive activity. Pinelectomy, in general, showed a tendency of lowered Hb content. Since a number of factors such as nutritional ion content, protein metabolism, iron absorption, haemolysis due to errors in metabolism of proteins or lipids etc. can affect the production or degradation of Hb, the presently observed lowered Hb content in PX birds might be due to any of the physiological alterations reported in ~~the~~ other chapters.