CHAPTER - VII

SEASONAL ALTERATIONS IN SODIUM AND POTASSIUM IONS AND WATER CONTENT IN THE GONADS OF NORMAL AND PINEALECTOMISED DOMESTIC PIGEONS, *COLUMBA LIVIA*

Sodium (Na^+) and potassium (K^+) along with calcium are some of the most important cations of the physiological fluids and tissues. Both the cations have important role in membrane polarization and permeability by their differential distribution on either side of the cells. Na^+ is the major constituent of extracellular compartment while K^+ is preferentially found in higher concentration within the cellular compartment. Excitability of nerves and muscle is also greatly dependent on these ions. Besides these functions, Colombo and Marcus (1973); Ebashi *et al.* (1965) and Diehl and Jones (1966) have related these electrolytes with a number of enzymic reactions. In turn, this can be expected to have profound influence on metabolic activities of various tissues and organs. Seasonal reproductive activities exercise differential metabolite requirement during the various phases of gonadal activity. The water content of tissues is also known to undergo alterations in response to changing metabolic activities. It is also known that the tissue concentration of Na^+ and K^+ ions influences water balance of tissues. In the course of the present studies on domestic pigeons, seasonal variations in gonadal metabolites and enzymes have been

documented (Chapters 3-6,8). Hence an attempt is being made currently to evaluate the water content and concentration of Na^+ and K^+ ions in the gonads of normal and pinealectomised pigeons during both the breeding and non-breeding periods.

MATERIAL AND METHODS

Normal (C) sham operated (PN) and pinealectomised (PX) domestic pigeons were brought to the laboratory from the aviary at the end of the experimental time periods (i.e. 30, 45 and 60 days post surgery) in the two seasons and sacrificed by decapitation under mild anesthesia. The gonads were removed and blotted free of blood and tissue fluids. They were then transferred to weighing bottles and dried. The difference in weight after complete drying was taken as the water content. Dry lipid-free gonads (ashed) were taken for the estimation of Na^+ and K^+ using 'Eel' flame photometer by the method described in the manual. The ionic concentration is expressed in terms of mg/100 mg dry tissue.

RESULTS

Alterations in the water content and concentration of Na^+ and K^+ ions in the gonads are presented in Table-1 and Figures 1-3.

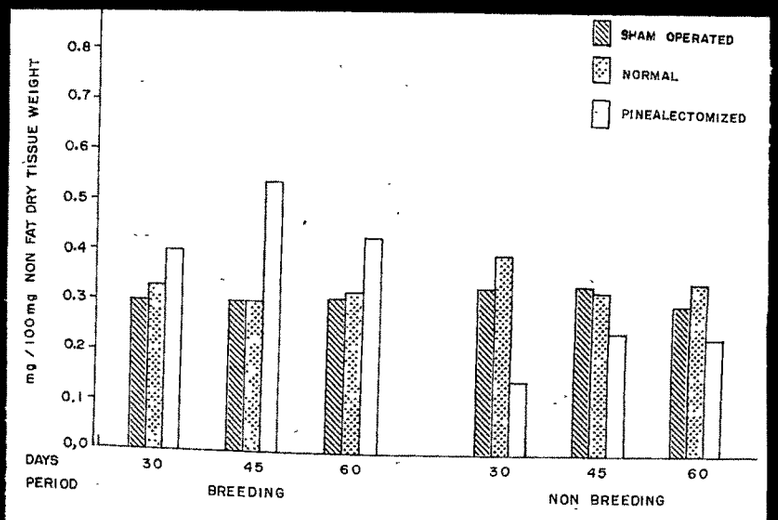

FIG. 1 ALTERATIONS IN GONADAL SODIUM ION CONTENT POST PINEALECTOMY IN DOMESTIC PIGEON

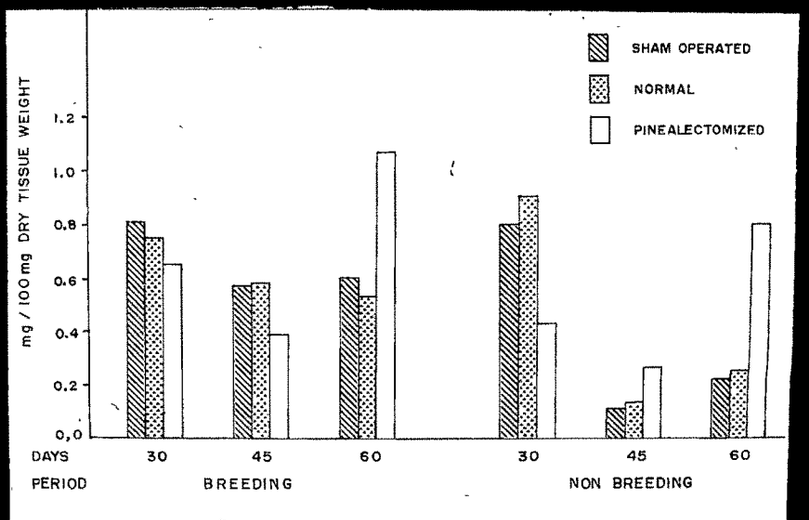

FIG. 2 ALTERATIONS IN GONADAL POTASSIUM CONTENT POST PINEALECTOMY IN DOMESTIC PIGEON

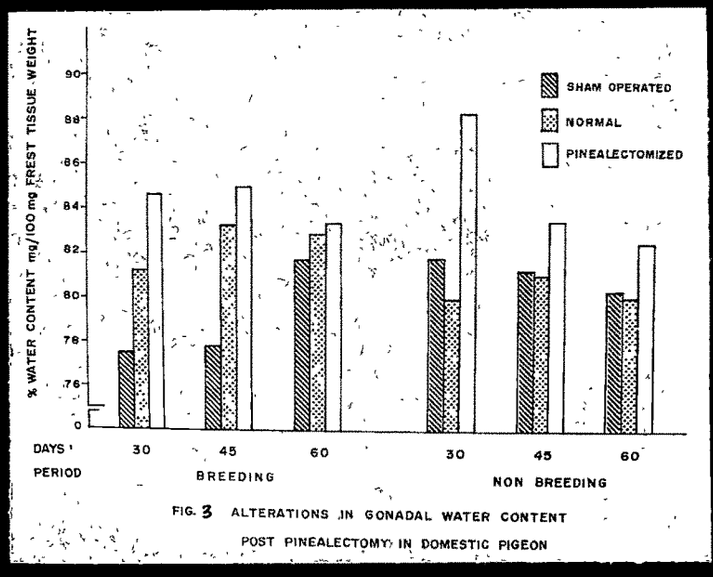

FIG. 3 ALTERATIONS IN GONADAL WATER CONTENT POST PINEALECTOMY IN DOMESTIC PIGEON

SEASONAL CHANGES IN NORMAL BIRDS

Of the three ions under investigation more significant changes were seen with reference to the K^+ ion content. As can be made out from the table and figures, K^+ ion content was high during the breeding period while it was low during the non-breeding period except for the immediate post-breeding phase whence the gonadal K^+ ion content was very high. In contrast, Na^+ ion content did not show much seasonal variation with a slightly lower content being the feature during the breeding season. Similarly, the water content too was more or less steady with a comparitively higher level being registered in the breeding season.

CHANGES DUE TO PINEALECTOMY

Pinealectomy induced more significant changes in the content of Na^+ , K^+ as well as water in gonads during both breeding and non-breeding periods. The changes in the Na^+ and K^+ ion contents depicted an inverse relationship. Accordingly the K^+ content was decreased and the Na^+ content increased during the breeding season and vice versa during the non-breeding season. In general, the water content of the gonads was increased after pinealectomy during both the seasons. However, the increase was more during the non-breeding season than during the breeding season.

DISCUSSION

As recorded herein the gonadal Na^+ and K^+ contents tend to strike a reciprocal relationship between them during the two phases of breeding activity. Whereas the K^+ content was higher during the breeding phase, the Na^+ content was slightly higher during the non-breeding phase. Obviously the breeding phase is marked by higher K^+ and lower Na^+ content, while the non-breeding phase by lower K^+ and higher Na^+ contents. It is needless to stress the fact that the breeding phase marked by peak gonadal functioning is favourably disposed with a higher K^+ content than Na^+. On a comparative basis the Na^+/K^+ ratio is low during breeding and elevated during post-breeding. Apparently, K^+ has a favourable influence on gonadal functioning while Na^+ increases along with other factors heralds gonadal regression or vice versa. Evidently, seasonal gonadal regression is related with increased Na^+ content and increased Na^+/K^+ ratio either in a cause or effect manner. The observation of increased K^+ content during gonadal activity is substantiated by the observation of Setchell *et al.* (1965) of doubled respiratory rate of testis homogenates in a high K^+ containing medium with no exogenous substrates. Further, K^+ entry into the tissues is also reported to facilitate entry of glucose and other metabolites (Pilo and Patel, 1978). By facilitating movement of metabolites and elevating metabolic activity K^+ could be considered to aid the gonads greatly in their functioning during the breeding season.

The alterations in the Na^+ and K^+ content of gonads are more clearly expressed in the pinealectomised animals though maintaining the same reciprocal relationship between them. Concomitant to the gonadal regression observed in the pinealectomised animals during the breeding season there was elevated Na^+ content and decreased K^+ content. In the light of the above cited importance of K^+ ions in gonadal functioning the reduced K^+ content with the regressed state of the gonads are understandable. These relationships are further emphasized by the reversed state of affairs in the non-breeding period whence pinealectomised birds depicted active gonads with increased K^+ content and decreased Na^+ content. In keeping with the dual role of pineal in domestic pigeons i.e. pro as well as antigonadal, the gonadal electrolytic balance also appears to undergo favourable or unfavourable transformations after pinealectomy. This might indicate a common axis which controls both gonadal activity as well as its electrolytic balance. One which can fit into this concept is the pineal-adrenal axis, especially in the light of previously observed alterations in histomorphology of the adrenals due to pinealectomy (Chapter 1). Decreased adrenocortical activity is known to induce rise in serum K^+ level and fall in Na^+ level (Keele and Neil, 1971). In fact such changes in the serum electrolyte levels have been recorded in pinealectomised wild pigeons in the breeding season (Patel, 1982). Decreased output of cortical hormones (either corticosterone or corticosterone and aldosterone both)

may in the present context lead to increased retention of tissue Na^+ and loss of K^+ which could directly or indirectly aid in gonadal regression post-pinealectomy in the breeding season. An entirely opposite set of changes may again contribute to the observed gonadal activation in pigeons pinealectomised during non-breeding period (Chapter 1). Unfortunately, there is paucity of information on pineal and tissue electrolyte levels, expect for that of Patel (1982) on levels of Na^+, K^+ and Ca^{++} in serum, liver, muscle and adipose tissue of wild pigeons. However, there are a few reports on serum electrolyte levels of pinealectomised rats which are contradictory. Whereas Karppanen et al. (1970) observed decrease in serum Na^+ content, Tanner and Hungerford (1962) observed increase in serum Na^+ content and Karppanen and Vapaatalo (1971) observed increased Na^+ level in the arterial wall. Most of the changes have however been related to altered adrenocortical hormone levels. Whatever be the nature of the findings, all available literature seem to indicate a definite influence of pineal in electrolyte balance of serum and tissues. Enigmatic though it is, pinealectomy does induce alterations in ionic concentration of tissues by as yet unknown mechanisms. Involvement of pineal, and Na^+ and K^+ in thermoregulation reported by Ralph et al. (1979) and Danbo and Edens (1981) are also relevant. Moreover, inability to regulate K^+ levels of brain in pinealectomised rats as reported by Quay (1965) is also interesting. A tentative relation between pineal and cationic balance can be deduced

from these reports and findings. Worth mentioning here is that Vlaming et al. (1979) have also suggested the possible involvement of pineal and photoperiods on plasma electrolyte levels and hinted that the direct or indirect functional relationship between pineal and serum electrolyte levels in teleosts has not been throughly examined.

The seasonal changes in the water content of gonads recorded for intact as well as pinealectomised pigeons tend to support the age old biological dictum of higher water content and increased metabolic ability. In both the groups of birds (i.e. C and PX) higher water content was recorded concomitant to gonadal activation. It is also worth noting that pinealectomy in general had a positive influence on gonadal water content which was more pronounced when there was simultaneous gonadal activation. It is reasonable to conclude from the above that pineal has definite season specific influences on gonadal electrolyte and water contents along with the alterations in reproductive activities in the domestic pigeons.