# Chapter 5

## INCUBATION PATCH FORMATION IN HOUSE SPARROW, PASSER DOMESTICUS : HISTOMORPHOLOGICAL STUDIES

Formation of the incubation patch in birds, involving feather loss from the ventrum resulting in the exposure of the skin and its progressive attainment of high vascularity and an edematous nature (for facilitating heat transfer to the eggs during incubation), have attracted considerable attention from avian biologists. Histological and experimental investigations by Bailey (1952) as well as a number of subsequent studies by others have brought to light the dependence of incubation patch formation and its maintenance on hormonal factors, notably sex steroids and prolactin (Jones, 1971). Despite the information available on the incubation patch in several species (Bailey, 1952; Jones, 1971), the condition and fate of feather papillae in the fully developed patch are poorly known. Bailey (1952) reported disappearance of the feather follicles and associated structures, such as smooth muscle fibres and fat cells during development of the patch. Loss of feather papillae and smooth muscle fibres was considered by Jones (1971) as characteristic of the incubation patch in a number of birds. Selender and Yang (1969), studying the incubation patch of the House Sparrow (Passer domesticus) noted that in the fully formed patch of incubating females, feather

## EXPLANATION FOR FIGURES

Fig.1 Ventral view of incubating female House Sparrow. Note defeathered, vascular and edematous ventral skin forming the incubation Patch (IP).

Fig.2 Ventral view of female House Sparrow during non-breeding seson. Note presence of down feather (DF) on the ventral skin.


1P
1


DP
2

papillae and follicles disappear. If these structures are totally lost when the incubation patch develops, refeathering of the patch skin after the termination of the breeding season or incubation would have to be preceded by formation of new feather papillae. This appears rather unlikely, but if it does happen, then it would provide an interesting model for developmental studies, where one can study dedifferentiation of well differentiated integumentary derivatives and their de novo formation in a well differentiated organ system like the integument. Hence it was thought desirable to ascertain the state of feather papillae in a fully developed incubation patch of House Sparrow, Passer domesticus. For this purpose, gross morphological and histological observations were made on ventral skin of House Sparrow, at various phases of incubation patch formation (employing the relevant methods described in Chapter 1). Similar studies were also made on the fully formed incubation patches in females of following birds : Redvented bulbul (Pycononotus cafer), Indian Robin (Saxicoloides fulicata), and the Brahmini Myna (Sturnus pagodarum).

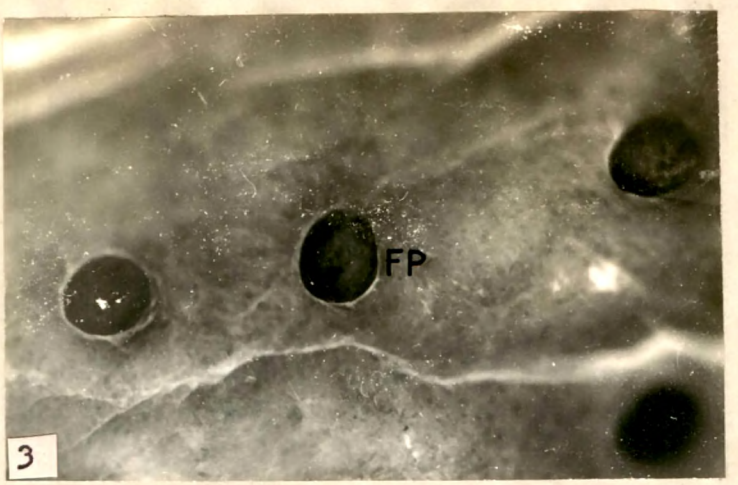
Morphological observations

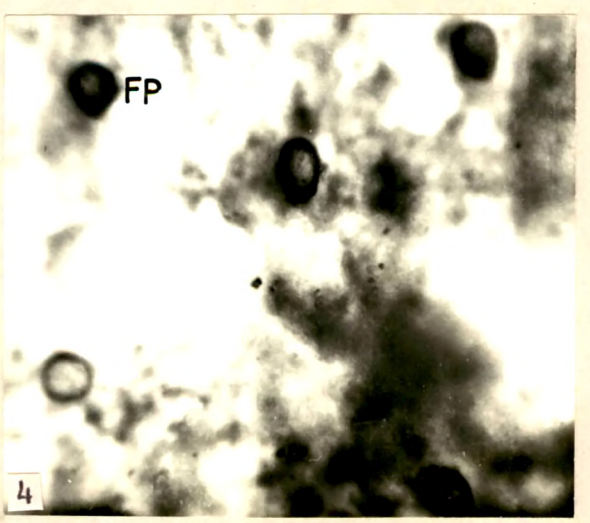
Gross examination of the intact patch skin failed to reveal presence of feather follicles and papillae in the patch skin of incubating female House Sparrows. However, when the separated dermis of a fully formed patch was stretched and observed

## EXPLANATION FOR FIGURES

Fig.3 Gross morphological picture of the dermis, showing the dermal feather papillae (FP) in the fully formed incubation batch of female House Sparrow.

Fig.4 Gross morphological picture of the dermis, showing the dermal feather papillae, in the fully formed incubation patch of female Indian Robin.


FP
3


FP
4

## EXPLANATION TO FIGURES

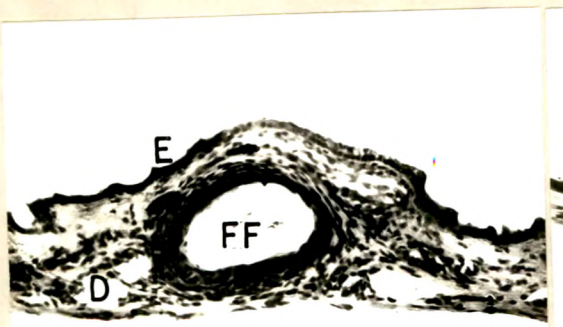
Figs. 5 to 12 Histomicrographs of the ventral skin of female House Sparrow during various phases of incubation patch formation. All 192 X.

Fig. 5 Non-breeding phase. Haematoxylin-Eosin.

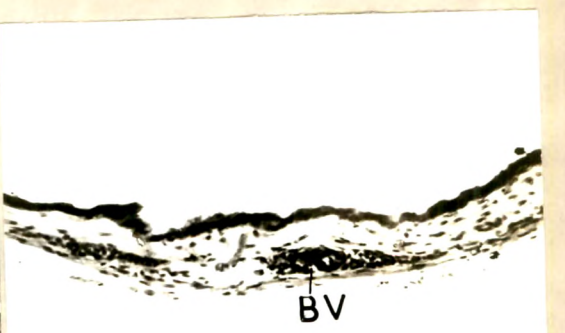
Fig.6 Non-breeding phase. Haematoxylin-Eosin.

Fig.7 Fully formed patch. Haematoxylin-Picro-penceau-S.

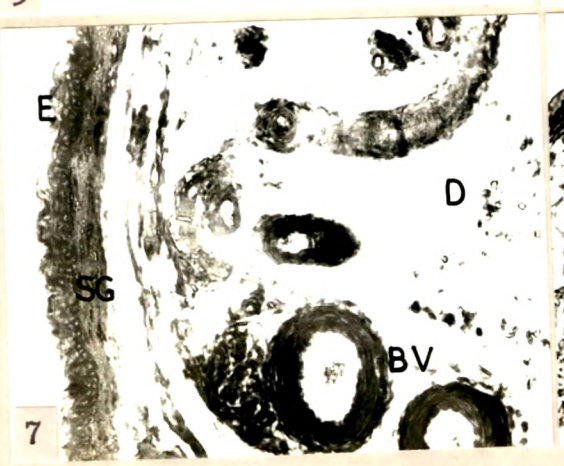
Fig.8 Fully formed patch. Haematoxylin-Eosin.



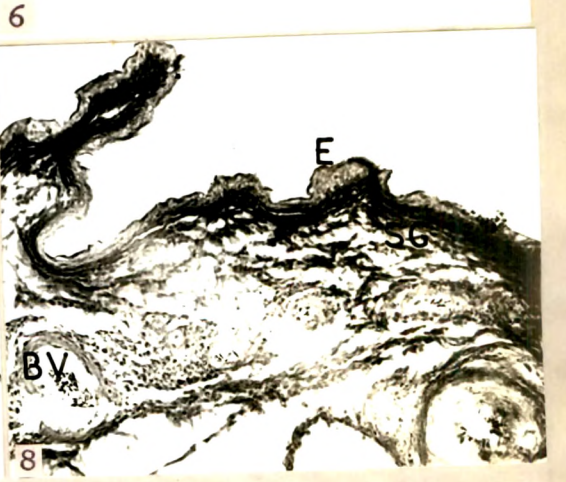

5




6




7




8

under dissection microscope (30x) feather papillae were seen to project as small rounded domes from its surface. They resembled similar structures seen in the dermis of the ventral skin from non-breeding females. The papillae stained more deeply with Haematoxylin than the rest of the dermis and hence they could be easily observed (Fig. 3). The papillae were those of down feathers as inferred from their location. The observations made on the incubation patch in females of the following birds, Redvented bulbul (Pycononotus cafer), Indian Robin (Saxicolodies fulicata) (Fig. 4), and the Brahmini Myna (Sturnus pagodarum), provide confirmatory evidences for the presence of dermal feather papillae in their fully developed incubation patch.

HISTOLOGICAL OBSERVATIONS

Non-Breeding period : (Figs. 5,6)

In the ventral skin of female House Sparrow, during non-breeding phase, the epidermis is of about 10-12 $\mu$ thickness, exhibiting a thin stratum germinativum, one or two layers of cells in transitional state and a thin stratum corneum formed of several layers. The dermis consists of a thick compact zone of fibrous connective tissue lying immediately under the epidermis and an underlying zone of reticular connective tissue. The total thickness of the dermis is about 111-112 $\mu$. The dermis also contains sensory nerve endings, blood vessels, smooth muscle fibres of follicular muscles and fat cells. Diameter

of feather follicles range between 85 to 87 $\mu$.

The skin adjacent to the prospective incubation patch area shows a similar epidermal structure, whereas the dermis is much more thick (about 500 $\mu$ in thickness) consisting of feather follicles of varied size ranging from 140 to 400 $\mu$ in diameter, follicular muscles, blood vessels, connective tissue, fat cells etc.

Nest Building Phase :

During the nest building phase, the incubation patch skin does not show any change in its histological features from those described for the skin during the non-breeding period.

Defeathered and Vascularized Phase :

During this phase, the thickness of the epidermis and dermis increases to about 18-20 $\mu$ and 300 $\mu$ respectively. This increase is due to epidermal and dermal tissue hyperplasia as well as hypervascularization. The diameter of the feather germs (which are by now in a dormant state) is reduced to about 25 $\mu$. The follicular muscles are still seen.

Though such histological changes occur in the patch skin, there are no such changes in the feather skin adjacent to the patch.

Fully Formed Patch (Figs. 7,8,9,10)

In this phase of the incubation patch, due to hyperplasia

## EXPLANATION FOR FIGURES

Fig.9 Fully formed patch. Haematoxylin-Eosin.

Fig.10 Fully formed patch. Mallory's triple stain.

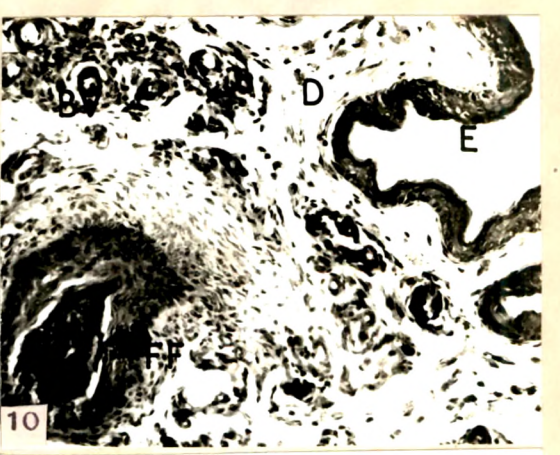
Fig.11 Regressing phase. Haematoxylin-Picro-poncreau-S.

Fig.12 Refeathering phase. Haematoxylin-Eosin.

## ABBREVIATIONS

BV- Blood Vessels, D- Dermis, DF- Down feather; E-Epidermis; FF- Feather follicle; FG- Feather germ, FP- Feather popillae; FW- Follicular wall; SG- Stratum germination, SM- Smooth muscles


9




10


11


12

and hypertrophy of the cells of stratum germinativum and thickening of stratum corneum, the total thickness of the epidermis increases to about 23-24 $\mu$ (i.e. 2 to 2.5 times the thickness noted in the non-breeding phase). As a result of dermal tissue hyperplasia, edema and hypervascularisation, the thickness of the dermis increases to 339-340 $\mu$ (i.e. about 3 times thicker than the dermis in the non-breeding period). The diameter of dormant feather germs remains as small as was seen during the early phase i.e. 25-25.5 $\mu$. The follicular muscles persist and do not show any degeneration.

No change in the histological features of the skin adjacent to the patch is noticed.

Regressing Phase (Fig. 11)

In this phase the thickness of epidermis and dermis of the patch skin considerably decrease i.e. to about 15-16 $\mu$ and 138-139 $\mu$ respectively. The diameter of the feather germs is found to increase to about 45 $\mu$. There is an obvious reduction in vascularity of the dermis.

Refeathering Phase : (Fig. 12)

All the histological features of the patch skin now got changed to attain a condition characteristic of the skin of the bird during the non-breeding period.

From the above facts it becomes amply evident, that in the patch skin, development of feathers from the follicles

after the feathers have been casted off during the defeathering phase of incubation patch formation, is suppressed rather than totally lost. Such a temporary suppression of functional activation of the feather germs in the incubation patch makes them an ideal model system for developmental as well as endocrinological studies. Hormonal regulation of the events leading to formation of the patch when viewed from the standpoint of developmental biology reveals an interesting paradoxical situation viz., whatever be the endocrine principle(s) causing hyperplasia of interplumar (non-feather) epidermis, they seem to inhibit proliferation of the epidermal cells of the feather germs. Proliferative activities of the feather forming tissue depend on activities of various metabolic pathways which are known to be controlled by the hormonal status (Chapter 4). A differential activation or suppression of metabolic events in the epidermis in these two different regions of the patch skin under hormonal influence could be expected to result in a specific response of the epithelial cells as mentioned above. These contentions are well supported on the basis of the studies reported in the following chapters.