CHAPTER 3

Histoenzymological observations of 3α-HSDH activity in gonadal and extra-gonadal tissues of seasonally reproducing birds.

3α-HSDH is an important multifunctional oxidoreductase capable of metabolizing steroid hormones, polycyclic aromatic hydrocarbons and prostaglandins (Stolz *et al.*, 1991; Usui *et al.*, 1994). Mammalian 3α-HSDH inactivates circulating steroid hormones and in target tissues regulates the occupancy of steroid hormone receptors (Penning *et al.*, 1997a; 1997b). Functional significance of 3α-HSDH based on the presence of this enzyme in various tissues has been reported by many workers (Lau, 1982; Penning *et al.*, 1986; Lang *et al.*, 1986; Nanjo *et al.*, 1992; Iyer *et al.*, 1992; Pirog and Collins, 1994; Usui *et al.*, 1994; Penning *et al.*, 1997b; Penning, 1999; Jin and Penning, 2001; Degitiar and Kushlinsky, 2001); reductive 3α-HSDH is known to terminate the action of potent androgen (*e.g.* 5α-dihydrotestorone) in target tissues (*e.g.* prostate) and oxidative 3α-HSDH isoforms are known to provide an alternative source of potent androgens by converting 3α-androstanediol to 5α-dihydrotestorone (Jin and Penning, 2001) [Flow Chart 1]. In bovine liver, the ability of 3α-HSDH to catalyze NADP (H)-dependent oxidoreduction of 3α-hydroxy and keto groups of steroids, and to catalyze the reduction of some ketones and quinines has been demonstrated (Nanjo *et al.*, 1992). 3α-HSDH has also been

demonstrated (Nanjo *et al.*, 1992). 3α-HSDH has also been demonstrated to catalyze the oxidoreduction of the C_3 position of bile precursors (Takikawa *et al.*, 1990a, 1990b) suggesting that the intrahepatic bile acid concentrations may affect the reduction of 3-oxo bile acid precursors and intrahepatic redox conditions may affect intracellular bile acid transfer. Yamamuro *et al.*, (1994) have identified and quantified 3α-HSDH, also known as Y' bile acid binder in the rat small intestinal mucosa suggesting the possible role of the binder in the intracellular transport of bile acid in the ileum. Verhoeven *et al.*, (1976) have demonstrated that the microsomal NADH-dependent oxidoreductase in kidney displays favourable characteristic to catalyze the 3α-dehydrogenation of 3α-androstenediol, which enables the kidney to use 3α-androstenediol as an efficient precursor for the local formation of 5α-dihydrotestosterone. From the literature cited so far, it is clear that the 3α-HSDH enzyme activity has multiparous physiological roles other than just its involvement in the metabolism of steroid hormones at different sites in the body.

As it is well known that the liver plays an important role in the metabolism of steroid hormones, and that significant biliary exit of several steroids occur, it would be of interest to know more about the role of epithelial cells of intestine villi as well as the kidney tubules in this context. With this view the present work was undertaken to investigate histoenzymologically the patterns of localizations of 3α-HSDH activities in the three extra-gonadal tissues like liver, intestine and kidney, along with gonads.

Results :

Pre-breeding season:

The ovaries of the Bank Mynas [Plate XVII (a)], during the pre-breeding months of February to April, showed high 3α-HSDH activity in the theca interna and the interstitial cells, whereas in the Brahminy Mynas, [Plate XVII (e)], the theca interna as well as the interstitial cells showed moderate activities. Granulosa layer had moderate 3α-HSDH activities in both the female Mynas [Table: 5]. During the pre-breeding phase in the females of both the species, the hepatocytes had moderate 3α-HSDH activity [Plate XVII (b, f)] (Table: 5). The epithelium of villi exhibited intense 3α-HSDH activity with little activity in intestinal glands and moderate activity in the corium of villi in both the female Mynas [Plate XVII (c, g)]. In the kidneys of Bank Myna females [Plate XVII (d)], the nephric tubules had high 3α-HSDH activity and the glomeruli had little 3α-HSDH activity, whereas in the Brahminy Myna females [Plate XVII (h)] (Table: 5), the enzyme was moderately localized in the nephric tubules and little in glomeruli. Medulla had no activity in both the species of Mynas.

The seminiferous tubules had moderate 3α-HSDH activities in the pre-breeding testes of both the Mynas [Plate XVIII (a, e)](Table: 6). However, the interstitial cells showed a marginal difference with higher 3α-HSDH localization in Bank Mynas whereas it was moderate in the Brahminy Mynas. Among the extra-gonadal tissues, the hepatocytes in both the males had moderate 3α-HSDH activity [Plate XVIII (b, f)](Table: 6), which was equal to that seen in the females. The epithelium of villi in the intestine had intense 3α-HSDH activity [Plate XVIII (c, g)] and the corium of villi and the intestinal glands had little localization of the 3α-HSDH enzyme in both male Mynas (Table: 6).

The nephric tubules in males showed moderate activity of 3α-HSDH and in the glomeruli, it was little [Plate XVIII (d, h)](Table: 6).

Breeding Season:

During the breeding season, in the ovaries of the Bank Mynas [Plate XIX (a)](Table: 5) intense 3α-HSDH activity was observed in the theca interna and the interstitial cells and high 3α-HSDH activity in the granulosa layer. In the Brahminy Mynas [Plate XIX (e)], the theca interna showed intense activity but the granulosa layer showed moderate activity and the interstitial cells showed little activity during the same period (Table: 5). The hepatocytes maintained moderate 3α-HSDH enzyme activity during breeding season in both the female Mynas [Plate XIX (b, f)](Table: 5). Activities comparable to that of pre-breeding were maintained in the epithelium of villi of this sex [Plate XIX (c, g)](Table: 5) and the intestinal glands and the corium of villi had little activities in both the species. In the female Bank Mynas, the nephric tubules had little 3α-HSDH activity and the glomeruli had mild activity [Plate XIX (d)], whereas in the Brahminy Myna females, the nephric tubules showed moderate activity and the glomeruli had little activity [Plate XIX (h)].

During this season, seminiferous tubules had moderate localization of 3α-HSDH activity and the interstitial cells of Leydig showed little localization of this enzyme [Plate XX (a, e)] (Table: 6) in both the Mynas. Compared to the previous phase the hepatocytes showed an increase in the 3α-HSDH activity in the Bank Mynas [Plate XX (b)] but maintained the activity at moderate activity in the Brahminy Mynas [Plate XX (f)](Table: 6). The 3α-HSDH activity in the epithelium of villi in the male birds was also maintained at intense levels during breeding season whereas in the intestinal glands it increased to high level [Plate XX(c, g)]. Simultaneously the nephric tubules of both the

male Mynas showed an increase in the enzyme activity to high level [Plate XX (d, h)] (Table: 6) as compared to the pre-breeding season and the glomeruli showed little localization of 3α-HSDH.

Post-breeding Season:

In Bank Mynas, compared to the previous season, a significant decrease in the 3α-HSDH activities in the theca layer and the granulosa cells was observed whereas that of the interstitial cells was reduced non-significantly [Plate XXI (a)]. In the female Brahminy Mynas, there was a remarkable decrease in the enzyme activity during post-breeding season in the theca interna and granulosa component but in contrast to this; there was a significant rise in enzyme activity in the interstitial cells [Plate XXI (e)]. In the hepatic tissue of Bank Myna females, a decrease from moderate activity of previous season to little activity during post-breeeing season was observed and in the other species, Brahminy Myna, it was maintained to that of the previous phase [Plate XXI (b, f)]. In the intestine, the 3α-HSDH activities were still maintained at intense level and in the intestinal glands and the corium of villi at little level in the Bank Myna females, [Plate XXI (c)]. However, in the Brahminy Myna females, the 3α-HSDH activity in the epithelium of villi decreased noticeably and in the intestinal glands, the enzyme activity was maintained at little level [Plate XXI (g)]. The nephric tubules had little activity and the glomeruli had mild activity in the Bank Mynas females [Plate XXI (d)] while in the Brahminy Mynas females [Plate XXI (h)], the activity in the nephric tubules exhibited a rise and the glomeruli showed little activity of 3α-HSDH.

The testes were observed with moderate 3α-HSDH activities in the seminiferous tubules and interstitial cells of both the species of male birds [Plate XXII (a, e)](Table: 6). The hepatocytic 3α-HSDH activity in the male Bank Mynas showed a significant decrease [Plate

XXII (b)] whereas in the Brahminy Myna males, the activity was maintained at moderate level [Plate XXII (f)]. The villar epithelial cells and the intestinal glands showed a significant decrease as compared to the breeding phase [Plate XXII (c, g)] in both the Mynas. In the nephric tubules, the 3α-HSDH activity decreased to moderate level and both glomeruli and medulla showed mild activity in the male birds of both the species [Plate XXII (d, h)].

Non-Breeding Season:

In the non-breeding ovaries of the Bank Mynas the interstitial cells maintained high 3α-HSDH activity; theca interna showed an increase to moderate activity and granulosa maintained little activity [Plate XXIII (a)] whereas in the Brahminy Mynas, the theca interna had no activity, the interstitial cells had little localization of 3α-HSDH and the granulosa had mild activity [Plate XXIII (e)][Table: 5]. The hepatocytes in the non-breeding phase were again maintained at little 3α-HSDH activity in both the female Mynas [Plate XXIII (b, f)]. The epithelium of villi which had intense activity during the pre-breeding, breeding and post-breeding phases of female Bank Mynas, now showed a decrease. In the female Brahminy Mynas, also the epithelium of villi exhibited a decrease that was more prominent and the intestinal glands had little activities of 3α-HSDH [Plate XXIII (c, g)]. The 3α-HSDH activity in the nephric tubules of the Bank Myna females was same as that observed during the breeding and post-breeding months *i.e.*, little in the nephric tubules and mild in the glomeruli [Plate XXIII (d)]. However, in the Brahminy Myna females, the nephric tubules maintained the activity at high level and the glomeruli showed little activity [Plate XXIII (h)].

There was no change in the enzyme activity of the testes when compared to that of the previous phase. The seminiferous tubules of

non-breeding testes in both the species of Mynas showed moderate 3α-HSDH activity and the interstitial cells showed high activity [Plate XXIV (a, e)][Table: 6]. Hepatocytic 3α-HSDH activity reduced to negligible in the Bank Mynas but in the Brahminy Mynas, it was unaltered [Plate XXIV (b, f)](Table: 6). The epithelium of villi of intestine showed moderate activity and the intestinal glands showed little 3α-HSDH activity [Plate XXIV (c, g)] (Table: 5 & 6) in both the species of males Mynas. There was no alteration in the enzyme activity in the nephric tubules as well as glomeruli in both the male Mynas. Medullary activity was nil in both cases [Plate XXIV (d, h)].

Discussion :

As mentioned in the introduction the 3α-HSDH family of enzymes is an important multifunctional oxidoreductase system capable of metabolizing steroid hormones, polycyclic aromatic hydrocarbons and prostaglandins (Stolz *et al.*, 1991; Usui *et al.*, 1994). Prostaglandins are a unique group of heterocyclic fatty acids, which with their biological actions, bring about marked changes in the steroid actions of tissues (Lee, 1981). In the target tissues the 3α-HSDH regulate access of steroid hormones to steroid hormone receptors (Penning *et al.*, 1997a). It is a well known fact that, in the seasonally breeding bird species, after recrudescence occurs both sexes enter the pre-breeding phase during which period the gonadal steroidogenic activity gradually picks up. Thereafter, the patterns of enhanced biosynthesis of gonadal hormones may show variations in the rate of formation, release as well as biological inactivation of sex-steroids in different species, as has been noted in case of Bank Mynas and Brahminy Mynas (Chapter 4). Further, it has also become very clear by now that the 3α-HSDH enzyme activity, acting in tandem with 5α-reductase, is actively

involved in the metabolism of gonadal steroids, and the multiple roles played by the resulting metabolites in different peripheral tissues in effecting the functional expression thereof (Lax, 1987; Jin and Penning, 2001). Taking these facts into consideration, it is proposed here to discuss the role of patterns of distribution of 3α-HSDH in the three extra-gonadal tissues as related to the role of circulating level of gonadal hormones through the four phases of the reproductive cycle.

It has been observed in these two species of female Mynas that the rise and fall of gonadal hormones in circulating blood plasma differs in the two species (Chapter 4). In case of Bank Mynas, the plasma level buildup as well as its decline is comparatively faster, but in case of Brahminy Mynas, the phenomenon is gradual. It is therefore apparent that, their metabolic fate in the three extra-gonadal tissues considered here may also vary. In the female Mynas, intense localization of 3α-HSDH in the ovarian tissues during pre-breeding [Plate XVII (a, e)] and breeding [Plate XIX (a, e)] season is probably an indicative of intra-ovarian metabolism of the steroids, at the very site of production itself. Hence, biosynthesis as well as release of ovarian steroids into circulating blood maybe equally faster. One possible explanation may be related to not allowing very high concentration in the circulation suddenly, and thereby, regulating the negative feedback at the hypophyseal level. Another probability is that the metabolites resulting out of this enzyme activity may indirectly facilitate quick release of gonadal hormones, within the species-specific limit of gonadal steroids in the circulation. It can be easily seen that among the three extra-gonadal tissues under consideration, the intestinal epithelium apparently plays an important role in the metabolism of gonadal hormones that may escape into the lumen from the liver through bile. The hepatic 3α-HSDH enzyme activity in these phases, though not very high, probably points to release of the hormone *via* bile. 3α-HSDH is

also involved in bile acid biosynthetic pathways and has been suggested to play an important role in net bile transport across the hepatocytes (Stolz *et al.*, 1989; Takikawa *et al.*, 1990a). In the bile acid biosynthetic pathways of human and rat, hepatic 3α-HSDH catalyzes the stereo-specific reduction of the 3-oxo groups of bile acid precursors and has been postulated to serve as a shuttle of bile acids from sinusoidal to apical membranes of rat hepatocytes (Stravitz *et al.*, 1994; Takikawa *et al.*, 1990b). In this whole process in the aves, the nephric epithelium is also actively involved but only during pre-breeding phase in female Bank Mynas. During the post-breeding and non-breeding phases the circulating levels of hormones are known to be reduced comparatively faster, the localization of enzyme activity clearly indicates insignificant roles played by the hepatic [Plate XXI; XXIII (c, g)] and uriniferous epithelial elements [Plate XXI; XXIII (d, h)]. However, whatever low levels of gonadal hormones are still in circulation are probably efficiently metabolically handled by the intestinal epithelium.

There is a gradual increase as well as decrease in circulating ovarian hormones in Brahminy Mynas. This is effectively indicated by the patterns of intensity of 3α -HSDH distributions within the ovary (Table: 5). Here also the role of intestinal epithelium apparently is more important in the steroid metabolism, but as opposed to what occurs in Bank Mynas, in this species, the involvement of hepatocytes and uriniferous tubules is to a better extent. This may be responsible for gradual rise and fall of circulating ovarian steroids through both pre-breeding and breeding phases. As far as the post-breeding and non-breeding phases are concerned in female Brahminy Mynas as compared to the Bank Myna counterparts, the circulating levels of gonadal hormones are lower and here, probably the participation in the steroid metabolism by the hepatocytes as well as the intestinal cells

gradually declines. Strangely enough, higher intensity of 3α-HSDH in the nephric tubules during these two phases apparently indicates a species-specific difference as far as the metabolism of circulating minimal levels of sex steroids is concerned (Table: 5).

What was stated in case of female Mynas with respect to the patterns of synthesis and release of gonadal steroids holds true for the male Mynas also. Another similarity between the sexes of both the species is related to prominent involvement of intestinal epithelium in the metabolism of steroids (Table: 5 & 6). However, there are two points of contrast concerning the involvement of hepatocytes and the kidney tubules. In the male Mynas of both the species the involvement of nephric epithelium, though less than intestinal epithelium was noteworthy, however, no species-specific difference in this tissue was noted in contrast to what has been observed in the female birds. Sex-specific differences in the 3α-HSDH activities of kidney have been demonstrated in the male and female rat kidneys (Verhoeven et al., 1976); female showing the highest activity of the soluble coenzyme dependent oxidoreductases. As against this, the role played by the hepatocytes in the male birds did show a species-specific difference. Hepatocytic involvement in steroid hormone metabolism clearly supports the observation regarding comparatively faster rise and fall of gonadal steroids in case of Bank Myna males as was apparent from the 3α-HSDH activity patterns during the various phases of the reproductive cycle [Plate XVIII; XX; XXII; XXIV (b)]. As opposed to this, the role of hepatocytes in male Brahminy Mynas [Plate XVIII; XX; XXII; XXIV (f)] indicates a steady pattern of involvement in the steroid metabolism throughout the breeding cycle.

Abbreviations :

Tl = Theca Layer

G = Granulosa

Ic = Interstitial Cells

S = Stroma

ST = Seminiferous Tubule

M.Externa = Muscularis externa

T.Propria= Tunica Propria

Int. Glands=Intestinal Glands

Epi. Of Villi= Epithelium of Villi

Cor. Of Villi= Corium of Villi

Neph. Tub= Nephric Tubules

Glom=Glomeruli

Pr-Br = Pre-Breeding

Br = Breeding

Po-Br = Post-Breeding

Non-Br = Non-Breeding

Activity Pattern :

- \- : No activity
- ± : Mild activity
- \+ : Little activity
- ++ :Moderate activity
- +++ :High activity
- +++++ :Intense-activity

Table 5: 3α-HSDH activities in the ovaries, liver, intestine and kidneys of Bank Myna, *Acridotheres ginginianus* and Brahminy Myna, *Sturnus pagodarum*.

	Bank Myna				Brahminy Myna			
BreedingPhases	Pr-Br	Br	Po-Br	Non-Br	Pr-Br	Br	Po-Br	Non-Br
Tissues	Ovary							
Tl	+++	+++++	+	++	++	+++++	-	-
G	++	+++	+	+	++	++	-	±
Ic	+++	+++++	+++	+++	++	+	+++	+
	Liver							
Hepatocytes	++	++	+	+	++	++	++	+
	Intestine							
M.ext.	±	±	±	±	±	±	±	±
T.Prop	±	±	±	±	±	±	±	±
Int.Gl.	+	+	+	±	+	+	+	+
Epi. Villi	+++++	+++++	+++++	+++	+++++	+++++	+++	+
Cor. Villi	++	+	±	+	++	+	+	±
	Kidney							
Medulla	-	-	-	-	-	-	-	-
Neph.Tub.	+++	+	+	+	++	++	+++	+++
Glom.	+	±	±	±	+	+	+	+

Table 6: 3α-HSDH activities in the testes, liver, intestine and kidneys of Bank Myna, *Acridotheres ginginianus* and Brahminy Myna, *Sturnus pagodarum*.

	Bank Myna				Brahminy Myna			
BreedingPhases	Pr-Br	Br	Po-Br	Non-Br	Pr-Br	Br	Po-Br	Non-Br
Tissues	Testis							
ST	++	++	++	++	++	++	++	++
Ic	+++	+	++	+++	++	+	+++	+++
	Liver							
Hepatocytes	++	+++	+	±	++	++	++	++
	Intestine							
M.ext.	±	±	±	±	±	±	±	±
T.Prop	±	±	±	±	±	±	±	±
Int.Gl.	+	+++	+	±	+	+++	+	+
Epi. Villi	+++++	+++++	+++	++	+++++	+++++	+++	++
Cor. villi	+	±	±	±	+	±	±	±
	Kidney							
Medulla	±	±	±	-	±	±	±	-
Neph.Tub.	++	+++	++	++	++	+++	++	++
Glom.	+	+	±	±	+	+	±	±

PLATE XVII

3α-Hydroxysteroid dehydrogenase activities in ovarian and extra-ovarian tissues of Bank Myna, *Acridotheres ginginianus*, and Brahminy Myna, *Sturnus pagodarum*.

- Pre-Breeding phase –

Bank Myna ♀		**Brahminy Myna** ♀	
a. Ovary	(500X)	e. Ovary	(500X)
b. Liver	(800X)	f. Liver	(800X)
c. Intestine	(800X)	g. Intestine	(500X)
d. Kidney	(500X)	h. Kidney	(500X)

Abbreviation :

Tl : Theca Layer ; G : Granulosa ; EV : Epithelium of villi ;
IG : Intestinal Glands ; NT : Nephric Tissue

PLATE **XVII**

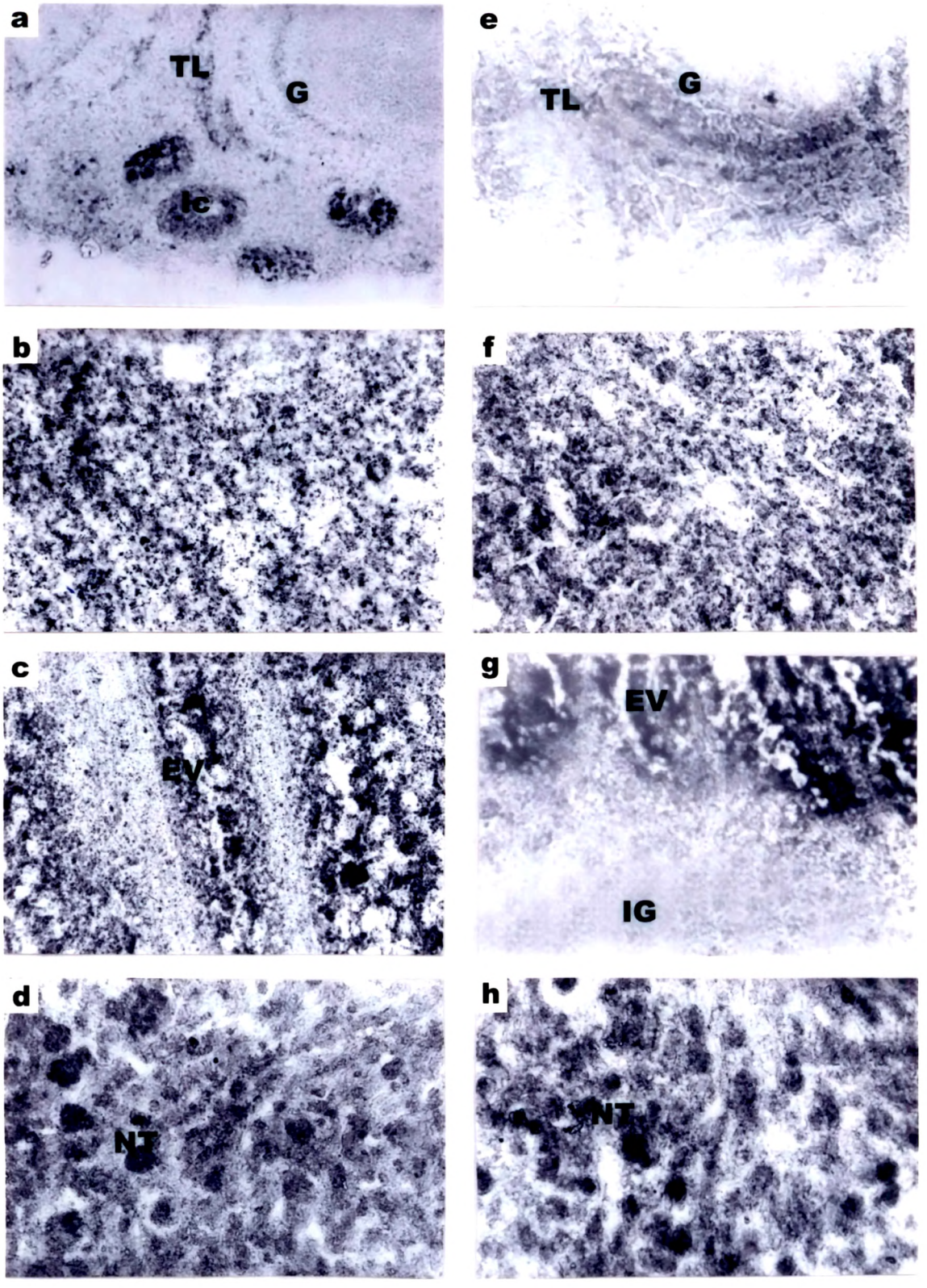


PLATE XVIII

3α-Hydroxysteroid dehydrogenase activities in testicular and extra testicular tissues of Bank Myna, *Acridotheres ginginianus*, and Brahminy Myna, *Sturnus pagodarum*.

- Pre-Breeding phase –

Bank Myna ♂		**Brahminy Myna ♂**	
a. Testis	(500X)	e. Testis	(500X)
b. Liver	(800X)	f. Liver	(800X)
c. Intestine	(800X)	g. Intestine	(500X)
d. Kidney	(500X)	h. Kidney	(500X)

Abbreviation :
ST : Seminiferous Tubule ; LC : Leydig Cells ; EV : Epithelium of villi ; IG : Intestinal Glands ; NT : Nephric Tissue

PLATE **XVIII**

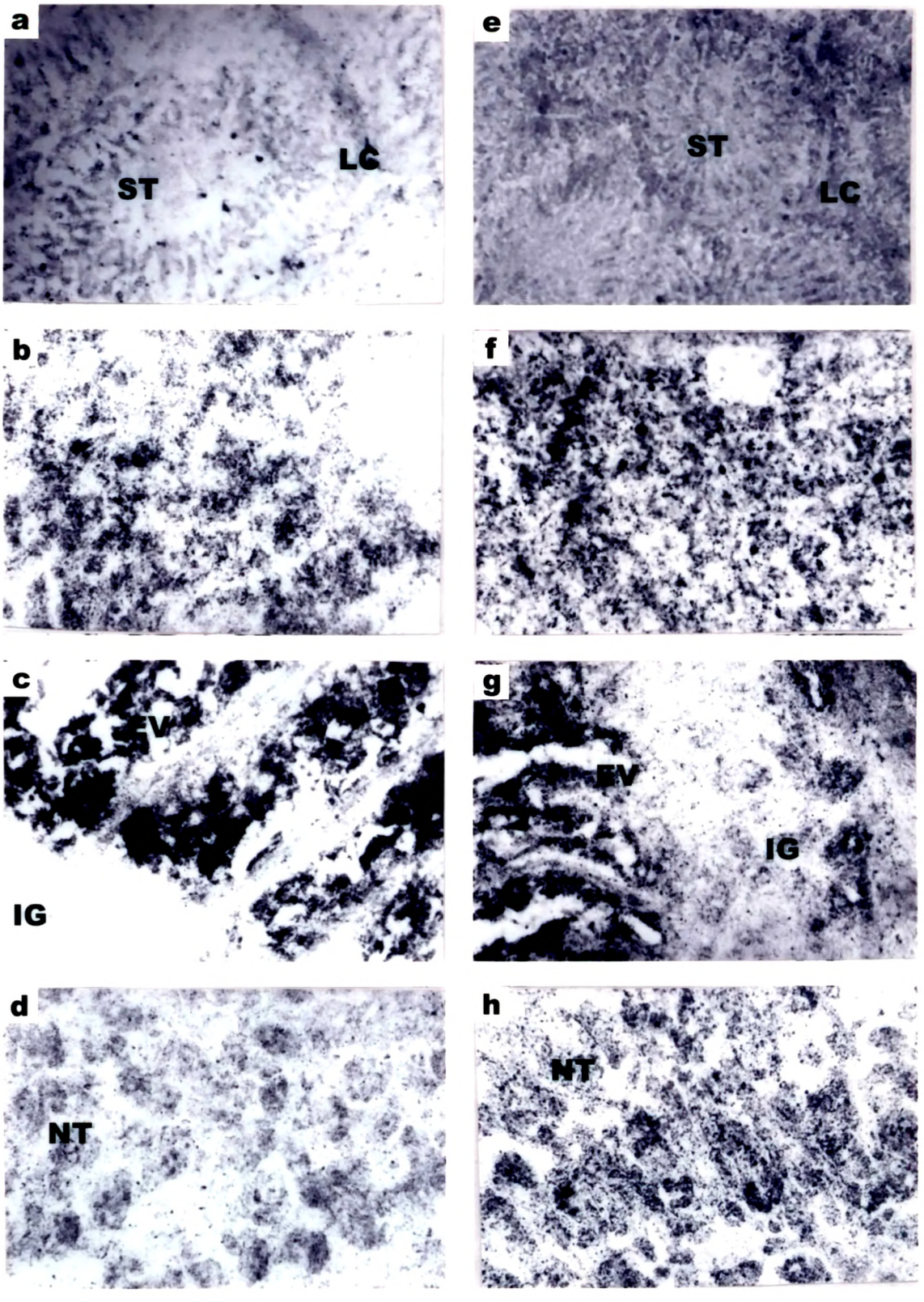


PLATE XIX

3α-Hydroxysteroid dehydrogenase activities in ovarian and extra ovarian tissues of Bank Myna, *Acridotheres ginginianus*, an Brahminy Myna, *Sturnus pagodarum*.

- Breeding phase –

Bank Myna ♀		**Brahminy Myna ♀**	
a. Ovary	(500X)	e. Ovary	(500X)
b. Liver	(800X)	f. Liver	(800X)
c. Intestine	(800X)	g. Intestine	(500X)
d. Kidney	(500X)	h. Kidney	(500X)

Abbreviation :
Tl : Theca Layer ; G : Granulosa ; EV : Epithelium of villi ;
NT : Nephric Tissue

PLATE **XIX**

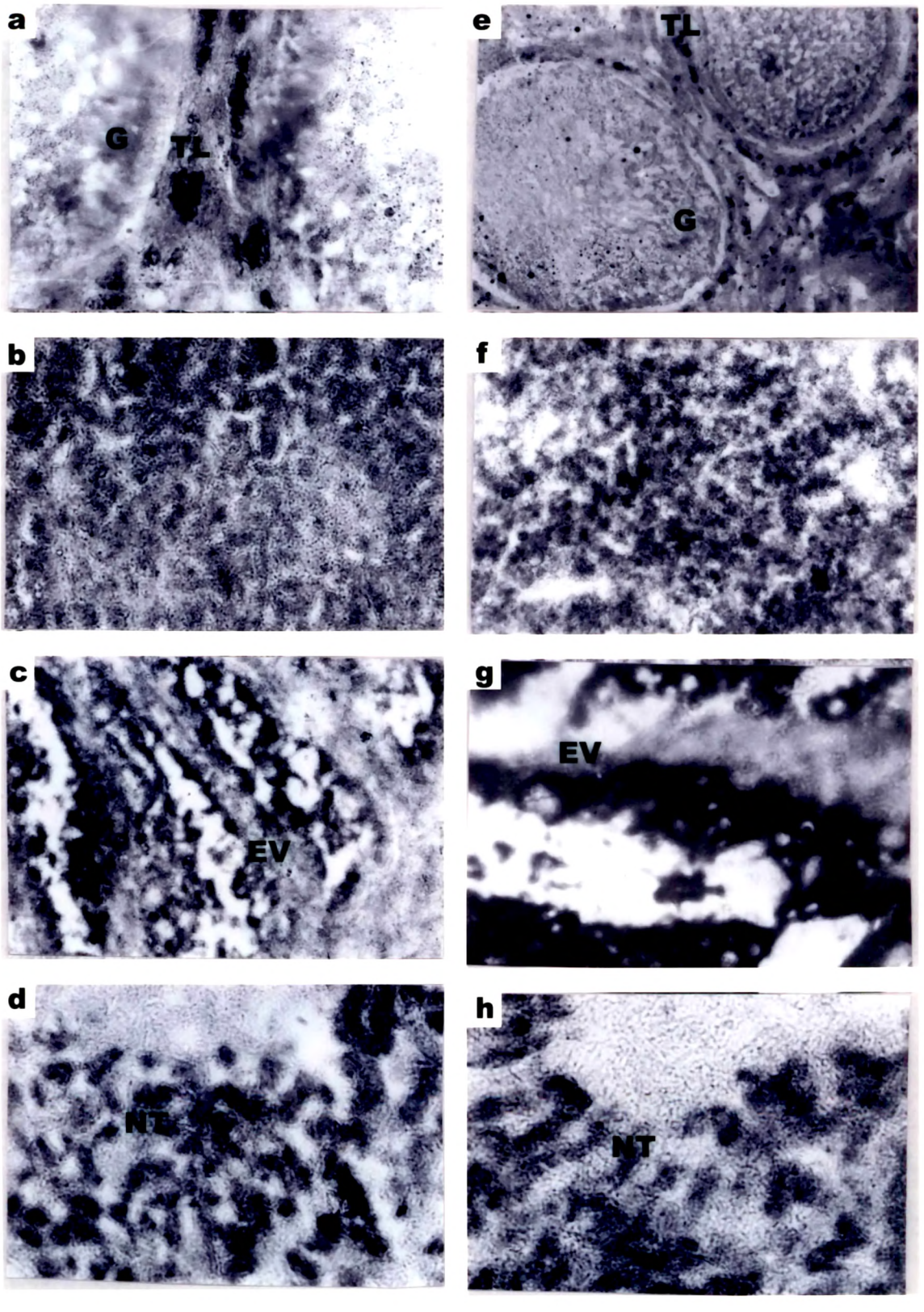


PLATE XX

3α-Hydroxysteroid dehydrogenase activities in testicular and extr testicular tissues of Bank Myna, *Acridotheres ginginianus*, ar Brahminy Myna, *Sturnus pagodarum.*

- Breeding phase -

Bank Myna ♂		**Brahminy Myna ♂**	
a. Testis	(500X)	e. Testis	(500X)
b. Liver	(800X)	f. Liver	(800X)
c. Intestine	(800X)	g. Intestine	(500X)
d. Kidney	(500X)	h. Kidney	(500X)

Abbreviation :
Tl : Theca Layer ; G : Granulosa ; EV : Epithelium of villi ;
NT : Nephric Tissue

PLATE XX

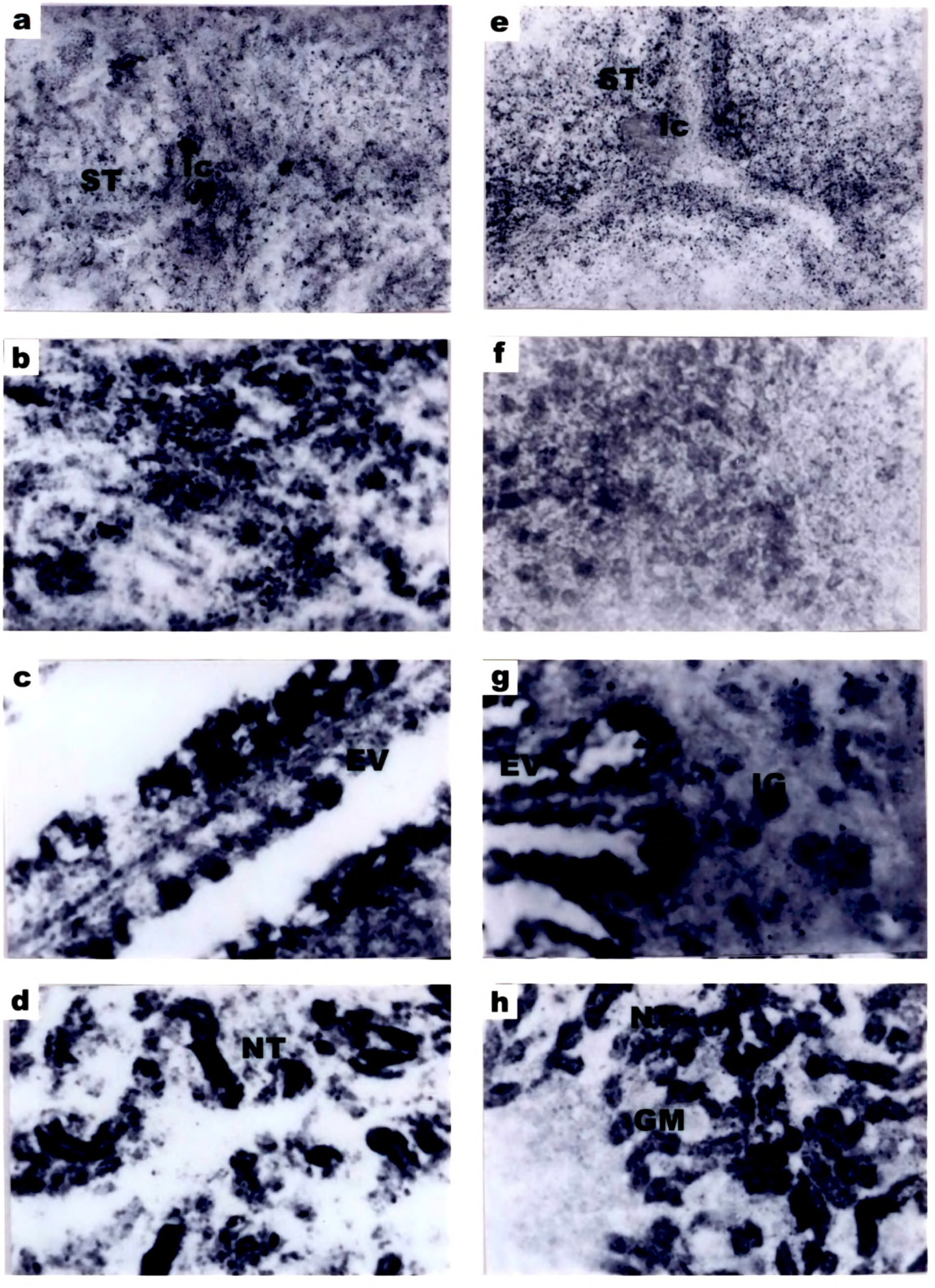


PLATE XXI

3α-Hydroxysteroid dehydrogenase activities in ovarian and extra ovarian tissues of Bank Myna, *Acridotheres ginginianus*, an Brahminy Myna, *Sturnus pagodarum*.

- Post-Breeding phase –

Bank Myna ♀		**Brahminy Myna ♀**	
a. Ovary	(500X)	e. Ovary	(500X)
b. Liver	(800X)	f. Liver	(800X)
c. Intestine	(800X)	g. Intestine	(500X)
d. Kidney	(500X)	h. Kidney	(500X)

Abbreviation :
ST : Seminiferous Tubule ; EV : Epithelium of villi ; NT : Nephric Tissue
GM : Glomerulus ; M : Medulla

PLATE **XXI**

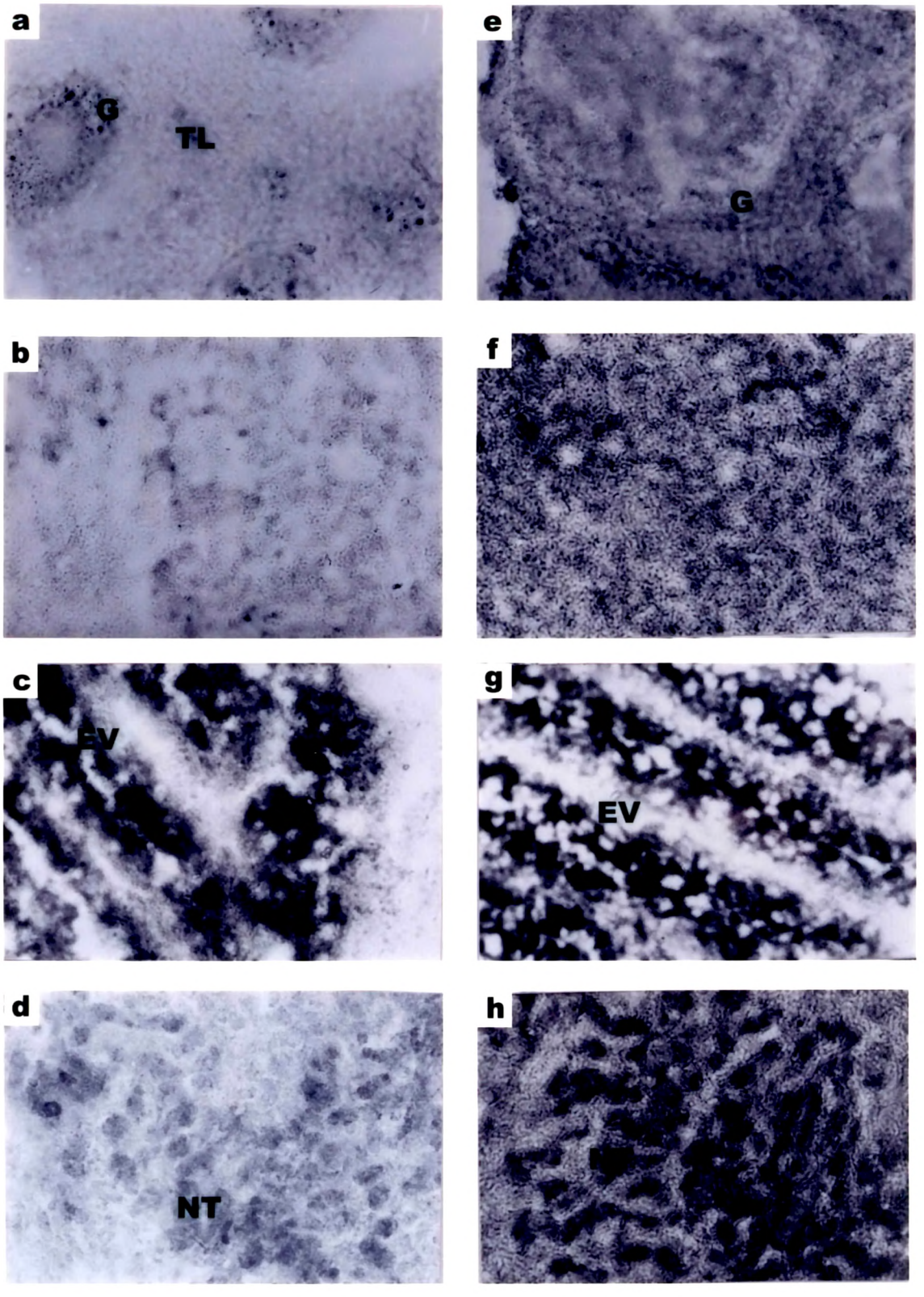


PLATE XXII

3α-Hydroxysteroid dehydrogenase activities in testicular and ext testicular tissues of Bank Myna, *Acridotheres ginginianus*, a Brahminy Myna, *Sturnus pagodarum*.

- Post-Breeding phase –

Bank Myna ♂		**Brahminy Myna** ♂	
a. Testis	(500X)	e. Testis	(500X)
b. Liver	(800X)	f. Liver	(800X)
c. Intestine	(800X)	g. Intestine	(500X)
d. Kidney	(500X)	h. Kidney	(500X)

Abbreviation :

ST : Seminiferous Tubule ; Ic : Interstitial Cells ; EV : Epithelium of vil IG : Intestinal Glands ; NT : Nephric Tissue ; GM : Glomerulus

PLATE XXII

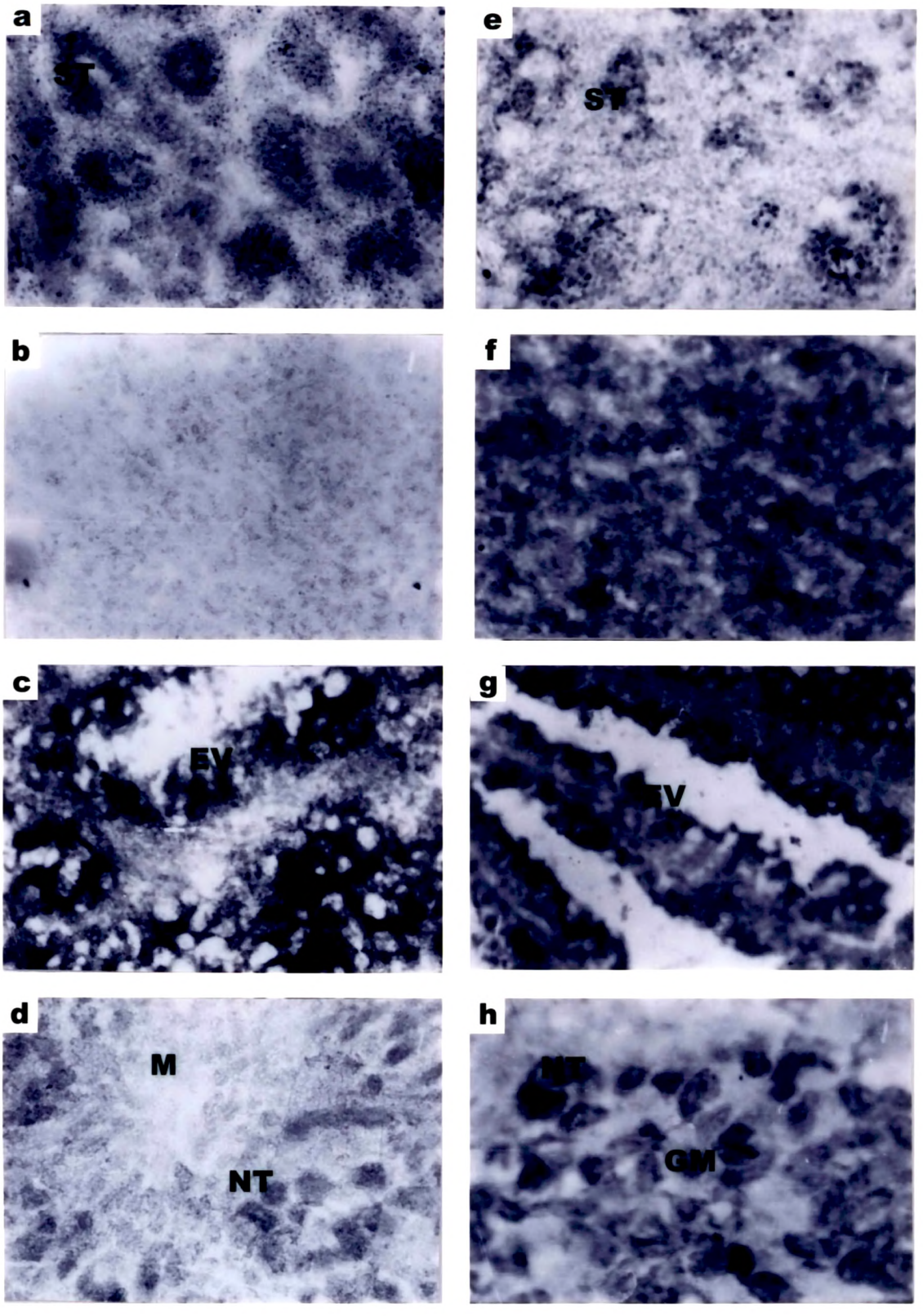


PLATE XXIII

3α-Hydroxysteroid dehydrogenase activities in ovarian and extra ovarian tissues of Bank Myna, *Acridotheres ginginianus*, and Brahminy Myna, *Sturnus pagodarum*.

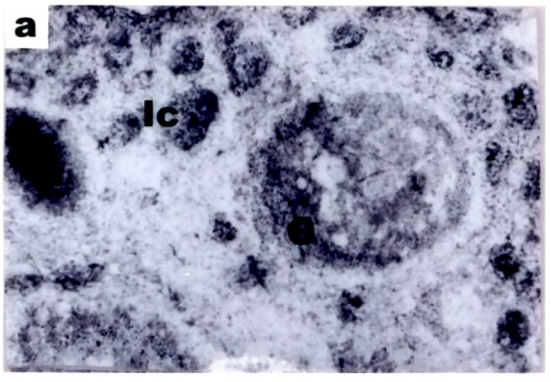
- Non-Breeding phase -

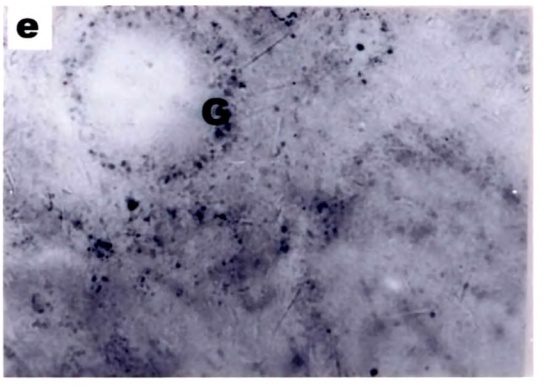
Bank Myna ♀		**Brahminy Myna** ♀	
a. Ovary	(500X)	e. Ovary	(500X)
b. Liver	(800X)	f. Liver	(800X)
c. Intestine	(800X)	g. Intestine	(500X)
d. Kidney	(500X)	h. Kidney	(500X)

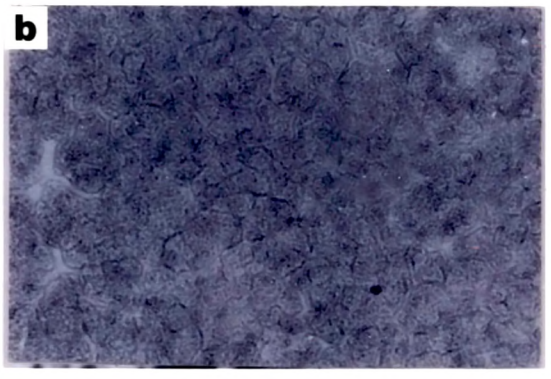
Abbreviation :

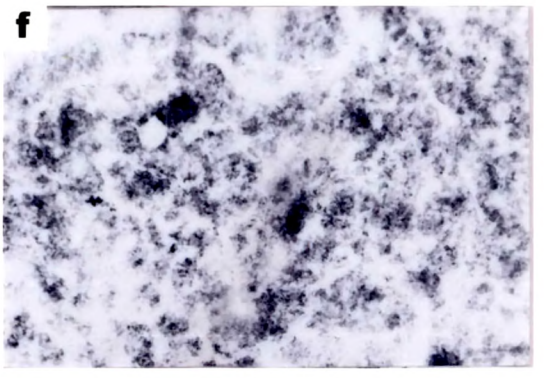
G : Granulosa ; Ic : Interstitial Cells ; EV : Epithelium of villi ; IG : Intestinal Glands ; NT : Nephric Tissue ; GM : Glomerulus

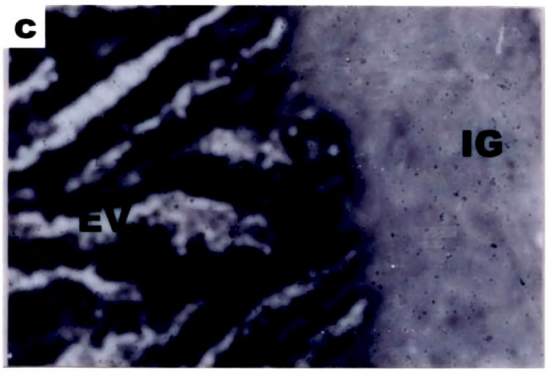
PLATE XXIII

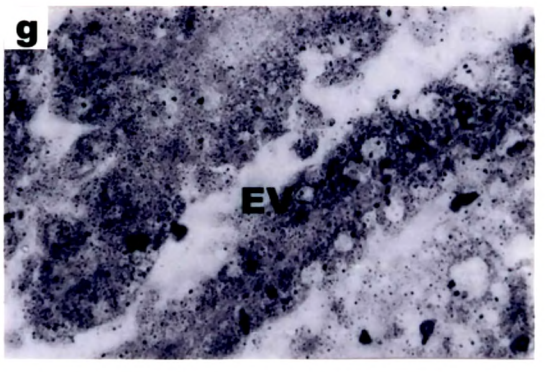


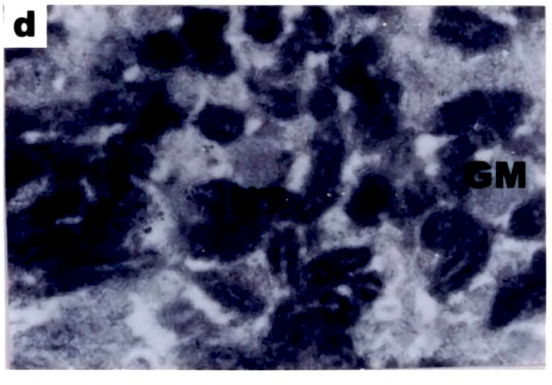












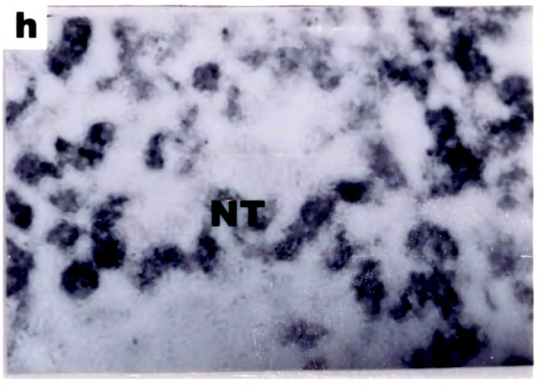


PLATE XXIV

3α-Hydroxysteroid dehydrogenase activities in testicular and extr testicular tissues of Bank Myna, *Acridotheres ginginianus*, ar Brahminy Myna, *Sturnus pagodarum*.

- Non-Breeding phase –

Bank Myna ♂		**Brahminy Myna ♂**	
a. Testis	(500X)	e. Testis	(500X)
b. Liver	(800X)	f. Liver	(800X)
c. Intestine	(800X)	g. Intestine	(500X)
d. Kidney	(500X)	h. Kidney	(500X)

Abbreviation :
ST : Seminiferous Tubule ; Ic : Interstitial Cells ; EV : Epithelium of vi
NT : Nephric Tissue ; M : Medulla

PLATE **XXIV**