CHAPTER 2

Histoenzymological observations of 17β-HSDH activity in the gonadal and extra-gonadal tissues of seasonally reproducing birds.

17β-HSDH plays an essential role in the formation of active intracellular sex steroids and it catalyzes the interconversions between the low activity, neutral and phenolic 17-oxosteroids such as androstenedione and estrone, into highly active 17β-hydroxysteroids, such as testosterone and estradiol respectively (Baillie *et al.*, 1966; Andersson *et al.*, 1995; Dufort *et al.*, 1999). 17β-HSDH is also pivotal in controlling the biological potency of steroid hormones by catalyzing oxidation or reduction at position 17 and has an important role in early evolution of physiological response (Blomquist, 1995; Peltoketo *et al.*, 1999; Jin and Lin, 1999; Adamski and Jacob, 2001; Baker, 2001). In humans, 17β-HSDH, the isozyme that converts the inactive C_{18} steroid estrone to the active estrogen-estradiol, promotes follicular maturation of the granulosa cells (Andersson and Moghrabi, 1997) and has a major role in the testosterone biosynthesis (Qin and Rosenfield, 2000). In aves, testosterone induces various secondary sex characters that differentiates the male bird from the female bird *i.e.,* the size of the comb, bill colour, structure of feathers, vocalization (Rieters *et al.*, 2002) and specific behavioral patterns like strutting, aggressive hop-charging (Soma *et al.,* 2000; Hau *et al.,* 2000; Fusani *et al.*, 2001a), wing flipping, nest-cooing etc. (Welty and Baptista, 1990). Further, hypothalamus has been reported to be stimulated by testosterone for the variations in sexual and aggressive behaviour, and is also known to influence the testes weight (Delvillie, *et al.*, 1984; Johnson, 1986b). In female birds, estrogens with progesterone are known to prime the hypothalamus and pituitary so that progesterone induces LH release (Wilson and Sharp, 1976; Phillips *et al.*, 1985). Estrogens/ estradiol enhances growth and development of the ovarian follicles and promotes the formation of tubular secretory glands and epithelial differentiation in oviduct. Estrogens also stimulate vitellogenesis (*via* its action on liver) (Mc Indoe, 1971; Giannoukos and Callard, 1995), food intake and calcium deposition during egg-laying periods (Nalbandov, 1970). Secondary sex characters such as colour and shape of bill and plumage of female birds and sexual behavior are also under the control of estrogens (Welty and Baptista, 1990; Perrins and Birkhead, 1983; Phillips *et al.*, 1985).

17β-HSDH have been identified in the extra-gonadal tissues *viz.*, liver of rabbit (Antoun *et al.*, 1985), rat (Andersson *et al.*, 1995; Lateef *et al.*, 1997), koala (Stupans *et al.*, 2000), human (Lang et al., 1986; Dufort *et al.*, 1999), intestine of rat (Farhting *et al.*, 1982), liver and intestine of rat (Andersson, 1995; Lateef *et al.*, 1997), kidney of kingfisher (Bhujle and Nadkarni, 1975) and rat (Jacobson, 1975; Ghraf *et al.*, 1975), frog brain (Mensah-Nyagan *et al.*, 1996) and other peripheral tissues (Vihko *et al.*, 2001). Presence of 17β-HSDH in the adrenal, small intestine, large intestine, kidney, liver, lung, fat, testis, prostate, seminal vesicle, ovary, myometrium and endometrium of the rhesus monkey has been reported and considered suggesting that these organs could possibly form the biologically active steroids like 17β-estradiol and dihydroxytestosterone from DHEA-sulphate (Martel *et al.*, 1994). According to Labrie *et al.*, (2000) in humans, seven types of 17β-HSDHs have been cloned which provide target cells with means of precisely controlling the intracellular concentration of each sex steroid according to local needs. These reports indicate the possibility of C-17 oxidoreduction of estrogens and androgens in the extragonadal tissues. To investigate the role of the 17β-HSDH enzyme in the gonadal and extra-gonadal tissues simultaneously and their relationship with each other, a study was carried out in two seasonally reproducing species of birds, Bank Myna, *Acridotheres ginginianus* and Brahminy Myna, *Sturnus pagodarum*, during their annual reproductive cycle. The reproductive cycle was divided into four phases: Pre-Breeding season (February to April), Breeding season (May to July), Post-Breeding season (August to October) and Non-Breeding season (November to January) on the basis of reproductive activities in and around Baroda.

Results :

Pre-Breeding Season :

During this period, the granulosa layer in the ovaries of Bank Mynas had intense 17β-HSDH activity and theca interna as well as the interstitial cells had high 17β-HSDH activities [Plate IX (a)](Table: 3). In the other species, Brahminy Myna, the granulosa had moderate, the theca interna had high, and the interstitial cells had little 17β-HSDH activities [Plate IX (e)] (Table: 3). The 17β-HSDH localization in the hepatocytes in both the species of female mynas was moderate [Plate IX (b, f)](Table: 3). On the other hand, though moderate activity was observed in the epithelium of villi of the intestine in Bank Myna females, [Plate IX (c)](Table: 4) and in the Brahminy Myna females, the epithelium of villi showed high 17β-HSDH activity [Plate IX (g)]. The intestinal glands showed little activity and the muscularis externa and tunica propria showed mild 17β-HSDH localization in the females of both the species of mynas. Further, high 17β-HSDH activity was observed in the nephric tubules of all the three (anterior, middle and posterior) lobes of kidney in the Bank Myna females [Plate IX (d)] and in the Brahminy Myna females, the activity in the kidney was moderate [Plate IX (h)][Table: 3]. The glomeruli had little enzyme activity during the pre-breeding seasons in female birds of both the species.

During the pre-breeding season, the interstitial cells in the testes of Bank Myna and Brahminy Myna showed moderate 17β-HSDH activity and the seminiferous epithelial cells had mild activity [Plate X (a, e)][Table: 4]. In the male mynas, the hepatocytes [Plate X (b, f)][Table: 4], the epithelium of villi in the intestine [Plate X (c, g)][Table: 4] and the nephric tubules in the kidney [Plate X (d, h)][Table: 4] showed moderate localization of 17β-HSDH. In the intestine, the intestinal glands showed little activity and the corium of villi showed mild activity whereas there was no activity in the tunica propria. In the glomeruli little 17β-HSDH activity was observed in both the male mynas [Plate X (d, h)][Table: 4].

Breeding Season :

In the female Bank Mynas, during the breeding months of May to July, intense 17β-HSDH activities were noted in the granulosa layer as well as the interstitial cells and the theca interna showed moderate activity [Plate XI (a)(Table: 3). Concurrently in the Brahminy Mynas, the patterns of localization of the enzyme activity did not change much [Plate XI (e)](Table: 3); it was as described in the previous season. Simultaneously, moderate 17β-HSDH activity was maintained in the hepatocytes of both the female Mynas [Plate XI (e)] as was noted during the pre-breeding months. Further, in the intestine of Bank Myna females, the epithelium of villi had moderate activity [Plate XI (c)] and the tunica propria, muscularis externa and the corium of villi showed mild 17β-HSDH activities (Table: 3). In the Brahminy Myna females, the epithelium of villi had high 17β-HSDH activity and the intestinal glands showed moderate activity [Plate XI (g)](Table: 3). The nephric tubules in the Bank Myna females had high 17β-HSDH activity [Plate XI (d)] whereas in the Brahminy Myna females moderate activity was observed [Plate XI (f)] (Table: 3) as in the pre-breeding months. Medulla had mild activity and the glomeruli had little activity in females of both the mynas.

In the male birds, an apparent change in the 17β-HSDH localization to that of the previous season was observed in the peripheral cells of the seminiferous tubules during breeding season [Table: 4]. There was a noticeable increase from mild activity of pre-breeding season to moderate activity, in the spermatogonial cells in both the male Mynas, whereas the enzyme activity was reduced to little level in the interstitial cells [Plate XII (a, e)]. At this period, the hepatocytes showed comparatively higher activity in both the species [Plate XII (b, f)][Table: 4]. The intestinal glands showed moderate 17β-HSDH activities [Table: 4], but the epithelium of villi in both the male mynas showed an increase to high level during the breeding season [Plate XII (c, g)]. In the nephric tubules also, the enzyme activity increased to high level in Bank Mynas, but was maintained at the same level as in pre-breeding phase in Brahminy Mynas. In the glomeruli, the activity was at low level in both the male mynas [Plate XII (d, h)](Table: 4).

Post-Breeding Season :

In the female birds, in the post-breeding ovaries, the 17β-HSDH activity was intense in the granulosa layer in the Bank Myna [Plate XIII (a)] and moderate in the Brahminy Myna [Plate XIII (e)] which was maintained as in the breeding season. In the interstitial cells, the enzyme activity decreased to moderate level in Bank Mynas but that in the Brahminy Mynas exhibited a slight increase. In the theca interna, the activity lowered down to little activity in both the female Mynas [Plate XIII (a, e)][Table: 3]. Among the extra-gonadal tissues, the hepatocytic 17β-HSDH activity was at the highest of all the phases noted in the post-breeding season in both the species of female Mynas [Plate XIII (b, f)][Table: 3]. The enzyme localization in the epithelium of villi of intestine was specific to the species and did not show any noticeable change when compared to previous phases in both the mynas. In the Bank Mynas, the 17β-HSDH activity was maintained at moderate level in the epithelium of villi and mild in the muscularis externa [Plate XIII (c)][Table: 3] as in the pre-breeding and the breeding months. In the Brahminy Myna females, the epithelium of villi had high activity [Plate XIII (g)] and the intestinal glands showed little 17β-HSDH activity. In the kidneys, the nephric tubules still maintained the high 17β-HSDH activity but with minimum levels in the glomeruli in both the female mynas [Plate XIII (d, h)] (Table: 3).

In the males birds of both Bank Myna and Brahminy Myna, the post-breeding testes showed high 17β-HSDH activity in the peripheral cells of the seminiferous tubules, but little activity in the interstitial cells [Plate XIV (a, e)](Table: 4). The hepatocytes [Plate XIV (c, f)] in the male mynas of both the species showed high 17β-HSDH activities. Epithelium of villi in the Brahminy Myna males [Plate XIV (g)] maintained high intensity whereas in the Bank Myna males [Plate XIV (c)], the activity decreased to moderate level. Other parts of the intestine exhibited mild 17β-HSDH activities in both the species of male birds. In the nephric tubules, the 17β-HSDH enzyme activity slightly decreased in Bank Mynas [Plate XIV (d)], but in Brahminy Mynas, [Plate XIV (h)], there was a noticeable increase. The glomelular 17β-HSDH activities were maintained at little intensity in both the species (Table: 4).

Non-Breeding Season :

In the non-breeding season, a noticeable change in the localization of 17β-HSDH activities was observed in the ovarian tissue of Bank Myna. Granulosa exhibited moderate activity, theca interna was sparsely active and the interstitial cells showed little activity [Plate XV (a)]. In case of female Brahminy Mynas [Plate XV (e)], the 17β-HSDH activities in different components of the ovarian tissues remained at levels similar to those described for the post-breeding season (Table: 3). The hepatic 17β-HSDH activities showed a distinct decline in case of Bank Myna females whereas the similar decline, to a lesser degree was noted, in the Brahminy Myna females [Plate XV (b, f)]. The enzyme activities in different parts of intestine remained more or less same as in post-breeding phase in Bank Myna females [Plate XV (c)]. In contrast to this, in Brahminy Mynas intestinal glandular activity showed an increase to moderate activity and that of villar epithelium exhibited a decline to moderate activity and the other components muscularis externa, tunica propria and the corium of villi showed little 17β-HSDH activity [Plate XV (g)] [Table: 3]. The nephric tubules in the Brahminy Myna females showed high 17β-HSDH activity whereas the same lowered significantly in the other species [Plate XV (d, h)] [Table: 3]. The glomeruli of both the species showed low activity in this season and medulla exhibited very mild intensity of 17β-HSDH.

In the male birds, as the non-breeding season set in, the 17β-HSDH activity at the peripheral cellular linings of the seminiferous tubules of the testes decreased and that of the interstitial cells became almost negligible in both the species [Plate XVI (a, e)] [Table: 4]. The hepatocytic activity decreased as compared to previous phases in both the male mynas [Plate XVI (b, f)]. The epithelium of villi showed moderate activity in both the male mynas [Plate XVI (c, g)] and the intestinal glands showed moderate activity only in the male Bank Mynas. In both the Mynas, in the muscularis externa and tunica propria no enzyme activity was observed. The nephric tubules in Bank Myna males showed weak 17β-HSDH localization, whereas in the Brahminy Myna males, it was as high as the preceding phase [Plate XVI (d, h)]. Glomerular 17β-HSDH activity was mild in the Bank Myna males and little in the Brahminy Myna males (Table: 4).

Discussion :

17β-HSDH is pivotal in controlling the biological potency of steroid hormones by catalyzing oxidation or reduction at position 17 of steroid molecule (Adamski and Jacob, 2001). Akaishi *et al.*, (1974) have observed moderate 17β-HSDH in liver of laying hens commenting on its intimate relationship with biosynthesis of ovarian steroids.

In the present study, among the three extra-gonadal tissues studied, through the female reproductive cycle, moderate presence of 17β-HSDH in hepatocytes during pre-breeding [Plate IX (b, f)], breeding [Plate XI (b, f)] and non-breeding months [Plate XV (b, f)] indicate certain positive role related to oxidative and reductive metabolic activities of 17β-HSDH in the liver (Table: 3). In both male Mynas hepatocytes showed considerably high 17β-HSDH activity during breeding [Plate XII (b, f)] and post-breeding phases [Plate XIV (b, f)], whereas in the female Mynas only during the post-breeding season hepatocytes [Plate XIII (b, f)] showed comparable high activities. Liver is the major site for androgen/estrogen metabolism where they are converted to metabolically inactive hormones (Cameron, 1964). Notable increase in 17β-HSDH activity in hepatocytes (Table: 3 & 4), during the post-breeding months in both the male and female Mynas may possibly be due to continued circulation and decreased uptake of gonadal hormones by target organs accompanied simultaneously with accelerated elimination of metabolites of various sex hormones *via* the liver. Similar observations were also reported in the case of Feral Blue Rock Pigeon, *Columba livia* (Kotak, 1979). Some indirect evidences on the involvement of hepatic tissues in non-avian species may be sighted here. Estrogen binding molecules have been reported in the cytosol and nuclear extracts of hepatocytes in the green frog, *Rana esculenta*, by Picariello *et al.*, (1982) and Paulocci and Botte, (1988), which indicate their role in the yolk protein synthesis. More recently, in the females of the same species, *Rana esculenta*, the presence of testosterone receptors (Fraction A and B) in liver have been demonstrated by ion exchange chromatography. Here, the uptake of plasma testosterone that induces hepatic aromatase system under influence of androgen receptor-fraction A, which inturn induces vitellogenin synthesis (Di Fiore *et al.*, 1998; Assissi *et al.*, 2000) has been suggested. According to Norman and Litwack (1997), in the mammalian liver, testosterone is converted to two 17-keto-compounds, androsterone and etiocholanolone, which are in turn conjugated to either glucuronic acid or sulfate to yield a water-soluble form amenable to urinary excretion.

Bile and urine supposedly are important pathways for excretion of metabolically inactive hormones (Smith, 1973). *In vivo* and *in vitro* studies of 17β-HSDH in the rat gastrointestinal tract have shown that the oxidation of testosterone is the major metabolic pathway in intestinal mucosa and the capacity of the GI tract to reduce the potency of testosterone is considerable (Farthing *et al.*, 1982). The presence of 17β-HSDH in the intestine indicates that the intestine is actively involved in the reduction and oxidation of steroid hormones - the estrogens and androgens. This can be supported by the already established facts that the 17β-HSDH type 2 catalyzes the NAD^+

dependent oxidation of androgens, estrogens and progestins in the secretory endometrium, placenta, liver and small intestine (Andersson, 1995; Andersson *et al.,* 1995; Labrie, *et al.*, 1997; Moghrabi *et al.*, 1997). Presence of 17β-HSDH in the intestine as well as nephric tubules in the Mynas strongly corroborates these reports and their possible role in steroid metabolism, as far as avian species are concerned.

From the values given for intestinal epithelium (Table: 3), it is clear that this element remains moderately functional throughout the reproductive cycle in case of the female Bank Mynas indicating its continued role in the metabolism of steroids. However, in the female Brahminy Mynas, the role of intestinal epithelium in the steroid metabolism was apparently at a higher level than the other species through first three phases of the reproductive cycle, [Plate IX (c, g); XI (c, g); XIII (c, g)], and was slightly reduced during the non-breeding phase [Plate XV (c, g)]. In the case of male birds of both the species, the situation is apparently similar to that in female birds though at a slightly lower level [Plate X (c, g); XII (c, g); XIV (c, g); XVI (c, g)](Table: 3). It is therefore obvious that 17β-HSDH in the intestinal epithelium in both the species is an efficient site of steroid metabolism almost throughout the reproductive cycle.

In the proximal and distal convoluted and collecting tubules of White-breasted Waterhen, *Amaurornis phoenicurus chinensis,* higher intensity of 17β-HSDH have been noted suggesting that the 17β-HSDH enzymes might have a role in converting certain hydroxysteroids to ketosteroids during steroid excretion (Bhujle and Nadkarni, 1975). From the observations recorded in Bank Mynas (Table: 3 & 4), it is obvious that the involvement of nephric tubules in steroid metabolism in both the sexes [Plate IX and X (d); XI and XII (d); XIII and XIV (d)] is higher in the first three phases of the reproductive cycle and declines during the non-breeding phase [Plate XV and XVI (d)]. As opposed to this, the involvement of the nephric epithelial 17β-HSDH activity in steroid metabolism in Brahminy Mynas is lower during the pre-breeding [Plate IX and X (h)] and breeding phases [Plate XI and XII (h)] but gets enhanced noticeably during the post-breeding [Plate XIII and XIV (h)] and non-breeding [Plate XV and XVI (h)] phases of the reproductive cycle. Therefore, in the pattern of involvement of the intestinal and nephric epithelia, as far as 17β-HSDH is concerned, there appears to be a marked species-specific difference between the two species.

Abbreviations :

Tl = Theca Layer	Pr−Br = Pre−Breeding
G = Granulosa	Br = Breeding
Ic = Interstitial Cells	Po−Br = Post−Breeding
S = Stroma	Non−Br = Non−Breeding

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. T= Nephric Tubules

Glom=Glomerulus

Activity pattern :

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

Table 3: 17β-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	+++	+++++	++	+	+	+	++	++
S	+	+	+	±	+	+	+	+
	Liver							
Hepatocytes	++	++	+++	+	++	++	+++	++
	Intestine							
M.ext.	±	±	±	±	±	±	±	+
T.Prop	±	±	±	±	±	±	±	+
Int.Gl.	+	++	+	+	+	++	+	++
Epi. Villi	++	++	++	++	+++	+++	+++	++
Cor. Villi	±	+	±	±	+	+	+	+
	Kidney							
Medulla	±	±	±	±	±	±	±	±
Neph.Tub.	+++	+++	+++	+	++	++	+++	+++
Glom.	+	+	+	±	+	+	+	+

Table 4: 17β-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							
Sem. Tub.	±	++	+++	++	±	++	+++	++
I. Cells	++	+	+	±	++	+	+	±
	Liver							
Hepatocytes	++	+++	+++	++	++	+++	+++	++
	Intestine							
M.ext.	±	±	±	-	±	±	±	-
T.Prop	-	±	±	-	-	±	±	-
Int.Gl.	+	++	++	++	+	++	+	+
Epi. Villi	++	+++	++	++	++	+++	+++	++
Cor. Villi	±	±	±	±	+	+	+	±
	Kidney							
Medulla	±	±	±	-	±	±	±	±
Neph.Tub.	++	+++	++	+	++	++	+++	+++
Glom.	±	+	+	±	+	+	+	+

PLATE IX

17β-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 IX

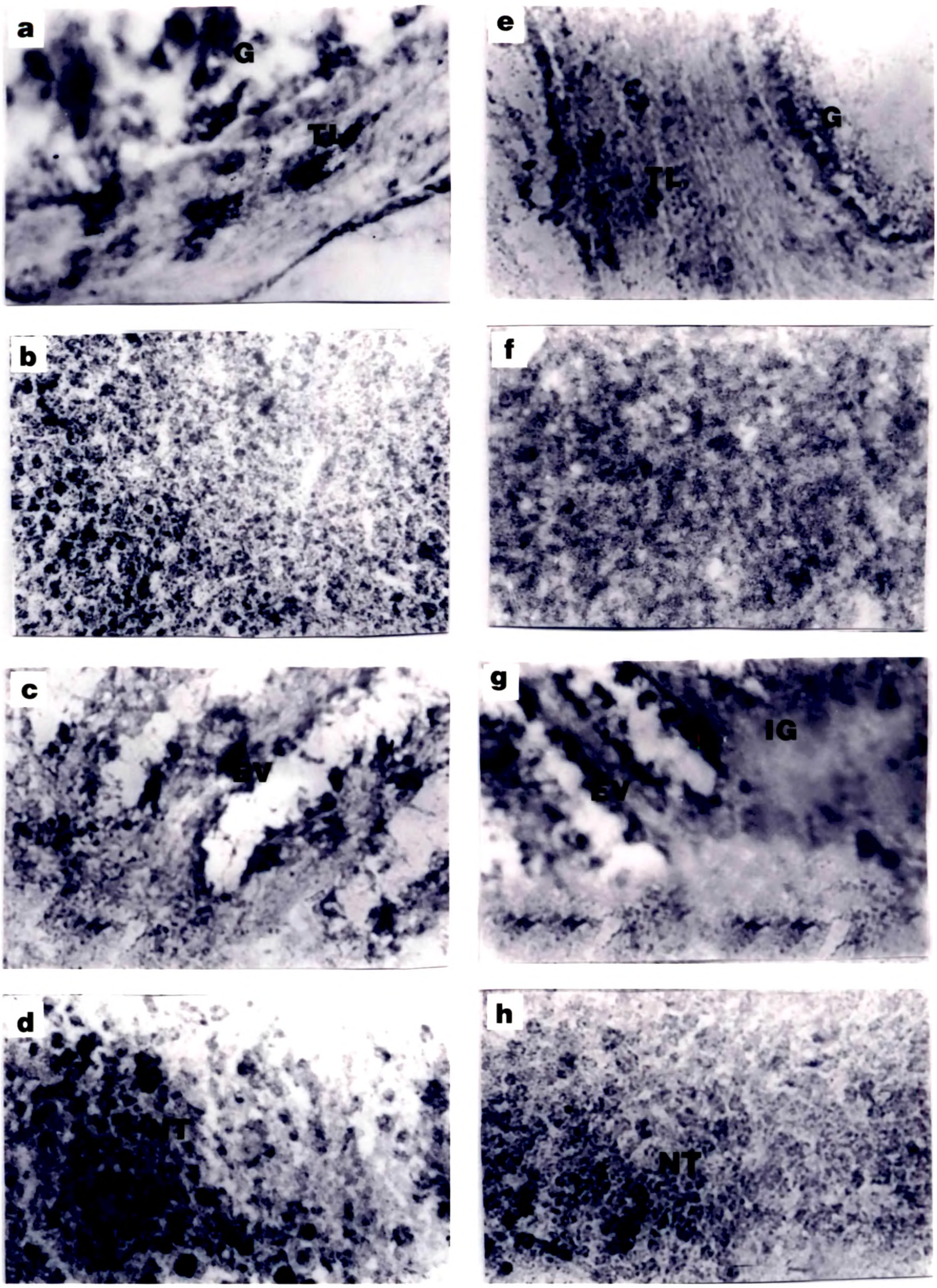

PLATE X

17β-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 ; EV : Epithelium of villi ; IG : Intestinal Glands
NT : Nephric Tissue

PLATE X

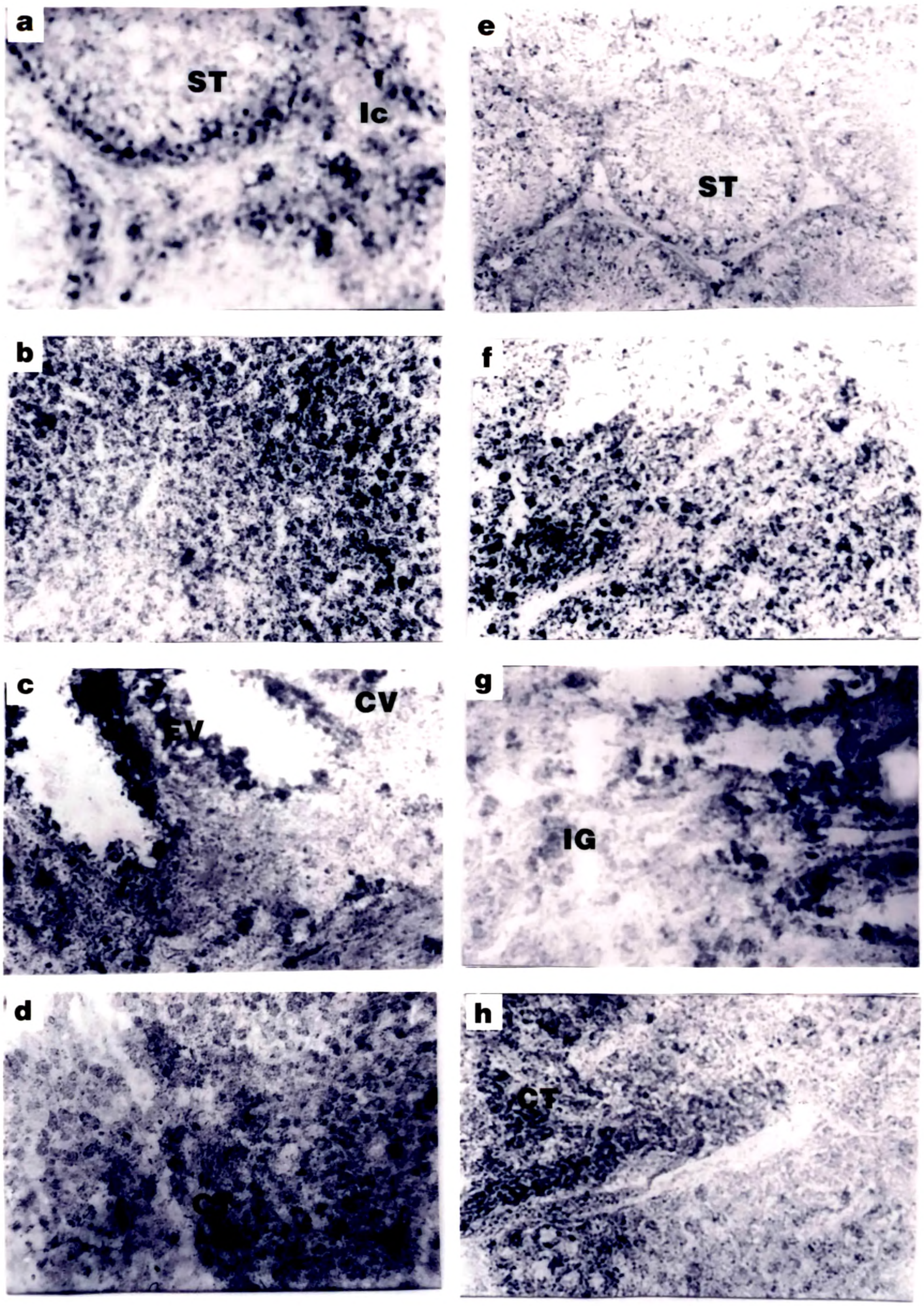

PLATE XI

17β-Hydroxysteroid dehydrogenase activities in ovarian and extra-ovarian tissues of Bank Myna, *Acridotheres ginginianus*, and 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 ; M : Medulla ; GM : GLomerulus

PLATE XI

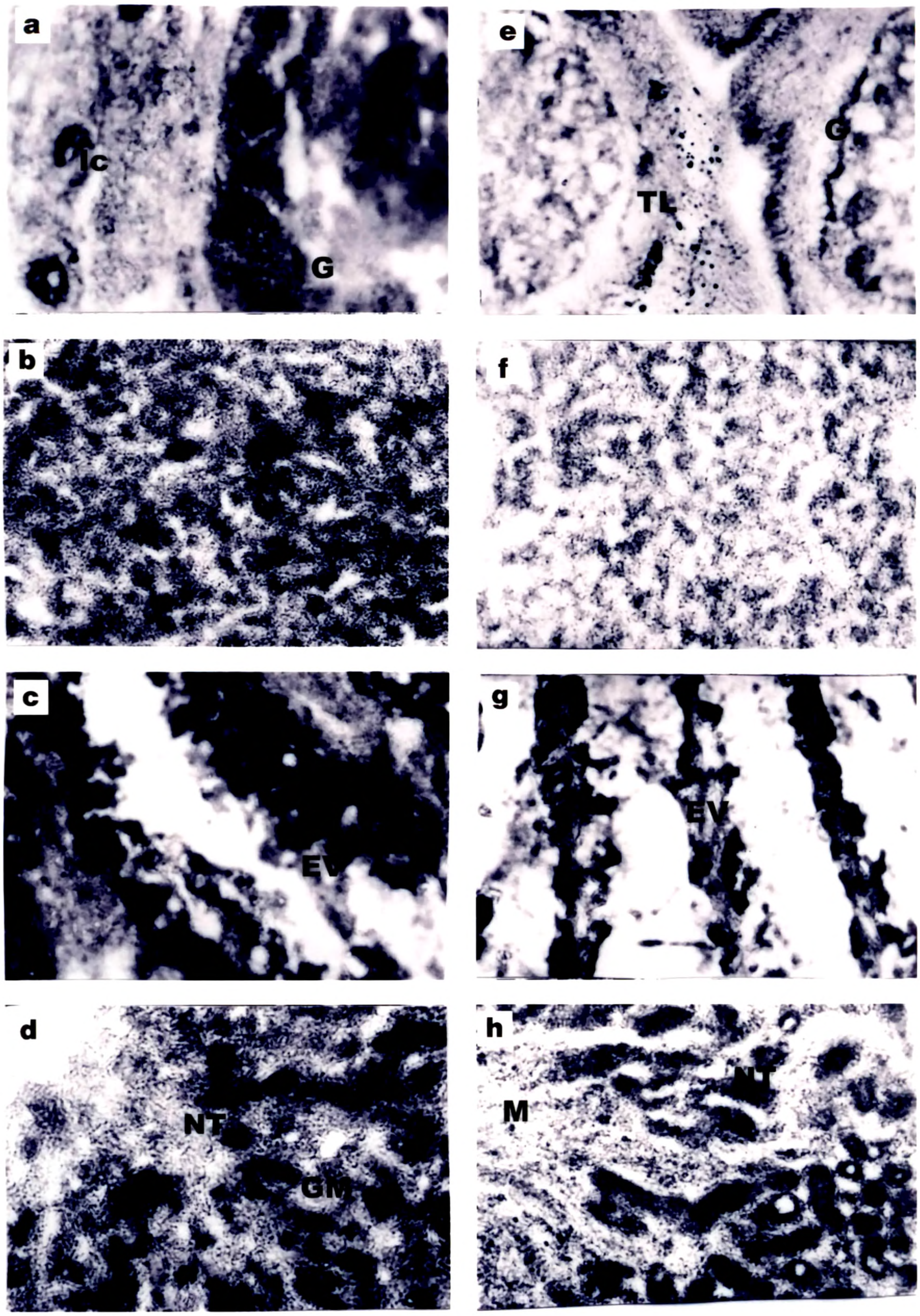

PLATE XII

17β-Hydroxysteroid dehydrogenase activities in testicular and extra-testicular tissues of Bank Myna, *Acridotheres ginginianus*, and 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 :
ST : Seminiferous Tubule ; IC : Interstitial Cells ; EV : Epithelium of villi ; NT : Nephric Tissue ; M : Medulla

PLATE XII

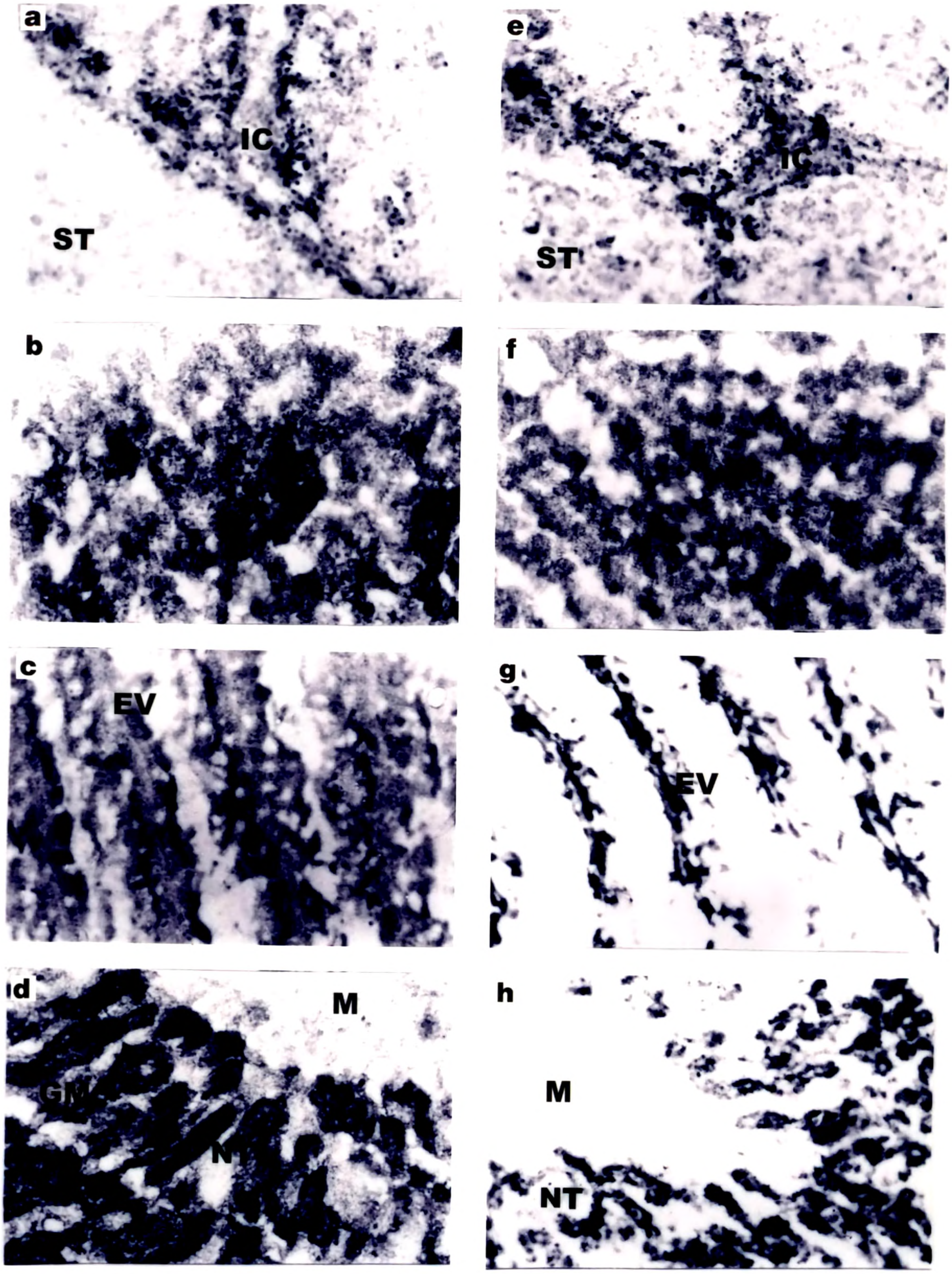

PLATE XIII

17β-Hydroxysteroid dehydrogenase activities in ovarian and extra-ovarian tissues of Bank Myna, *Acridotheres ginginianus*, and 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 :
G : Granulosa ; EV : Epithelium of villi ; NT : Nephric Tissue

PLATE XIII

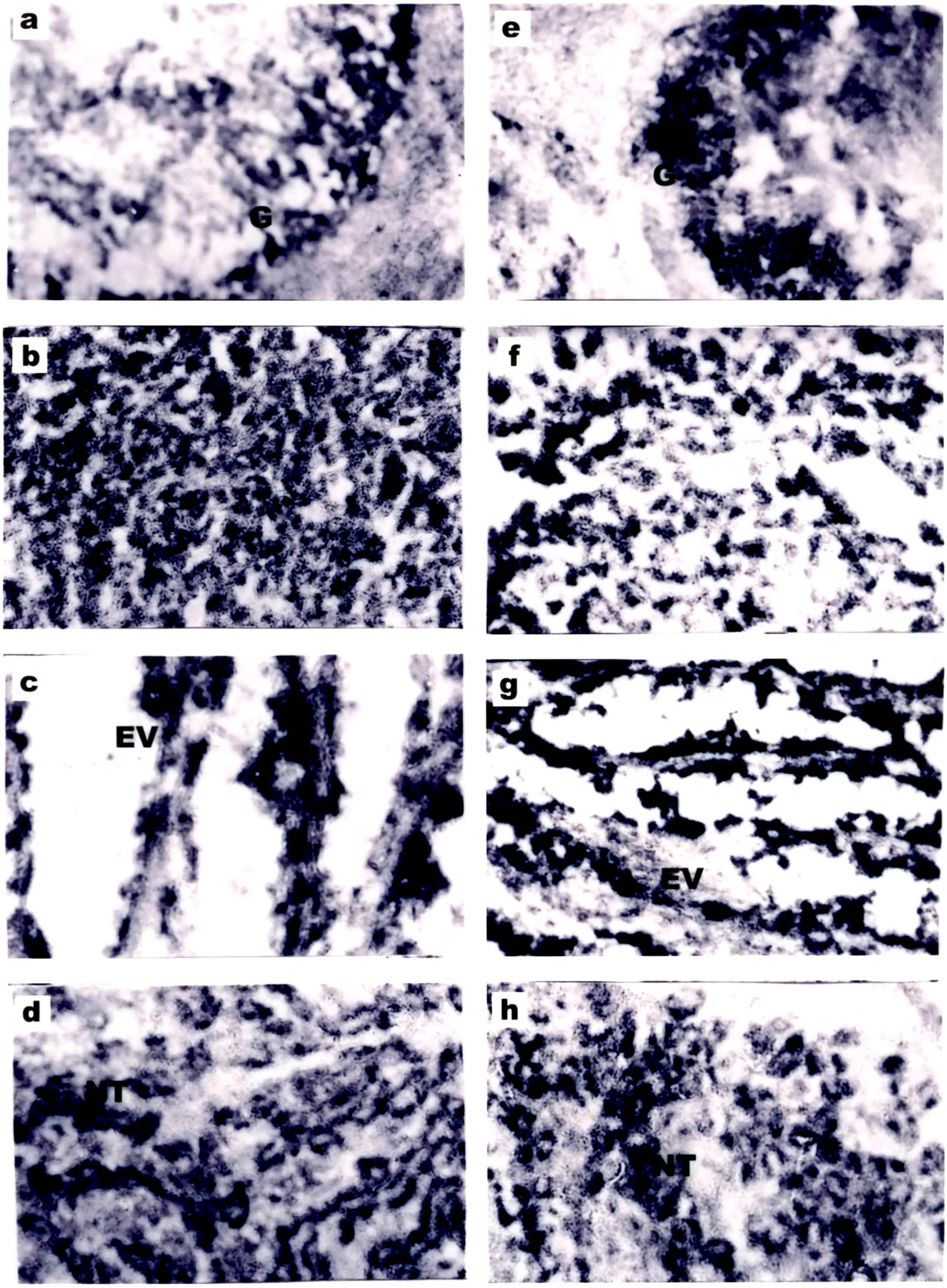

PLATE XIV

17β-Hydroxysteroid dehydrogenase activities in testicular and extra-testicular tissues of Bank Myna, *Acridotheres ginginianus*, anc Brahminy Myna, *Sturnus pagodarum*.

- Post-Breeding phase -

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

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

PLATE **XIV**

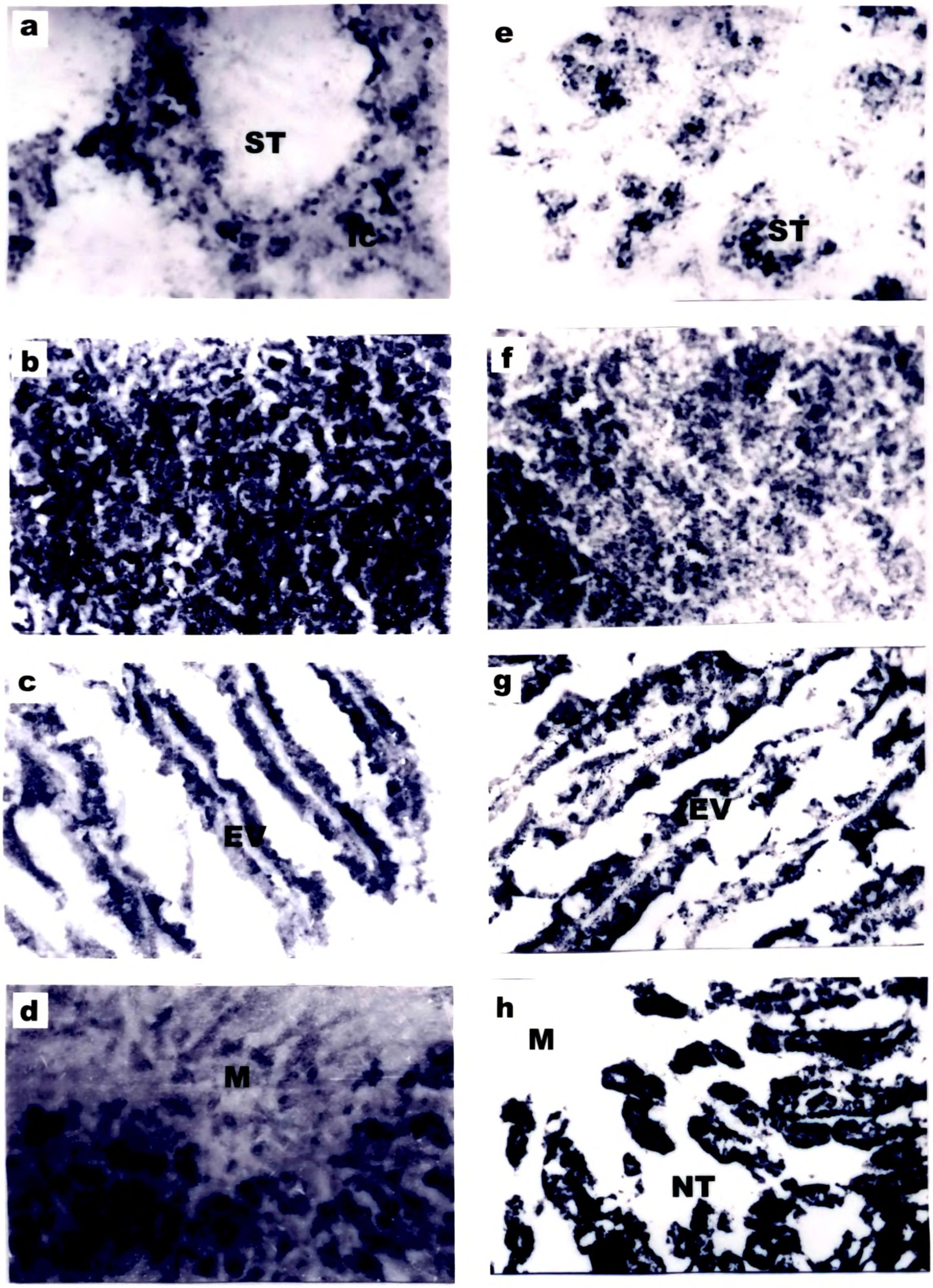

PLATE XV

17β-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 ;
NT : Nephric Tissue ; M : Medulla

PLATE XV

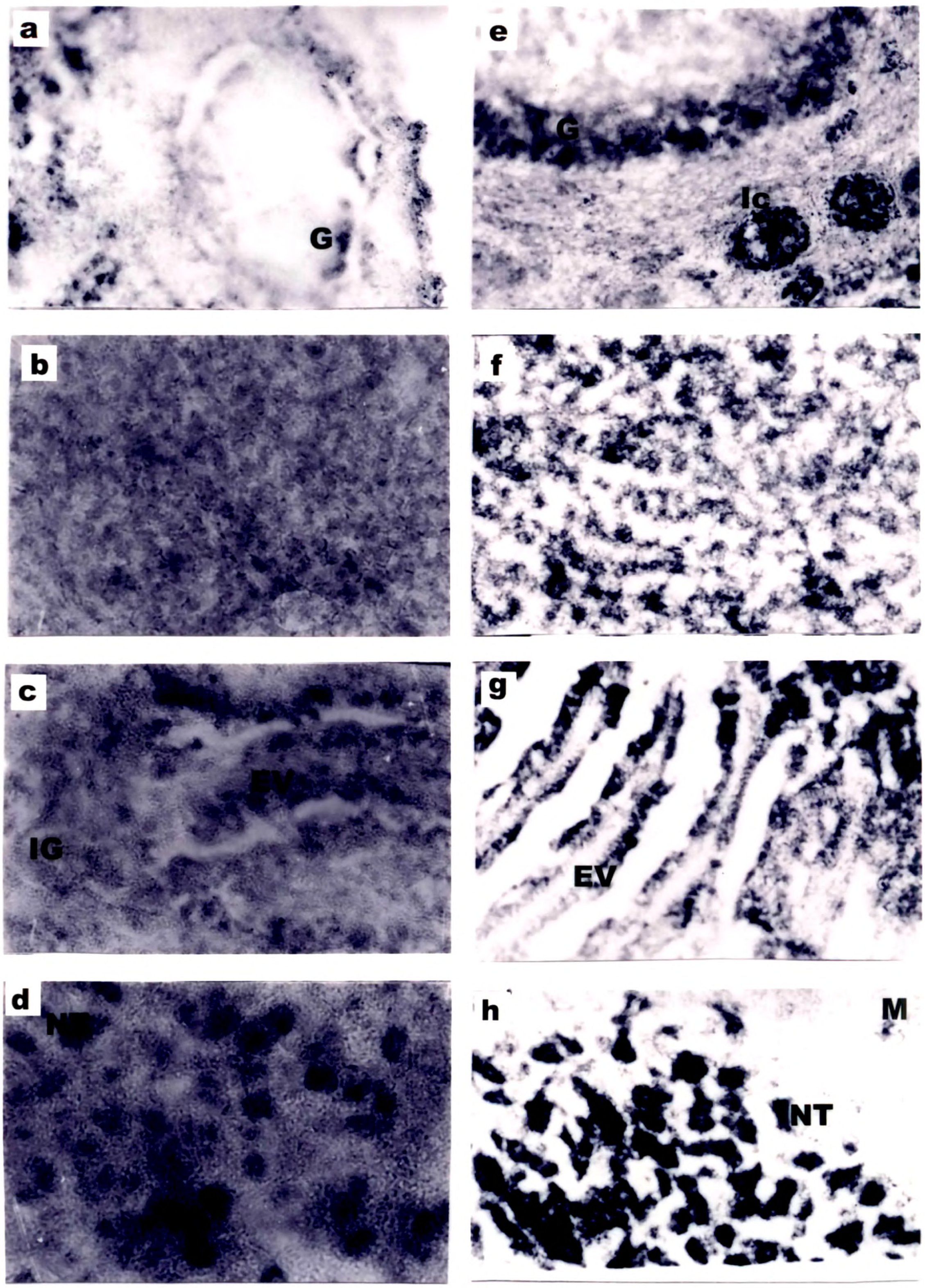

PLATE XVI

17β-Hydroxysteroid dehydrogenase activities in testicular and extra-testicular tissues of Bank Myna, *Acridotheres ginginianus*, and 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 ; EV : Epithelium of villi ; CV : Corium Of Villi ; NT : Nephric Tissue ; GM : Glomerulus ; M : Medulla

PLATE XVI