CHAPTER IX

SEASONAL ALTERATIONS IN THE LIPID FRACTIONS IN ADRENAL AND GONADS OF NORMAL AND ADRENAL MANIPULATED FERAL BLUE ROCK PIGEONS, <u>COLUMBA LIVIA</u>

Seasonal breeders usually have their breeding activity restricted to a particular part of the year which is by far the best period for reproductive activities, and for begetting and rearing the young ones. Onset of breeding activities in seasonal breeders could be triggered by any of the environmental factors (photoperiod, humidity or temperature) acting as important cues. Alone or in combination these factors could be responsible for initiating the breeding activities. These environmental cues in general activate the hypothalamo-hypophysial-gonadal axis through proper neuro-endocrine transducers. This in turn triggers off a series of well synchronised specific changes in general body metabolism in association with very intricate histophysiological changes in the gonads. Most of these alterations are induced and regulated by an interplay of other endocrine glands so as to create the right environment for the successful process of gametogenesis and reproductive behaviour. Concomitant changes in metabolic physiology in terms of alterations in metabolites and enzyme systems can be envisaged and have in fact been observed by Patel (1982) and Patel (1984) in tropical pigeons, <u>C. livia</u>.

Lipids apart from their structural and energy yielding properties are also important precursors for gonadal steroids. Quantitatively high content of lipids in gonads bespeaks of important metabolic roles that they play (Jhonson, 1970). The so called lipid cycle in relation to testicular cyclicity occurs as an integral part of annual testicular cycle in reptiles (Lofts and Boswell, 1960; Lofts et al., 1966; Lofts, 1969; Shivanandappa and Devraj, 1974) in amphibians (Lofts and Boswell, 1960; Lofts, 1965; 1974) and in some teleost fishes (Lofts and Marshall, 1957; Singh and Singh, 1979) apart from avian and mammalian species. In all the reported cases, same inverse relationship between lipids and spermatogenic cycle has been highlighted. Similar changes have been reported to occur in the ovaries too during the annual oogenic cycle (Chalana and Guraya, 1977; Singh and Singh, 1979; Singh and Singh, 1983). Further, Jhonson (1970) has opined that several factors can affect the gonadal lipid contents both qualitively and quantitatively thereby influencing the functional capability of the reproductive organs. Cortisol has been reported to affect the fatty acid composition of total lipids of plasma in eels (Dave et al., 1979). Similarly, infusion of ACTH has been reported to cause hyperglycaemia and hypercholesterolemia (Lozowski et al., 1977; Freeman and Manning, 1977; Freeman et al., 1980). Hence in the present study, seasonal alterations in the various lipid fractions of adrenal and gonads of normal and experimental (adrenal suppressed and adrenal activated) subtropical Indian pigeons have been investigated to assess the role of gonadal lipids in reproductive cyclicity and the influence of adrenal steroids thereat.

MATERIALS AND METHODS

As outlined in Chapter I

RESULTS

The results are depicted in tables 1-11 and figs. 1-9.

Seasonal Changes in Normal Birds

Both the organs, adrenal and gonads exhibited seasonal alterations in their total lipid content in accordance with the breeding cycle. Adrenal total lipids, free cholesterol and cholesterol ester were found to undergo drastic changes. A progressive increase in adrenal total lipid content was the feature with the approach of the breeding season. The increase being about 171% from its lowest level during the regression phase to the recrudescent phase and a further increase of about 21% from recrudescence to breeding. Similarly, there was a continuous increase in free cholesterol content to the tune of about 12% and 56% from regression to recrudescence and from recrudescence to breeding respectively. Contrary to this, cholesterol ester depicted a decrease (28%) from its maximum content during regression to recrudescence, with a further decrease of about 79% from recrudescence to breeding thereby recording the lowest content at this stage. However the total cholesterol content exhibited only marginal seasonal fluctuations.

Gonadal total lipid content too exhibited seasonal fluctuations. In general, the total lipid content and cholesterol contents were slightly higher in the female gonad (ovary) as compared to the male gonad (testis). However the pattern of changes in the lipid fractions of both the gonads in normal and experimental birds being identical, has been discussed under the general terms of gonadal lipids, cholesterol etc. in the text. Total cholesterol, free and esterified cholesterol, phospholipids, free fatty acids and triglycerides exhibited significant changes on a seasonal basis. Total cholesterol content was found to be maximum during regression with progressive decrease from regression to breeding through recrudescence. The free cholesterol and ester contents depicted a reciprocal relationship with the free cholesterol pool exhibiting a continuous increase from regression to recrudescence (120%) and a further increase of about 37% from recrudescence to breeding. Cholesterol ester content was found to exhibit an increase of about 22% initially from regression to recrudescence and then a fall of about 67% from recrudes-

TABLE-1 : SEASONAL ALTERATIONS OF ADRENAL TOTAL LIPID CONTENT (mg/gm DRY TISSUE WEIGHT ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, C. LIVIA

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE			
		80µg	120µg	160µg	0.5 I.U.	1µgM	1µgE	3µgM	3µgE
RECRUDESCENT	147.17 ±32.89	195.48@ ±40.21	232.86** ±44.54	247.40*** ±43.52	-	-	-	-	-
BREEDING	177.92 ±27.08	213.80* ±33.06	201.60* ±27.23	254.08+ ±36.30	-	-	-	-	-
REGRESSION	54.32 ±14.67	-	-	-	110.77++ ±23.50	93.43** ±17.32	68,69 ±9.37	102.09*** ±14.70	47.10 ±10.61

+ $P < 0.01$ @ $P < 0.02$ * $P < 0.05$ ** $P < 0.005$ *** $P < 0.0005$

M - MORNING E - EVENING

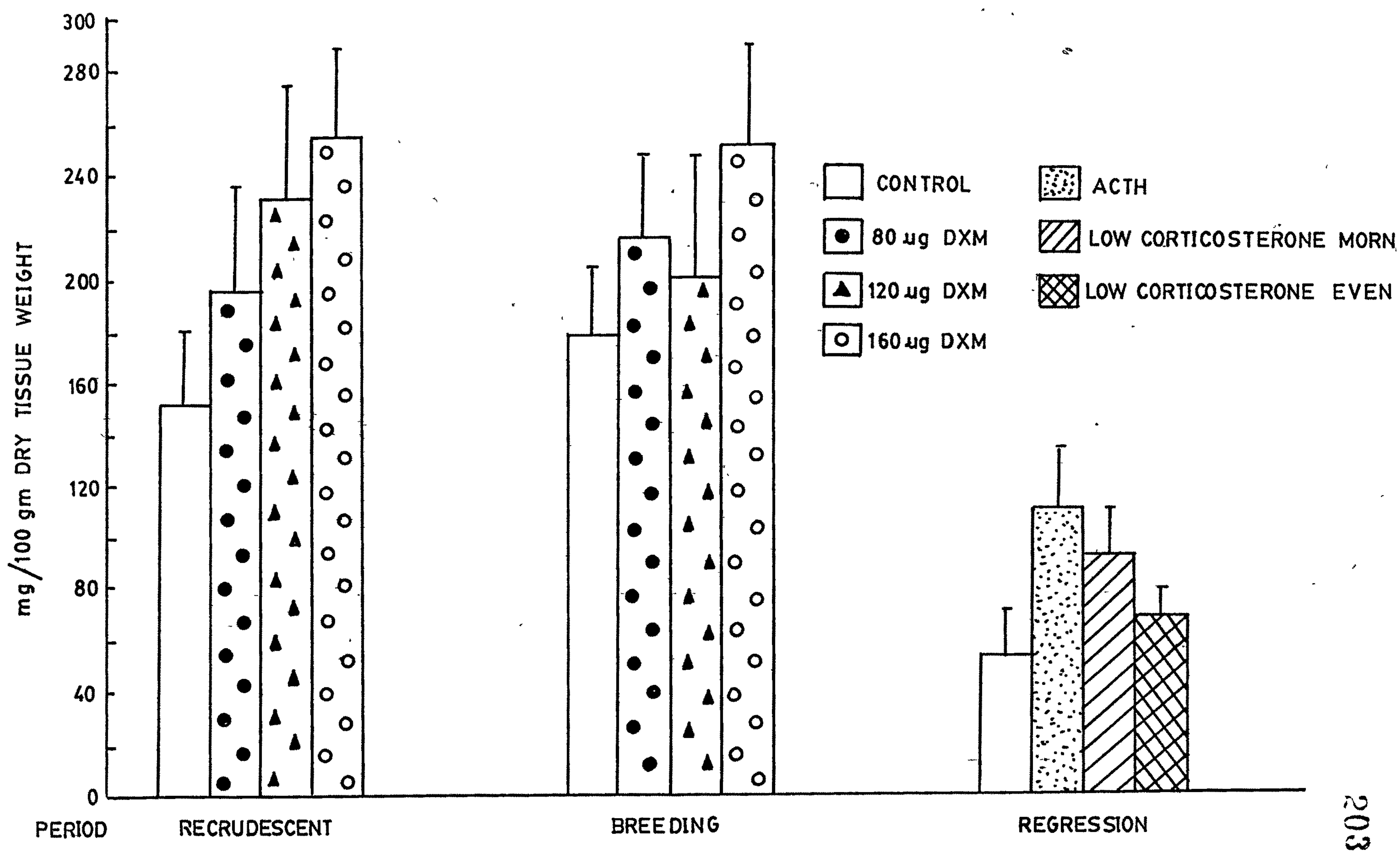

FIG.1. CHANGES IN ADRENAL TOTAL LIPID CONTENT

TABLE-2 : SEASONAL ALTERATIONS OF ADRENAL TOTAL CHOLESTEROL CONTENT (mg % TOTAL LIPID CONTENT ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, *C. LIVIA*

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE			
		80µg	120µg	160µg	0.5 I.U.	1µgM	1µgE	3µgM	3µgE
RECRUDESCENT	16.49	25.39^{+}	41.50***	32.63**	-	-	-	-	-
	±4.25	±4.01	±8.43	±9.06					
BREEDING	15.68	28.83***	30.94***	37.19***	-	-	-	-	-
	±2.24	±4.17	±8.43	±10.15					
REGRESSION	14.68	-	-	-	8.20***	10.03$^{@@}$	7.59**	7.19^{++}	6.09***
	±1.06				±1.45	±2.07	±1.23	±2.98	±1.44

++ $P < 0.001$ + $P < 0.01$ @@ $P < 0.002$ ** $P < 0.005$ *** $P < 0.0005$

M- MORNING E - EVENING

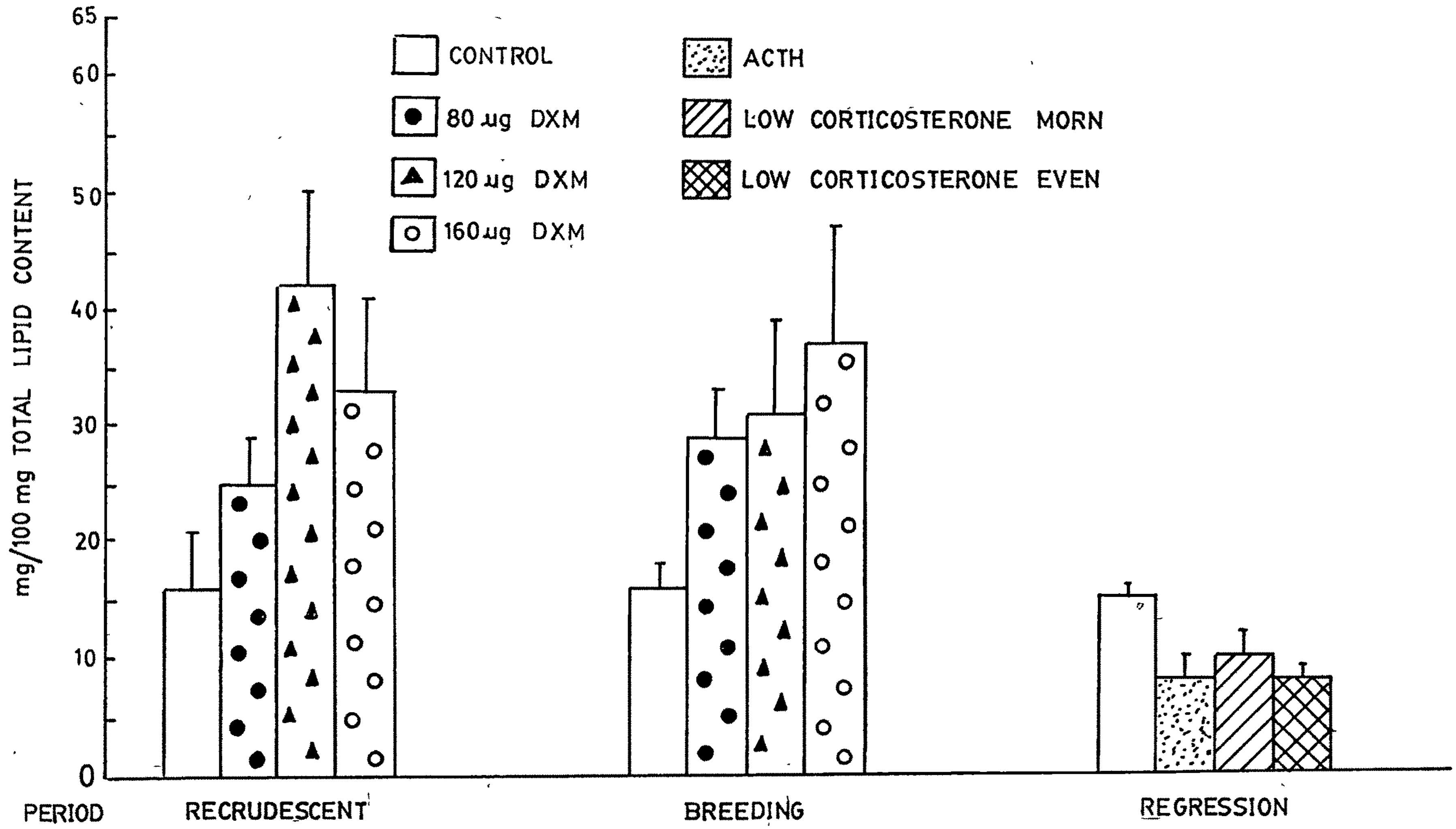

FIG.2. CHANGES IN ADRENAL TOTAL CHOLESTEROL CONTENT

TABLE-3 : SEASONAL ALTERATIONS OF ADRENAL FREE AND ESTERIFIED CHOLESTEROL CONTENT (mg % TOTAL LIPIDS; ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, C.LIVIA

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE			
		80µg	120µg	160µg	0.5 I.U.	1µgM	1µgE	3µgM	3µgE
RECRUDESCENT									
F.C.	9.90	4.49^{***}	3.8^{***}	3.6^{***}	-	-	-	-	-
	±9.90	±0.20	±0.31	±0.20					
E.C.	8.91	22.2^{***}	32.5^{***}	30.0^{***}					
	±0.41	±1.20	±1.0	±1.3					
BREEDING									
F.C.	11.1	4.05^{***}	4.10^{***}	3.09^{***}	-	-	-	-	-
	±1.12	±0.81	±0.49	±0.93					
E.C.	0.89	22.10^{***}	22.3^{***}	34.0^{***}					
	±0.08	±1.2	±2.0	±0.90					
REGRESSION									
F.C.	4.30	-	-	-	6.19^{**}	6.17^{**}	4.9	2.0^{***}	2.32^{***}
	±0.61				±0.60	±0.11	±0.29	±0.001	±0.02
E.C.	12.4	-	-	-	2.93^{***}	3.00^{***}	2.51^{***}	5.10^{***}	5.01^{***}
	±1.20				±0.11	±0.90	±0.25	±0.29	±0.04

** $P < 0.005$ *** $P < 0.0005$ M - MORNING E - EVENING

F.C. - FREE CHOLESTEROL E.C. - ESTERIFIED CHOLESTEROL

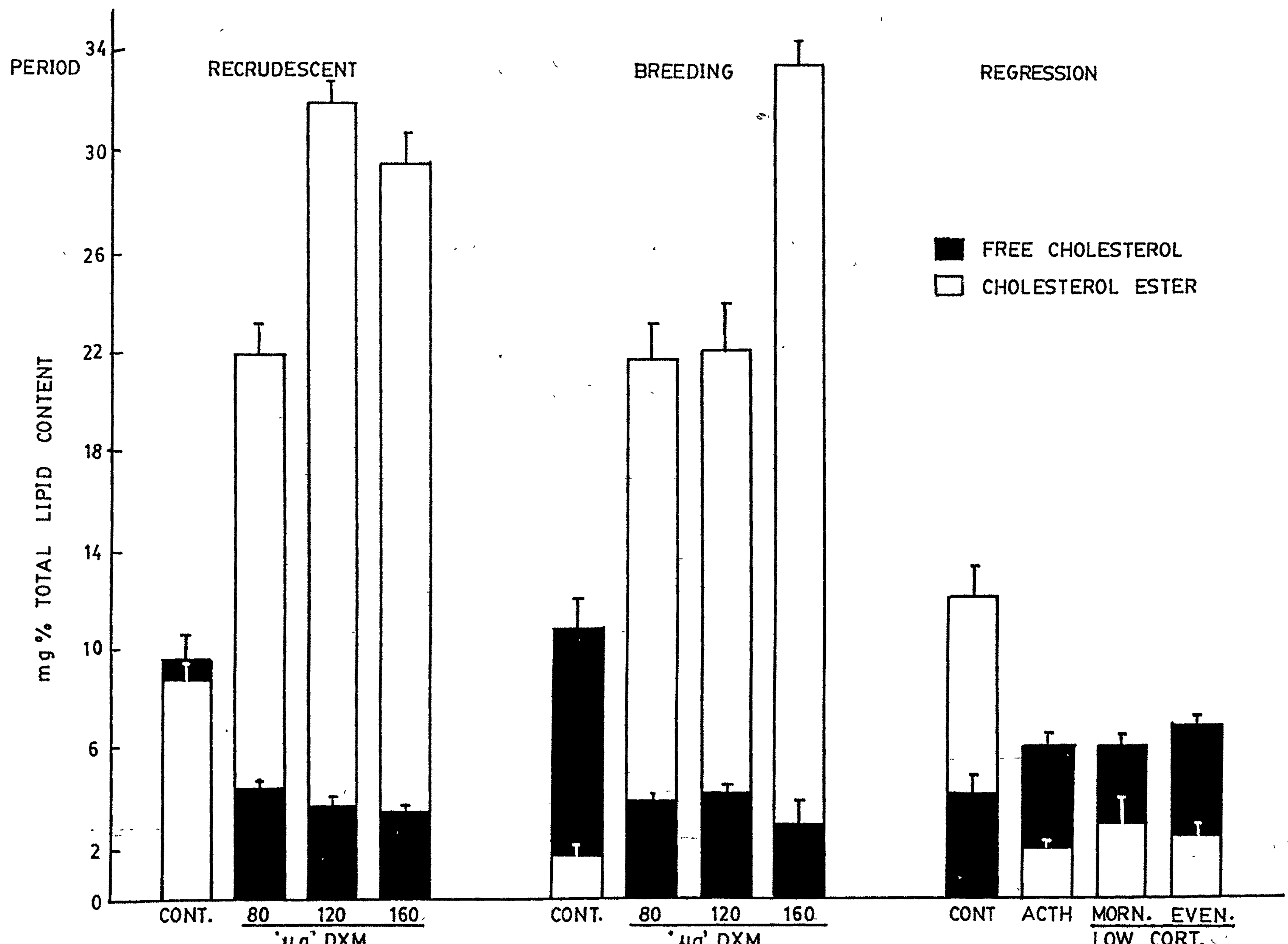

FIG.3. CHANGES IN ADRENAL CHOLESTEROL CHOLESTEROL ESTER CONTENT

TABLE-4 : SEASONAL ALTERATIONS OF TOTAL TESTICULAR LIPID CONTENT (mg/gm DRY TISSUE WEIGHT; ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, *C.LIVIA*

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE	
		80μg	120μg	160μg	0.5 I.U.	1μgM	1μgE
RECRUDESCENT	42.10 ±6.0	89.90+ ±8.60	95.68+ ±9.99	99.79+ ±10.20	-	-	-
BREEDING	30.00 ±6.19	48.10* ±4.89	52.9* ±6.20	51.20* ±4.89	-	-	-
REGRESSION	50.09 ±1.11	-	-	-	40.00+ ±4.00	38.89+ ±4.32	47.19 ±7.68

+ $P < 0.01$ * $P < 0.05$

M - MORNING E - EVENING

TABLE-5 : SEASONAL ALTERATIONS OF TOTAL OVARIAN LIPID CONTENT (mg/gm DRY TISSUE WEIGHT; ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, *C. LIVIA*

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE	
		80µg	120µg	160µg	0.5 I.U.	1µgM	1µgE
RECRUDESCENT	56.79	112.25**	75.39**	69.59**	-	-	-
	±10.06	±18.4	±9.60	±7.89			
BREEDING	40.99	68.12**	70.12**	71.11**	-	-	-
	±4.07	±6.23	±7.12	±3.45			
REGRESSION	68.98	-	-	-	52.19*	50.19*	65.29
	±2.98				±2.8	±1.99	±5.68

* $P < 0.05$ ** $P < 0.005$

M - MORNING E - EVENING

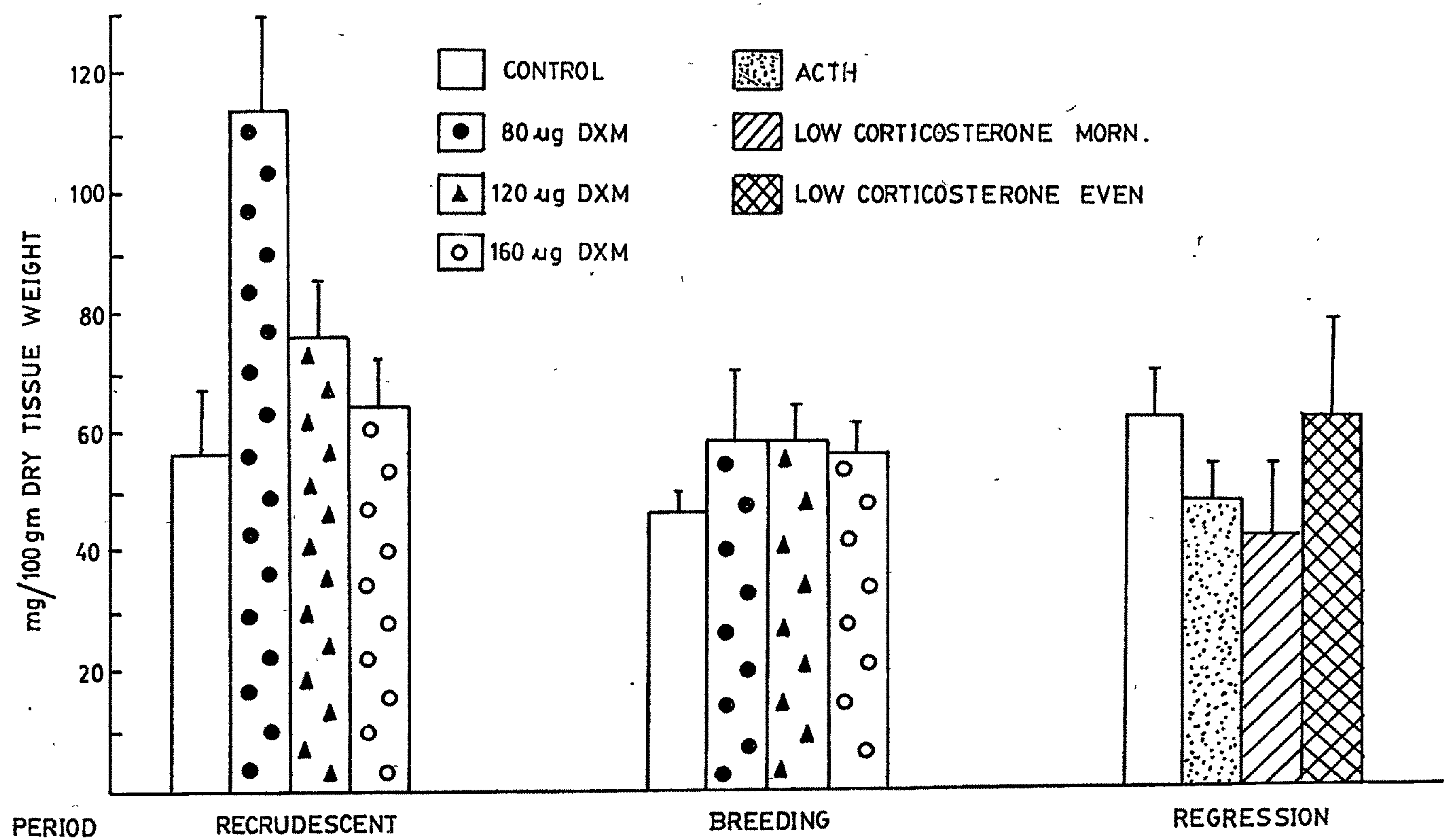

FIG.4. CHANGES IN GONADAL TOTAL LIPID CONTENT

TABLE-6 : SEASONAL ALTERATIONS OF TESTICULAR TOTAL CHOLESTEROL CONTENT (mg/100mg WET TISSUE WEIGHT; ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, *C.LIVIA*

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE	
		80µg	120µg	160µg	0.5 I.U.	1µgM	1µgE
RECRUDESCENT	0.75	1.25^{+}	1.00^{+}	1.36^{+}	-	-	-
	±0.23	±0.26	±0.22	±0.27			
BREEDING	0.51	1.11^{++}	1.37^{++}	1.53^{++}	-	-	-
	±0.13	±0.11	±0.05	±0.09			
REGRESSION	1.30	-	-	-	0.67^{+}	0.68^{+}	$0.75^{@}$
	±0.90				±0.12	±0.06	±0.12

$+$ $P < 0.01$ $++$ $P < 0.001$ @ $P < 0.02$

M - MORNING   E - EVERNING

TABLE-7 : SEASONAL ALTERATIONS OF OVARIAN TOTAL CHOLESTEROL CONTENT (mg/100mg WET TISSUE WEIGHT; ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, *C.LIVIA*

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE	
		80µg	120µg	160µg	0.5 I.U.	1µgM	1µgE
RECRUDESCENT	1.45 ±0.09	2.09^{+} ±0.40	2.33^{+} ±0.31	2.62^{+} ±0.33	-	-	-
BREEDING	1.00 ±0.04	2.90^{++} ±0.23	2.60^{++} ±0.61	2.71^{++} ±0.39	-	-	-
REGRESSION	2.09 ±0.09	-	-	-	1.01^{+} ±0.09	$1.12^{@}$ ±0.06	1.09^{+} ±0.09

+ $P < 0.01$ ++ $P < 0.001$ @ $P < 0.02$

M - MORNING E - EVENING

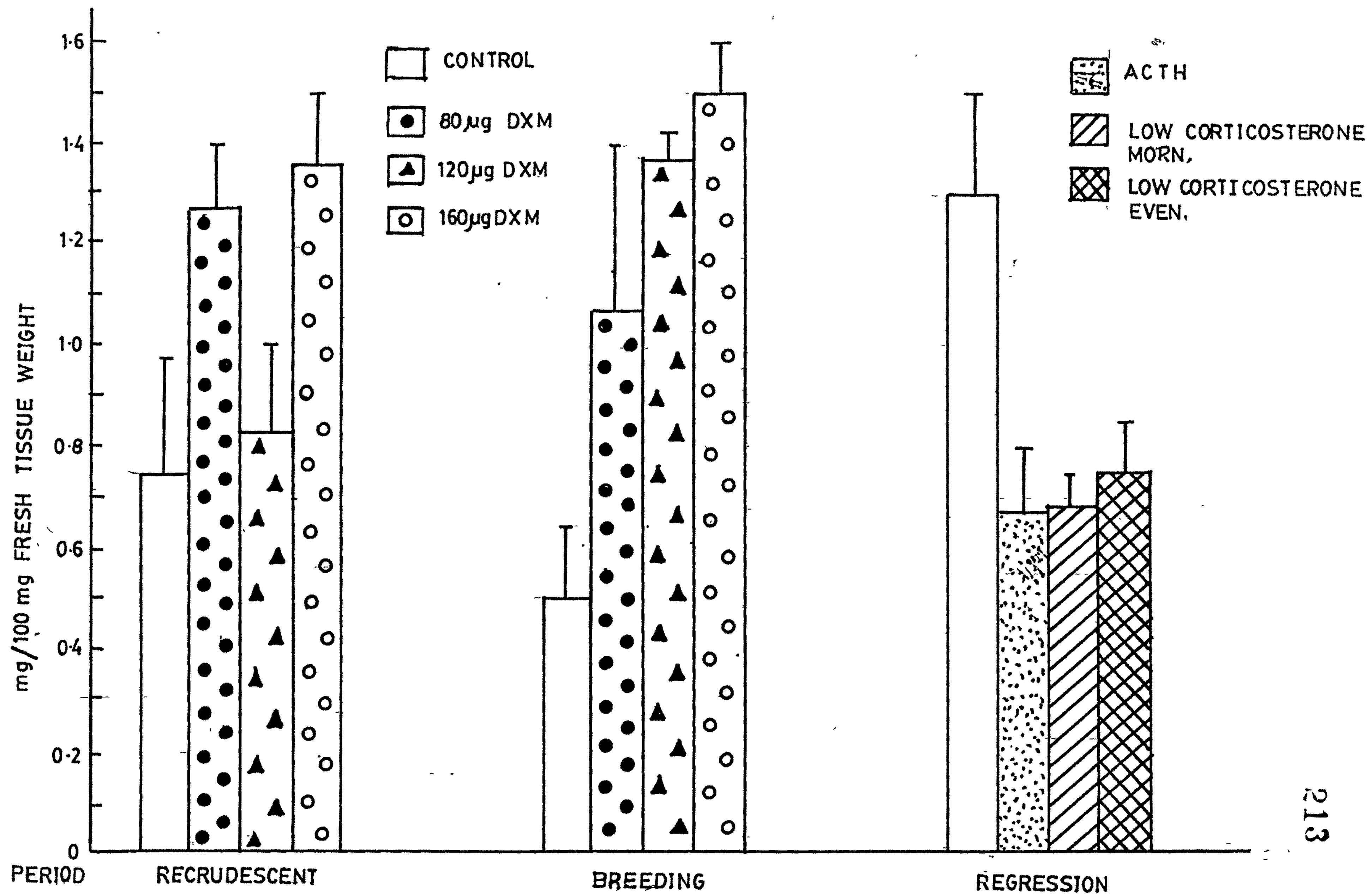

FIG.5. CHANGES IN GONADAL TOTAL CHOLESTEROL CONTENT

TABLE-8 : SEASONAL ALTERATIONS OF GONADAL FREE AND ESTERIFIED CHOLESTEROL CONTENT (mg % TOTAL LIPID CONTENT; ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, *C. LIVIA*

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE	
		80μg	120μg	160μg	0.5 I.U.	1μgM	1μgE
RECRUDESCENT							
F.C.	4.33	1.12***	1.00***	1.00***	-	-	-
	±0.22	±0.001	±0.009	±0.69			
E.C.	4.00	5.86***	4.92**	5.00***	-	-	-
	±0.06	±0.09	±0.41	±0.10			
BREEDING							
F.C.	5.92	1.92***	1.00***	0.98***	-	-	-
	±0.69	±0.001	±0.004	±0.001			
E.C.	2.01	5.92***	4.25***	2.32***	-	-	-
	±0.29	±0.09	±0.004	±0.04			
REGRESSION							
F.C.	1.96	-	-	-	5.24***	6.11***	2.92***
	±0.001				±0.62	±0.06	±0.40
E.C.	4.92	-	-	-	3.11**	2.01***	3.10**
	±0.04				±0.003	±0.02	±0.42

** $P<0.005$ *** $P<0.0005$

M - MORNING E - EVENING F.C. - FREE CHOLESTEROL
E.C. - ESTERIFIED CHOLESTEROL

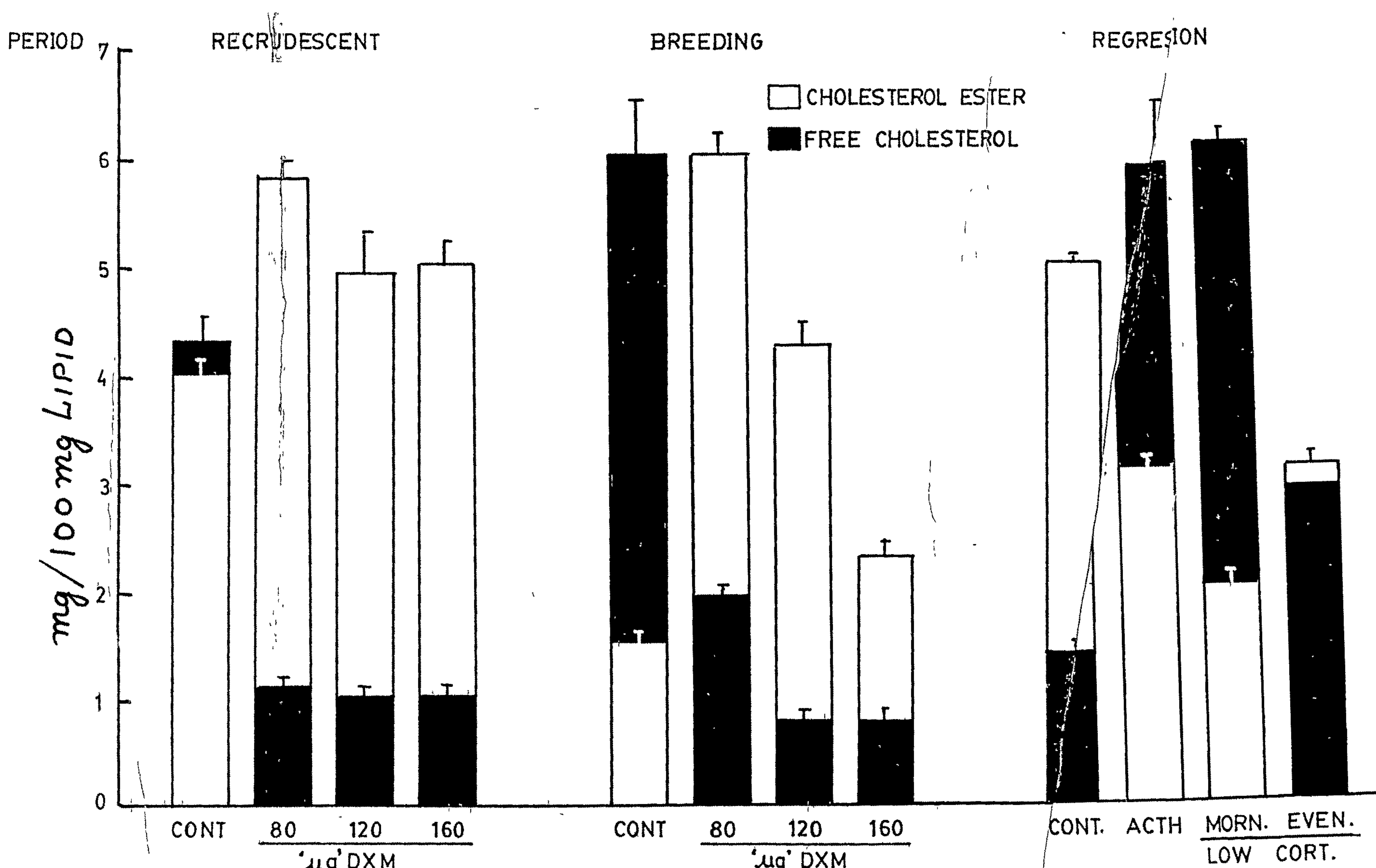

FIG.6. CHANGES IN GONAD CHOLESTEROL/CHOLESTEROL ESTER CONTENT

TABLE-9 : SEASONAL ALTERATIONS OF GONADAL TRI GLYCERIDE CONTENT (mg % TOTAL LIPID CONTENT; ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, *C.LIVIA*

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE	
		80μg	120μg	160μg	0.5 I.U.	1μgM	1μgE
RECRUDESCENT	13.69	16.39***	16.76***	16.93***	-	-	-
	±0.62	±0.21	±0.99	±0.76			
BREEDING	12.69	14.69**	16.60***	19.08***	-	-	-
	±0.39	±0.99	±0.68	±1.09			
REGRESSION	25.96	-	-	-	13.99***	13.90***	14.68***
	±0.12				±0.38	±1.00	±0.86

** $P < 0.005$ *** $P < 0.0005$

M - MORNING E - EVENING

TABLE-10 : SEASONAL ALTERATIONS OF GONADAL PHOSPHOLIPID CONTENT (mg % TOTAL LIPID CONTENT; ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, *C.LIVIA*

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE	
		80µg	120µg	160µg	0.5 I.U.	1µgM	1µgE
RECRUDESCENT	39.68	44.20**	43.92**	43.69**	-	-	-
	±0.71	±0.72	±1.29	±1.10			
BREEDING	38.28	48.29***	46.20***	48.99***	-	-	-
	±1.70	±0.93	±0.38	±0.53			
REGRESSION	47.03	-	-	-	30.29***	31.23**	34.32**
	±1.76				±1.32	±0.91	±2.39

** $P < 0.005$ *** $P < 0.0005$

M - MORNING E - EVENING

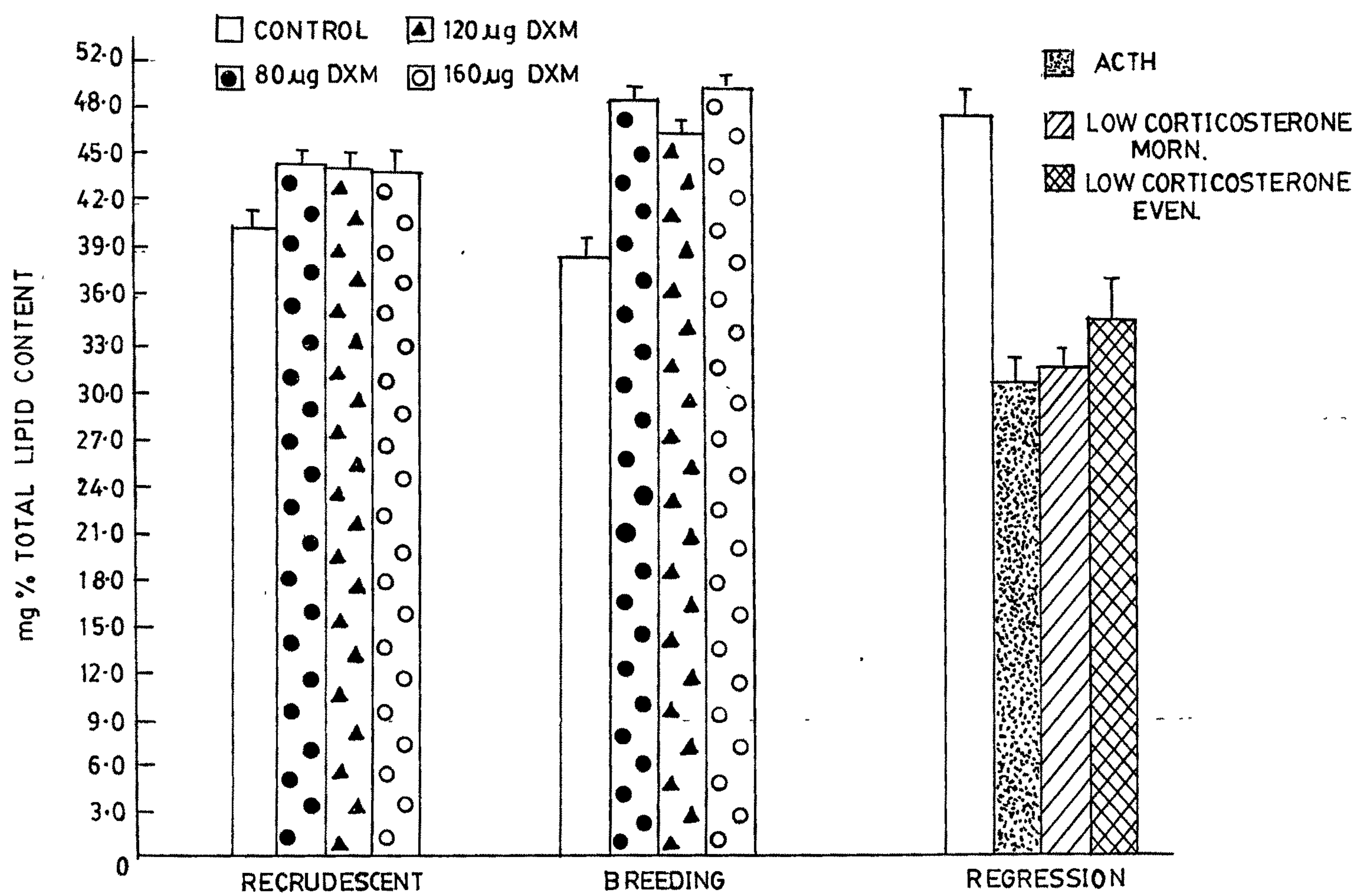

FIG. 7. CHANGES IN GONADAL PHOSPHOLIPID CONTENT

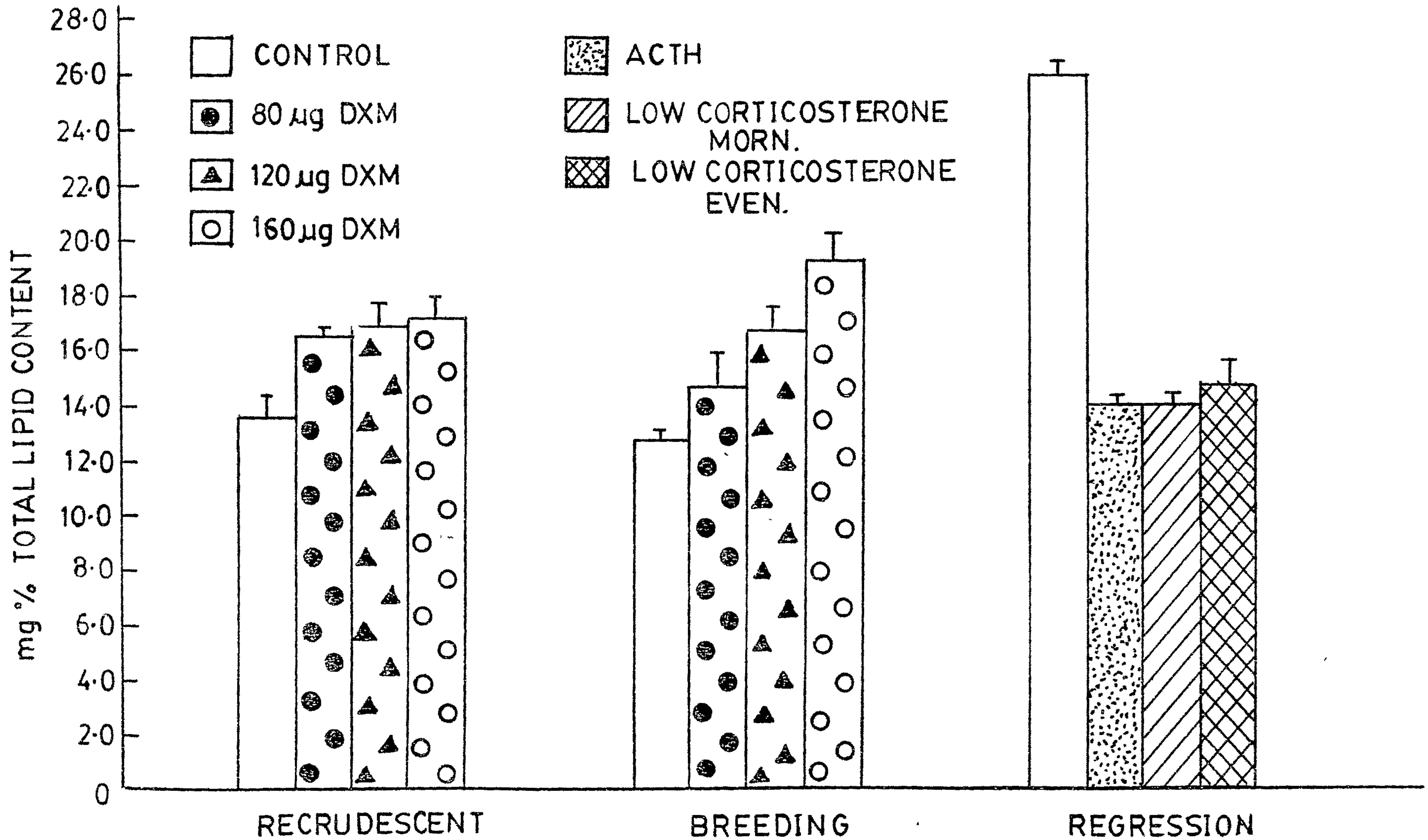

FIG.8. CHANGES IN GONADAL TRIGLYCERIDE CONTENT

TABLE-11 : SEASONAL ALTERATIONS OF GONADAL FFA CONTENT (mg % TOTAL LIPID CONTENT; ± S.D.) IN NORMAL AND EXPERIMENTAL PIGEONS, C. LIVIA

REPRODUCTIVE PHASES	NORMAL	DEXAMETHASONE			ACTH	CORTICOSTERONE	
		80µg	120µg	160µg	0.5 I.U.	1µgM	1µgE
RECRUDESCENT	18.63	10.10***	12.10***	13.20++	-	-	-
	±1.86	±1.00	±2.20	±3.06			
BREEDING	22.96	10.10***	16.29++	16.39++	-	-	-
	±2.0	±0.10	±2.10	±3.00			
REGRESSION	15.63	-	-	-	21.23*	20.00*	18.19
	±1.59				±1.57	±3.0	±2.52

++ $P < 0.001$ * $P < 0.05$ *** $P < 0.0005$

M - MORNING E - EVENING

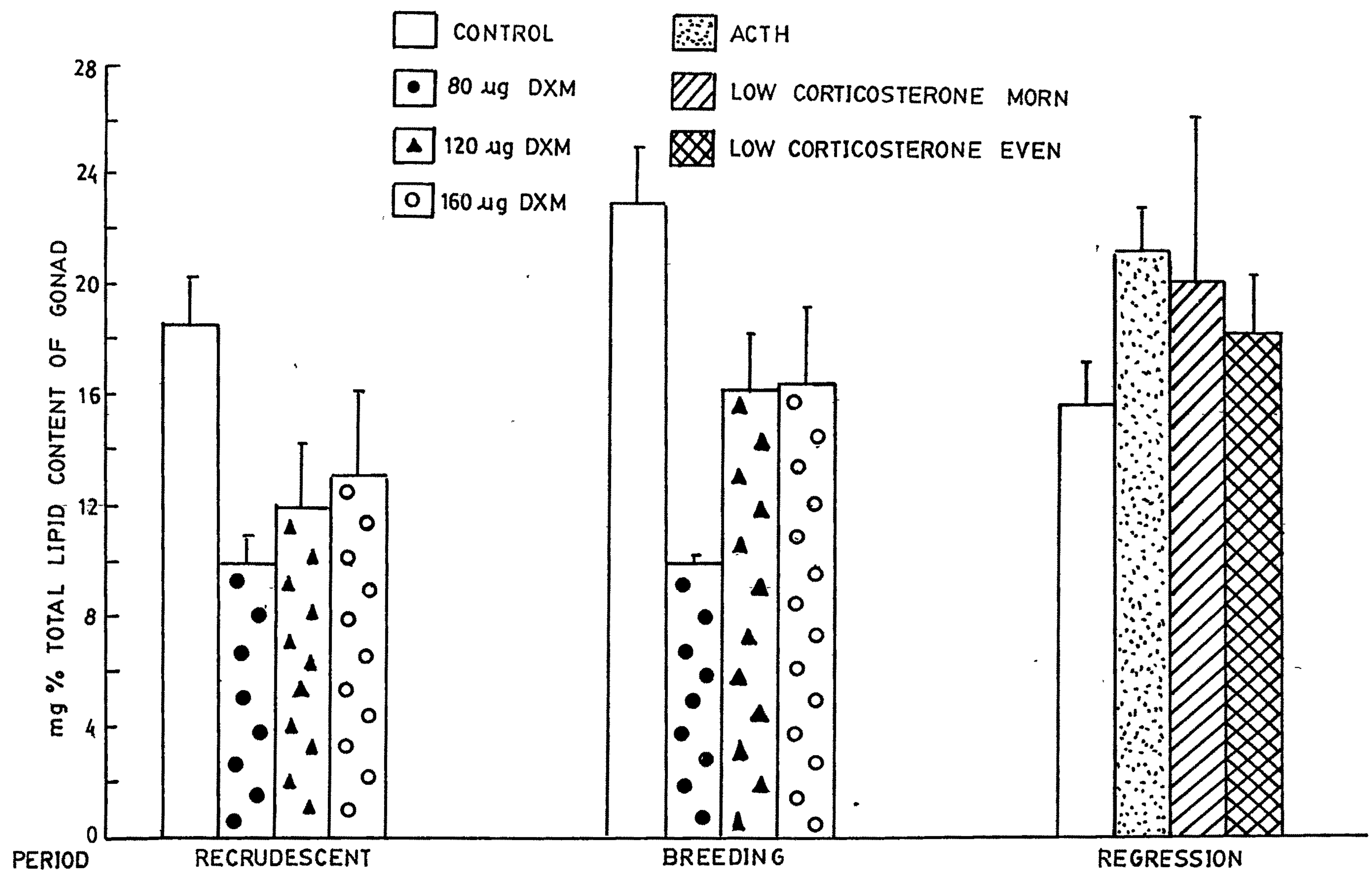

FIG.9. CHANGES IN GONADAL FREE FATTY ACID CONTENT

-cence to breeding. Phospholipids and total glycerides depicted a similar pattern of changes exhibiting progressive reduction with the approach of breeding activities. The reduction in phospholipid content from regression to recrudescence and from recrudescence to breeding on a percentage basis was equivalent to 16% and 5% respectively. Glycerides too depicted a decrease to the tune of about 48% and 8% respectively from regression to recrudescence and from recrudescence to breeding. In comparison, Free fatty acids (FFA) increased progressively during recrudescence and breeding and decreased to a minimal level during the regression phase.

Changes in Experimental Birds

Total lipids and total cholesterol contents of adrenals in dxm treated. hypoadrenalic birds exhibited a significant increase. Injection of ACTH/corticosterone too brought about an increase in total lipid content. However cholesterol (total) content exhibited a marked reduction in dxm treated birds. Cholesterol ester content in adranal suppressed birds exhibited a marked increase, while the free cholesterol pool decreased. Hyperadrenalism resulting due to injection of ACTH/corticosterone brought about a reverse set of changes with increase in free cholesterol pool and decrease in the esterified content; a picture comparable to that of normal birds during the active breeding phase.

Total gonadal lipids of dxm treated birds depicted a tremendous accumulation and stock piling. On the contrary, corticosterone or ACTH treatment brought about marked reduction in lipid content of gonads. However, LCE, and, HCM and HCE failed to bring about any significant alteration. Total cholesterol content of gonads in adrenal suppressed birds depicted an increase, as that in the normal birds during the regression phase. Decrease in total cholesterol content was the feature in ACTH/corticosterone treated birds. Decrease in free cholesterol content and increase in cholesterol ester content were observable in adrenal suppressed birds. While reverse was the case in ACTH and corticosterone treated birds with the change in free cholesterol content being more pronounced.

Phospholipid and triglyceride contents were found to be increased in the gonads of dxm treated birds while decreased contents were recorded in ACTH/corticosterone treated birds. Free fatty acid content was found to decrease in the gonads of adrenal suppressed birds. On the contrary, this pool was increased in the gonads of ACTH/corticosterone treated birds.

DISCUSSION

Mammalian and avian adrenals are known to be capable of converting acetate to cholesterol (Lamoureux *et al*., 1964;

Sandor et al., 1965; Lamoureux, 1966). In this respect, lipid and cholesterol contents of adrenals can be considered to undergo alterations in relation to adrenocortical activity. Circannual changes in steroidogenic activity of the adrenal gland has been well recognised as the characteristic feature of seasonal breeders. The tropical Indian pigeon, a seasonal breeder, has been shown to exhibit parallel adrenal-gonad relationship thereby suggesting higher adrenocortical activity during the breeding months relative to the non-breeding months (Chapters II & III). In this behest, the adrenal lipids studied on a seasonal basis has shown an increase in neutral lipids content and free cholesterol pool during the recrudescent and breeding phases amounting to 227% and 158% respectively. Cholesterol ester showed a reciprocal decrement with the total cholesterol content remaining unchanged. The seasonal adrenal activity in Columba livia seems to be marked by increased lipid mobilization and/or synthesis and increased conversion of cholesterol ester to free cholesterol. This is well substantiated by the decreased free cholesterol pool and increased ester content noted in adrenals of dxm treated pigeons during the recrudescent and the breeding phases and increased cholesterol with decreased ester content in the adrenals of birds administered ACTH/corticosterone during the non-breeding phase. Similar observations have been made by Morgan (1980) and Freeman et al. (1979, 1980) in the Japanese quail and fowl respectively and by Davis and Garren (1966) in rats and by Griffith *et al*.(1963) in man. Though the total cholesterol content did not show much variations between the three reproductive phases, dxm induced adrenal suppression during recrudescence and breeding was noted to bring about 100% increment in total cholesterol level. Similarly, both ACTH and corticosterone administration brought about a decrement in total cholesterol content. Interestingly, the total lipid content also depicted tremendous elevation in the dxm treated birds supporting the above contention. Similarly, in ACTH/corticosterone administered birds the free cholesterol content was elevated by 60-70% and the ester fraction was reduced drastically.

Dxm induced adrenal suppression increased the total cholesterol content which was mostly esterified, and the total lipid content, indicating the continuing mobilization and/or synthesis with reduced utilization. ACTH/corticosterone administration in the regression phase decreased the total cholesterol content, essentially the ester form while the free fraction was elevated significantly along with total lipids. It has been reported that the bulk of cholesterol in adrenal glands is contained as insoluble droplets consisting of small amounts of free cholesterol, and major constituent being cholesterol esterified with long chain fatty acids

(Moses et al., 1959). Though the levels of both total lipids and free cholesterol were elevated, they were however still 35-40% below the recrudescent and breeding levels. The increase in the total lipid content in the active adrenals should in all probability represent the increase in non-cholesterol fractions. Of the various corticosterone regimes, only the morning schedule appeared effective and the low dose more responsive thereby suggesting not only an auto-regulatory role of corticosteroids in modulating adrenal lipid profile but also the time specificity involved in optimising such changes (Chapters II, V & VI).

Cholesterol and cholesterol positive lipids have been essentially linked with gonadal functions, and gonadal regression has been reported to be marked by accumulation of such lipids (Lofts and Marshall, 1957, 1959; Hoffman, 1968; Johnson, 1970). Herein recorded data corroborates this aspect and provides evidence to the fact that the gonadal awakening and their activity during recrudescence and breeding involve depletion of cholesterol positive lipids while gonadal quiescence causes accumulation. Hoffman (1960) too observed similar change in cholesterol content, with increased cholesterol concentration in small inactive testis during the non-breeding phase and decreased content as the testis grew more active spermatogenically and hormonally in the pigeon. These changes in cholesterol content involve reciprocal alterations in the free versus esterified form is indicated by the observed decrease in cholesterol ester coupled with the increase in free cholesterol during the active phases and the reverse changes during the inactive phase. Such reciprocal changes between the ester and free pool of cholesterol were shown not only by the control pigeons during the normal phases of annual gonadal cycle but also by the adrenal manipulated birds. Dxm induced adrenal suppression during the active phases, which led to gonadal involution, increased the cholesterol ester content and decreased the free cholesterol content, changes characteristic of normal birds during regression; and ACTH/corticosterone administration during regression, which led to gonadal activation, reversed the set of changes like in the control birds during the recrudescent and breeding phases. Hypophysectomy induced alterations in cholesterol content has been reported by Perlman (1950) and Nakamura et al. (1968) in rats. Hypophysectomised rats without supplemental hormones were found to exhibit increase in testicular cholesterol, with free cholesterol pool changing from 1.7 to 3.4 mg/gm and esterified from 0.08 to 2.27. These values indicate a definite shift in the free : esterified cholesterol ratio toward a heavy preponderance of esterified fraction.

The total lipid content of the gonads also showed changes in relation to the reproductive phases and was marked by decrease during the inactive phase. The presence of lipids in the male gonads was shown very early by Loisel (1903) and the utility of lipids in steroidogenic and gonadal functioning have been highlighted in relation to both testicular and ovarian functions (Srere et al., 1950; Ambadkar and Kotak, 1976; Chalana and Guraya, 1978; Singh and Singh 1979; Singh and Singh, 1983).

The currently noted reduction in total lipid content of gonads in the wild pigeons during the reproductively active phases involved apart from cholesterol ester, the phospholipids and the triglycerides. This has been further emphasised by the similar changes obtained with ACTH/corticosterone induced gonadal activation during the regression phase. Similarly, gonadal involution during the non-breeding phase and the induced gonadal regression during the breeding phases by adrenal suppression were marked by increased contents of the above lipid fractions. These changes substantiate the occurrence of a lipid cholesterol cycle reported in the gonads of seasonally breeding vertebrates on a seasonal basis (Johnson, 1970; Lofts and Lam, 1973; Skinner et al., 1973; McPherson and Marion, 1982).

Alterations in phospholipid content identical to the present observations have also been noted by Patel (1982) and Patel (1984) in wild and domestic pigeons respectively.

Moreover, Manimekala and Govidarajulu (1980) have also reported alterations in phospholipid and glyceride contents of rat ovary during oestrous cycle. The decrease and increase in total lipid content noted in the gonads during active and inactive gonadal status of both the normal and experimental birds are accompanied by correlatable reciprocal changes in the free FFA content. The lipid depletion during the active phases seem to elevate the pool of FFA which can be considered to be of utility value not only for providing metabolic energy but also for the many qualitative aspects associated with gametogenesis and gonadal functioning. Though there are not many reports on FFA content of gonads in relation to seasonal cyclicity, Heald and Baldman (1963) and Heald *et al*. (1964) have shown increased FFA in the plasma of hen prior to laying. Further, hypophysectomy induced decrease in fatty acids of less than 20 carbon units has also been reported by Nakamura *et al*. (1968). Hormonal regulation involving cyclic changes in gonadal lipid chemistry has been chiefly attributed to the gonadotropic hormones, in keeping with their purported functions, and has also been inferred by hypophysectomy induced changes (Jhonson, 1970; Hafiez and Bartke, 1972). However the influence of adrenal corticosteroids in the modulation of gonadal lipid content has not been categorically demonstrated with reference to any vertebrate species. The present study is the only one which has demonstrated the definite unequivocal influence of corticosteroids in controlling the seasonal lipid cycle of gonads irrespective of the changes in gonadotropic hormones. A report of some relevance in the present context is that of Balasubramaniam et al. (1984) who have shown a qualitative effect of adrenalectomy on the constitution of epididymal lipids in pubertal and adult rats. Though the reports of several workers underscore the influence of gonadotropins and gonadal steroids in alterations of the lipid fractions of gonads (Ewing et al., 1964; Barysan, 1980; Sinha, 1982; Mukerjee and Bhattacharyya, 1982), the results accrued herein suggest the probable role of corticosteroids either directly, or indirectly via the hypothalamo-hypophysial-gonadal axis, in modulating gonadal lipid content in association with histomorphological changes (Chapters II & III) at least in some avian species.

S U M M A R Y

Total lipids and the various lipid fractions have been analysed in the adrenal and gonads of normal and adrenal manipulated pigeons on a seasonal basis. The total lipid content and free cholesterol of the adrenal showed a parallel relation with its functional status. An inverse relation was shown by the gonads with respect to total lipids. Free fatty acids and cholesterol content of the gonads were high during the reproductively active phases while the content of phospholipids and triglycerides was less. The regression phase was marked by reverse set of changes in the gonads. However, these changes could be reversed by either adrenal suppression during the active phases or by ACTH or corticosterone administration during the inactive phase. These changes are indicative of a seasonal lipid cycle in the gonads of the pigeons and the ability of corticosteroids to induce these modulations along with altered gonadal functioning and are as such discussed in the text.