

EMBRYONIC DEVELOPMENT OF ENDOCRINE SYSTEM IN SILVER FOX AFTER LONG-TERM SELECTION FOR DOMESTIC BEHAVIOUR.

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SUMMARY

Selection of silver foxes for lack of aggression towards man leads to some destabilization in maturation of separate units of pituitary-testicular and pituitary-adrenal systems during embryogenesis. It was shown that testicular production of testosterone stimulated by chorionic gonadotrophin in vitro was increased at the earlier period of embryogenesis in selected group than in unselected control. The adrenal content and serum level of cortisol were significantly lower in domesticated embryos than in undomesticated ones at the end of embryonic life. Adrenocorticotrophin increased in vitro cortisol production by fetal adrenals in both groups but to the less values in domesticated animals.

INTRODUCTION

The hereditary reorganization of silver fox behaviour has been realized in the course selection for domestic behaviour (Belyaev, 1979). Selection for reduced aggression towards man was accompanied by endocrine changes in gonadal and adrenocortical functions (Naumenko and Belyaev, 1980; Osadchuk, 1992). It was suggested that timing shifts of embryonic formation of the pituitary-gonadal and the pituitary-adrenocortical systems could be of crucial importance in changes of these function in adult animals.

The purpose of the present paper is to describe the embryonic development of endocrine activity of gonads and adrenals after 30 years of experimental domestication in silver foxes.

MATERIALS AND METHODS

Gestation in silver fox lasts 51-52 days. Pregnant females were killed humanly at 45 and 50 days after breeding. The blood of decapitated embryos was collected and the serum obtained was frozen. Fetal gonads and adrenals were weighed and incubated for 2 hours. The right gland was taken as control and the left one was incubated in the presence of 100 mIU chorionic gonadotrophin (hCG) for gonads and 50 mIU adrenocorticotrophic hormone (ACTH) for adrenals. If no incubation was performed, the pair of glands was weighed, placed in a physiological salt solution and frozen. After thawing, the glands were homogenized. Samples were assayed for testosterone, oestradiol and cortisol with commercial RIA kits. For statistical purposes Student t-test was applied. All values are expressed as mean \pm SEM.

RESULTS

The weights of silver fox embryos, gonads and adrenals showed pronounced increase during the experimental period of embryogenesis (Table 1). The weights of embryos and adrenals were significantly lower in selected groups than in unselected ones (Table 1).

It was shown that the serum concentrations and testes contents of testosterone in male embryos did not differ between domesticated and undomesticated animals (Table 2). Testicular fetal production of testosterone was stimulated by chorionic gonadotrophin in vitro. The increase of the hormone production under CG appeared earlier in domesticated animals than in undomesticated ones (Table 3). In female fetuses, oestradiol serum levels and its contents of the ovaries were rather small during embryonic life and hormonal production by incubated ovaries was unaffected by addition of CG.

The cortisol level was decreased significantly from day 45 to day 50 in domesticated embryos of both sexes. Serum level and adrenal content of cortisol were significantly lower in domesticated animals than in undomesticated ones at the end of pregnancy (Table 4). When embryonic adrenals were incubated with ACTH, the cortisol content in incubating medium was significantly increased on all studied days of embryonic development in all groups (Table 5). A significant decreased control cortisol production was demonstrated in domesticated embryos as compared with undomesticated ones. It has been found that the enhancement of the steroidogenic response of fetal adrenals to ACTH was pronounced to the less extent in selected animals than in unselected ones especially on day 45 (Table 5).

DISCUSSION

It is well known that steroid hormones could play a great role in regulation and integration of developmental processes and the small timing shifts in maturation of endocrine functions could be of great phenotype effects. The present results demonstrate the evidence that the reorganization of silver fox behaviour in the process of selection induces the destabilization of embryonic formation of endocrine function of gonads and adrenals.

The testicles stimulated by chorionic gonadotrophin in vitro demonstrated increased testosterone production at the earlier period in the domesticated group than in the undomesticated one. It is quite probable that the earlier sensitivity of fetal gonads to CG in domesticated animals could be related to the earlier maturation of functioning gonadotrophin receptors and of a post-receptor system in the testis.

It has been shown that the cortisol adrenal content and the cortisol serum level in the domesticated embryos of both sexes were significantly lower than in the undomesticated ones at the end of embryogenesis. In present experiments, ACTH increased cortisol production by fetal adrenals in all groups of animals but the responsiveness to ACTH was less in domesticated groups than in undomesticated ones (Table 5). The data obtained suggest that the selection of silver foxes leads to reducing to the glucocorticoid function of adrenals already during the prenatal development.

REFERENCES

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Table 1. Weights of embryos, their gonads and adrenals in silver foxes.

	Days of pregnancy	Males		Females	
		Undomesticated	Domesticated	Undomesticated	Domesticated
Embryo weight (g)	45	60.5±1.7 (32)	51.2±1.7 * (32)	59.1±1.6 (23)	49.0±2.5 * (21)
	50	96.7±4.2 (16)	88.0±3.3 * (20)	93.2±4.2 (14)	82.6±3.7 * (17)
Gonad weight (mg)	45	10.1±0.5 (27)	8.4±0.5 (20)	11.9±0.6 (16)	10.5±0.5 (12)
	50	11.0±0.5 (9)	12.3±0.8 (10)	14.0±1.8 (5)	13.7±0.7 (9)
Adrenal weight (mg)	45	8.8±0.6 (25)	6.8±0.7 * (20)	7.4±0.8 (16)	7.6±1.2 (12)
	50	13.9±1.3 (9)	9.8±0.8 * (10)	15.3±1.7 (7)	9.0±1.0 * (9)

In all tables: No of animals or samples in parentheses. * Significant differences ($p < 0.05$) between domesticated and undomesticated animals. \square Those between the control and the experiment.

Table 4. Cortisol serum level and cortisol adrenal content in silver fox embryos at different stages of pregnancy.

	Days of pregnancy	Males		Females	
		Undomesticated	Domesticated	Undomesticated	Domesticated
Serum level (ng/ml)	45	22.2±1.3 (18)	22.7±5.0 (18)	20.4±1.4 (9)	19.2±1.5 (11)
	50	18.8±2.0 (7)	12.4±1.7 * (9)	23.5±1.7 (7)	15.6±2.6 * (9)
Adrenal content (ng/both glands)	45	67.6±3.8 (9)	65.8±2.8 (10)	59.7±7.7 (5)	50.8±8.9 (3)
	50	85.9±12.7 (8)	51.3±4.8 * (10)	86.5±11.5 (7)	54.9±5.9 * (9)

Footnote as in Table 1.

Table 2. Testosterone serum level and testosterone testis content in silver fox embryos at different stages of pregnancy.

	Days of pregnancy	Undomesticated		Domesticated	
Serum level (ng/ml)	45	0.46±0.05	(29)	0.46±0.05	(25)
	50	0.52±0.09	(14)	0.43±0.07	(14)
Testis content (ng/both glands)	45	4.05±0.28	(17)	4.00±0.26	(15)
	50	23.60±2.30	(7)	21.68±3.40	(7)

Footnote as in Table 1.

Table 3. Effect of CG on testosterone production by fetal testes in vitro (ng/both glands/hr).

Days of pregnancy	Undomesticated				Domesticated	
	Control	CG	Control	CG	Control	CG
45	0.32±0.08 (7)	0.45±0.04 (7)	0.39±0.04 (8)	1.03±0.30 (6)		*
50	0.55±0.13 (7)	0.90±0.18 (7)	0.44±0.05 (10)	1.07±0.19 (10)		

Footnote as in Table 1.

Table 5. Effect of ACTH on cortisol production by adrenals in vitro (ng/both glands/hr).

Days of pregnancy	Undomesticated				Domesticated	
	Control	ACTH	Control	ACTH	Control	ACTH
m a l e s						
45	18.6±2.1 (6)	37.2±6.0 (5)	11.0±2.3 (4)	21.1±2.3 (5)		*
50	28.9±2.1 (6)	49.7±3.9 (7)	24.6±2.3 (10)	42.8±3.5 (10)		
f e m a l e s						
45	11.5±2.7 (5)	28.5±4.1 (5)	7.8±1.4 (7)	18.4±3.6 (7)		*
50	35.2±3.3 (6)	49.3±2.9 (6)	24.3±3.1 (5)	44.5±5.0 (5)		*

Footnote as in Table 1.