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Development of Gonads and Spermatogenesis in Hybrids of European Bison and Domestic Cattle [1]

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Jacek KORWIN-KOSSAKOWSKI & Edward SUMIŃSKI

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The paper presents the results of studies carried out on 19 hybrids obtained by mating domestic cows with European bison, and 11 backcross cows, hybrids of generation F_1 mated with European bison. Morphometric and histometric examination showed that postnatal development of testes and epididymis of hybrids proceeded more slowly than in domestic cattle, and ended before the 18th month of life. Seminiferous tubulae in hybrids are far narrower than those in domestic cattle and European bison. Spermatogenesis in F_1 hybrids is completely inhibited at the stage of spermatogoniogenesis and in backcross hybrids at the stage of spermatocytogenesis, although individual differences occur. The area occupied by the spermatogenetic epithelium can be seen in a cross-section of the testes, as distinctly smaller in hybrids than in the testes of domestic cattle. There are parallel developmental and degenerative changes in the testis of backcross hybrids and the intensity of these changes depend on the stage reached by spermatogenesis.

[Mickiewicza 33 D m. 7, 01-625 Warszawa (JK-K); State Farm, Jeziory Wielkie, 63-200 Zaniemyśl (ES), Poland]

1. INTRODUCTION

The first attempts made in Poland at crossbreeding domestic cattle, *Bos taurus* Linnaeus, 1758 and European bison, *Bison bonasus* (Linnaeus, 1758) go back as far as the previous century. The Mammals Research Institute, Polish Academy of Science, at Białowieża has conducted systematic research since 1958, and as from 1973 the State Farm Enterprise at Poznań has undertaken large-scale breeding experiments (Krasińska, 1967; Małecka & Sumiński, 1976). During the period 1947—1977 a total of 206 hybrids of domestic cattle and European bison have been obtained in Poland (Krasińska, 1979). Both breeding and research are being carried out on a large scale on the North American continent (Krasińska, 1967; Smith, 1977).

The greatest difficulty encountered in breeding consists in the sterility

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of hybrid males of the first generation. Males from the first backcross are also sterile, but further backcrossing makes it possible to obtain fertile males. This phenomenon has not been fully interpreted. Although it has been suggested that intratesticular temperature differs in males of the initial species, since the scrotum of the European bison has a thicker skin and is suspended higher (Basrur, 1969), yet it has been proved that the intratesticular temperature in domestic cattle, European bison and their hybrids is identical (Peters & Newbound, 1957).

The sterility of male hybrids has also been attributed to structural differences in chromosome Y in the parent species, but it has been found that crossbreeding species with different Y chromosome structure may produce fertile male progeny, while crossbreeding species between which there is no difference in the structure of chromosome Y may produce sterile male progeny (Fedyk & Sysa, 1971). Gartler & Burt (after Fedyk & Sysa, 1971) found that chromosome Y in *Bos taurus* replicates at least two hours later than autosemes. It may be that the differences in replication time of the DNA of chromosome Y between species may cause sterility (Fedyk & Sysa, 1971). Fechheimer (1970) in summing up the discussion of the problem of sterility in hybrids of domestic cattle and European bison, American bison or yak, found that inhibition of spermatogenesis may be due to other genetic factors than absence of homology of parent genomes. The degree of sterility depends chiefly on the percentage of blood of one of the initial species. Boyd (after Basrur, 1969) considers 25% American bison blood as the maximum in a female intended to produce fertile progeny. Peters (after Basrur, 1969) states that cattelos with 14% American bison blood are fertile.

The purpose of our studies was to describe the postnatal development of the testes and epididymis, and spermatogenesis, in hybrids with 50% and 25% domestic cattle blood, which may throw some light on the causes of sterility in male F_1 hybrids and from backcrossing.

2. MATERIAL AND METHODS

The material used for the studies consisted of hybrids bred and kept at the State Farm Enterprise at Łękno in the Poznań voivodship. The animals were 19 F_1 hybrids from 257 to 700 days old, obtained from natural mating of European bison with cows of the lowland black and white, Polish red and lowland black and white × charolaise, and from artificial insemination of cows with frozen European bison semen (Małecka *et al.*, 1976); Małecka & Sumiński, 1976) and 11 animals from backcrossing European bison with F_1 generation cows from 361 to 591 days old.

Morphometric examination was made of the testes, epididymis and glands, and histological examination of the testicular tissue. Testes of F_1 hybrids were

obtained for morphometric measurements after the animals had been killed, or from castration (from one animal only). The testes were weighed immediately after dissection from the scrotum and removal of the epididymis. The seminal glands were taken and weighed during the initial preparation of the carcass. Measurements were made of the testes through the scrotum *in vivo* for backcross hybrids.

Sections of testes for histological examination were obtained either in vivo by biopsy, or after the animal had been killed. A total of 31 biopsy operations of the testis were made in the two groups of animals and in four backcross hybrids twice during the interval of 97 to 117 days. Testis sections were also taken from four F_1 hybrids twice during the interval of 24 to 75 days.

The animals were immobilized for biopsy by administering Immobil (Janssen Pharmaceutica Beerse, Belgium (Kania *et al.*, 1985). After cleaning hair and dirt from the skin of the scrotum and injection of polocainium hydrochloricum cum adrenalino (Polfa) subcutaneously into the scrotum and testis (both for local anaesthesia and to limit parenchymatous bleeding), an incision of about 1.5 cm was made in the scrotal skin on the posterior side. *Tunica albuginea* was next incised and a section taken from the testicular tissue protruding above the surface of *tunica albuginea* when the testis operated upon was lightly pressed with the fingers. The wound was then sprinkled with penicillinum crystallisatum (Polfa), but not sutured. After completing the operation the state of complete immobilization was reversed. Immobilized and operated animals were usually kept isolated from the herd for some hours to prevent their being exposed to the aggressive attacks of the other animals.

In the case of testes obtained from slaughtered animals sections were taken immediately after making measurements. The testes were cut along the long axis of the free margin to the opposite *tunica albuginae*. At least two sections measuring 5×5×5 mm from two different places were taken from each testis. The sections of testicular tissue were fixed in AFA fluid (ethyl alcohol 96%—75%, formalin — 20%, glacial acetic acid — 5%). After 24 hours the sections were dehydrated in increasingly strong concentrations of alcohol, irradiated in xylene and embedded in paraffin. Sections 8 μ thick were stained by the PAS method with Harris's hematoxylin (Zawistowski, 1965). The diameter of spermatogenic ducts was measured in histological preparations, taking into account 20 round cross-sections and determining two dimensions of each cross-section. The reciprocal ratio was found for 7 elements of testicular tissue, namely: the boundary membrane of the seminiferous tubulus, cells of seminiferous tubulae (supporting cells + generative cells), lumen of the tubula, interstitial cells, connective tissue cells, blood vessels and the artefact by the method of chance finding, using a double grid for 20 fields of vision chosen at random. The percentage area of testicular tissue occupied by the given element was calculated in relation to the total number of findings, reduced by the number of findings in the artefact (Kennelly & Foote, 1964; Kowiński & Szymkowiak, 1975). Ten young bulls of the lowland black and white breed, from 388—400 days old, were used as the comparative group, and the same morphometric and histometric measurements were carried out on them.

In presenting results both F_1 hybrids and backcross hybrids were divided into age groups as follows: — up to 1 year, — from 1 year to 1.5 years, — over 1.5 years.

3. RESULTS

Before beginning the examination proper it was essential to work out a method for immobilizing the animals and for taking sections of testicular tissue *in vivo*. It is a simple matter to carry out biopsy of the testis in the way described above and gives adequate results. The operation was not found to have any serious side-effects. The post-operative wound ceased bleeding quickly and healed well. Scars on which fresh hair was growing were found in animals either re-operated or killed after 1.5 to 4 months after the operation.

There was a small number of adhesions of *tunica albuginea* with the testicular tissues and scrotal skin. No histological examination was made of the testis on the operation sites, but data in literature (Eqbunike *et al.*, 1974). show that the operation has no effect on further function of the testis. Animals immobilized and operated upon were usually considerably disturbed by the other animals if immediately allowed to join their own herd, and frequently became objects of attack. On this account the operated animals were isolated for a time until they had completely regained their physical capacities. This usually took from a few to nearly twenty hours.

3.1. Length, Breadth and Weight of Testes, Epididymis and Seminal Glands

In F_1 hybrids (measurements made on killed animals — Table 1) and backcross hybrids (measurements *in vivo* — Table 2) the testes were observed to grow more slowly than those in domestic cattle, and such growth ceased before the hybrids reached the age of 1.5 years. In older animals there was even a slight regression in all three measurements. Increase in weight of the testes and epididymis in F_1 hybrids (Table 3) was also slower than in domestic cattle and ended before the animals

Table 1

Ranges of variations and mean sizes (cm) of testes in F_1 hybrids and domestic cattle.

Age group Days	n	Length of testis		Breadth A of testis		Breadth B of testis	
		Left	Right	Left	Right	Left	Right
I		8.3—9.1	7.3—8.6	4.6—5.0	4.2—4.8	4.3—4.7	3.9—5.0
483—506	3	8.6	7.8	4.8	4.4	4.5	4.3
II		6.1—9.0	7.0—9.1	3.6—5.3	4.1—5.3	3.4—4.8	3.8—4.9
578—695	10	7.7	8.0	4.5	4.7	4.3	4.4
Domestic cattle		8.6—11.7	9.2—11.3	4.7—6.2	4.8—6.3	4.7—6.3	4.7—6.3
388—400	10	9.9	10.3	5.7	5.8	5.6	5.8

Table 2

Ranges of variations and mean sizes (cm) of testes in backcross hybrids [1]

Age group Age in days	n	Length of testis		Breadth A of testis		Breadth B of testis	
		Left	Right	Left	Right	Left	Right
I		5.8—7.9	5.3—8.3	3.1—5.0	3.0—4.5	3.2—3.9	2.9—4.5
288—361	5	6.7	6.2	3.9	3.9	3.8	3.5
II		6.1—8.8	6.2—8.3	3.2—5.2	3.0—5.0	2.7—5.7	3.0—5.0
408—478	6	7.6	7.0	4.1	3.8	3.8	3.6
III		7.8—7.9	4.8—7.6	3.4—4.0	2.4—3.8	3.2—4.0	2.4—3.6
585—604	3	7.8	6.4	3.7	3.2	3.6	3.2
Domestic cattle		8.4—13.5	9.3—13.3	5.0—7.0	4.7—7.6	4.9—6.8	4.4—7.4
388—400	10	11.9	11.6	6.2	6.3	5.9	5.8

[1] Measurements made *in vivo*.

Table 3

Ranges of variations and mean weight (g) of testes, epididymis and seminal glands of F_1 hybrids and domestic cattle

Age group Age in days	n	Testis		Epididymis		Seminal glands
		Left	Right	Left	Right	
I		89.0—124.5	69.0—111.5	7.5—13.5	7.0—13.5	31.0—44.0
483—506	3	109.2	84.5	10.5	10.2	37.5
II		84.0—122.0	69.0—124.5	7.5—10.5	7.0—11.0	34.0—40.0
578—695	5	98.6	92.5	9.2	9.6	37.0
Domestic cattle		88.0—226.0	87.0—223.0	6.0—16.0	6.0—18.0	10.8—54.0
388—400	10	158.5	161.0	13.0	13.1	32.0

were 1.5 years old. The epididymis in older hybrids was even slightly lighter in weight, whereas increase in weight of the seminal glands took place at a similar rate in F_1 hybrids and domestic cattle. As in the case of testes and epididymis, this increase ended at the age of approximately 1.5 years.

3.2. Microscopic Observations

A picture of normal complete spermatogenesis was observed in young domestic bulls, whereas there was complete inhibition of spermatogenesis in all the F_1 hybrids examined. The seminiferous tubulae were narrow, irregular in shape, with thickened boundary membrane. They contained only supporting cells and spermatogonia situated in one level. Numerous little tubulae, the lumen of which was almost completely filled with the cytoplasm of supporting cells, gave the impression of being occluded. The space between the tubulae was considerable, only partly filled with

interstitial cells and elements of connective and vascular tissue. If the histological picture of testicular tissue in F_1 hybrids gave the impression of being homogeneous, in backcross hybrids it was fairly distinctly diversified, both between individuals and between tubulae in the same individual. Seminiferous tubulae in these animals were narrow, with distinctly thickened boundary membrane and an irregular outline. In addition to tubulae containing supporting cells and scanty spermatogonia, there were tubulae containing numerous order I spermatocytes. Many tubulae were observed with the lumen filled either with the cytoplasm of supporting cells or irregularly scattered nuclei of generative cells. The spaces between tubulae were large, as was the case in F_1 hybrids.

3.2.1. Area of the Cross-section of Seminiferous Tubulae

The area of the cross-section of seminiferous tubulae in both F_1 hybrids and backcross hybrids was noticeably smaller than in domestic cattle (Table 4). In F_1 hybrids the average area of a seminiferous tubulae increased with age. Considerable individual variation was observed. In

Table 4

Range of variations and mean area in cross-section of seminiferous tubulae in F_1 hybrids, backcross hybrids and domestic cattle

Genetic group	Age group and age in days	n	Area in cross-section of seminiferous tubulae (×1000 μ²) Min.—Max.	Avg.
F_1 hybrids	I 257—339	4	3.51—13.45	7.70
	II 431—506	7	9.32—14.80	12.14
	III 554—695	8	11.02—21.09	14.29
Backcrosses	I 313—365	5	4.47—14.93	8.19
	II 408—478	6	5.20—15.60	9.07
	III 585—604	3	4.00— 5.96	5.18
Domestic cattle	388—400	10	19.78—35.89	28.57

backcross hybrids there was distinct reduction in the area of the cross-section of seminiferous tubulae in the group of oldest hybrids. In hybrids from 1 year and from 1 year to 1.5 years old the tubulae were similar in size to those of F_1 hybrids in the corresponding age groups. Considerable individual variation was also observed there which, however, became distinctly narrower in the oldest age group.

3.2.2. Reciprocal Ratio of Elements of the Testicular Tissue

In F_1 hybrids 67.8% of the area in a cross-section of the testis was occupied by the seminiferous tubula, 66.7% in backcross hybrids and 79.8% in young domestic bulls. Thickening of the boundary membrane of the seminiferous tubula in relation to young bulls (7.6%) was more distinct in backcross hybrids (10.9%) than in F_1 hybrids (9.0%). The disappearance of the lumen of the seminiferus tubula is very distinct in backcross hybrids. Only 3.3% of the area in the cross-section of the testis was occupied in them by the lumen of the tubula, whereas this figure was 5.2% in F_1 hybrids and 10.3% in young domestic bulls (Table 5). The loose arrangement of the seminiferous tubulae and the considerable distances between them, only partly filled by interstitial cells and elements of connective and vascular tissue, were characteristic of the animals examined. The occurrence of this specific "free space" is probably due to disturbances in the developmental processes of the testis. *In vivo* this space is probably filled with amorphous interstitial substance which was not visible in the preparations. In F_1 hybrids this space occupies 21.4% of the cross-section of the testis and in backcross hybrids 29.2%. In the histological picture of a normally functioning testis in a domestic bull the seminiferous tubulae are closely arranged and the small spaces between them are filled with interstitial cells and elements of connective and vascular tissue. In domestic cattle the "free space" occupied 8.1% of the area in a cross-section of the testis, and in this respect is probably the result of dissecting the tissues. In order to describe the "free space" the term "artefact" has been used in the text. By taking testicular tissue twice for histological examination it proved possible to follow the changes taking place in the proportions of the different elements of testicular tissue. In F_1 hybrids, in which spermatogenesis was inhibited at spermatogoniogenetic level and the histological picture exhibited degenerative characteristics, two different observations, separated in time, confirmed the development of the degenerative process. Reduction in the area occupied by spermatogenetic epithelium in the cross-section of the testis or absence of changes were found. Changes consisted in proliferation of connective tissue between the seminiferous tubulae and in shrinking of the tubulae. In backcross hybrids there was no such distinct direction in the changes seen in the histological picture of the testis. In the animal Albin, in which most advanced spermatogenesis was observed, these changes took place more in the direction of a picture of a testis with normal spermatogenesis. The area occupied in the cross-section of the testis by supporting and generative cells, the lumen of the tubula and interstitial cells increased,

Table 5

Proportions of testicular tissue elements — percentage of area and mean area in cross-section of testis in F_1 hybrids, backcross hybrids and domestic cattle (n=10).

Name of hybrid	Age, days	Boundary membrane of seminiferous tubula	Supporting and generative cells	Lumen of seminiferous tubula	Seminal tissue	Interstitial cells	Connective tissue	Blood vessels	Intraparenchyma of testis	Artefact
F1 hybrids										
Age group I										
Łaciak	257	9.7	52.6	0.0	62.3	20.1	16.8	0.7	37.6	9.5
Łaciak	281	10.0	41.5	0.0	51 5	20.1	28.6	0.3	49.0	37.5
V	282	7.0	63.4	7.4	77.8	11.0	9.5	1.8	22.3	5.4
Łucznik	339	9.1	58.2	3.4	70.8	9.0	19.0	1.4	29.4	7.1
$\bar{x}$		9.0	53.9	2.7	65.6	15.0	18.5	1.1	34.6	14.9
Age group II										
Jawor	431	7.2	61.4	4.6	73.2	12.9	13.3	0.3	26.5	32.5
Jantar	448	10.8	61.7	3.9	76.4	11.4	10.4	1.8	23.6	26.9
Jankes	454	10.7	56.8	8.2	75.8	14.4	8.8	0.6	23.8	35.5
Łopian	474	10.5	54.1	0.7	65.3	20.5	13.2	1.0	34.7	33.4
Łowicz	483	9.9	50.6	9.8	70.2	12.5	16.6	0.7	29.8	10.9
Łan	497	11.6	60.5	1.6	73.6	12.1	13.6	1.4	27.1	10.4
Jawor	506	8.4	55.7	3.5	67.6	14.2	17.5	0.6	32.3	17.1
$\bar{x}$		9.9	57.2	4.6	71.7	14.0	13.3	0.9	28.2	23.8
Age group III										
Łoskot	554	7.5	42.9	19.9	70.7	17.2	12.2	0.1	29.6	32.1
Łuk	578	8.9	48.5	10.4	67.0	8.3	21.0	2.8	32.2	16.1
Łotysz	592	9.3	51.1	7.8	68.2	13.0	17.4	1.4	31.8	26.2
Ławnik	592	6.3	56.0	1.3	63.5	19.7	15.9	1.2	36.7	27.3
Łącznik	600	8.3	53.0	5.5	66.8	15.0	16.2	2.1	33.3	26.4
Łoskot	629	8.1	49.3	4.7	62.1	17.2	19.2	1.4	37.8	8.9
Ławnik	667	8.8	52.4	2.0	63.3	22.5	13.1	1.1	36.7	17.4
Łazęga	695	9.6	47.3	3.6	60.5	19.4	17.2	2.9	39.5	25.0
$\bar{x}$		8.3	50.1	6.9	65.4	16.5	16.5	1.6	34.7	22.4
Backcrosses										
Age group I										
Abbas	313	18.4	40.3	0.2	58.7	22.3	16.7	2.3	41.3	30.5
Andor	325	9.2	46.4	0.7	56.3	18.7	23.8	1.3	43.8	34.2
Ataman	338	8.9	54.1	0.9	63.9	12.4	22.9	0.7	36.1	30.7
Albin	347	7.3	52.9	4.3	64.5	13.7	20.9	0.9	35.4	22.3
Ałun	361	12.3	40.4	9.4	62.1	17.9	17.7	1.4	37.0	39.4
$\bar{x}$		11.2	46.8	3.1	61.1	17.0	20.4	1.3	38.7	31.4

Name of hybrid	Age, days	Boundary membrane of seminiferous tubula	Supporting and generative cells	Lumen of seminiferous tubula	Seminal tissue	Interstitial cells	Connective tissue	Blood vessels	Intra parenchyma of testis	Artefact
Age group II										
Ares II	408	9.8	58.2	10.2	78.2	12.4	8.9	0.5	21.8	26.9
Andor	442	14.6	39.6	0.0	54.3	27.1	17.1	1.6	45.7	33.2
Ataman	435	11.7	51.2	2.5	65.5	19.6	14.5	0.8	34.8	37.4
Albin	445	6.1	57.4	5.4	69.0	15.3	14.5	1.2	31.0	29.6
Adamaszek	476	8.3	64.1	0.0	72.3	19.8	6.6	1.3	27.6	6.2
Ałun	478	10.1	54.2	9.6	73.9	10.8	15.4	0.0	26.2	42.3
$\bar{x}$		10.1	54.1	4.6	68.9	17.5	12.8	0.9	31.2	29.3
Age group III										
Argus	585	12.6	61.8	0.0	74.4	16.2	9.2	0.2	25.6	19.1
Armand	604	12.2	61.7	0.1	74.0	17.4	7.2	0.9	26.1	27.9
$\bar{x}$		12.4	61.8	0.1	74.2	16.8	8.5	0.5	25.8	23.5
Domestic cattle	388—400	7.6	61.9	10.3	79.8	10.9	8.6	0.6	20.4	8.1

while simultaneously the area occupied by connective tissue decreased. The diameter of the seminiferous tubula increased. In Ataman, in which spermatogenesis was far less advanced than in Albin, in addition to increase in the area occupied in the cross-section of the testis by the lumen of the tubula and interstitial cells, thickening of the boundary membrane of the seminal duct was observed, and disappearance of the supporting and generative cells. The scope of these changes was not great, but the diameter of the seminiferous tubula distinctly decreased. In Ałun, in which scanty order I spermatocytes were observed, the direction taken by changes was similar to that in Albin.

4. DISCUSSION

Young bulls of lowland black and white cattle attain sexual maturity at the age of 8—10 months, whereas in the European bison the corresponding age has been variously defined as from 15—20 months up to the 3rd—4th year of life (Krasiński & Raczyński, 1967). It is difficult

to say at what age F_1 hybrids and backcross hybrids would attain sexual maturity if they were fertile, and consequently it is difficult to define to what degree the histological picture of the testis in hybrids is a function of age and to what a function of the extent of disturbances in sexual maturation processes.

In comparison with domestic cattle hybrids have distinctly smaller testes. Jasiorowski *et al.* (1980) give a testes weight of 485 to 530 g for young bulls of the lowland black and white breed at the age of 385—400 days. F_1 hybrids occupy an intermediate position in relation to initial species. Testes weight of approximately 200 g in the European bison is reached up to the 4th year of life (Świeżyński, 1968). An intermediate weight of the testes was also found in hybrids of American bison and domestic cattle (Peters & Newbound, 1957).

F_1 hybrids are also characterised by a lower epididymis growth rate. In the age groups distinguished in this study epididymis weight was lower than in domestic young bulls in this experiment and almost twice lower than that given for young bulls in the paper by Jasiorowski *et al.* (1980) referred to above.

It may be stated quite clearly that hybrids in which inhibited spermatogenesis is observed have seminiferous tubulae with a distinctly smaller area of cross-section than the initial breeds, in which spermatogenesis was observed to take a normal course. The individual variation of this feature is so great that it is difficult to draw conclusions as to the connection between the area in the cross-section of the seminal duct and progress of spermatogenesis or increase of the percentage of blood of one of the initial species. The tendencies observed in this experiment indicate that animals with a higher percentage of European bison blood (3/4 of European bison) had smaller seminiferous tubulae than F_1 hybrids, and also B_2 hybrids (1/8 and 1/16 European bison) described by Fedyk & Krasińska (1980).

The histological picture of the testes in F_1 hybrids and backcross hybrids agrees with the observations made by Fedyk & Krasińska (1971 and 1980). In generation F_1 spermatogenesis is completely inhibited at the level of spermatogoniogenesis. Diversity in the picture of tubulae within one testis is characteristic of backcross hybrids.

It was suggested previously, on the basis of morphometric studies, that the development of the testes in F_1 and backcross hybrids had already ended at the present stage of their postnatal development. Histometric studies show that changes both in the direction of the histological picture of the testis with a normal course of spermatogenesis, and also degenerative changes, take place side by side in the same testis.

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Jacek KORWIN-KOSSAKOWSKI i Edward SUMIŃSKI

ROZWÓJ GONAD I PRZEBIEG SPERMATOGENEZY U HYBRYDÓW ŻUBRA Z BYDŁEM DOMOWYM

Streszczenie

U 19 hybrydów F_1 pochodzących z krycia krów bydła domowego żubrem i 11 hybrydów z krzyżowania wstecznego z żubrem badano rozwój gonad i przebieg spermatogenezy. Na podstawie pomiarów morfometrycznych i histometrycznych stwierdzono, że wzrost ciężaru i rozmiarów jąder i najądrzy przebiega u hybrydów dużo wolniej niż u bydła domowego i kończy się przed osiągnięciem przez hybrydy wieku 1,5 roku. W rezultacie czego gonady hybrydów są mniejsze i lżejsze niż gonady bydła domowego w porównywalnym wieku (Tabele 1, 2 i 3). U wszystkich hybrydów F_1 stwierdzono całkowite zatrzymanie spermatogenezy. Kanaliki nasieniotwórcze były wąskie, nieregularne w kształcie o pogrubionej w stosunku do bydła domowego błonie granicznej. Zawierały one jedynie komórki podporowe i ułożone w jednym poziomie spermatogonie. Śródmiąższ jądra był silnie rozwinięty, przestrzenie między kanalikami duże, jedynie częściowo wypełnione śródmiąższem jądra. U hybrydów z krzyżowania wstecznego obok kanalików zawierających komórki podporowe i nieliczne spermatogonie znajdowały się kanaliki zawierające liczne spermatocyty I-rzędu. Kanaliki nasieniotwórcze hybrydów są wyraźnie węższe od kanalików nasieniotwórczych bydła domowego i żubra (Tabela 4). Powierzchnia zajmowana na przekroju jądra przez nabłonek plemnikotwórczy jest mniejsza u hybrydów niż u bydła domowego (Tabela 5). W obrazie histologicznym jądra hybrydów z krzyżowania wstecznego zmiany degeneracyjne i zmiany w kierunku obrazu jądra o normalnym przebiegu spermatogenezy występują równolegle a ich nasilenie decyduje o zaawansowaniu spermatogenezy. Wykazano przydatność zabiegu biopsji jądra na zwierzętach obezwładnianych przy pomocy preparatu Immobil do tego typu badań.