

## THE SEXUAL ACTIVITY AND EJACULATE TRAITS OF DUROC, HAMPSHIRE AND PIETRAIN BOARS AND THEIR CROSSES

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**Abstract.** The experiments involved 31 boars, including: 5 Duroc, 5 Hampshire and 7 Pietrain boars, as well as 9 Duroc × Pietrain and 5 Hampshire × Pietrain hybrids. Two series of measurements were performed at three-month intervals for each animal. Sexual activity of the boars was assessed by the time at which the subsequent sexual reflexes were released during manual semen collection. We also analyzed the traits of ejaculates: ejaculate volume, sperm concentration and motility, total sperm count in ejaculate, and the number of insemination doses from one ejaculate. Hampshire × Pietrain hybrids demonstrated the best qualities in terms of insemination. These boars showed the shortest times of reaction to the phantom and – with a relatively long ejaculation – they produced ejaculates with the highest sperm counts, providing most insemination doses. In the pure-breds, Pietrain boars revealed the most positive traits. This breed is characterised with the longest time of ejaculation and produces ejaculates with high sperm counts. Pietrain ejaculates can be used to prepare 5 insemination doses more than Hampshire and 10 doses more than Duroc ejaculates.

**Key words:** boar, breed group, libido, semen

### INTRODUCTION

Intensively developing artificial pig insemination is putting increasingly more emphasis on the role of the boar. At present, a relatively low number of insemination boars exert a decisive influence on the results of pig reproduction and pig meat

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production. The currently common use of artificial insemination in reproduction provides motivation for undertaking studies of the efficiency of boar insemination service. Inseminators mostly use boars with high levels of traits important for breeding and commercial production. Boars with outstanding growth rates and high carcass meat contents are selected for use at insemination centres. Insemination boars should also have remarkable reproductive traits, such as: high sexual activity and ejaculatory performance. Insemination practice shows that some boars produce a lot of high-quality semen, as well as easily and quickly exhibiting copulatory reflexes. Such animals are particularly useful for insemination service [Bertani et al. 2002, Foote 2003].

Some researchers think that sexual activity parameters and ejaculatory efficiency are conditioned by genetic factors, determined by the breed, crossing variant or genetic lines, as well as environmental factors [Ciereszko et al. 2000]. The reproductive performance of boars changes along with sire age [Bertani et al. 2002, Clark et al. 2003, Deka et al. 2002] and depends on the season and the year [Kozdrowski and Dubiel 2004, Sancho et al. 2004, Wysokińska et al. 2009]. What is of particular importance in insemination practice is the diversity stemming from the influence of genetic factors. Boars representing different breeds have different sexual activity levels and produce ejaculates that differ in quantitative and qualitative traits [Ciereszko et al. 2000, Park and Yi 2002, Wysokińska et al. 2006, Wolf and Smital, 2009, Kondracki et al. 2012]. Inseminators make an extensive use of hybrid boars, which are quicker in sexual development, grow faster and are better fit for reproduction in comparison with pure-bred sires [Smital et al. 2004, Wysokińska and Kondracki 2004, Smital 2009, Wysokińska and Kondracki 2013].

Variable sexual activity levels and variable facility in producing semen are serious technical and organisational problems in connection with the insemination service of boars. Young insemination boars should be trained to leap on the phantom while still at the piggery where they had been raised. However, the intensity of their libido is still insufficiently explored at the time. It also remains unknown whether the intensity of developing copulatory reflexes is clearly correlated with ejaculatory efficiency, both at the beginning of service and later on. The current state of knowledge of the influence of sexual behaviour on ejaculatory efficiency of boars is much poorer than the knowledge of semen production physiology [Levis and Reicks 2005].

This work was aimed at assessing the sexual activity and ejaculatory efficiency of the following breeds of insemination boars: Duroc, Hampshire and Pietrain, plus the two-breed hybrids: Duroc × Pietrain and Hampshire × Pietrain.

## MATERIAL AND METHODS

The experiments were conducted on 31 boars, including: 5 Duroc, 5 Hampshire and 7 Pietrain boars, as well as 9 Duroc  $\times$  Pietrain and 5 Hampshire  $\times$  Pietrain hybrids. The boars selected for the experiments were used at sow insemination centres. They were the same age and similar body weight, equally fed and maintained in similar environments. The libido analyses were carried out between June and October. Two series of measurements were performed at three-month intervals for each individual animal. The sexual activity of the boars was assessed on the basis of measurements of the time at which the successive sexual reflexes were released when manually collecting semen. The duration of sexual reflexes was identified with a stopwatch. The following sexual activity parameters were selected for the assessment:

- time from entering the arena until mounting the phantom (s),
- time from mounting the phantom until developing erection (s),
- time from developing erection until the start of ejaculation (s),
- duration of ejaculation (s),
- duration of copulation, i.e. the overall time from effectively mounting the phantom until dismounting it following finished ejaculation (s),
- the number of times the boar needed to mount the phantom to successfully yield semen.

The following physical traits were identified in freshly collected ejaculates: ejaculate volume determined after decanting the gelatinous fraction, sperm concentration evaluated colorimetrically with a spectrophotometre, the percentage of progressively motile spermatozoa on the basis of microscopic examination of sperm motility in a drop of fresh semen, total number of spermatozoa in the ejaculate and the number of insemination doses obtained from a single ejaculate – calculated with SYSTEM SUL software.

The data were analysed using the STATISTICA (2012) statistical package. The data was analysed using the following mathematical model:

$$Y_{ij} = \mu + a_i + e_{ij}$$

where:

- $Y_{ij}$  – value of the analysed parameter,
- $\mu$  – populational mean,
- $a_i$  – the effect of boars breed,
- $e_{ij}$  – error.

Tukey's test was used to assess the significance of between-groups differences.

## RESULTS

Table 1 presents the data describing the sexual activity of the analysed boars. The data show that the Duroc, Hampshire and Pietrain boars did not differ significantly in their times of reaction to the phantom. No significant differences were identified between these breeds with regard to the time from entering the arena until successfully mounting the phantom, the time from successfully mounting the phantom until developing full erection and the time from developing erection until the start of ejaculation ( $P > 0.05$ ).

Table 1. Sexual activity depending on the breed group of boars

Tabela 1. Aktywność płciowa knurów w zależności od rasy knura

Item Wyszczególnienie	Breed group – Grupa rasowa					
		Duroc	Hampshire	Pietrain	Duroc × Pietrain	Hampshire × Pietrain
Number of boars Liczba knurów		5	5	7	9	5
Number of measurements Liczba pomiarów		10	10	14	18	10
Time from entering the arena until mounting the phantom, s Czas od wejścia knura do maneżu do wspięcia na fantom, s	$\bar{x}$ SD	225.20 77.89	188.50 48.01	192.43 106.75	243.72 112.75	165.30 93.38
Time from mounting the phantom until developing erection, s Czas od wspięcia na fantom do wystąpienia erekcji, s	$\bar{x}$ SD	54.50 10.79	88.10 36.18	79.71 65.43	68.83 57.43	50.90 91.87
Time from developing erection until the start of ejaculation, s Czas od wystąpienia erekcji do rozpoczęcia ejakulacji, s	$\bar{x}$ SD	39.30 11.56	37.70 16.32	46.07 30.59	62.72 53.25	32.90 19.86
Duration of ejaculation, s Czas ejakulacji, s	$\bar{x}$ SD	196.10 <sup>a*</sup> 42.19	195.40 <sup>a</sup> 78.43	357.79 <sup>b</sup> 99.53	201.33 <sup>a</sup> 50.71	226.30 <sup>a</sup> 44.44
Duration of copulation, s Czas kopulacji	$\bar{x}$ SD	289.90 <sup>aa</sup> 51.49	321.20 <sup>a</sup> 84.86	492.79 <sup>bb</sup> 133.88	322.67 <sup>a</sup> 87.66	310.10 <sup>a</sup> 117.08
Number of times the boar mounted the phantom Liczba skoków knura na fantom	$\bar{x}$ SD	1.30 0.48	1.20 0.42	1.21 0.43	1.50 0.79	1.70 0.82

\*Different superscripts mean significant differences between means within particular rows; lower-case letters:  $P \leq 0.05$ ; upper-case letters:  $P \leq 0.01$ .

\*Wartości w rzędach oznaczone różnymi literami różnią się istotnie przy  $P \leq 0,05$  (małe litery) lub przy  $P \leq 0,01$  (duże litery).

The cumulative times from entering the area until the start of ejaculation were almost identical in the case of all the boars representing these breeds, ranging from 315 to 320 seconds (Fig. 1). The mean numbers of leaps taken at the phantom prior

to the start of ejaculation were also similar in these breeds, ranging from 1.22 to 1.30.

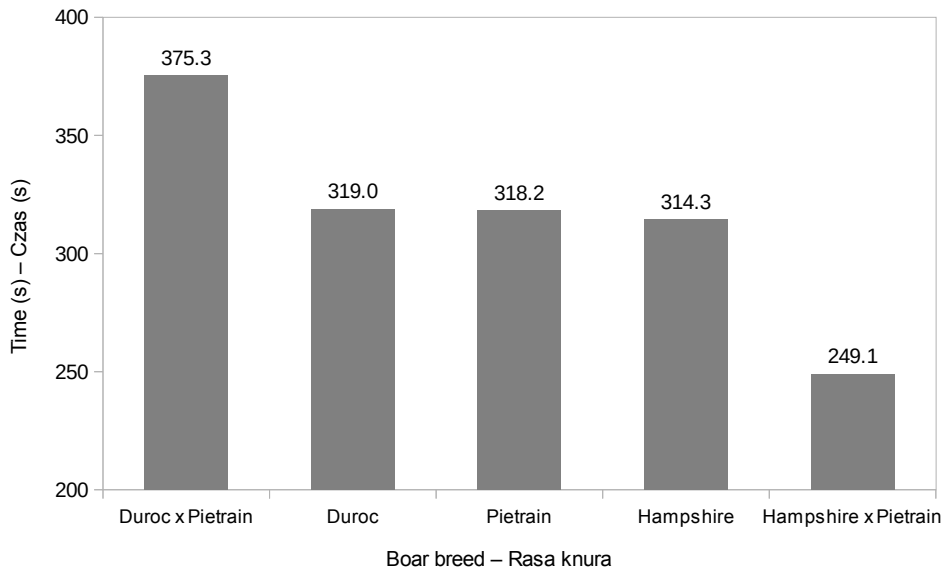


Fig. 1. Time from entering the arena until the start of ejaculation according to the breed group

Rys. 1. Czas upływający od wejścia knura do manézu do rozpoczęcia ejakulacji w zależności od rasy knura

On the other hand, differences in the time of reaction to the phantom were observed between the two-breed hybrids. Both the times from entering the arena until successfully mounting the phantom and the times from successfully mounting the phantom until developing full erection, as well as the times from developing full erection until the start of ejaculation were longer in the case of the Duroc × Pietrain hybrids than in that of the Hampshire × Pietrain crosses. Although these particular differences were not statistically confirmed, the differences in the cumulative times of reaction to the phantom, from entering the arena until the start of the ejaculation, were substantial and statistically significant. The Duroc × Pietrain hybrids needed 126 seconds more than the Hampshire × Pietrain crosses to start ejaculation (Fig. 1).

More prominent differences between the analysed breeds were observed in the case of the duration of ejaculation and cumulative semen collection time. In this respect, the Pietrain boars clearly stood out among the analysed animals. The longest duration of ejaculation was observed in the Pietrain boars, amounting on

average to 357.79 seconds and approximately 120–162 seconds longer than in the case of the other breeds and two-breed hybrids ( $P \leq 0.05$ ). The longest cumulative collection times were also measured for the Pietrain boars (492.79 seconds, on average), over 200 seconds longer than those of the Duroc boars ( $P \leq 0.01$ ) and approximately 170–180 seconds longer than the Hampshire boars and the two-breed hybrids ( $P \leq 0.05$ ).

Table 2 contains a juxtaposition of data describing the physical traits of the ejaculates obtained during the boar libido analyses.

Table 2. Physical traits of the ejaculates collected during the libido analyses

Tabela 2. Cechy fizyczne ejakulatów pobieranych podczas badania libido

Item Wyszczególnienie	Breed group – Grupa rasowa				
	Duroc	Hampshire	Pietrain	Duroc × Pietrain	Hampshire × Pietrain
Number of boars Liczba knurów	5	5	7	9	5
Number of ejaculates Liczba ejakulatów	10	10	14	18	10
Volume ejaculate, ml Objętość ejakulatu, ml	146.90 <sup>A</sup>	226.50 <sup>B</sup>	227.71 <sup>B</sup>	164.28 <sup>A</sup>	258.80 <sup>B</sup>
Sperm concentration, '000 · mm <sup>-3</sup> Koncentracja plemników, tys. · mm <sup>-3</sup>	589.50 <sup>Bb</sup>	352.60 <sup>Aa</sup>	400.36 <sup>Aa</sup>	477.00 <sup>b</sup>	361.80 <sup>Aa</sup>
Total number of progressively motile spermatozoa, % Odsetek plemników wykazujących prawidłowy ruch, %	77.00	80.50	80.00	79.44	80.00
Total number of spermatozoa in the ejaculates, billion Ogólna liczba plemników w ejakulacie, mld	70.00	65.90	81.64	67.72	82.60
The number of insemination doses Liczba dawek inseminacyjnych	16.70 <sup>Aa</sup>	21.60 <sup>ab</sup>	26.21 <sup>b</sup>	19.61 <sup>ab</sup>	27.30 <sup>Bb</sup>

\*Different superscripts mean significant differences between means within particular rows; lower-case letters:  $P \leq 0.05$ ; upper-case letters:  $P \leq 0.01$ .

\*Wartości w rzędach oznaczone różnymi literami różnią się istotnie przy  $P \leq 0,05$  (małe litery) lub przy  $P \leq 0,01$  (duże litery).

The data in Table 2 reveal that the Duroc ejaculates evidently stand out among the analysed ejaculates. The ejaculates of this breed were characterised with definitely the lowest volumes and, simultaneously, highest sperm concentrations. The volume of the Duroc ejaculates was more than 80 ml lower than the volumes of the ejaculates produced by the Hampshire and Pietrain boars and the Hampshire × Pietrain hybrids ( $P \leq 0.01$ ). The sperm concentration in the ejaculates yielded by the Duroc boars was approximately  $159,000 \cdot \text{mm}^{-3}$  higher than that of the Pietrain ejaculates ( $P \leq 0.01$ ) and almost  $237,000 \cdot \text{mm}^{-3}$  higher than the concentration of the Hampshire ejaculates ( $P \leq 0.01$ ). The sperm concentration in the Duroc ejaculates was also almost  $228,000 \cdot \text{mm}^{-3}$  higher than in the ejaculates yielded by the Hampshire × Pietrain hybrids ( $P \leq 0.01$ ). On the other hand, no

differences were found in the sperm concentration between the purebred Duroc and Duroc  $\times$  Pietrain hybrid ejaculates.

## **DISCUSSION**

The commercial efficiency of reproduction boar service depends on the number of insemination doses obtained from ejaculates (Borg et al. 1993, Kondracki et al. 2014). The data show that Duroc ejaculates provide fewer insemination doses than Hampshire and Pietrain ejaculates. Specifically, the Hampshire ejaculates provided 4.9 more insemination doses, and the Pierain ejaculates 9.5 more insemination doses than the Duroc ejaculates. The most numerous insemination doses were obtained from the Hampshire  $\times$  Pierain hybrid ejaculates which provided 10.6 more insemination doses than the Duroc ejaculates.

Special attention should be devoted to Duroc sires which produce ejaculates with low volumes but high sperm concentrations. This seems to be a genetically perpetuated trait of this breed, since similar observations were also made by other researchers (Castro et al. 1996, Park and Yi 2002, Smital et al. 2004, Smital 2009, Kondracki et al. 2011, Kondracki et al. 2012, Wysokińska and Kondracki 2013). Duroc is a specific pig breed which evidently stands out among other currently used pig breeds with regard to ejaculate traits. The above trait is the reason why Duroc ejaculates practically provide fewer insemination doses which, however, contain more spermatozoa in comparison with ejaculates of other breeds, which is generally disadvantageous.

Inseminators make an extensive use of hybrid boars, which are quicker in sexual development, grow faster and are better fit for reproduction in comparison with pure-bred sires [Smital et al. 2004, 2008, Smital 2009, Wysokińska et al. 2013]. They usually produce spermatozoa with high motility and correct morphological structure, as well as exhibiting heterotic effects with regard to the total number of spermatozoa in the ejaculate [Wysokińska and Kondracki 2004]. The results of the present study seem to indicate that advantageous effects relating to the traits of hybrid ejaculates largely depend on the selection of breeds for crossing. Data show that hybrids created from Duroc boars (Duroc  $\times$  Pietrain) produce ejaculates with traits similar to the ejaculates of Duroc boars. In our study, their ejaculates were found to have low volumes, with high sperm concentrations. As regards the number of spermatozoa in the ejaculates and the number of insemination doses prepared from a single ejaculate, they had only a slight advantage over the pure-bred Duroc boars. It seems then that the Duroc breed has a prominent expression in two-breed crossing in relation to ejaculate traits. The expression of the Duroc breed is certainly greater than that of the Pietrain breed. The ejaculates of pure-bred Pietrain boars specifically contained high numbers of sperma-

tozoa and provided a lot of insemination doses. These traits were also prominent in the Hampshire  $\times$  Pietrain hybrid ejaculates, containing the highest numbers of spermatozoa and providing the most numerous insemination doses. However, the Pietrain traits were not observed in the ejaculates of the Duroc  $\times$  Pietrain crosses. This testifies to a greater expression of the Duroc breed in comparison with Pietrain.

The most advantageous traits were identified in the ejaculates produced by the Hampshire  $\times$  Pietrain hybrids. Their ejaculates contained the highest numbers of spermatozoa and provided the most numerous insemination doses. The positive effects of crossing these breeds are also confirmed by the results obtained by Smital et al. [2004] who identified positive and prominent heterotic effects in Hampshire  $\times$  Pietrain crosses in relation to ejaculate volume (30.6%) and ejaculate sperm count (18.24%). Highly pronounced and positive heterotic effects were observed in the case of Hampshire  $\times$  Pietrain hybrid boars with regard to ejaculate volume, overall number of spermatozoa in the ejaculate and the number of insemination doses obtained from a single ejaculate by Wysokińska and Kondracki [2013]. The data obtained in the present study, as well as observations made by other researchers [Smital et al. 2004, Wysokińska and Kondracki 2013] confirm the sense of using Hampshire  $\times$  Pietrain crosses.

In conclusion, it must be stressed that Hampshire  $\times$  Pietrain hybrids turn out to have the most advantageous traits from the point of view of insemination use. They are characterised with the shortest times of reaction to the phantom and, with a relatively long ejaculation, they produce ejaculates with the highest numbers of spermatozoa, providing the most numerous insemination doses. Among the purebred boars, the most advantageous traits were found in the Pietrain boars. These boars are characterised with the longest time of ejaculation and produce ejaculates with high sperm counts. Pietrain ejaculates can be used to prepare 5 insemination doses more than in the case of Hampshire ejaculates and 10 insemination doses more than in the case of Duroc ejaculates.

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## AKTYWNOŚĆ PŁCIOWA ORAZ CECHY EJAKULATÓW KNURÓW RAS DUROC, HAMPSHIRE I PIETRAIN ORAZ MIESZAŃCÓW TYCH RAS

**Streszczenie.** Badania przeprowadzono na 31 knurach, w tym: 5 knurów rasy Duroc, 5 knurów rasy Hampshire, 7 knurów rasy Pietrain, 9 knurów mieszańców Duroc × Pietrain i 5 knurów mieszańców Hampshire × Pietrain. Dla każdego osobnika wykonano dwie serie pomiarów w odstępach trzymiesięcznych. Aktywność płciową knurów oceniono na podstawie pomiarów czasu wyzwania kolejnych odruchów płciowych podczas pobierania nasienia metodą manualną. Ocenie poddano także pobierane ejakulatory na podstawie pomiarów objętości ejakulatu, koncentracji i ruchliwości plemników oraz ogólnej liczby plemników w ejakulacie i liczby dawek inseminacyjnych sporządzanych z ejakulatu. Wykazano że najkorzystniejsze cechy z punktu widzenia wykorzystania inseminacyjnego mają knury mieszańce Hampshire × Pietrain. Charakteryzują się one najkrótszym czasem reakcji na fantom, a jednocześnie przy relatywnie długim czasie ejakulacji wydają ejakulatory o największej liczbie plemników, z których można sporządzić najwięcej dawek inseminacyjnych. Spośród knurów czystorasowych najkorzystniejsze cechy mają knury rasy Pietrain. Charakteryzują się one najdłuższym czasem ejakulacji i wydają ejakulatory o dużej zawartości plemników. Z ejakulatów knurów rasy Pietrain można sporządzić o 5 dawek inseminacyjnych więcej niż z ejakulatów knurów rasy Hampshire i o 10 dawek inseminacyjnych więcej niż z ejakulatów knurów rasy Duroc.

**Słowa kluczowe:** knur, grupa rasowa, aktywność płciowa, nasienie

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