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Sex ratio in foal crops sired by purebred Arabian stallions in the years 1989–2010

Rozkład płci źrebiąt koni czystej krwi arabskiej w stawkach potomstwa ogierów
użytkowanych w latach 1989–2010

Summary. The sex ratio was analysed in a population of 3080 purebred Arabian foals born in the years 1990–2011, sired by 127 Arabian stallions. The study evaluated the influence of the sire and the year of birth on the ratio of colts to fillies. In crops sired by 86 stallions, only two, Eurykles 2001 (Emigrant – Eutona) and Salar 2000 (Ecaho – Saba), were found to have a significant effect on the sex of the foals. Despite the higher percentage of fillies among the Arabian foals in 8 years of birth out of the 22 analysed, the influence of year of birth on sex ratio was highly significant only in 2007.

Key words: sex ratio, purebred Arabian horses

INTRODUCTION

In breeding of purebred Arabian horses, the birth of fillies is highly desirable, as they can be used in the future in breeding herds. There is less demand for breeding stallions, but the requirements they need to meet are very high. In this situation it is essential to maintain the optimal number of stallions and mares. Genetic sex is determined at the moment of fertilization by the set of chromosomes passed on by the parents, with the sex chromosome playing a particularly important role [Zwierzchowski 1997]. In mammals, the sex of offspring is determined exclusively by the male gamete, i.e. the sperm, which penetrates the egg during fertilization. Sex ratio in the offspring of farm animals has for many years been a subject of interest both from a scientific and practical viewpoint [Budzyński *et al*. 2000, Chmiel and Sobczuk 1998, Jeżewska *et al.* 1998, Pankiewicz 1989, Pięta and Patkowski 1997, Sobczuk and Chmiel 2005].

Research has previously been conducted on the effect of the sire and the birth year on percentages of fillies or colts in a population of Polish Konik foals [Sobczuk 2012]. A similar study was carried out on purebred Arabian horses using data from an early research period than that discussed in the current publication [Chmiel *et al.* 1999].

The aim of the study was to determine whether significant deviations occurred with respect to the expected frequency of births of each sex in crops sired by particular stallions or in particular breeding seasons.

MATERIAL AND METHODS

The material for the study consisted of the offspring of 127 purebred Arabian stallions used in the years 1989–2010 in Polish breeding of Arabian horses, from which 3080 foals of both sexes were obtained. From the entire crop of Arabian sires 86 stallions were distinguished which had produced at least 5 offspring. Together they sired a total of 2995 foals – 1486 colts (49.62%) and 1509 fillies (50.38%).

The ratio of colts to fillies was calculated both in the crops sired by particular stallions and for each year of birth. The analysis was based on data on breeding mares used in stud farms producing purebred Arabian horses in Janów Podlaski, Michałów and Białka [Breeding show catalogues for the years 1990–2011]. Stillborn foals were not taken into account in the study.

The percentage of male and female individuals was determined in the population of foals studied, both in crops sired by particular stallions and in successive years of birth.

In total, 3080 foals, including 1528 (49.61%) colts and 1552 (50.39%) fillies, were analysed by year of birth.

In addition, the observed and expected (1 : 1) frequency of births of foals of both sexes were compared using the χ^2 test [Ruszczyc 1978]:

$$\chi^2 = \sum \left\{ \frac{(f-F)^2}{F} \right\} ; n' = r - 1,$$

where:
r – number of classes,
f – value observed in the experiment,
F – expected value,
n' – number of degrees of freedom,

The significance of χ^2 was verified by comparing it with the tabular critical value.

RESULTS AND DISCUSSION

A total of 3080 foals (1528 colts and 1552 fillies) born in the years 1990–2011 were classified according to their year of birth [Breeding show catalogues from the Janów

Podlaski, Michałów and Białka stud farms]; the offspring of all stallions used during this period was counted for this analysis.

For the entire period covered by the study there were no significant differences found in the proportions of foals born of each sex (Tab. 1). The highest deviation from the expected sex ratio of 1:1, in favour of fillies, measured by the χ^2 value for the year 2007, was 11.95, which is statistically highly significant.

Table 1. Sex ratio of purebred Arabian foals born in the years 1990–2011
Tabela 1. Rozkład płci źrebiąt koni czystej krwi arabskiej urodzonych w latach 1990–2011

Year/Rok	Number of foals Liczba źrebiąt	Number of stallions Liczba ogierków	Number of mares Liczba klaczek	% stallions % ogierków	% mares % klaczek	χ^2
1990	124	53	71	42.74	57.26	2.61
1991	123	66	57	53.66	46.34	0.66
1992	113	52	61	46.02	53.98	0.72
1993	122	61	61	50.00	50.00	0.00
1994	117	60	57	51.28	48.72	0.08
1995	133	68	65	51.13	48.87	0.07
1996	114	54	60	47.37	52.63	0.32
1997	103	59	44	57.28	42.72	2.18
1998	115	61	54	53.04	46.96	0.43
1999	126	65	61	51.59	48.41	0.13
2000	149	72	77	48.32	51.68	0.17
2001	136	74	62	54.41	45.59	1.06
2002	140	57	83	40.71	59.29	**4.83[a]**
2003	152	77	75	50.66	49.34	0.03
2004	158	68	90	43.04	56.96	3.06
2005	181	101	80	55.80	44.20	2.44
2006	158	77	81	48.73	51.27	0.10
2007	162	59	103	36.42	63.58	**11.95[A]**
2008	176	90	86	51.14	48.86	0.09
2009	175	96	79	54.86	45.14	1.65
2010	143	76	67	53.15	46.85	0.57
2011	160	82	78	51.25	48.75	0.10
Total Łącznie	3080	1528	1552	49.61	50.39	0.19

Values χ^2 indicated by small letters are significant and capital letters are highly significant

Numerical superiority of fillies was observed in eight years of birth: 1990, 1992, 1996, 2000, 2002, 2004, 2006 and 2007. In the years 1990, 1997, 2001, 2002, 2004, 2005, 2007 and 2009 the value of χ^2 was greater than 1, while in the remaining years it was less than l.

The value of χ^2 for the entire study period was 0.19, which does not indicate a significant effect of year of birth on sex ratio in this population of foals.

The percentages of foals of each sex born in the years 1990–2011, according to year of birth, are illustrated in Fig. l. Despite the higher percentage of fillies sired by the Arabian stallions in 8 years of the 22 analysed, only in two years did the χ^2 value exceed the threshold of significance; in 2002 the χ^2 value was significant, and in 2007 highly significant – 4.83 and 11.95, respectively.
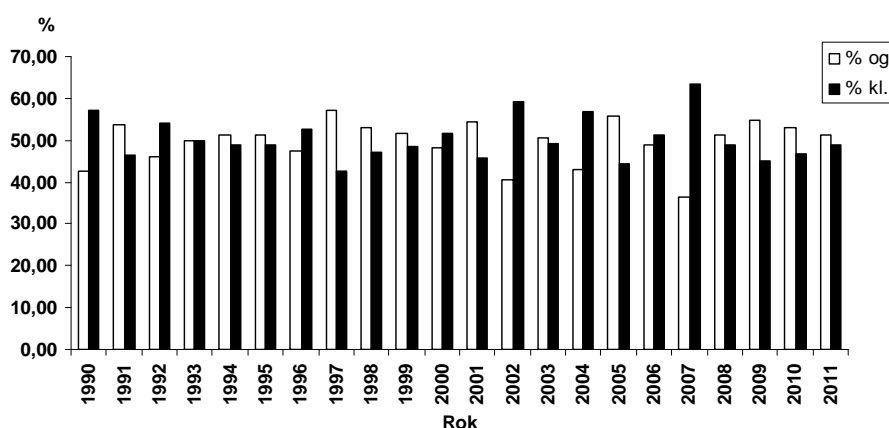

Fig 1. Sex ratio of purebred Arabian horses born in the years 1990–2011
Ryc. 1. Stosunek płci koni czystej krwi arabskiej urodzonych w latach 1990–2011

Analysis of the sex ratio in the offspring of particular stallions included 2995 foals – 1486 colts (49.62%) and 1509 fillies (50.38%) – sired by 86 sires, as only individuals that had produced at least 5 foals were taken into account.

Table 2 presents the sex distribution of foals sired by purebred Arabian stallions for which the value of χ^2 was equal to or greater than 1.00.

The percentage of foals of each sex in the crops sired by particular stallions ranged from 81.82% colts and 18.18% fillies (Eurykles – 11 foals) to 16.67% colts and 83.33% fillies (Gabaryt – 6 foals).

Deviation from the expected frequency of births of foals of each sex, measured using the χ^2 test, was statistically significant for 2 stallions. For the offspring of the stallion Salar 2000 (Ecaho – Saba) χ^2 was 3.77, and for Eurykles 2001 (Emigrant – Eutona) it was 4.45, which was the highest value. A clear predominance of fillies was observed in the offspring of the following sires: Eol, Esparto, Etogram, Falsyfikat, Gabaryt, Gadir, Galba, Pesal, Piruet and Salar.

Exactly equal frequency of both sexes was noted in the progeny of 18 of the 127 stallions.

On a small scale it was possible to distinguish stallions that sired more colts or more fillies, or in whose offspring the proportion of the sexes was equal, but these tendencies were not statistically significant.

Table 2. Sex ratio in foal crops sired by purebred Arabian stallions with 5 or more offspring, $\chi^2 \geq 1$
Tabela 2. Rozkład płci źrebiąt w stawkach reproduktorów koni czystej krwi arabskiej,
posiadających 5 i więcej sztuk potomstwa, dla których $\chi^2 \geq 1$

Stallion Ogier	Number of foals Liczba źrebiąt	Number of stallions Liczba ogierków	Number of mares Liczba klaczek	% stallions % ogierków	% mares % klaczek	χ^2
Alegro	39	24	15	61.54	38.46	2.08
Aleppo	5	4	1	80.00	20.00	1.80
Ararat	83	35	48	42.17	57.83	2.04
Druid	18	12	6	66.67	33.33	2.00
Dziewierz	9	6	3	66.67	33.33	1.00
Ecaho	73	42	31	57.53	42.47	1.66
Ekstern	184	82	102	44.57	55.43	2.17
El Bak	9	6	3	66.67	33.33	1.00
Enzo	44	28	16	63.64	36.36	3.27
Eol	10	3	7	30.00	70.00	1.60
Equifor	10	7	3	70.00	30.00	1.60
Esparto	29	11	18	37.93	62.07	1.69
Etogram	29	11	18	37.93	62.07	1.69
Eurykles	11	9	2	81.82	18.18	**4.45[a]**
Falsyfikat	16	5	11	31.25	68.75	2.25
Gabaryt	6	1	5	16.67	83.33	2.67
Gadir	16	6	10	37.50	62.50	1.00
Galba	48	19	29	39.58	60.42	2.08
Grandorr	26	17	9	65.38	34.62	2.46
Hs Etiquette	17	12	5	70.59	29.41	2.88
Pegasus	56	33	23	58.93	41.07	1.79
Pesal	80	32	48	40.00	60.00	3.20
Piruet	41	15	26	36.59	63.41	2.95
Polon	7	5	2	71.43	28.57	1.29
Porto	8	6	2	75.00	25.00	2.00
Salar	13	3	10	23.08	76.92	**3.77[b]**
Samsheik	8	6	2	75.00	25.00	2.00
Wachlarz	76	43	33	56.58	43.42	1.32

Values χ^2 indicated by small letters are significant

This information may be of some use to breeders looking for "fathers of sires" or "fathers of dams".

CONCLUSIONS

1. In the offspring of 86 stallions, only 2 were found to have had a significant influence on the sex of the foals, although in some individuals a tendency was observed to sire more colts or more fillies.

2. Despite the higher percentage of fillies among the offspring of the purebred Arabian horses in 8 of the 22 years analysed, the year of birth was found to have a highly significant effect on sex ratio only in the year 2007.

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Streszczenie. Analizowano rozkład płci w populacji 3080 źrebiąt koni czystej krwi arabskiej urodzonych w latach 1990–2011, pochodzących od 127 ogierów tej rasy. W badaniach oszacowano wpływ reproduktorów i roczników urodzenia na rozkład urodzonych ogierków i klaczek. Wśród stawek potomstwa 86 ogierów stwierdzono istotny wpływ tylko dwóch ogierów Eurykles 2001 (Emigrant – Eutona) oraz Salar 2000 (Ecaho – Saba) na płeć źrebiąt. Pomimo zaobserwowanej przewagi procentowej na korzyść klaczek w potomstwie ogierów arabskich, w 8 rocznikach urodzeń z analizowanych 22 lat, wysoko istotny wpływ rocznika urodzenia na rozkład płci potomstwa stwierdzono tylko w 2007 r.

Słowa kluczowe: rozkład płci, konie czystej krwi arabskiej