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Analysis of the inbreeding level in the Polish population of the Alpine Dachsbracke dog breed in the years 2000-2016

Elżbieta Bednarek[1#], Anna Sławińska[1], Sławomir Mroczkowski[2]

University of Science and Technology in Bydgoszcz, Faculty of Animal Breeding and Biology,
[1]Department of Animal Biochemistry and Biotechnology,
[2]Department of Genetics and General Animal Breeding,
ul. Mazowiecka 28, 85-084 Bydgoszcz; [#]e-mail: elzbieta-bednarek2@wp.pl

The aim of the study was to analyse the level of inbreeding in the Alpine Dachsbracke dog breed. The research was conducted using pedigrees of 405 individuals of this breed (195 male and 210 female), born in the years 2000-2016. The inbreeding coefficients (F_x) were estimated based on four-generation pedigrees. The individual inbreeding coefficients ranged from 0% to 25%. The average inbreeding coefficient for the population was 2.25% and did not differ between sexes (P>0.05). For 49.4% of individuals, the mean F_x value was 4.55%. The F_x values between years of birth were highly significant (P<0.0001). The trend analysis showed no significant changes in F_x during the period analysed. The mean inbreeding coefficient in the Polish population of Alpine Dachsbracke dogs was not high, but attention should be paid to the inbreeding coefficients of certain individuals, and mating of closely related individuals should be avoided.

KEY WORDS: inbreeding / hunting dogs / leash hounds / Alpine Dachsbracke

The Alpine Dachsbracke dog breed comes from Austria. It was created in the mid--nineteenth century by crossing scent hounds with short-haired standard dachshunds [5]. The breed was registered by the Fédération Cynologique Internationale (FCI) in 1975, and its standard was published in 1995. The Alpine Dachsbracke belongs to group 6, 'scent hounds and related breeds', i.e. dogs used for tracking and chasing animals. The FCI also included this breed in section 2 – 'leash (scent) hounds', i.e. dogs that track down game that has been shot, leaving traces of blood [17].

The Alpine Dachsbracke is small, robust, resilient, lively, stubborn, and resistant to weather conditions. It has an excellent sense of smell and a strong voice. It is used as a dog that works at a slow pace. It is usually used for hunting, as a boarhound or leash hound, or as a companion dog. It is subjected to working trials for scent hounds and leash hounds [16].

Breeding work based on the mating of related animals (inbreeding) may increase the homozygosity of individuals. Inbreeding is estimated using the inbreeding coefficient (F_x), which provides an estimate of the probability that a given individual will inherit the same alleles from related parents. An increase in inbreeding in the population may lead to inbreeding depression, which is manifested as problems with fecundity and fertility, defects and diseases, or mental disorders [7]. Numerous scientific studies have found a relationship between the level of inbreeding and the occurrence of genetic diseases. For example, this dependence has been confirmed for hip dysplasia in the Icelandic Sheepdog [9] and German Shepherd [11]. In a study conducted on the Bouvier Belge des Flandres [20], a high level of inbreeding was found to influence the occurrence of such diseases as osteochondrosis, laryngeal paralysis, cancer, autoimmune diseases, trachea hypoplasia, and food allergies. The risk of disease can be reduced by mating unrelated animals, particularly those that have been tested for diseases characteristic of a given breed. It is assumed that the proportion of offspring of a given male should not exceed 5% of the puppies in the population of a given breed within five years. It is therefore recommended that dogs with health disorders, including psychological disorders, should be eliminated from breeding, and that puppies born with defects should be registered [10].

The Alpine Dachsbracke breed appeared in Poland in the 1960s. It is not a popular breed, with a dozen or so breeding facilities registered in the country [16]. Inbreeding depression in Alpine Dachsbracke dogs may result in hyperactivity or fearfulness, which causes problems during trials, competitions and hunting. An increase in the number of such dogs, which are a product of inbreeding, may cause a decline in interest in the breed. Therefore, due to the small number of dogs of this breed, the level of inbreeding in the population must be controlled. Hence the aim of the study was to analyse inbreeding in the Polish population of Alpine Dachsbracke dogs.

Material and methods

The material for analysis consisted of four-generation pedigrees of Alpine Dachsbracke dogs published in the online Bavarian Mountain Scenthound pedigrees database [1]. Data were collected for 405 Alpine Dachsbracke individuals (195 males and 210 females) born in Poland in the years 2000-2016. The results were divided according to gender and year of birth.

The inbreeding coefficient (F_x) was calculated using a simplification of Wright's formula [22]:

$$F_x = 0.5\Sigma(0.5)^{n+m}$$

where:

n – number of generations between mother and common ancestor

m – number of generations between father and common ancestor

The inbreeding coefficients were averaged for the population and broken down into males and females. We present the distribution of numbers of inbred and non-inbred indi-

viduals, taking into account sex or year of birth, in the following inbreeding classes: $F_x=0$; $0<Fx\leq6.25\%$; $6.25\%<F_x\leq12.5\%$; $12.5\%<F_x\leq18.75\%$; and $18.75\%<F_x\leq25\%$.

Due to the lack of normality of the distribution of inbreeding coefficients, the results for averages for the year of birth and sex were analysed using nonparametric tests. The relationship between the level of inbreeding and sex was analysed by the Mann-Whitney U test (also known as the Wilcoxon test), and the relationship between inbreeding and year was determined by the Kruskal-Wallis test. The SAS and PQStat statistical software packages were used for the analyses.

Results and discussion

Population size. The number of Alpine Dachsbracke males increased, while the number of females decreased (Fig. 1). The declining number of females may cause a reduction in the population in the future. The most males were born in 2009 (22 individuals), and the most females in 2008 (22 individuals). The fewest males and females (three of each) were registered in the database from 2003 (males) and 2013 (females). Differences in the number of dogs registered in the database in different years may be due to the low popularity of the breed and the fact that breeders are focused on the sale of puppies, mainly to hunters.

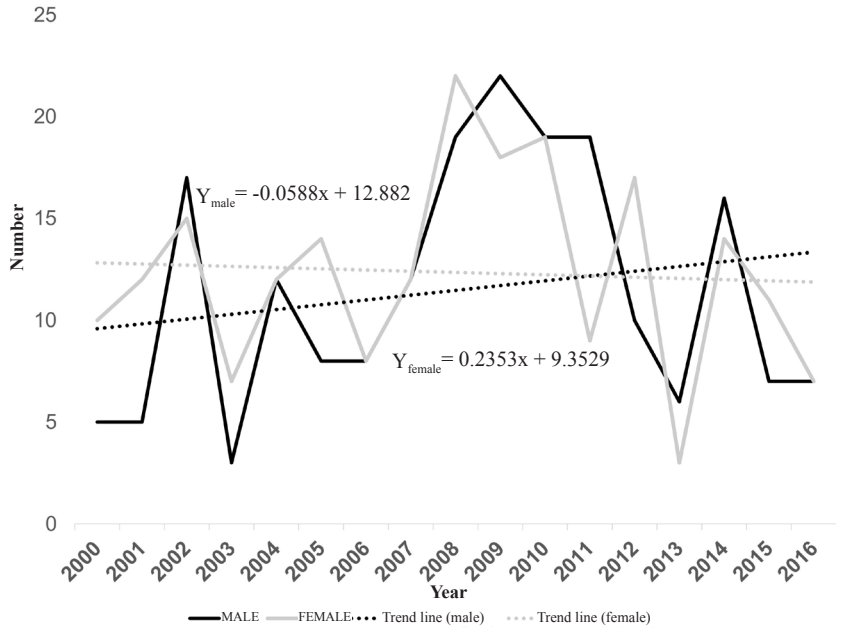

Fig. 1. Number of male and female Alpine Dachsbracke dogs born in 2000-2016

Inbreeding coefficient. Table 1 shows the minimum and maximum values as well as the average for inbreeding in the entire Alpine Dachsbracke population. In the years 2000-2016, the inbreeding coefficient ranged from 0% to 25%. The average inbreeding coefficient in the entire analysed population was 2.25%, and was slightly lower in males (2.19%) than in females (2.30%). The inbred Alpine Dachsbracke group consisted of 200 individuals, which was almost half (49.4%) of the total study population. There were 95 inbred males and 105 inbred females. The percentage of inbred animals was considerable, which may be due to the small population size. In the inbred portion of the population the average F_x value ranged from 0.78% to 25%. The average inbreeding coefficient in the inbred animals was 4.55%. This value was similar for males (4.49%) and females (4.61%).

Table 1
Average inbreeding coefficients (F_x) for Alpine Dachsbracke dogs

Whole population	Males	Females	Total
N	195	210	405
Mean F_x (%)	2,19	2.30	2.25
Min. F_x (%)	0	0	0
Max. F_x (%)	25.00	25.00	25.00
Inbred animals	Males	Females	Total
N	95	105	200
Mean F_x (%)	4.49	4.61	4.55
Min. F_x (%)	0.78	0.78	0.78
Max. F_x (%)	25.00	25.00	25.00

Considering the relatively small population and lack of popularity of the Alpine Dachsbracke breed in Poland, inbreeding in most individuals was relatively low [14]. The inbreeding coefficient was above 5% in about 16% of individuals [2]. This may result in symptoms of inbreeding depression, especially in individuals in which the F_x value approached 25%. Breeders should choose parents who are as little related to each other as possible, or not at all. The inbreeding coefficient is also influenced by the size of the population. The F_x level increases when the population decreases and vice versa – when numbers are higher we can expect lower F_x ratios. Therefore, it would be advisable to consider increasing the import of males for breeding, but only those that are unrelated to the females of the population.

Inbreeding coefficients obtained in analyses by other authors are presented in Table 2. The mean F_x values in the Alpine Dachsbracke breed differ from the results reported by other authors. Non-hunting breeds generally had a higher level of inbreeding than was fo-

und in our research (with the exception of Hovawart and Pembroke Welsh Corgi) [18, 19]. The highest F_x values were found for the German Shepherd and Labrador Retriever [4], used as guide dogs, whose populations were small due to selection to meet the needs of this type of work. High coefficients were found in the German Shepherd [14] and the Lancashire heeler [15].

Table 2
Inbreeding coefficients in different dog breeds

Dog breed	F_x (%)	Source
Hovawart	0.26	Różańska-Zawieja et al. [18]
Beagle	0.68	Gierdziewicz et al. [6]
Golden Retriever	0.82	Kania-Gierdziewicz et al. [13]
Labrador Retriever	0.83	Kania-Gierdziewicz et al. [13]
Pembroke Welsh Corgi	1.76	Świderek et al. [19]
Alpine Dachsbracke	2.25	our own research
Tatra Shepherd	4.40	Kania-Gierdziewicz and Gierdziewicz [12]
Bavarian Mountain Hound	4.51	Voges and Distl [21]
10 purebred dogs*	2.40-5.80	Caliboli et al. [3]
Hanover Hound	6.78	Voges and Distl [21]
Tyrolean Hound	9.47	Voges and Distl [21]
Lancashire heeler	10.00	Mäki [15]
Germam Shepherd	12.86	Kania-Gierdziewicz et al. [14]
Labrador Retriever	22.00	Cole et al. [4]
Nova Scotia Duck Tolling Retriever	26.00	Mäki [15]
German Shepherd	26.20	Cole et al. [4]
Polish Hound	7.71-37.00	Głażewska [8]

*Akita Inu, Boxer, English Bulldog, Chow Chow, Greyhound, German Shepherd, Labrador Retriever, English Springer Spaniel, Golden Retriever, Long-Haired Collie

Among hunting dogs, the F_x level was similar or higher in other leash hounds (4.5% for the Bavarian Mountain Hound and 6.8% for the Hanover Hound), belonging to the same section as the Alpine Dachsbracke [21]. In the Tyrolean Hound, the average F_x was 9.5% [21]. Despite the larger size of the populations analysed, the inbreeding coefficient reported by Voges and Distl [21] was higher than in our research. The F_x level was very high in the Polish Hound population (7.71-37%) [8], significantly exceeding the inbreeding level in the Alpine Dachsbracke. The high level of inbreeding in the Polish Hound is due to improper selection, in which breeders are guided by the popularity of an individual dog when choosing parents.

For some breeds, the inbreeding values were very low. The F_x level in beagles estimated by Gierdziewicz et al. [6] was lower than in the Alpine Dachsbracke, amounting to 0.68% for the whole population (0.66% for females and 0.70% for males). Low inbreeding coefficients in dogs are indicative of well-conducted selection, import of sires, and an adequate population size for reproduction [6]. A study by Kania-Gierdziewicz et al. [13] found low F_x values: 0.83% in Labradors (0.66% in females and 1.08% in males) and 0.82% in Golden Retrievers (0.76% in females and 0.90% in males). Such low results were mainly due to the popularity of these two breeds.

A direct relationship between the inbreeding coefficient and population size has been demonstrated by Calboli et al. [3]. The highest inbreeding coefficient among hunting dogs was found in Greyhounds (5.8%), with the smallest population (16 individuals), and the lowest in Labrador Retriever (2.4%), which is the most numerous breed (97,884 individuals). In some cases, despite a large population of dogs, the inbreeding coefficients were high. The level of inbreeding in the Nova Scotia Duck Tolling Retriever [15] was very high (26%), with a population of 28,668 individuals. The high F_x value may have been due to the fact that while dogs were imported from a variety of countries, they were related to one another.

Size of the inbred population. In our research, 49.4% of individuals were inbred, with an average F_x coefficient of 4.55% for the inbred population. These values are quite high in comparison with other hunting breeds bred in Poland. In the case of the Beagle, a similar level of inbreeding was obtained in the inbred part of the population (4.92%), but only 14% of individuals were inbred [6]. A low percentage of inbred animals indicates that breeders have made an effort to properly select pairs for breeding and not to mate related individuals. In contrast, the inbred portion of the population was relatively large in the case of the most popular breeds of hunting dogs in Poland, i.e. the Labrador Retriever (32%) and Golden Retriever (49%). Nevertheless, in both cases the inbred populations had relatively low mean inbreeding coefficients (2.58% for the Labrador Retriever and 1.67% for the Golden Retriever) [13].

Differences in mean F_x between sexes and birth years. Differences in mean F_x between the sexes were negligible ($P>0.05$), while differences between the mean inbreeding coefficients of dogs born in different years were highly statistically significant ($P<0.0001$). The lack of differences between the level of inbreeding of males and females was due to the similar number of individuals of each sex in the Alpine Dachsbracke population. During the period covered by the study (2000-2016), the number of individuals born in a given

year was varied. This is linked to the relatively low popularity of the Alpine Dachsbracke breed, which is mainly used as a hunting dog. Due to the limited demand for puppies of this breed, breeding is carried out irregularly.

Table 3
Distribution of animals among inbreeding classes according to sex and year of birth

Birth year	Inbreeding class					
	$F_x=0$	$0<F_x\leq6.25\%$	$6.25\%<F_x\leq12.5\%$	$12.5\%<F_x\leq18.75\%$	$18.75\%<F_x\leq25\%$	Total
	N	N	N	N	N	N
2000	4	11	0	0	0	15
2001	5	5	5	0	2	17
2002	23	8	0	0	0	32
2003	8	2	0	0	0	10
2004	13	8	3	0	0	24
2005	20	2	0	0	0	22
2006	15	1	0	0	0	16
2007	12	7	0	0	5	24
2008	23	18	0	0	0	41
2009	28	12	0	0	0	40
2010	11	23	4	0	0	38
2011	9	17	2	0	0	28
2012	1	22	3	0	0	27
2013	3	5	1	0	0	9
2014	9	14	7	0	0	30
2015	10	0	8	0	0	18
2016	11	2	1	0	0	14
Sex						Total
Males	100	76	16	0	2	195
Females	105	92	18	0	3	210

Trends in the level of the inbreeding coefficient. The values of the inbreeding coefficient varied over the years (Figure 2). The inbreeding level was lowest in males in 2003 and 2006 (0%), and in females in 2009 (0.36%). The average F_x was highest in males in 2001 (5.78%) and in females in 2007 (8.20%). A study by Głażewska [8] found that the average F_x in the Polish Hound increased from 7.71% in 1960 to 37% in 2004. In the author's opinion, the increase in the inbreeding coefficient was due to breeders choosing sires based on their popularity and to numerous matings of closely related pairs. The level of inbreeding in the Nova Scotia Duck Tolling Retriever increased from 5% in 1961 to 26% in 2006, and that of the Lancashire heeler from 0% in 1976 to 26% in 2006 [15]. According to the author of that study, the increase in inbreeding was due to the fact that a small percentage of the animals born were used for breeding. In our own research, changes in the inbreeding coefficient in 2000-2016 were not so pronounced. In this period, a gentle downward trend

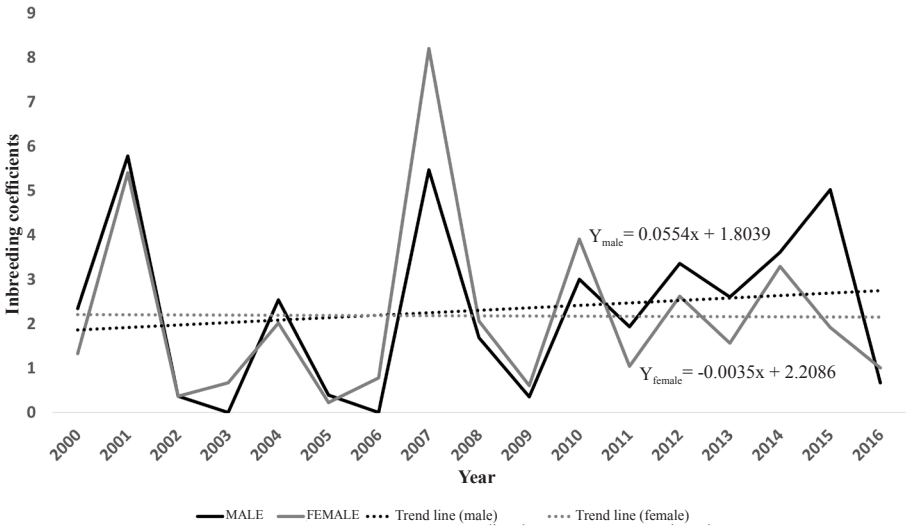

Fig. 2. Mean inbreeding coefficients for Alpine Dachsbracke dogs in the years 2000-2016, by gender and year of birth

in the F_x level was observed in the case of females (y = −0.0035x + 2.2086), and a slight upward trend in males (y = 0.0554x + 1.8039). It is worth noting that in many dog breeds, inbreeding increases significantly when the periods analysed are widely separated in time.

In conclusion, in the analysed population of Alpine Dachsbracke dogs, the number of females has decreased while the number of males has increased. When such a situation persists for a long time it has unfavourable consequences for breeding and may lead to a decrease in the effective population size. The average inbreeding coefficients were at an appropriate, low level. Particular attention should be paid to mating of closely related animals and the creation of individuals with a high level of inbreeding, such as the individuals in the population in which the F_x value reached 25%.

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