Analysis of genetic relatedness and inbreeding in Polish population of the Newfoundland dog breed

BRYGIDA KRUZIŃSKA[1], NATASZA ŚWIĘCICKA[2], ZUZANNA NOWAK-ŻYCZYŃSKA[1], AGNIESZKA BORUTA[1], ALEKSANDRA KALIŃSKA[1], JULIA GŁOWACKA[1]

[1]Faculty of Animal Sciences, Warsaw University of Life Sciences – SGGW
[2]Faculty of Animal Breeding and Biology, University of Science and Technology – UTP

Abstract: *Analysis of genetic relatedness and inbreeding in Polish population of the Newfoundland dog breed*. The aim of the study was to analyse the five-generation pedigrees of Newfoundland dogs, registered in the Polish Kennel Club and shown in 2015 in Poland. Pedigrees come from the Polish Newfoundland Club website and their analysis was possible with the use of the international pedigree database (https://www.newfoundlanddog-database.net/). Inbreeding coefficient (COI) and ancestor loss coefficient (AVK) were calculated and pedigrees were analysed for the presence of common ancestor. Results indicate low mean COI values, with individual values ranging from 0.78% to 7.03%. The mean kinship was 3.14. Five-generation pedigree analysis did not show high inbreeding in the population studied and AVK exceeded the suggested value of 85% only in one case. It can be thus concluded that the population of Polish Newfoundlands, at least its part, presented at shows in 2015 and most likely intended for breeding, is not to be considered inbred.

Key words: Newfoundland, inbred, ancestor loss

INTRODUCTION

Pedigree dog breeding is getting increasingly popular and has already led to distinct changes in phenotypes of the breeds subjected to breeding strategies. The Newfoundland, as its name indicates, comes from the Canadian island and was originally used as a draft- and companion dog. Descending from different European dogs, brought to the island, the breed gained popularity when imported to Great Britain and Europe. Imposing presence, calm personality and great patience made the Newfie a valued companion and beloved pet (Nowak 1995).

Years of selective breeding and establishing of breed clubs, gathering enthusiasts and breeders, resulted in forming the breed type, albeit differing slightly between countries and organizations. Breed standard, accepted by Fédération Cynologique Internationale (FCI), set the maximum size at 71 cm for males and 66 cm for females and weight at appr. 68 kg and 54 kg, respectively (Wzorzec FCI...). American Kennel Club (AKC) accepts heavier specimens – males at 65––75 kg and females at 50–60 kg. Height at withers can be by 1 cm lower (Official Standard...). British breed standard, published by KC (British Kennel Club) does not differ from that by FCI as far as size is concerned, whereas weight is slightly lower – between 64–69 kg for males and 50–54.5 kg for females (Newfoundland Breed Standard).

The pedigree is an individual document and gives information on the ancestors, their health tests results and colours. In Polish Kennel Club the pedigree covers four generations (Nowak 1995). Several mating systems are employed in breeding dogs, one of those being inbreeding, i.e. mating individuals related by one or more common ancestors (Nalazek 1994a, b, Kosowska and Nowicki 1999, Amstrong 2001, Charon and Świtoński 2006, Monkiewicz et al. 2011). Such matings, however, may result in so-called inbreeding depression. Its typical symptoms, observed with progeny, are decreased size, various health problems, premature ageing and lower fertility (low fertilization rate, tendency to miscarriages, high newborn mortality) (Amstrong 2001, Głażewska 2005, Monkiewicz et al. 2011).

One of inbreeding strategies is line breeding, when a certain distinguished ancestor appears several times in the pedigree, in case of a male e.g. as grandfather and grand-grandfather. This is not to be confused with so-called popular sire effect when genetic diversity in next generations is reduced in result of frequent use of a popular champion and winner of many shows (Amstrong 2001, Monkiewicz et al. 2011, Hannula et al. 2014).

Wright coefficient of inbreeding (COI), measured on a scale from 0 to 100%. It determines the probability that alleles of a given gene in one of the parents are identical to alleles of the same pair in the other parent, as a consequence, it will make the offspring more likely to inherit identical copies of a given gene. Homozygosity of progeny is directly connected with increasing inbreeding. It is recommended that the coefficient should not exceed 6% for 5-generation pedigrees, and 9% for 10-generations. Specialists in the FCI for rare breeds determined that the COI should not exceed 10%.

Ancestor loss coefficient (AVK) enables both to estimate the unique gene pool and inbreeding in earlier generations on both sides of the pedigree. Its value describes the proportion of the unique ancestors to the total number of independent ancestors in the pedigree.

The mean kinship coefficient (MK) is calculated for each individual in a given population, showing the degree of relationship with a given population. The most valuable individuals for the breeding are those that have a relativity of few common genes with the remaining individuals considered, i.e. they have the lowest average kinship coefficient.

The Kennel Club in Poland in 2015 in its statistics showed that in all units of the total registered individuals of the Newfoundland race there were 448 pieces. Of these 183 dogs, 69 of them had the authority of a sire. 265 registered bitches, 113 had the rights of a breeding female. In Poland, 42 litters of this breed were born in breeding associated in the Kennel Club in Poland.

The aim of this study is to analyse the active population for 2015 of Newfoundland dogs registered in the Kennel Club branches in Poland, including only dogs taking part in exhibitions during this period. Determination of the average kinship coefficient and estimation of the degree of inbreeding of the tested individuals based on the available pedigree information. As well as showing which dogs were most commonly used in breeding.

MATERIAL AND METHODS

The analysis covered dogs taking part in exhibitions organized in Poland and the list was created on the basis of the Newfoundland Club website (Związek Kynologiczny…), where results from individual exhibitions are published. The focus was only on the 2015 show season, Veterans class is not included because dogs of this age are no longer used for breeding. The analysed material consisted of fiver-generation pedigrees, obtained from the international Newfoundland dog database (The newfoundlanddog…). Although, the published pedigrees cover five generations, we decided to take for consideration only five of them as it had been done in case of other similar studies. Only dogs, registered with the Polish Kennel Club were included in the study, without those shown in Poland yet registered abroad.

The total number of 115 pedigrees (50 males and 65 females) was collected to estimate the COI. Each pedigree consisted of 62 ancestors (31 pairs of dogs). COI (inbreeding coefficient) and AVK (ancestor loss coefficient) values were then calculated (Jeżewska 2006) by Wright equation for the inbreeding coefficient introduced in 1922 where Fx is the inbreeding coefficient for the dog for which it is calculated.

A comparison of the occurrence frequency of a given individual in the studied population was also made in tabular form.

Using Microsoft Excel 2003, a database of pedigree probands was created, which contained data up to 5 generations ago. The database contained a total of 1297 individuals. Then data in the form of MS Excel spreadsheets were analyzed in the GeneDrop program (Lacy 1989). This program made it possible to estimate the inbreeding coefficient for each individual and for the entire study population. According to calculated COI, the mean kinship coefficient (MK) was also estimated.

RESULTS AND DISCUSSION

In the studied group of 115 animals of the Newfoundland breed, 50 specimens were males (43.48%), 65 females were females (56.52%). In the whole group, 31 individuals (26.96%) were found to be inbred (15 males and 16 females). The COI value occurring most frequently was 0.78% (4 males and 7 females) and the single values obtained were 3.91%, 4.69%, 6.25% and 7.03% (Table 1). According to FCI guidelines, for less numerous breeds the acceptable COI level should not exceed 10% in 0 to 100% scale, representing the degree of genetic relationship between the parents of a given individual. The increase of COI suggests the increase of homozygosity in the whole population.

However, it should be remembered that COI gives only a general picture and only if there is a relationship between the parental pair through their ancestors. Even if the dog and bitch intended for breeding are inbred, but come from two separate breeding lines, the COI of their offspring is 0 and AVK – 100. The breeding practice has shown that the value of COI below 3% and AVK above 85% obtained for a given mating is a very good result (Amstrong 2001).

TABLE 1. Characteristics of Newfoundland dogs population, according to calculated coefficients of inbreeding

Sex	Fx value (0–100%)	*N*	% in relation to the total population studied
Females	0	49	42.61
Males	0	35	30.43
Females	0.78	7	6.09
Males	0.78	4	3.48
Females	1.56	2	1.74
Males	1.56	5	4.35
Females	3.13	3	2.61
Males	3.13	3	2.61
Females	3.91	1	0.87
Males	3.91	1	0.87
Males	4.69	1	.087
Females	6.25	2	1.74
Males	6.25	1	0.87
Females	7.03	1	0.87

The highest COI value at 7.03% together with the lowest AVK at 80% in the entire studied population were calculated for the female King of Helluland YELLOW ROSE. Newfoundlands are not classified as rare breed; their numbers in the world are kept constant. Taking into account the guidelines from FCI and their permissible level of 10% of inbreeding, it can be concluded that this single female in our entire group showed close to the acceptable values of both coefficients (Table 1).

Comparing our results with those of other research conducted in Poland on other breeds and in other countries, the average value of the inbreeding coefficient for the breed we study is not high. In the population of the Polish Tatra Sheepdog, analysed by Kania-Gradziewicz et al. (2009), the level of inbreeding was much higher than in the studied population of Newfoundland and ranged from 1.01% to 8.72%. The population of the Polish Hound, which can be considered a small one, showed very varied results from 7 to 40%, which is a much higher result than for the studied population of Newfoundland (Głażewska 2008, Kania-Gierdziewicz et al. 2011). Kania-Gierdziewicz et al. (2014) in the study of the Golden Retriever and Labrador Retriever populations registered in the Kraków branch of the Polish Kennel Club estimated the inbreeding at 2.15––13.18% for the first and 2.29–13.28% for the second breed. For the group of inbred Labradors, the average inbreeding coefficient was from 2 to 3.5% and for the same group of Golden Retrievers the mean value of this parameter was at the level of 1.5%. For both studied populations, the average coefficients were around 1% or less (Kania-Gierdziewicz

et al. 2014, Leroy et al. 2006) focused on nine French breeds in their research and estimated their inbreeding ratio. Values ranged from just over 3% for French Bulldogs to 12.4% for Barbets and they were comparable with values obtained for Tatra Sheepdogs from the Silesian branch of the Kennel Club in Poland. The same research team has once again undertaken to estimate this coefficient for another set of breeds located in France. The list included Pyrenean Sheepdog (8.8%) and Lagotto Romagnolo (0.3%) (Leroy et al. 2009).

In the Kraków branch of the Polish Kennel Club, the German Shepherd population was analysed and the values of the inbreeding coefficient were 12–17%, which showed that the COI values for the Tatra Sheepdog were significantly lower (Kania-Gierdziewicz et al. 2009, 2011).

The average kinship coefficient (MK) took into account 228 dogs included in pedigree dogs from the active population in 2015 in Poland and it amounted to 3.14. The range of values of the inbreeding coefficient for the examined individuals turned out to be very diverse and varied between 0.02–28% (Fig.).

Compared to the average inbreeding coefficient for golden retriever (1.67%) and Labrador Retriever (2.58%) (Kania-Gierdziewicz et al., 2014), the value obtained was high. In the case of beagle breed analysis in the Krakow branch of the Polish Kennel Club, a higher score (4.92%) was obtained (Gierdziewicz et al. 2011) or another hunting breed, i.e. Alpine hound-horned pigeon all over Poland (4.55%) (Bednarek et al 2018). In the whole pool of dogs tested, only 18 of them had significant inbred, the others had a very low score.

The optimal AVK value should be at 85–100% (Amstrong 2001). In our research on the population of Newfoundland, 46 individuals were characterized by lower than 100% AVK values (22 males and 24 females). Considering the 85% value as the lowest level of this coefficient suggesting a good result, it can be therefore stated that only 4 specimens from the study population had results below the accepted norm (Table 2).

After analysing the five-generation pedigrees, it turned out that the most-repeated stud dog (95 times) in 115 available pedigrees was Midnight Lady Espe-
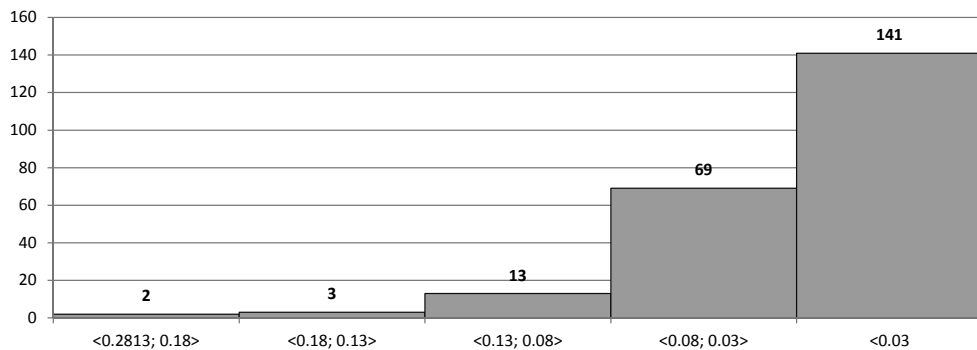

FIGURE. Groups of dogs with different values of inbreeding

TABLE 2. Characteristics of Newfoundland dogs population, according to AVK values

Sex	AVK value (0–100%)	*N*	% in relation to the total population studied
Males	100	28	24.35
Females	100	41	35.65
Males	96.67	13	11.3
Females	96.67	16	13.91
Males	93.33	3	2.61
Females	93.33	3	2.61
Males	90	4	3.48
Females	90	2	1.74
Males	86.67	0	0
Females	86.67	1	0.87
Males	83.33	2	1.74
Females	83.33	1	0.87
Males	80	0	0
Females	80	1	0.87

cially for You. When it comes to female Halszka Kniaziowa Wichrowe Łąki performed 89 times, the 10 most used for breeding studs occurred 81 to 22 times, while the 10 most common breeding females were repeated from 56 to 22 times.

Similar comparisons in research for Golden Retrievers and Labrador Retrievers registered in the Krakow branch of the Polish Kennel Club showed a tendency to use only a small number of the supposedly best males. Additionally, their progeny is related by mothers. Strikingly, a single Golden Retriever stud produced over 100 puppies, closely followed by a single Labrador with over 60 puppies to his credit. Even if not all of these puppies will be eventually used in breeding, they still may contribute to increased levels of inbreeding with its all negative consequences known as inbreeding depression (Kania-Gierdziewicz et al. 2014).

CONCLUSIONS

The inbreeding coefficient (COI) in the population of Newfoundlands exhibited at various dog shows, organized by the Polish Kennel Club (ZKwP) in 2015 did not reach high values. From the group of 115 individuals, only one dog showed a disturbingly high IC value, yet it was still similar to the values obtained for rare (i.e. less numerous) breeds.

The analysis of ancestor loss as shown by AVK revealed only one individual with low level (80%) of this parameter. It can be therefore concluded that the studied population of Newfoundlands in Poland is not related. One of the studs appeared in 115 pedigrees was alarmingly high (95 times). The average inbreeding ratio was not very high compared to other populations studied in Poland. The 5 dogs with the highest inbreeding come from parents closely related to each other. One of

the studs appeared in 115 pedigrees was alarmingly high (95 times). The average inbreeding ratio was not very high compared to other populations studied in Poland, but it was also not small due to the very large discrepancy between the minimum and the maximum.

REFERENCES

AMSTRONG J. 2001: Breeding Schemes. Retrieved from http://www.dogenes.com/diverse.html#info [accessed: 13.05.2016].

BEDNAREK E., SŁAWIŃSKA A., MROCZ-KOWSKI S. 2018: Analiza poziomu inbredu w polskiej populacji psów rasy alpejski gończy krótkonożny w latach 2000–2016 [Analysis of the inbreeding level in the Polish population of the Alpine Dachsbracke dog breed in the years 2000–2016]. Rocz. Nauk. PTZ. 14(3): 9–18 [in Polish].

CHARON K.M., ŚWITOŃSKI M. 2006: Genetyka zwierząt. PWN, Warszawa [in Polosh].

GIERDZIEWICZ M., KANIA-GIERDZIE-WICZ J., KALINOWSKA B. 2011: Analysis of genetic structure of the Beagle population in the area of Cracow Branch of the Polish Kennel Club. Anim. Sci. Pap. Rep. 29(4): 359–367.

GŁAŻEWSKA I. 2005: Kilka zdań o inbredzie. Biuletyn Klubu Ogara i Gończego Polskiego 2(4): 10–13 [in Polish].

GŁAŻEWSKA I. 2008: Genetic diversity in Polish hounds estimated by pedigree analysis. Livest. Sci. 113: 296–301.

HANNULA P., EJERSTAD M., GALLIC-CHIO B., LAHTINEN J., LÄMSÄ P., MILVI L., NYGĹRD M., RAUTIALA K. 2014: Niezbędnik hodowcy – czyli jak hodować naprawdę dobre psy [Keys to Top Breeding]. Transl. A. Redlicka. Sylwia Sadłowska-Kurkowska.

JEŻEWSKA W. 2006: Kalkulator współczynnika inbredu. A. Sobczyk. Retrieved from http://www.sobczyk.eu/inb/?Ing=pl [accessed: 13.05.2016] [in Polish].

KANIA-GIERDZIEWICZ J., GIERDZIE-WICZ M., KALINOWSKA B. 2009: Analiza struktury genetycznej populacji owczarków podhalańskich z terenu województwa śląskiego [Genetic structure analysis of Tatra Shepherd dog population from Silesian Voivodeship]. Rocz. Nauk. PTZ 9(3): 9–19 [in Polish].

KANIA-GIERDZIEWICZ J., GIERDZIE-WICZ M., KALINOWSKA B., 2011: Analiza udziałów założycieli i przodków w populacji aktywnej owczarka niemieckiego w rejonie działania Krakowskiego Oddziału Związku Kynologicznego w Polsce [Analysis of the contribution of founders and ancestors to the active dog population of German Shepherd in the area of Cracow branch of the Polish Kennel Club]. Rocz. Nauk. PTZ 7(2): 9–17 [in Polish].

KANIA-GIERDZIEWICZ J., GIERDZIE-WICZ M., KALINOWSKA B. 2014: Analiza spokrewnienia i inbredu golden i labrador retrieverów z krakowskiego Oddziału Związku Kynologicznego w Polsce [Inbreeding and relationship analysis of the Golden and Labrador Retriever populations in the Cracow Branch of the Polish Kennel Club]. Rocz. Nauk. PTZ 10(1): 9–19 [in Polish].

KOSOWSKA B., NOWICKI B. 1999: Genetyka Weterynaryjna. Wyd. Lekarskie PZWL, Warszawa [in Polish].

LACY R.C. 1989: Analysis of Founder Representation in Pedigrees: Founder Equivalents and Founder Genome Equivalents. Zoo Biology 8: 111–123.

LEROY G., ROGNON X., VARLET A., JOFFRIN C., VERRIER E. 2006: Genetic variability in French dog breeds assessed by pedigree data. J. Anim. Breed. Genet. 123: 1–9.

LEROY G., VERRIER E., MERIAUX J.C., ROGNON X. 2009: Genetic diversity of dog breed: within-breed diversity com-

paring genealogical and molecular data. Anim. Genet. 40(3): 323–332.

MONKIEWICZ J., ROGOWSKA K., WAJDZIK J. 2011: Kynologia. Wiedza o psie. Wyd. UP Wrocław, 119–166 [in Polish].

NALAZEK A. 1994a: Dobór hodowlany. Związek Kynologiczny w Polsce. Klub Nowofundlanda i Landseera. Retrieved from http://www.nowofundland-klub.pl/dobor_hodowlany.html [accessed: 13.05.2016].

NALAZEK A. 1994b: Kojarzenie w pokrewieństwie czyli inbred. Związek Kynologiczny w Polsce. Klub Nowofundlanda i Landseera. Retrieved from http://www.nowofundland klub.pl/kojarzenie_krewniacze.html [accessed: 13.05.2016].

Newfoundland Breed Standard. Retrieved from http://www.thenewfoundlandclub.co.uk/breedstandard.html [accessed: 13.05.2016].

The newfoundlanddog database. Retrieved from http://www.newfoundlanddog-database.net/en/ [accessed: 13.05.2016].

NOWAK M. 1995: Nowofundland, Agencja Wydawnicza „Egros" s.c. [Official Standard of the Newfoundland. Retrieved form http://images.akc.org/pdf/breeds/standards/Newfoundland.pdf?_ga=1.88872921.357750622.1463346634 [accessed: 13.05.2016].

www.czerwonytrop.com/inb/index.php?full=ok&lng=pl

Wzorzec FCI nr 50, 1996, Retrieved from http://www.zkwp.pl/zg/wzorce/50.pdf [accessed: 13.05.2016].

Związek Kynologiczny w Polsce. Klub Nowofundlanda i Landseera. Retrieved from http://www.nowofundland-klub.pl/wystawy2015.html [accessed: 13.05.2016].

Streszczenie: *Analiza spokrewnienia i inbredu psów rasy Nowofundland.* Celem pracy było dokonanie analizy pięciopokoleniowych rodowodów psów rasy Nowofundland, zarejestrowanych w oddziałach Związku Kynologicznego w Polsce, wystawianych w 2015 roku na terenie Polski. Lista rodowodów została opracowana na podstawie danych dostępnych na stronie Klubu Nowofundlanda, a analiz dokonano dzięki stronie newfoundlanddog-database (międzynarodowa baza rodowodów). Wyliczono współczynnik inbredu (COI) oraz współczynnik utraty przodków (AVK) oraz przeanalizowano rodowody pod kątem wspólnych przodków. Uzyskane wyniki wskazują na niską wartość współczynnika inbredu w polskiej populacji psów rasy Nowofundland. Jednakże, wartości COI wynosiły od 0,78 do 7,03%. Średni współczynnik pokrewieństwa wyniósł 3,14. Analiza pięciopokoleniowych rodowodów badanej populacji nie wykazała dużego spokrewnienia osobników między sobą. Tylko jeden pies miał współczynnik AVK poniżej sugerowanego poziomu 85%. Na podstawie analiz danych można stwierdzić, że populacja Nowofundlanda, która w 2015 roku była wystawiana w kraju, a co za tym idzie w krótkim czasie prawdopodobnie użyta do hodowli, nie powinna zostać uznana za zinbredowaną.

Słowa kluczowe: nowofundland, inbred, utrata przodków

Authors' address:
Brygida Kruzińska
Zakład Hodowli Drobiu
Katedra Szczegółowej Hodowli Zwierząt
Wydział Nauk o Zwierzętach SGGW
ul. Ciszewskiego 8
02-786 Warszawa
Poland
e-mail: brygida_kruzinska@sggw.pl