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INBREEDING IN PEMBROKE WELSH CORGI POPULATION IN POLAND*

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Abstract
The objective of this study was to determine changes in the coefficients of inbreeding for a comparatively new Polish population of Pembroke Welsh Corgis. Calculations were based on 780 pedigrees of dogs born between 1979 and 2010 and registered with the Polish Kennel Club. The mean inbreeding coefficients for animals born during those years varied from 0.4% to 8.93%. The lowest individual inbreeding coefficient was 0.06%, whereas the highest reached 25.1%.

Key words: Welsh Corgi Pembroke, pedigrees, inbreeding coefficients

According to commonly accepted theories Welsh Corgi Pembroke originated from Wales and the breed type was established in the early Middle Ages (Hubbard, 1952). Earlier it was suggested that its development was influenced by Scandinavian Spitz dogs brought to the Isles by the Vikings. However, recent studies which employed molecular genetic techniques place the breed among herding dogs (Vonholdt et al., 2010). Originally, the corgi was a multi-purpose farm dog, mainly herder and drover, thus it was classified as FCI Group I. Nowadays it is bred as a companion and show dog, rarely employed in its traditional role. Pembroke Welsh Corgi's popularity can be partly attributed to HRM Queen Elisabeth II, who has owned dogs of this breed since 1934. The first individual, namely Yngхariad-i-Cherry Blossom (female), was imported to Poland in 1979 from Germany. Her pedigree was based on old British Stormerbanks and Kaytop bloodlines, established in the years before World War II.

The breed has relatively long lifespan. According to the British Welsh Corgi Club the average life expectancy is 12 years and 3 months (Thekennelclub, online). As

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a typical achondroplastic breed corgis are prone to intervertebral disc disease and canine hip dysplasia (CHD). Other inherited diseases which occur in the breed, albeit with rather low frequency, include degenerative myelopathy, PRA – progressive retinal atrophy (rod-cone dysplasia 3), retinal dysplasia, epilepsy, and von Willebrand's disease (PWCCA, online).

Breeding to type, strong effect of popular sires and selection aimed at developing and standardization of specific phenotypic features can have a strong negative effect on genetic diversity. As shown by Pedersen et al. (2013), the loss of genetic diversity is much stronger in show breeds than in those bred for performance purposes. Leroy and Baumung (2011) claim that the main reason for spreading genetic disorders, as well as diminishing genetic diversity is excessive use of popular studs and founder effects. This was confirmed by Petersen-Jones et al. (1999), who found that all dogs of Cardigan Welsh Corgi breed (closely related to Pembroke) affected by a single base deletion at codon 616 in the *PDE6A* gene resulting in PRA (rcd3) descended from a popular British show champion from the 1950s.

Monitoring of pedigrees to prevent popular founder effects and excessive inbreeding has been an indispensable part of breeding strategies. Pedigree data can be a valuable source of information for analyzing genetic diversity and population structure in purebred dogs, especially as far as inbreeding depression and occurrence of inherited disorders are concerned (Leroy, 2011). For example, pedigree data of 9 French dog breeds were analyzed by Leroy et al. (2006) and relatively high coefficients of inbreeding in the range of 3.3% to 12.4% were obtained. They estimated that 90% of genetic diversity had been lost in the last decades. In a subsequent study of 61 French breeds, this same group found somewhat lower inbreeding coefficients (0.2% to 8.8%) (Leroy et al., 2009). Similar values were reported for pure breeds of dogs in Sweden (Jansson and Laikre, 2014), the Netherlands (Nielen et al., 2001), Finland (Mäki et al., 2001), United Kingdom (Calboli et al., 2008), Australia (Shariflou et al., 2011), and the Czech Republic (Vostry et al., 2012). In contrast, much higher values of inbreeding coefficient were reported for German Shepherds (25.3 and 26.2%) and for Labrador Retrievers (15.5 and 22.0%) (Cole et al., 2004), as well as 21% for the Icelandic dogs (Ólafsdóttir and Kristjánsson, 2008). In references to the current study, inbreeding coefficients for several Polish breeds varied from 0.68 to 12.86% (Gierdziewicz et al., 2011; Kania-Gierdziewicz et al., 2011).

Breeders of Pembroke Welsh Corgis in Poland have been active since 1979 and have attempted to rely on pedigrees to minimize inbreeding and particular founder effects. The aim of this study was to evaluate their progress by determining individual and average coefficients of inbreeding over a period of time from 1979 to the present.

Material and methods

Calculations were performed on pedigree data of 780 Welsh Corgi Pembroke of both sexes, born in the years 1979–2010, and registered with the Polish Kennel Club. On the basis of pedigrees, individual and average coefficients of inbreeding (F) were calculated using Wright's method (Wright, 1922). Calculations were performed with the use of PedScope 2.4.01 (Tenset, online) on 10 generations of ancestors.

Due to low numbers of dogs bred in the years 1979–1991 and lack of full pedigree data, also in the international database (Pedigreedatabase, online), inbreeding coefficients for those years were not calculated.

Results

Pedigree analysis of 664 individuals (352 females and 310 males) born in the years 1992–2010 (Table 1) reveals that over 46% of individuals were inbred (164 females and 142 males). Mean inbreeding coefficient for the whole population was calculated as 1.76%, compared to 3.84% for the inbred part of the population. Inbreeding levels were similar in both sexes: 3.99% in females and 3.69% in males. Individual values varied from 0.06% to 25.1%.

Table 1. Mean inbreeding coefficient values in Pembroke Welsh Corgis (females, males) born in the years 1992–2010

Specification	All individuals		Inbred individuals		Percentage of inbred individuals	Range F (%)	
	N	mean F (%)	N	mean F (%)	(%)	min	max
Females	354	1.84	164	3.99	46.3	0.06	25.1
Males	310	1.67	142	3.69	45.8	0.06	25.0
Total	664	1.76	306	3.84	46.05	0.06	25.1

Table 2. Mean inbreeding coefficient values in Pembroke Welsh Corgis born in the years 1992–2010

Year	All individuals		Inbred individuals		Range F (%)	
	N	mean F (%)	N	mean F (%)	min	max
1992	15	0.21	1	3.12	3.12	3.12
1993	17	0.09	1	1.56	1.56	1.56
1994	27	0.58	5	3.12	3.12	3.12
1995	35	1.32	9	5.12	0.78	6.25
1996	40	1.32	18	2.93	0.78	6.25
1997	38	3.29	14	8.93	6.25	12.5
1998	23	0.00	0	0.00	0.00	0.00
1999	23	4.55	13	8.05	0.78	25.00
2000	31	0.59	6	3.06	1.76	3.91
2001	31	0.18	13	0.42	0.20	0.98
2002	35	4.83	23	7.35	2.64	14.06
2003	37	1.65	21	2.90	0.59	7.62
2004	45	2.07	22	4.23	0.20	6.74
2005	55	1.04	25	2.29	0.39	7.81
2006	56	1.95	32	3.40	0.12	7.09
2007	45	2.17	19	5.13	0.59	13.16
2008	41	2.83	31	3.75	0.12	13.16
2009	50	1.38	40	1.72	0.06	3.64
2010	20	1.48	9	3.29	0.18	7.47

Table 2 presents mean values of inbreeding coefficient in Pembroke Welsh Corgis born in the years 1992–2010. It shows that those values varied distinctly, from 0.00% to 4.83% in all individuals and from 0.42% to 8.93% in inbred ones. Most values did not exceed 6% and the highest ones were found in the years 1997 (8.93%), 1999 (8.05%) and 2002 (7.35%). In the same years higher individual inbreeding coefficients (12.5%–25%) were also found.

Discussion

Mean inbreeding coefficients calculated for the Polish population of Pembroke Welsh Corgi are relatively low (Table 2) with the highest value in 1997 (8.93%). Individual inbreeding coefficient values varied distinctly (Table 1), both in males and in females (0.06%–25%). The highest results found in the years 1997, 1999 and 2002 came from a few highly inbred matings which took place in those years.

Similar results were obtained by other authors. Leroy et al. (2009), analyzing the pedigrees of 61 breeds of dogs in France, found large variation of inbreeding coefficients, from 0.2% (Romagna Water dogs) up to 8.8% (Pyrenean Shepherds). Average inbreeding coefficients calculated by Nielen et al. (2001) varied from 1.8% (Golden Retrievers) to 7% (Kooiker dogs). Similar results were obtained by Mäki et al. (2001) in dogs born in Finland (Finnish Hounds – 5.1%) and by Gierdziewicz et al. (2011) for Beagle dogs (4.92 % on average). Higher average values of the inbreeding coefficients were observed in German Shepherds: 25% (Cole et al., 2004) and 12.86% (Kania-Gierdziewicz et al., 2011). Głażewska (2008) and Urfer (2009) showed an increase in coefficients of inbreeding in successive generations. Mäki et al. (2001) and Vostry et al. (2012) have observed a downward trend of the average value of F in successive years. A similar tendency was reported by Jansson and Laikre (2014), who analyzed inbreeding in 26 breeds of dogs in Sweden: increase in mean values of inbreeding coefficient (F) in 1980–1995 and its subsequent decrease in 1995–2010. Interestingly, in the case of 15 so-called "unhealthy breeds" this decrease was as high as 50%.

Monitoring of inbreeding levels remains an indispensable part of breeding strategies. Decrease of genetic variability together with increasing inbreeding can have a detrimental effect on purebred dogs' welfare, as confirmed by common occurrence of hip dysplasia in German Shepherd dogs and Golden Retrievers (Mäki et al., 2001) and decreased fertility in Irish Wolfhounds (Urfer, 2009). However, a study by Jansson and Laikre (2014), based on pedigree data and information concerning veterinary costs obtained from the largest Swedish insurance companies, and aimed at establishing the relationship between inbreeding levels and health problems in dogs, did not show higher inbreeding in "unhealthy breeds".

Low inbreeding levels in Polish Pembroke Welsh Corgi population contrast with those found in other breeds (Cole et al., 2004; Ólafsdóttir and Kristjánsson, 2008) and indicate that breeders are following proper breeding practices. These differences may result from breeding strategies employed. These practices have included: 1)

Limiting matings by individual stud sires to a maximum of 10; only 2 males met this limit and the average number of matings for one stud sire was 4. 2) Introducing imported unrelated stud sires every two years, and 3) Advising breeders to avoid inbreeding.

Although Polish breeders of Welsh Pembroke Corgis have been relatively good at maintaining genetic diversity, specific genetic disorders existed in the breed at the time of introduction into Poland. Therefore, breed specific disorders have been monitored by the Club, either from the beginning (hip dysplasia – HD, hypothyroidism), or since genetic tests have been made available (progressive retinal atrophy – PRA, retinal dysplasia – RD, persistent pupillary membrane – PPM). Clinical eye examination started in Poland in 1999 and degenerative myelopathy (DM) testing has not been done until quite recently (2011). No hypothyroidism case has ever been reported in the Polish population. HD results, though varying from A to D (in continental FCI system), are mostly A and B level, i.e. OFA excellent to good (71%). Ophthalmological examination revealed 2 cases of PRA and 2 cases of RD (Garncarz, personal communication). Considering very low incidence of eye diseases, breeders do not feel obliged to perform genetic tests for them. DM is a relatively new issue and only DNA tested since 2011 and no dogs with this defect are known to exist in Poland. The only affected (homozygous recessive) individual is a male (inbreeding coefficient 0.125) imported from the USA which has not been used in breeding. Nevertheless, information from abroad is seriously taken into consideration. It must be noted that even if certain recessive deleterious traits exist in a population, their importance can be minimized, not only by eliminating the causative mutation, but by scrupulous random breeding to dilute carriers (Leroy and Rognon, 2012).

Thus, monitoring breeding strategies and breeders' choices, based on reliable and complete breeding documentation, remains an important tool in preventing increase of inbreeding levels and their possible negative consequences.

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