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GENETIC DISEASES IN PUREBRED DOGS*

Magdalena Pieszka[1], Dominika Luboń[1], Jarosław Łuszczyński[1], Ksenia Pieszka[2]

[1]Department of Genetics, Animal Breeding and Ethology, Agricultural University, Al. Mickiewicza 24/28, 30-059, Cracow, Poland
[2]Veterinary Clinic "Skarabeusz", ul. Rodziny Poganów 19, 32-080 Zabierzów, Poland

The present study aimed at analyzing the prevalence of genetic diseases in dogs depending on the breed and drawing the attention to the breeds which are not observed to exhibit such issues. In addition, the most common problems of genetic background occurring in dogs were characterized. Literature data on the prevalence of such diseases were used. Based on the conducted study it was determined that genetic diseases typically occur in dogs of the most common breeds, such as German Shepherd, Labrador Retrievers, Golden Retrievers, Boxers and Dachshunds. This situation may stem from the rapid increase in the numbers of representatives of these breeds, oftentimes as a result of a snobbish fashion for the given dog type. Local, little-known breeds turned out to be healthiest, because although they occur in considerably lower numbers, they often exhibit greater genetic diversity, for example: Polish Hound, Polish Greyhound, Barbet, Broholmer or Eurasier. It should be noted that they include numerous working dog types, primarily hunting dogs, often still used for work, as well as participating in utility trials and work competitions, which constitute strong selection factor and determine their later fate.

Key words: genetic disorders, purebred dogs

Introduction

Humans and dogs have coexisted for thousands of years. Over the last several centuries, dog breeds have been created in the process of selection, taking into account specific physical and psychological traits, which were separated and strengthened by means of, among others inbreeding within closed lines. The development of such noble, purebred dog breeds can be both a blessing and a curse. The desired traits are maintained or even improved upon, but through this process the genes responsible for different diseases or susceptibility to such diseases can be permanently built-in into the genetic material of the given breed. Unfortunately, certain extreme breed models

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or their erroneous interpretations may also contribute to the occurrence of problems with health and welfare of dogs (Hedhammar et al., 2011).

Some genetic diseases can manifest only in the presence of two copies of the faulty gene and these are diseases with recessive background. If a popular sire carries such gene copy, it can quickly spread throughout the entire breed population. Similarly, if a breed was created from a small number of ancestral individuals and several of them carried the faulty gene, then again it is probable that the prevalence of the disease may increase in the growing population (Farrell et al., 2015; Goddard and Beilharz, 1985). Nearly a thousand dog breeds are currently distinguished around the world, of which approximately 350 are registered, depending on the cynological organizations rules. Such large number of unregistered breeds often means breeding in numerous small, often isolated populations, where each breed comprises a relatively restricted gene pool (Parker et al., 2004). Artificial, long-term selection carried out by breeders targeting specific physical and behavioral traits has greatly increased the differences between breeds and at the same time it has reduced the genetic diversity within individual breeds. In addition, numerous breeds originate from a low number of ancestors and thus they experience the so-called 'bottleneck' effect and the effect of popular breeders. This means that active populations, that is populations involved in breeding are significantly restricted (Calboli et al., 2008; Karlsson and Lindblad-Toh, 2008; Hedhammar et al., 2011). Disorders related to a specific appearance of the given breed are often not treated as diseases and seen as compliant with the breed model. Unfortunately, they are becoming increasingly common. This is the case for brachycephalic obstructive airway syndrome (BOAS), generally referred to as airway syndrome. It occurs in breeds with shortened muzzle (short snout) that is brachycephalic cranium structure and causes various chronic breathing problems. Improper breathing, wheezing or snoring exhibited by a dog of such a breed is often taken as a norm (O'Neill et al., 2014).

Genetic diseases with similar symptoms can have various causes, depending on the breed or even within the breed itself. Genes, which differ but cause the same disease are referred to as genocopies. They are responsible for example for various forms of progressive retinal atrophy (PRA). Thus, genetic testing towards a given disease for one breed is not always applicable for other breeds (Bell et al., 2013).

The majority of genetic diseases characteristic of a given breed are associated to the low genetic diversity. Closure of pedigree records and absence of addition of "new fresh blood" results in accumulation of harmful genes in the genetic material of the given breed. In such a case, even access to advanced genetic testing does not solve the problem, as it is extremely difficult to find an individual for breeding purposes that would not have the harmful gene in its DNA (Bell et al., 2013). The sources provide various data concerning the occurrence of different genetic disorders characteristic of individual breeds or susceptibility to them.

The purpose of the present study was to indicate the dog breeds in which the highest number of diseases with genetic background occur, and distinguishing the breeds in which such problems are not observed. These traits were characterized with regards to the population sizes of the selected dog breeds. Furthermore, the most common genetic disorders were characterized.

Material and methods

Analysis of the number of genetic disorders occurring in dogs of different breeds was carried out on the basis of three main publications:

Source 1: Gough A., Thomas A. (2018). Breed Predispositions to Disease in Dogs and Cats. Third Edition, Wiley-Blackwell, United Kingdom;

Source 2: Padgett G.A. (1998). Control of Canine Genetic Diseases, Appendix 1 – Genetic Disease Predisposition by Breed. Howell Book House, New York;

Source 3: Bell J.S., Cavanagh K.E., Tilley L.P., Smith F.W.K. (2013). Veterinary Medical Guide to Dog and Cat Breeds. Polish Edition: Rasy Psów i Kotów, Przewodnik Weterynaryjny, Charakterystyki ras, Predylekcje do chorób, Wskazania diagnostyczne i terapeutyczne. Wyd. Galaktyka, Łódź.

Furthermore, we characterized the data on the prevalence of diseases of the skeletomuscular system (Cywińska et al., 2007; Krzyżewska and Max, 2008; Franas and Poral, 2010; Pomianowski et al., 2011; Degórska, 2014; Wąsiatycz, 2016), cardiovascular system (Alcaraz Rodriguez et al., 2013; Gruszczyńska and Łobodzińska, 2013; Sapierzyński, 2013), nervous system (Simon, 2014; Kalwas-Śliwińska, 2016), respiratory system (Bednarek and Depta, 2002), digestive system (Jankowski, 2014; Jankowski et al., 2014), reproductive system (Max, 2014), endocrine system (Cekiera and Popiel, 2011; Juranek, 2014; Sikorska-Kopyłowicz, 2014; Kalinowski, 2016), ophthalmological diseases (Madany, 2007; Lew, 2012; Bedford 2014a, b, c; Bryła, 2016; Iwabe et al., 2020; Joyce et al., 2021) and dermal diseases (Szczepanik, 2015). Based on the obtained information the most common genetic diseases observed in different dog breeds were characterized.

Based on the above literature sources, 325 dog breeds were listed with the number of genetic diseases specified in the references and with the numbers of individuals registered in 2020 by the Polish Kennel Club (ZKwP) (http://www.zkwp.pl/main.polish/_documents/zkwp-pdf-doc-sprawozdanie-hodowlane-za-rok-2020.pdf). The obtained data were listed in a table including classification of each breed to FCI group **(**Fédération Cynologique Internationale**)**, with which ZKwP is affiliated and the requirements for carrying out work tests.

On such a basis of this list, 10 dog breeds were distinguished which were found to have the highest number of genetic disorders, with emphasis on their most common disorders and the population sizes of these breeds in Poland. Furthermore, 10 breeds best known in Poland were distinguished from the healthiest breeds, in which no or singular cases of diseases were observed.

Results

Characteristics of most common genetic diseases in purebred dogs

Retinal dysplasia (RD) is an inherited disorder resulting in retinal folding and delamination of its nervous part, which separates from the underlying pigment epithelium. This leads to a complete loss of vision. DNA test can prove useful to diagnose the disease. It is an autosomal recessive disease. It is most common in different bre-

eds of Spaniels and Terriers, but also in Golden and Labrador Retrievers, Samoyeds, Schnauzers, Welsh Corgi Pembroke and Cardigan, Irish Wolfhounds or German Pointers (Bedford, 2014a; Iwabe et al., 2020; Joyce et al., 2021).

Entropion and ectropion – these are congenital eyelid deformations, which manifest by eyelid folded inward (entropion) and outward (ectropion). They lead to conjunctival swab and corneal inflammation and may produce complications in the form of corneal ulcerations and lesions. Breeds with predisposition for these disorders are: Basset Hound, St. Bernard, Bloodhound, Bulldog, Chow Chow, Great Dane, Golden Retriever, Labrador Retriever, Shar-Pei, Rottweiler. Furthermore, these diseases may occur in several dozens of other breeds (Lew, 2012; Guandalini et al., 2017; Lin et al., 2019).

Progressive retinal atrophy (PRA) – this term concerns several types of primary retinal degenerative diseases. At the initial stage they are manifested by visual disturbances in the dark, which develop into a complete loss of vision. This disease is inherited recessively, with the exception for Samoyeds and Siberian Husky, where it occurs as sex-linked trait and in Bullmastiffs and English Mastiffs, in which it is inherited predominantly. The disease occurs in over fifty dog breeds, particularly common in such breeds as: Australian Cattle Dog, Border Collie, Briard, Cocker and Springer Spaniel, Labrador and Golden Retriever, Dachshund, Lhasa Apso, Shetland Sheepdog, Collie, Poodle, Irish Setter, Miniature Schnauzer, Welsh Corgi Cardigan and Irish Wolfhound (Bedford, 2014c; Bunel et al., 2019; Sheet et al., 2020; Sunirmal et al., 2020).

Cataract is clouding of the lens and/or its capsule. This restricts incident light from reaching the retina of the eye (which receives visual stimuli and transmits them as nerve impulses through the optic nerve to the brain), and causes visual disturbance or even blindness. Cataract is inherited both as recessive or dominant disease. A genetic test was developed enabling a rapid detection of the disease. In severe cases surgical treatment is possible. The disease is observed in all breeds, particularly commonly in Spaniels and Bloodhounds, Dobermans, Golden Retrievers, Old English Sheepdog and Collie, Poodles, Rottweilers (Bedford, 2014a, b; Uhl et al., 2021).

Congenital deafness can be uni- or bilateral and its appearance is typically linked to the coat color. White coat and blue eye iris in certain dog breeds predispose for the occurrence of congenital deafness. However, its inheritance mechanism has not been fully understood. Its occurrence should exclude dogs from breeding. The disease has been recorded in over forty breeds, of which it is particularly common in: Bullterrier, French Bulldog, Border Collie, Cocker Spaniel, Dalmatian, Dogo Argentino, Jack Russell Terrier, Collie, old English Sheepdog, English Setter, West Highland White Terrier (Selvaraj et al., 2018; Hayward et al., 2020).

Degenerative myelopathy (DM) – this disease manifests by the paresis of pelvic limbs and inability to walk, which is caused by spinal cord injury in the area from the third thoracic vertebra to the third lumbar vertebra. It is an advancing disease, someti-

mes the paralysis includes anterior limbs, and in the final stage respiratory muscle paralysis and eventually death of the animal. The detailed causes for the disease remain unknown, however many factors point to genetic background. A recessive autosomal gene was discovered, which in homozygous form predisposes for the disease, but it is not an absolute determinant of its occurrence. Older dogs of large breeds most often suffer from this disease, such as: St. Bernard, Boxer, Siberian Husky, Labrador Retriever, Belgian Shepherd, German Shepherd, Rhodesian Ridgeback, Weimaraner. However, there are smaller breeds that often experience this disorder, such as Miniature Poodle or Welsh Corgi Pembroke. However, DM is most frequently observed in German Shepherds and Chesapeake Bay Retrievers (Pomianowski et al., 2011; Mandrioli et al., 2020; Santos et al., 2020).

Idiopathic epilepsy is a complex brain disease, in which sudden and abnormal excitation of the nervous system occurs. It is manifested by seizures, which can be accompanied by loss of consciousness, behavioral aberrations, mobility and coordination difficulties. Ill dogs must receive special antiseizure drugs throughout their lives. The disease has likely a genetic origin. Breeds predisposed for the disease are: Springer Spaniel, Beagle, Bernese Mountain Dog, Border Collie, Border Terrier, Cavalier King Charles Spaniel, Dalmatian, Golden and Labrador Retriever, Dachshund, Australian, Belgian, German, Shetland, Scottish Shepherds, Medium Poodle, Vizsla, Bracco Italiano and Irish Wolfhound. The disease is observed in many other breeds and even in mixed breeds (Kalwas-Śliwińska, 2016; Forsgård et al., 2019; Couper Jones et al., 2021).

Elbow and hip dysplasia – this term refers to the majority of lameness cases caused by elbow and hip diseases. Mobility problems are typically caused by joint instability, looseness of tissues around the joints, abnormal shape of the bones that are parts of joints and their mismatch, as well as hypertrophic lesions which are accompanied by joint inflammation. It is a polygenic disease, which is inherited to a varying degree and varies between breeds. Its development further depends on environmental factors such as injuries, excessive physical effort or rapid growth caused by high-energy diet. The problem concerns all dog breeds, but it is most common in large breeds such as Bernese Mountain Dog, Bullmastiff, Golden Retriever, Labrador Retriever, Newfoundland, German Shepherd, Rottweiler. In many dog breeds, assessment of hip and elbow joints based on a radiographic test is required to prepare the animal for applying for a pedigree certificate. In the majority of countries animals with the disease are excluded from breeding. The best method of combating the disease are genetic tests that may help detecting the carriers of genes responsible for the disease, even without visible disease symptoms (Wąsiatycz, 2016; Baers et al., 2019; Yumi Babá et al., 2019).

Luxating patella consists in the loss of connectivity of the joint surfaces of the bones that make up the knee. Luxating patella is typically congenital, occurs in the medial direction with four-point intensity scale. It results in problems with walking and lameness caused by improper setting of the rear limb, but it does not produce pain.

Typically operative therapy is used. If not treated it leads to increasing difficulties in movement. All breeds experience the disease, and small breeds are particularly predisposed, such as: Chihuahua, Maltese, Pug, Papillion, Miniature Pinscher, Yorkshire Terrier (Degórska, 2014; Maeda et al., 2019).

Dilated cardiomyopathy – one of the more common heart diseases in dogs consisting in heart contractility disorders, which result in blood accumulation in the chambers and its dilatation. This results in heart failure and as a consequence weight loss, easy fatigability, shortness of breath, coughing, cardiac dysrhythmias, ascites, jugular venous distension. A sudden death may occur which often is the first and last symptom of the fact that the disease occurred in the given individual. The disease is inherited differently between various breeds – it is a trait determined by autosomal recessive or dominant genes, and males are considerably more exposed to the disease than females. The disease affects large breeds, and the most predisposed breeds are: Airedale Terrier, St. Bernard, Boxer, Borzoi, Afghan Hound, Scottish Deerhound, Dalmatian, Doberman, Great Dane, Leonberger, Newfoundland, German Shepherd, Portuguese Water Dog, Poodle, Standard Schnauzer, Irish Wolfhound (Sapierzyński, 2013; Meurs et al., 2019).

Von Willebrand disease (vWd) – concerns abnormalities resulting from the deficiency or structural disorders of the von Willebrand factor (plasma protein involved in blood clotting). It is manifested by bleeding on the skin surface and mucosal areas and largely prolonged bleeding time from wounds, with intensity from minor to acute. This disease is caused by a defect in the gene encoding von Willebrand factor and it is typically inherited predominantly, but it can also be inherited recessively. The disorder is observed in over fifty breeds, typically in: Airedale Terrier, Akita Inu, Basset Hound, Bernese Mountain Dog, Spanish Hound, Doberman, Golden Retriever, Dachshund, Kerry Blue Terrier, Manchester Terrier, Shetland Sheepdog, Papillon, Pinscher, Kooikerhondje, Poodle, Keeshond, Miniature Schnauzer, Rottweiler, Scottish Terrier, Irish Wolfhound, Welsh Corgi Pembroke, German Pointer (Gruszczyńska and Łobodzińska, 2013; Crespi et al., 2018; de Boer and Eikenboom, 2019).

Type A and B hemophilia – these diseases are caused by mutation of genes encoding VIII (hemophilia A) and IX (hemophilia B) coagulation factors, which results in the absence of these factors or disturbance in their functioning. This disables and impedes the process of clot formation. It is a recessive disease, linked to chromosome X. Symptoms are visible already at a young age and include bleeding from the umbilical cord, during tooth eruption, strong and prolonged bleeding from wounds, spontaneous bleeding and formation of hematomas. In dogs the symptoms are much more pronounced than in humans with the same disease type. Genetic tests are available that enable determination of asymptomatic carrier state. Hemophilia A is most common in Golden Retrievers and German Shepherds, while hemophilia B in: Airedale Terrier, French Bulldog, black and tan Coonhound, Lhasa Apso, Rhodesian Ridgeback, German Wirehaired Pointer (Alcaraz Rodriguez et al., 2013; Nishitani and Kitoh, 2021).

Gastric Dilatation Volvulus (GDV) – this disease consists in the dilatation of the stomach due to excessive accumulation of gases and its twisting along the long axis (typically right by 180° or 360° or left by 90°). The twisting results in ileus, which has further accumulation of gases and secretions. It is manifested by a considerable expansion of the abdominal cavity volume, salivation, retching. This condition is life-threatening for the animal and requires instantaneous surgical intervention. The disease affects almost fifty breeds but particular predispositions for it are exhibited by large and giant breeds such as St. Bernard, Leonberger, Great Dane, German Shepherd. It may also affect approximately 30% medium sized and small breeds, mainly Chow Chow, Shar Pei, Dachshund (Jankowski, 2014; Song et al., 2020).

Atopic dermatitis – is a genetic predisposal for the appearance of allergic, inflammatory and pruritic dermal disease. It is associated with production of antibodies against different environmental allergens. Different types of lesions occur on the skin, such as discolorations, erythemas, erosive lesions, scratches, hair loss and lichenifications. Numerous genes that can influence the development of the disease have been discovered, however no precise genetic tests have yet been developed. The breeds with strongest predispositions for the disease are: Boxer, Pug, German Shepherd, Rhodesian Ridgeback, West Highland White Terrier. Over a dozen other breeds can also be affected (Szczepanik, 2015; Aglera et al., 2019; Bozorgpanah et al., 2020).

Cleft lip and palate – cleft lip concerns the primary palate, that is the area referred to as medial nasal eminence, whereas cleft palate means defects of the secondary (proper) palate, consisting of a hard and soft palate. Defects arise as a result of abnormal fusion of the palatine plates in the womb. They cause problems with eating and breathing, and cause recurrent respiratory infections. Treatment consists of surgical intervention. Several recessive genes are responsible for fission defects, and their disclosure also depends on the action of environmental factors. Dogs with such defects are excluded from breeding. The defects are typically observed in such breeds as: Beagle, St. Bernard, Boston Terrier, Bulldogs, Cocker Spaniel, Fox Terrier, Pug, Newfoundland, Dachshund, Caucasian Shepherd Dog, Pekingese, Poodle, Rottweiler, Miniature Schnauzer, Yorkshire Terrier (Krzyżewska and Max, 2008; Sousa et al., 2018; Roman et al., 2019).

Discussion

Breeds predisposed for the highest number of genetic diseases

Based on the conducted analyses, particular breeds were distinguished in which the highest number of genetic diseases were found. These include:

1. German Shepherd is the most common dog breed in Poland, it should undergo psychological and obedience tests before use in breeding. In 2020 ZKwP 2244 males and 4350 females of the breed were registered (total of short- and longhaired), including 604 breeding males and 2011 breeding females. A total of 6134 pups were born in 1070 litters. According to the sources analyzed in the study, this breed is prone

to the highest number of diseases – from 76 according to literature Source 3 to 138 according to literature Source 2. The most common are: elbow and hip dysplasia, exocrine pancreatic insufficiency, luxating patella, hemophilia A, von Willebrand disease, hyperuricosuria, bladder stones, mucopolysaccharidosis, growth hormone deficiency, allergic dermatitis, hypothyroidism, gastric dilatation volvulus, intestinal malrotation, osteochondrosis, degenerative myelopathy, corneal dystrophy, angiosarcoma, cataract, chronic superficial keratitis, persistent pupillary membrane, retinal dysplasia, ventricular arrhythmia/sudden cardiac death, inguinal hernia, epilepsy, acquired megaesophagus, German Shepherd dog pyoderma, dilated cardiomyopathy and others.

2. Poodle used to be a highly popular, but nowadays lower interest in this breed is observed. It does not undergo any work trials. In 2020 ZKwP registered 278 males and 386 females including 150 breeding males and 274 females. 561 pups were born in 129 litters. Similarly to German Shepherds, Poodles are prone to numerous diseases – from 86 according to Source 3 to 124 according to Source 2. The most common are: hip and elbow dysplasia, luxating patella, progressive retinal atrophy, Leggo-Perthes disease, von Willebrand disease, adrenal insufficiency, double eyelashes, cataract, persistent pupillary membrane, collapse of the trachea, mitral valve disease, cryptorchidism, idiopathic epilepsy, diabetes, secondary and primary glaucoma, patent ductus arteriosus, mammary gland osteosarcoma, acanthosis nigricans – severe hair loss, dilated cardiomyopathy, perineal hernia, squamous cell carcinoma of the fingers, instability of the shoulder joint, tongue squamous cell carcinoma, degenerative myelopathy, anal atresia and others.

3. Labrador Retriever, is not subject to work trials, and it has been subject of an unwavering popularity in Poland for several years – in 2020 ZKwP registered 754 males and 1632 females, including 317 breeding males and 776 breeding females. 2609 pups were born in 405 litters. Also this breed has predispositions for numerous diseases – from 73 according to Source 3 to 111 according to Source 2. The most common diseases are: hip and elbow dysplasia, luxating patella, progressive retinal atrophy, exercise induced collapse, retinal dysplasia, myopathy, tricuspid valve dysplasia, allergic dermatitis, hypothyroidism, persistent pupillary membrane, epilepsy, cataract, separating, aseptic osteoarticular necrosis, hypertrophic osteodystrophy, double eyelashes, corneal dystrophy, lymphoma/lymphosarcoma, entropion, diabetes, hemolytic anemia, secondary glaucoma, limbal melanoma, squamous cell carcinoma of the tongue, squamous cell carcinoma of the fingers and others.

4. Golden Retriever – 509 males and 1013 females, including 190 breeding males and 490 breeding females. A total of 1757 pups were born in 252 litters. Dogs of this breed do not undergo work trials and have predispositions for a large number of diseases – from 66 according to Source 3 to 98 according to Source 2. Their most common diseases are, among others: elbow and hip dysplasia, luxating patella, progressive retinal atrophy, hemophilia A, von Willebrand disease, ichthyosis, atopic dermatitis, hypothyroidism, double eyelashes, cataract, idiopathic epilepsy, hemangiomas, lymphoma/lymphosarcoma, mast cell tumor, aortic stenosis, aseptic osteoarticular necrosis, osteosarcoma, primary glaucoma, retinal dysplasia, oral melanoma, fibrosarcoma of the tongue, corneal limbal melanoma, leukemia, thyroid cancer.

5. American Cocker Spaniel is the least common breed on the list – 48 males and 69 females, including 27 breeding males and 26 females. 37 pups were born in 6 litters. This breed is prone to numerous diseases – from 36 according to Source 3 to 117 according to Source 2. Its most frequent diseases include: hip and elbow dysplasia, luxating patella, progressive retinal atrophy, negative XX hermaphroditism, double eyelashes, bronchiectasis, hypothyroidism, behavioral aberrations, retinal dysplasia, cataract, glaucoma, atopic dermatitis, epilepsy, dry conjunctivitis and keratitis, congenital deafness, ectropion, hemolytic anemia, dilated cardiomyopathy, incomplete ossification of the humerus condyle, oral melanoma.

6. Boxer used to be a highly popular breed, yet nowadays it is less common, and it is subject to psychological tests – in 2020 ZkwP registered 208 males and 388 females, including 79 breeding males and 140 breeding females. A total of 268 pups were born in 56 litters. This breed exhibits predispositions for a large number of diseases – from 62 according to Source 3 to 90 according to Source 2. Boxers most often suffer from such diseases as: intensified neoplastic processes, right ventricular cardiomyopathy with arrhythmia, dysplasia of the hip and elbow joints, luxating patella, progressive boxer axonopathy, hypothyroidism, double eyelashes, corneal dystrophy, ulcerative boxer colitis, atopic dermatitis, ectropion, epilepsy, chronic pancreatitis, myelopathy, cleft lip and palate, oral cancer, intracranial meningioma and others.

7. Dachshund is not subject to work trials and similarly to boxer or poodle it once was a highly popular breed, in 2020 ZKwP registered 811 males and 1311 females, including 399 breeding males and 749 females. 1105 pups were born in 270 litters. Dachshunds are characterized by predispositions for numerous diseases – from 56 according to Source 3 to 98 according to Source 2. The most common Dachshund diseases include: luxating patella, hip and elbow dysplasia, Leggo-Perthes disease, progressive retinal atrophy, mucopolysaccharidosis, progressive myoclonal epilepsy, disc disease, persistent pupillary membrane, double eyelashes, corneal dystrophy, cataract, hypothyroidism, hypothyroidism, adrenal insufficiency, microphthalmia, retinal dysplasia, congenital deafness, cutaneous histiocytosis, congenital muscle fatigue, narrowing of the nasopharynx.

8. Beagle – 222 males and 431 females, including 114 breeding males and 215 breeding females. 350 pups were born in 123 litters. Beagle dogs are not subject to work trials and are prone to a high number of diseases – from 58 (Source 3) to 103 (Source 2). The most common diseases are: hip and elbow dysplasia, luxating patella, primary glaucoma, blood coagulation factor VII deficiency, chondrodystrophy, Chinese Beagle syndrome, double eyelashes, hypothyroidism, retinal dysplasia, cataract, persistent pupillary membrane, prolapse of the third eyelid gland, idiopathic epilepsy, juvenile polyarthritis (Beagle pain syndrome), microphthalmia, congenital deafness, renal amyloidosis, progressive myoclonal epilepsy (Lafora's disease).

9. Doberman undergoes psychological tests and BH training (Begleithundeprüfung). In 2020 ZKwP registered 148 males and 260 females, including 46 males and 98 females for breeding. 2926 pups were born in 44 litters. Doberman exhibits predispositions for a large number of disorders – from 54 (Source 3) to 96 (Source 2). The most common diseases are: von Willebrand disease, dilated cardiomyopathy, hip and elbow dysplasia, luxating patella, narcolepsy, congenital blindness,

hypothyroidism, cataract, psychogenic licking of the body sides, persistent pupillary membrane, retinal dysplasia, double eyelashes, hair follicle dysplasia, peripheral neuropathy (dancing Doberman disease), congenital deafness and vestibular disease, atherosclerosis.

10. Rottweiler – 285 males and 491 females, including 105 males and 220 females for breeding. A total of 506 pups were born in 90 litters. This breed is prone to numerous diseases – from 58 (Source 1) to 75 (Source 2). The most common are: hip and elbow dysplasia, luxating patella, osteoarthritis, cataract, hypothyroidism, osteosarcoma, juvenile osteitis, allergic dermatitis, sebaceous cysts, osteochondrosis, inflammatory bowel disease, idiopathic epilepsy, persistent pupillary membranes, cryptochorchidism, intervertebral disc disease, retinal dysplasia, corneal dystrophy, entropion, progressive retinal atrophy, adrenal insufficiency, degeneration of the spinal cord and cerebellum, leukoencephalomyelopathy, juvenile peripheral myopathy.

As a result of the conducted analyzes, breeds known in Poland for which no genetic diseases were found were also indicated based on the available literature. The following breeds were selected: **Barbet** – in 2020 ZKwP registered 33 males and 34 females, 42 pups were born in 5 litters; **Bavarian Mountain Hound** – 295 males, 391 females, 65 litters, 239 pups; **Polish Greyhound** – 94 males, 121 females, 5 litters, 28 pups; **Broholmer** – 3 males and 14 females, 1 litter, 8 pups; **Eurasier** – 19 males and 21 females, 7 litters, 50 pups; **Icelandic Sheepdog** – 2 males and 9 females, 4 litters, 16 pups; **Mudi** – 5 males and 14 females, 1 litter, 5 pups; **Polish Hound** – 186 males and 253 females, 39 litters, 160 pups; **Laikas: Russian European**, **West Siberian and East Siberian** – 157 males and 214 females, 40 litters, 244 pups; **Thai Ridgeback** – 47 males and 76 females, 18 litters, 112 pups.

Conclusions

The presence of a large number of genetic diseases is a very serious threat to the existence of many modern dog breeds. Based on the above mentioned analyzes, it was found that the most popular breeds of dogs, such as the German Shepherd (the most numerous breed of dogs registered in Poland in 2019) or the Labrador and Golden Retriever, as well as dogs of breeds that used to be very popular in Poland, are most often affected by genetic diseases, e.g. Poodle, Boxer or Dachshund. This problems may be due to the past or present large or rapidly growing population of these breeds, often the result of a snobbish fashion for certain types or breeds of dogs. Some modern breed populations arose from a small number of ancestors registered in breeding books, which has greatly reduced their genetic variability. Diseases affect more frequently the breeds the selection of which places too much emphasis on the features of their conformation and emphasizing the characteristic anatomical features, which has changed their structure a lot recently, a typical example of which is the lowering of the croup of German Shepherds. However, it should be remembered that because well-known and popular breeds are much more numerous, they are also better tested for the presence of various diseases, including genetic diseases. However, these analyzes have shown that dogs with no genetic diseases are representatives of local, little-known breeds, present at much smaller numbers, but often greater genetic diversity.

Among them, there are many working dogs, mainly hunting dogs, which are still often used for work, and also take part in utility trials and competitions that determine their future fate.

For the sake of health, and therefore also the welfare of purebred dogs, all attempts should be made to alleviate the problem of their genetic diseases. Cynological organizations play a significant role here, and they should take decisive action to solve this problem. This may be, for example, promoting breeding selection based mainly on the health and performance of dogs and not only on the basis of specific appearance, introducing more compulsory genetic tests to detect defective gene carriers among females and males, introducing greater restrictions on the use of relatives in breeding, or increasing genetic variability within breeds. It seems also necessary to partially open breeding books in order to add foreign, „fresh" blood to closed breeds populations, in which defective genes responsible for diseases are accumulated, while maintaining the characteristics of a given breed.

However, the most important thing seems to be to make breeders, dog owners, veterinarians and all persons involved in breeding of purebred dogs aware of the problem of genetic diseases, so that they pay special attention to the health of breeding males and females intended for breeding. The common goal of all of the above groups of people should be breeding and rearing healthy, functional, long-lived and happy dogs.

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