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***Canis lupus familiaris* – DOMESTICATION**

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Abstract. The dog has accompanied man the longest of all animals. Over the last several hundred thousand years, the dog has deserved to hold a special place in the life of man. It has become a rescuer, a guide, an assistant, a therapist, a defender and a friend. The relations of people and dogs are unlike the relations between man and any other domesticated animal. What has made the dog such a close friend for man? Using modern research methods, scientists have been looking for answers to this question. What was the domestication process, how long did it take and where did it start? Today we already know that the dog domestication process was started many times and independently in different parts of the world. The cradle of dog species turned out to be in Europe, not Asia, as was suggested before. The aim of this study was to review the latest research on the course of the dog's domestication process, as well as an indication of the characteristics of this species, which influenced the achievement of success in his domestication. It presents the results of archaeological, morphological and genetic studies. Different theories, as well as the behavioural aspect of this process, were described.

Key words: *Canis familiaris*, dog, domestication, human–dog interaction.

INTRODUCTION

According to the data published by the European Pet Food Industry Federation, in 2014 there were over 80 million dogs in Europe, 7.5 mln of which were in Poland (www.fediaf.org). The same source stated that in year 2014, 37% of homes in our country had at least one dog. In 2014, TNS Poland agency run a survey which showed that almost half (48%) of the Poles has a pet, and in 83% of cases it is a dog. 87% of the respondents claimed that a dog is man's best friend (TNS, 2014). Researchers continue to search answers to the questions about when and where exactly *Canis familiaris* began to accompany man in his journey through life. With a dynamic growth of sciences interested in animals behaviour, among the questions which are asked as frequently as "when and where" are "how and why". The aim of the work was to systematize knowledge about the dog's domestication process, including the results of archaeological, genetic and behavioral studies.

ARCHAEOLOGICAL AND GENETIC RESEARCH

The domestication of dog was a long-lasting process, recurring independently in many parts of the world. The dog has accompanied man the longest of all animals. The oldest

archaeological findings which are considered to be dog remains are the dog of Goyet and the dog of Altai. The skull found in the Goyet cave in Belgium was dated 36 000 years old. The jawbone and the teeth found in the Razboinichya cave in Altai were dated to be 33 500 years old (Thalmann et al. 2013). Apart from those findings, there are also remains discovered in Predmosti in the Czech Republic (32 000–22 000 years old) and in Eliseevich in Russia (15 000 years old) – Germonpré et al. (2009). The first remains of a supposed predecessor of a domestic dog found in a common burial site with people come from Bonn-Oberkassel in Germany and are dated to be 14 700 years old (Thalmann et al. 2013).

With the passing of time and the advances in sciences, archaeological research was updated with genetic analysis. Already in 1993, Robert Wayne proved that the domestic dog was a very close relative of the grey wolf. He determined the differences in the genotype of both species to be 0.2% of the mitochondrial DNA sequence. For comparison, the difference between the grey wolf and its close relative – the coyote – is about 4% of the mitochondrial DNA sequence (Wayne 1993). In the same year, in the second edition of the Mammal Species of The World, *Canis familiaris* was changed to *Canislupus familiaris* – a domesticated form of the grey wolf (A taxonomic... 1993). Currently both names – *Canis familiaris* and *Canislupus familiaris* – are regarded as correct (Gentry et al. 2004). Only six year later, in 1999, Wayne proposed a hypothesis that the dog may also come from an extinct species of the dog family whose closest living relative is the wolf (Wayne 1999). At present time, it is believed that the ancestor of dogs and wolves was a large, wolf-like animal that lived between 9000 and 34 000 years ago (Viegas, <https://www.seeker.com/dogs-not-as-close-kin-to-wolves-as-thought-1768231128.html>).

In 2011, the results were published of a spectrometric and a morphological analysis of the fossils found in the Razboinichya cave in Altai, Siberia. The remains, i.e. a skull and the left side of a jawbone, of a supposed dog from Altai were studied in three independent science centres in the US, the Great Britain and in the Netherlands. The age of the samples was estimated at 33 000 years (Ovodov et al. 2011). Thanks to a very good state of preservation of the samples, it was possible to perform a full morphological description. The skull and the jawbone of the dog from Altai were compared with remains of wolves from Pleistocene, from 33 000 years ago found in Predmosti in the Czech Republic; these are prehistoric northern dogs and two canids from Eliseevich (Russia) from the ice age (Sablin and Khlopachev 2002). It was said that that the remains from Altai are most likely of a dog at a very early stage of domestication. They were not the fossils of a wolf. As the tested fossil material was assessed to date prior to the last ice age, and other remnant of supposed dogs did not occur later for thousands of year, researchers assume that the line represented by the Altai dog did not survive the ice age (Ovodov et al. 2011). Two years later results were published of genetic testing of samples which came from the Razboinichya cave. 413 nucleotides of the mitochondrial DNA of the incisors and the jawbone were isolated, sequenced and analysed. The obtained material was compared with samples of the genome of 72 contemporary dogs and 30 wolves (17 from the Old World and 13 from the New World), 35 prehistoric canids from the New World and 4 coyotes. The analysis showed that the genotype of the Altai dog is closer to the contemporary dogs than wolves (Dhruzhdova et al. 2013).

In October 2013, a group of researchers led by Olaf Thalmann showed their results of an analysis of the mitochondrial DNA of 18 surviving fossils of canids dated at 1000–36 000 years old, coming from the New World and the Old World. The samples were compared with the mitochondrial genome of 49 contemporary wolves, 77 contemporary dogs of various breeds and 4 coyotes. The results of those research show that there is a connection of contemporary dogs with the ancient canids from Europe and some of the European wolves. They do not show a close relation between contemporary dogs and the contemporary wolves from the Middle East or Asia. Based on the results of their research, the authors suggest that the cradle of the dog was not Asia, as was previously suggested, but Europe (Thalmann et al. 2013).

IGF-1 GROWTH GENE

Grey and Wayne tested the presence of the IGF-1 mutation gene, which is responsible for the size of an animal, in the population of the grey wolf. They concluded that the type of the IGF-1 gene which occurs in the representatives of all the breeds of small dogs is most similar to the type which is present in the genome of wolves for the Middle East. This would be indicative of small dogs originating in the region of the Middle East. Having analysed IGF-1 gene, the researchers concluded that a mutation conducive to size diminishing had occurred after the domestication of the wolf. However, this took place at the early stage of domestication if all the small dogs have the same version of IGF-1 (Gray et al. 2010). The results of next genetic research were published in 2014. Adam Freedman with other researchers analysed the genetic makeup of six different pedigree lines. The research concerned the genome of three wolves from Croatia, Israel and China, thus the areas considered as the hypothetical place of the domestication of dog (Europe, the Middle East, Asia). Also the pedigree of the Australian dingo was tested, as well as that of the Basenji dog and the golden jackal.

One of the tests showed a sibling relation between the wolf and the dog. However, another test showed that none of the wolf populations was related to dogs more closely than the others. This means that the ancestry line of today's dogs and the ancestry line of today's wolves split at about the same time. The population of wolves from which dogs have descended is extinct and the current variety represents other, younger pedigrees. The tests also determined the time of separation of the jackal and wolf/dog ancestors to be 400 000 years ago. Dogs and wolves separated around 14 900 years ago, and wolves themselves divided into separate groups resulting from geographical barriers.

THE IMPACT OF FEEDING ON THE DOMESTICATION OF THE DOG

Development of agriculture had an important influence on man's diet; their menu was becoming richer in grains, i.e. in carbohydrates. The key factor in the domestication of dogs was the ability to digest starch. The genes which play part here are a piece of evidence to support the evolutionary selection. They also show that the digestive tract of the dog's ancestors got used to a diet similar to that of man's. The genetic analysis carried out by

Freedman was focused on the presence and the count of copies of AMY2B gene in individual pedigrees. The AMY2B gene codes the protein (alpha amylase) which participates in the process of starch digestion. The tests showed a presence of 2 copies of this gene in wolves and the dingo dog, 4 copies in the Siberian Husky and 29 copies in Persian hart (a breed connected with the region of so-called Fertile Crescent, regarded as the cradle of agriculture) The obtained data show that the presence of AMY2B gene in dogs is linked with the development of agriculture-based civilisation and thus a change of the dog's diet. The presence of AMY2B gene in wolves and the primeval dogs such as the Siberian husky suggests that at the beginning of the domestication dogs' diet was that of a predator, which was connected with the nomadic life of man (Freedman et al. 2014). Taking into consideration the data and the estimated time of the separation of dogs from wolves (16 000 years ago), it can be concluded that the process of the dog's domestication preceded the beginnings of agriculture, which was considered to be the driving force behind this process, by several thousand years. The theory that wolves followed the nomadic tribes explains to a degree such genetic discrepancies which have impact on the appearance of dogs. Wolves which followed nomadic peoples, and scavenged from the remains of food they had left behind, cross-bred with other members of the species, depending on the area they travelled through (Wolpert, <http://newsroom.ucla.edu/releases/dogs-likely-originated-in-europe-249325>). Abandoning their territorialism by some wolves had an enormous impact on the process of domestication of dogs. The process of co-evolution (or inter-species interaction) began, which meant sharing the territory.

SELF-DOMESTICATION? THE ROLE OF MAN IN THE DOMESTICATION OF DOGS

There are a few leading theories which explain how and why the dog was domesticated. One of them explores the idea of self-domestication. Wolves following people were to eat out the food remains left behind by man and to gradually get closer and closer to people's homesteads. The individuals which showed less fear and no aggression towards people followed them and bred in their proximity and were gradually populating the man-dominated environment (Crockford 2000). It cannot be excluded that those wolves were involuntarily helping people by being present during man's hunts, scavenging on whatever the human hunters had left behind, and that they also protected people from other large predators (Thalmann et al. 2013). These theories assume a lack of active human involvement in the process of domestication of dogs. Others stipulate a greater or lesser active involvement of people. It is suggested that man could have captured wolf cubs and kept them because of their usefulness. They were used as pets, in various ceremonies, had symbolic value, and also took part in fights (Shipman 2010). Orphaned cubs were taken in and fed. The most useful and least aggressive animals were allowed to breed. The literature of the subject contains hypotheses that wolves were a live food source for people. It is likely that the reason for domestication could have been man's appetite for dog meat, which is still considered a delicacy in Asia (Pang et al. 2009).

THE ROLE OF BEHAVIOURAL FACTORS IN THE DOMESTICATION OF DOGS

Why the wolf? What characteristics did the ancestors of today's dogs possess? First and foremost, the distance they would run off to would have to be short. Only wolves which showed less fear and higher tolerance to the presence of man were able to stay and feed near human settlements. The key issue is that wolves possess a wide array of social behaviours. As studies have shown, those behaviours are closer to the social behaviours of people than chimpanzees (Scheldt and Shalter 2009). The relations of people and dogs are unlike the relations between man and any other domesticated animal. Already in the Neolithic, unlike other animal species, dogs were always owned by only one person or family.

This is substantiated by some ancient Egyptian paintings depicting a dog sitting next to a person's chair. Dogs were also the first species whose value was estimated. It was probably because they had many different applications; they could serve man as a guard, a hunting dog, they provided warmth and company, and in emergency situations could be a source of food. In the Neolithic people could bury a dog in the same tomb with its master (Ellickson 2013). Throughout the years, they've risen to the rank of a friend, even a family member. They receive gifts, they have burials, they are mourned (Empel 2009). Dogs are capable of assuming double identity (Bradshaw 2013) and directing their social behaviours towards people as well as the members of their own species (limiting sexual preferences to their own species). It could be that this ability for forming relationships with people is not the consequence of domestication but a key characteristic which made domestication possible, even if it appeared in some wolves by accident (Bradshaw 2013).

RECAPITULATION

The human-animal interaction had a significant impact on the dog's domestication process. The differences in the behaviour of dogs and wolves are the most striking result of domestication, as much so as the differences in the physical appearance (Rigternik and Houpt 2014). During the domestication process the wolf had been radically changed to a degree where it has become a different animal. Domestication influenced its appearance, physiology and, most of all, behaviour.

REFERENCES

- A taxonomic and geographic reference.** 1993. 2nd edition. Ed. W. Wozencraft. Washington D.C., Smithsonian Institution Press.
- Bradshaw J.** 2012. In *Dementia of dogs. Why dogs need our understanding.* London, Penguin Books.
- Crockford S.** 2000. A commentary on dog evolution: regional variation, breed development and hybridization with wolves, in: *Dogs through time: An archeological perspective.* Ed. S. Crockford. Oxford, BAR International, England, 295–312.
- Dhruzhdova A., Thalmann O., Trifonov V., Leonard J., Vorobieva N., Graphodatsky A., Wayne R.** 2013. Ancient DNA analysis affirms the canid from atai as a primitive dog. *PLoS ONE.* DOI: 10.1371/journal.pone.0057754.
- Ellickson R.C.** 2013. Stone-age property in domestic animals: an essay for Jim Krier. *Prop. Rights Conf. J.* 2, 001.

- Empel W.** 2009. O nierównym traktowaniu zwierząt [About unequal treatment of Animals]. *Życie Weter.* 84, 889–891.
- Freedman A., Schweizer R., Gronau I., Han E., Ortega Del Vecchyo D., Silva P., Galaverni M., Fan Z., Marx P., Lorente-Galdos B., Beale H., Ramirez O., Hormozdiari F., Alkan C., Vilà C., Squire K., Geffen E., Kusak J., Boyko A., Parker H., Lee C., Tadisotla V., Siepel A., Bustamante C., Harkins T., Nelson S., Ostrander E., Bonet T., Wayne R., Novembre J.** 2014. Genome sequencing highlights genes under selection and the dynamic early history of dogs. *PLOS Genet.* (PLOS Org). DOI:10.1371/journal.pgen.1004016.
- Gentry A., Clutton-Brock J., Groves C.** 2004. The naming of wild animal species and their domestic derivatives. *J. Archeol. Sci.* 31, 645–651.
- Germonpré M., Sablin M., Stevens R., Hedges R., Hofreiter M., Stiller M., Despre's V.** 2009. Fossil dogs and wolves from Palaeolithic sites in Belgium, the Ukraine and Russia: osteometry, ancient DNA and stable isotopes. *J. Archeol. Sci.* 36, 473–490.
- Gray M., Sutter N., Ostrander E., Wayne R.** 2010. The IGF1 small dog haplotype is derived from Middle Eastern grey wolves. *BMC Biol.* 8, 16. DOI: 10.1186/1741-7007-8-16.
- Musil R.** 2000. Evidence for the domestication of wolves in Central European Magdalenian sites, in: *Dogs through time: An archeological perspective.* Ed. S. Crockford. Oxford, BAR International, England, 21–28.
- Ovodov N., Crockford S., Kuzmin Y., Higham T., Hodgins G., Plicht J. van der.** 2011. A 33,000-Year-Old Incipient Dog from the Altai Mountains of Siberia: Evidence of the Earliest Domestication Disrupted by the Last Glacial Maximum. *PLoS ONE.* DOI:10.1371/journal.pone.0022821.
- Pang J., Kleutsch C., Zou X., Zhang A., Luo L., Angleby H., Ardalan A., Extröm C., Sköllermo A., Lundeberg J., Matsumura S., Leitner T., Zhang Y., Savolainen P.** 2009. mtDNA data indicate a single origin for dogs south of Yangtze River, less than 16,300 years ago, from numerous wolves. *Mol. Biol. Evol.* 26, 2849–2864. DOI: 10.1093/molbev/msp195.
- Rigterink A., Houpt K.** 2014. Genetics of canine behavior: A review. *World J. Med. Genet.* 27, 46–57.
- Sablin M., Khlopachev G.** 2002. The earliest Ice Age dogs: evidence from Eliseevichi. *Current. Antropol.* 43, 795–799.
- Schleidt W., Shalter M.** 2009. Co-evolution of humans and canids: An alternative view of dog domestication: Homo Homini Lupus? *Evol. Cognit.* 9, 57–72.
- Shipman P.** 2010. The animal connection and human evolution. *CA Forum on Theory in Anthropology.* *Curr. Anthropol.* 51, 4.
- Thalmann O., Shapiro B., Cui P., Schuenemann V., Sawyer S., Greenfield D., Germonpré M., Sablin M., López-Giráldez F., Domingo-Roura X., Napierala H., Uerpmann H., Loponte D., Acosta A., Gíemsch L., Schmitz R., Worthington B., Buikstra J., Druzhkova A., Graphodatsky A., Ovodov N., Wahlberg N., Freedman A., Schweizer R., Koepfli K., Leonard J., Meyer M., Krause J., Pääbo S., Green R., Wayne R.** 2013. Complete mitochondrial genomes of ancient canids suggest a European origin of domestic dogs. *Science (AAAS)* 342, 871–874. DOI:10.1126/science.1243650.
- TNS.** 2014. Zwierzęta w polskich domach, http://www.tnsglobal.pl/archiwumraportow/files/2014/11/K.073_Zwierz%C4%99ta_w_polskich_domach_O10a-14.pdf, access: 26.10.2019. [in Polish]
- Viegas J.** Dogs not as close kin to wolves as thought <https://www.seeker.com/dogs-not-as-close-kin-to-wolves-as-thought-1768231128.html>, access: 26.10.2018.
- Wayne R.** 1993. Molecular evolution of the dog family. *Trends Genet.* 9(6), 218–224.
- Wayne R., Ostrander E.** 1999. Origin, genetic diversity and genome structure of the domestic dog. *BioEssays* (PLOS Org). DOI:10.1002/(sici)1521-1878(199903)21::3<247::aid-bies(>3.0.co:2-z.
- Wolpert S.** Dogs likely originated in Europe more than 18,000 years ago, <http://newsroom.ucla.edu/releases/dogs-likely-originated-in-europe-249325>, access: 26.10.2018.

***Canis lupus familiaris* – DOMESTYKACJA**

Streszczenie. Pies w ciągu kilkuset tysięcy lat zasłużył sobie na wyjątkowe miejsce w życiu człowieka. Stał się ratownikiem, przewodnikiem, asystentem, terapeutą, obrońcą, przyjacielem. Co sprawiło, że jest obecnie tak bliskim towarzyszem człowieka? Naukowcy, wykorzystując coraz nowsze metody badań, poszukują odpowiedzi na pytania: Jak przebiegał proces udomowienia? Kiedy się rozpoczął? Jak długo trwał? Gdzie miał swoje korzenie? Dziś już wiadomo, że proces udomowienia psa rozpoczął się wielokrotnie i niezależnie w różnych częściach świata. Miejscem pochodzenia psa okazała się Europa, a nie Azja, jak wcześniej sugerowano. Celem niniejszej pracy był przegląd najnowszych badań dotyczących przebiegu procesu domestykacji psa. Omówiono wyniki badań archeologicznych, morfologicznych i genetycznych. Opisano różne teorie udomowienia oraz behawioralny aspekt tego procesu.

Słowa kluczowe: *Canis familiaris*, pies, domestykacja, interakcje człowiek–pies.

