Proceedings of the 3rd International Conference on Environmental Geoscience and Earth Ecology
DOI: 10.54254/2753-8818/81/2025.20183

# *The Relationship Between Wolf-to-dog Evolution and Geographic Variation and Its Implications for Biodiversity*

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***Abstract:*** The evolutionary relationship between wolves and dogs is a fascinating subject in the field of biology, revealing how natural selection and human activity work together to shape the evolutionary trajectory of species. This paper takes the East Asian grey wolf as a research subject and analyse the evolutionary process from wolf to dog and the impacts caused by geographic distribution and human activities. At the same time, geographical isolation from Eurasian wolves also led to the differential evolution of wolves. Human activities, especially domestication and selection by humans, accelerated the evolution and diversity of dogs. The East Asian gray Wolf may be a key contributor to the East Asian dog breed, with humans selectively breeding wolves, forming a variety of dog breeds to meet different needs. The global distribution of dogs reflects the significant influence of geographical factors, with dog breeds in different regions forming unique breed differences due to differences in adaptation to the environment, as well as the influence of selective breeding by humans. This paper provides new insights into the formation of species diversity and reveal the important role of human activities in biological evolution.

***Keywords:*** Wolves, Dogs, Evolution, Geographic distribution, Biodiversity.

## 1. Introduction

The notion that dogs descended from wolves is a familiar one, and while gray wolves were the first canines to be domesticated, the East Asian wolf is considered the most likely direct ancestor of the modern dog, and their evolutionary relationship is a fascinating subject in biology. Dogs are thought to have evolved from wolves, and human activity played a major role in this process. However, in addition to the influence of human activities, geography and natural selection have also had a profound impact on the evolution of wolves and dogs, ultimately shaping canine diversity. Over countless generations, wolves adapted to different environments, developing unique traits that allowed them to thrive in their respective habitats. For instance, wolves in colder regions evolved thicker coats, while those in warmer climates developed lighter coats. The process of domestication, initiated thousands of years ago, involved selective breeding, where humans chose wolves with desirable traits—such as docility, size, and physical characteristics to reproduce. Over time, this intentional breeding led to the remarkable diversity of dog breeds we see today, each uniquely adapted to specific roles and human needs. In essence, the evolution of wolves and dogs is a testament to the dynamic interplay of natural selection, geographic isolation, and human intervention.

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In recent years, with the progress of molecular biology technology, scholars have conducted in-depth studies on the genomes of wolves and dogs, revealing the relationship and evolutionary path between them. Foreign scholars have done a lot of research on the evolution of wolves and dogs, and have made important progress. Domestic scholars have also studied the evolution and distribution of wolves and dogs, especially the evolutionary history and genetic diversity of the East Asian gray Wolf. Species are usually in a perfectly adapted state, with little or no individual variation, so the struggle for survival is not necessary. Organisms will choose the most appropriate response to environmental challenges, and their bodies will adopt the most appropriate shape for new patterns of behavior through use. Individual variation occurs only when the environment changes, thus providing the raw material needed for natural selection, under the action of natural selection, the species changes, until the species in the new environmental conditions once again reached a perfect state of adaptation, natural selection stops[1].

The motivation for this study is that although a large amount of research has been accumulated, there is a need for a deeper understanding of the evolution of the wolf to the dog, as well as the effects of geographic distribution and human activities on it.

In this paper, the East Asian grey wolf is used as a study object, and comparative analysis with other wolf species is used as a framework to understand the ways in which the East Asian grey wolf has adapted to the unique geographic and climatic conditions of East Asia over a long period of evolution, and to analyse the effects of geographic isolation on the evolution of East Asian wolves, and the relationship between East Asian wolves and the East Asian dog breeds. The evolutionary process from wolf to dog is explored through comparative morphological and genetic analyses of wolves and dogs, as well as a study of the geographical distribution and evolutionary history of grey wolves in East Asia [2].

## 2. Regional differences and divergence reveal evolutionary trajectory from wolves to dogs

Wolves and dogs are two of the most iconic species with similar evolutionary relationships to humans and apes. The connection between wolves and dogs is rooted in a shared ancestry that dates back millions of years, reflecting a fascinating evolutionary history. Although they are often seen as separate species, their undeniable common genealogy highlights the important role of natural selection and human influence in their independent development. The idea that dogs evolved from wolves is familiar, and while the first wild animal to be domesticated by humans was the grey wolf, the East Asian grey wolf, a species of Canis lupus in the family Canidae, is thought to be the most likely to have evolved directly into a dog. Mainly found in China, Mongolia and the Korean Peninsula, they are large in size, mostly grey-brown in colour, and have a unique social structure and behavioural pattern. In this respect, it is appropriate to choose East Asian gray wolves as the main species of evolution. East Asian gray wolves have a very long evolutionary history, the earliest can be traced back to the late Pleistocene, they and Mongolian wolves are the same canine species in China, the two seem to have the same and close evolutionary relationship. The evolutionary details do not seem to be particularly different from those of the Eurasian gray Wolf of the same period. The East Asian gray Wolf may be a subspecies of the Eurasian gray Wolf. During the long evolutionary process, it gradually adapted and evolved its life due to the different climatic environments in East Asia. The East Asian grey wolf is mainly found in China in the northeast, Inner Mongolia, Xinjiang and Tibet, and is a highly adaptable species whose main prey includes large mammals such as wild boar, deer and yellow sheep, as well as small rodents[3]. East Asian gray wolves are highly social animals, and they usually live in family units consisting of a pair of adults and their pups. Each pack has its own territory and communicates through scent marking, howling, and body language.

Through anatomical and morphological studies, the skull and teeth of wolves are very similar to those of dogs. But compared to wolves, dogs have slightly changed skulls and limbs, mainly because

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wolves have lived in the wild for a long time[4]. There are significant differences in skull morphology between wolves and dogs, which reflect their respective living environments and habits. Wolves have longer, sharper snouts that are better suited for biting prey, while dogs have shorter, rounder snouts that are better suited for eating human food. The frontal bone of the Wolf is flatter and not significantly raised, while the frontal bone of the dog is more rounded, especially the purebred dog, whose skull shape is more varied to adapt to different functional needs. Wolves have deep eye sockets that allow for clear vision while hunting, while dogs have shallow eye sockets that allow for better interaction with humans. Wolves have longer, muscular jaws with a strong bite, while dogs have shorter jaws with a weaker bite but are better suited to chewing human food. Wolves have sharper teeth suited for tearing prey, and their canines and molars are more prominent, while dogs have more rounded, blunt teeth suited for grinding food, and their teeth vary widely in shape and size. Finally, wolves have larger and sturdier skulls overall, which is associated with being larger and more aggressive, while dogs have smaller and more elaborate skulls, which are more adapted to human companionship needs. In addition, the Wolf's tail is strong and straight, mainly for balance. Dogs' tails are more flexible, taking on different shapes and functions depending on the breed. As a result of adaptive evolution, it is evident that the limb anatomy of dogs and wolves is strongly correlated with their living conditions and lifestyles. The effect of adaptive evolution during the evolution of species is seen in the morphological differences between the limbs and skulls of dogs and wolves. Dog evolution has been significantly influenced by human domestication and artificial selection.

Wolves and dogs evolved to make the species better adapted to their environment, and geographic isolation is one of the reasons for changes in evolutionary patterns, and changes in the two squirrels in the canyon explain this change. For some reason, the habitat of two species of squirrels that used to be one has changed, and a huge canyon has opened up in the middle of the habitat separating the species. As a result, the squirrels are forced to live on both sides of the canyon. Over the years, the squirrels on both sides changed because of changes in the environment. The two squirrels, which were originally the same species, became two different kinds of squirrels. One has a puffier tail and the other has an enhanced mouthpart. The isolation of wolf populations is the major geographic variables affecting the evolution of dogs. Different geographic locations frequently pose distinct environmental problems, which causes isolated wolf populations to evolve specific adaptations. Variations in size, coat thickness, hunting techniques, and even social behaviors could be examples of these adaptations. Dog breed diversity was also influenced by the geographical isolation of various human groups. Dog breeds evolved to meet certain environmental requirements and cultural norms as a result of human migration and settlement in various locations. As a sled dog for nomadic people, the Siberian husky originated in the snowy regions of Siberia thanks to its thick fur and resistance to harsh cold. Even after evolution, the wolves that live there make the finest targets because of their thick coats and cooperative nature. The distribution of dog breeds around the world demonstrates how geography has influenced canine evolution. With their extensive and varied ecosystems, regions such as East Asia and Europe are home to a greater variety of indigenous dog breeds, each of which has evolved to suit certain environmental and cultural circumstances. Because of the lengthy history of human-wolf contact in certain areas, dog breed differences are more noticeable[5]. Different regions have different features, which naturally bring different survival challenges to the species, and thus affect the development direction of Wolf pack characteristics. Although East Asian gray Wolf and Eurasian gray Wolf have close pedigree, they have some differences in alerting and other aspects due to their adaptation to different environments.

The evolutionary path of the East Asian gray Wolf shows a unique adaptive evolution, and they face challenges from the unique geographical environment and climate conditions in East Asia, and are also influenced by human activities. Human activities affect wolf evolution, and the expansion of the human footprint shrinks wolf habitat. In areas where human interaction is common, some smaller

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wolves or some pups are easily subdued by humans and become docile and obedient after long periods of captivity and learning. The three widely accepted methods of ancient domestication are symbiosis, predation and orientation. In the symbiotic pathway, wild animals are attracted by food residues and filth, take the initiative to approach human ecological niche and gradually establish a two-way partnership with humans. In this process, people move from the unconscious to gradually increasing the purpose of domestication.

One of the changes from Wolf to dog is the product of human-wolf interaction, resulting in Wolf pups that have undergone several generations of changes over the long years, changing their form, behavior, and even significant differences in their genetic makeup, but retaining the personality and attitude of their Wolf days. Studies of dog domestication have revealed interesting geographical differences. There is a strong hypothesis that the East Asian gray Wolf was a key contributor to the emergence of the East Asian dog breed, and that the Chinese pastoral dog and the East Asian Wolf are somewhat similar in terms of body and personality[6]. The unique physical characteristics of these breeds indicate that they are genetically related to East Asian gray wolves. The distinctive characteristics of many wolf breeds were mostly shaped by the selective breeding of wolves for certain uses, such as hunting, protection, or friendship, in various human communities. For instance, humans deliberately selected this feature and interbred it in this way, resulting in the Tibetan Mastiff's thick fur and strong build. The genetic diversity of dogs is extremely complex, and the domestication process, driven by human interaction and selective breeding, has produced a significant genetic mix that mixes the characteristics of different Wolf populations, resulting in significant differences between individual dog breeds[7].

The characteristics of the Chinese pastoral dog, such as the sharp muzzle and strong physique, echo the characteristics of the Wolf, which seems to confirm that the Wolf is the ancestor of the dog[8]. This suggests that East Asian gray wolves may play an important role in shaping the genetic pattern of East Asian dog breeds. Given that many dog breeds are now unique and varied, it is not ruled out that wild Wolf herds have interbred through migration or other means to introduce genetic traits into the East Asian dog population and diversify their gene pool. Some studies have claimed that the genetic polymorphism of wolves in China is higher than in other parts of the world, which could also form some connection with the diversity of dogs obtained as described above, suggesting that the two did indeed evolve through interbreeding[9]. Given that different dogs may have very different morphological differences, it could be because in addition to evolving from different breeds, there must have been some artificial selection to maximize a particular trait and create a new species, a good example of this is the variation from wolves to dogs, where people wanted to domesticate wolves to be docile and loyal, to be used for hunting and guarding, or as playmates or pets, so there are dog variants. A wide variety of dog breeds evolved as a result of human interaction, which accelerated the process of divergence.

The evolution of dogs from their wolf ancestors is characterized by a multifaceted process involving various factors such as evolution, migration, and human influence, rather than a straightforward trajectory. The East Asian gray wolf, along with other wolf populations, has significantly contributed to the genetic composition of East Asian dog breeds, underscoring the geographical diversity inherent in their origins. Notwithstanding the significant distinctions between them, the wolf and the dog are fundamentally connected, their common lineage resonating within their core characteristics. The dog's sporadic manifestations of instinctual behaviors, including the tendencies to chase and herd, highlight its ancestral roots in the wild[10]. Similarly, the wolf reflects the influence of its domesticated counterpart, as evidenced by its intricate social organization and capacity for learning, which indicate a mutual potential for intelligence and adaptability.

Socio-ecological coevolution is the idea that evolution in a social system influences the biophysical environment, which in turn influences evolution in a social system, and that humans are

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extremely good at controlling evolution and coevolution may dominate natural coevolution, especially in the short term[11]. Because of the environmental challenges brought about by geographical disparities, animals in different regions naturally have different personalities, and the more violent species are naturally more difficult to domesticate. The global distribution of dog breeds reflects the significant impact of geographical factors. Areas such as East Asia and Europe, characterized by their extensive and varied ecosystems, feature a broader spectrum of indigenous dog breeds, each uniquely suited to their respective environments[12]. These regions, which have a rich history of human engagement with wolves, exhibit the most notable diversity in dog breeds. The terms "geographical distribution" and "paleomodern geological relations" refer to changes in the temporal and spatial distribution of organisms, respectively. The importance of obstacles is to prevent the migration of living things, just as the importance of time is to make living things gradually change. Some studies have found that dogs in North America did not originate from wolves in North America, but may have originated from dogs in Siberia. Compared with the wolves in different regions, the North American gray Wolf, as the main predator in North America, is larger in size and fierce in character. In the early domestication process, it became more stubborn and difficult to deal with the Eurasian gray Wolf. The Alaskan coyote, which lives in the cold Alaskan region, is solitary, has a wide range and is more omnivorous, and has a strong adaptability to life, which meets and is easy to domesticate.

## 3. Conclusion

This research explores the evolution of dogs from wolves, analyzing the influence of geographical environment, human activities, and natural selection on the East Asian gray wolf and the subsequent development of various dog breeds. Domestication and selection by humans have accelerated the evolution and diversity of dogs. And according to the study, the East Asian gray Wolf may be a key contributor to the East Asian dog breed, with humans selectively breeding wolves to form a variety of dog breeds to reinforce a trait that helps people live or work better. Dog breeds in different regions have formed unique breed differences due to differences in adaptation to the environment and the influence of human selective breeding. The significance of this study is to understand the effects of geography, human activities and natural selection on species evolution by analysing the evolutionary paths of grey wolves in East Asia and the differences between different wolfdog breeds. However, the current level of scientific research has certain limitations. Because the research object of this paper is East Asian gray Wolf, and some comparisons with other canids, so more East Asian gray Wolf as the research object. Whether other Wolf species have evolved in a different or more efficient way will require further research and consideration before more comprehensive conclusions can be drawn. In addition, more in-depth research is needed on the domestication process of dogs, including specific time points, domestication methods, and the contributions of different Wolf populations. Since evolution is a long process, we need to know more about this aspect to ensure the accuracy of the information. In the future, scientific research can further study and explore the genetic diversity of East Asian wolves and its deep relationships with other Wolf populations, as well as the specific contributions of specific East Asian wolves to the genetics of East Asian dogs. And whether differences between dogs are related to changes in wolves. Artificial selection from canids to canids suggests that evolution should evolve on the basis of some Wolf changes, rather than entering the bottleneck. The morphologic and behavioral characteristics of the different breeds were then analyzed, as well as the degree to which these characteristics were similar to the geographical environment to which they were adapted and to the ecological environment before wolves evolved. With more in-depth research, humans can better understand the evolution of wolves to dogs and the impact of human activities on biodiversity.

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