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# China as a Center of Origin and Domestication of Chicken: A Review

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## ABSTRACT

China has about 107 local chicken breeds and is considered one of the richest countries in terms of genetic resources. This diversity is a source of richness natural resources across the globe and is regarded as an excellent material for genetic improvement of breeds or breeding new breeds around the world. The present review highlights the recent evidence and studies of chicken origin and domestication in China and Southeast Asia. The evidence of molecular genetics and archeological results supported that multiple regions and event were contributed to the creation of chicken evolution from Red Jungle fowl and the findings proposed that one of events happened in domestication of chicken 8000 BP in Southeast of Asia. Several researchers confirmed that China was declared as most important of the world as a first centers for the chicken's domestication and these chickens have remained in many archaeological sites in China.


**Key words:** Chicken, Domestication, Origin.

For hundreds of centuries, poultry has been playing an important, various and essential role in the economy, culture, religion, as well as the preservation of incomes in the majority countries of the planet (Kryger *et al*. 2010) and it is bred provide humans with a stable quantity of protein and is also being utilized for religious activities and entertaining occasions. The most prevalent poultry on planet earth is the domestic chicken (*Gallus gallus* domestics) (Rischkowsky and Pilling 2007).

Now there are approximately thirty-eight varieties of domestic animals and bird that are now regarded as farm animals for (medicine, food, clothing, work, *etc*.), in the globe (Scherf and Pilling, 2015). The total number of breeds reached about 8,774 breeds as animal genetic resources within the FAO Global Data Bank of the United Nations (Aho 2004; Aho 2002; Roenigk 1999; Scherf and Pilling 2015). Over their lengthy time of development in a complicated and a varied natural environment, local chickens have suffered genetic mutations, crossbreeding of breeds and development of specific strains, consequently accumulating a wealthy setting of genetic resources.

Currently, global databank of Food and Agriculture Organization reports has confirmed that there are approximately 1729 breed of chickens, representing about 20% of the overall number of breeds of farm animals around the globe. The raising of poultry was not restricted just to produce eggs and meat, several native breeds were raised for the purpose of entertaining, especially the breeds that have an attractive and specific phenotypic, for example, various morphologies (body size, tail feathers, comb, color feathers, shape, *etc*.), as well as behavioral traits such as increased noise of crowing and aggressive of roosters during fighting (Food and Agriculture Organization 2015). The basis of animal selection and breeding is genetic diversity; therefore, animals should be genetically characterized in order to sustainably preserve them as an inexhaustible genetic resource and it is extremely important to survey the genetic variety within and between animals' population. Biodiversity, genetic diversity and chicken evolution has been completely explored at various levels, diverse regions and countries throughout the world. All the studies approved that the Asia, particularly southern Asia and China are the center domestication and origin of chicken as early as 8000 years BC (Crawford 1990; Liu *et al*. 2006).

Although the approach of mtDNA analysis offer a useful introductory explanation of demographic history, genetic diversity and structure of population, however markers of nuclear such as SNPs and microsatellite would offer precious supplemental information to complete the analysis. There are many of mtDNA studies have been shown that Red Jungle fowl is a closely correlated and ancestor of domestic chicken although there is evidence to contribution of other Junglefowls species in the process of chicken evolution. In future It is necessary to involve all disciplines, including archeology studies, genetic studies, computer

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science and data science to reveal more details about the evolution and domestication of poultry (Di Lorenzo *et al*. 2015). China has about 107 local chicken breeds and is considered one of the richest countries in terms of genetic resources. This diversity is a source of richness natural resources across the globe and is regarded as an excellent material for genetic improvement of breeds or breeding new breeds around the world (Chen *et al*. 2004). In this current review a comprehensive overview of previous studies conducted on domestication history of chicken breeds.

## Domesticated animals in China

China is considered one of the richest countries in terms of agricultural resources, biological diversity and biological resources, especially with regard to the genetic resources and origins of agricultural animals and poultry, as it was regarded like a genetic pool for the world (Chen *et al*. 2008; Zhang 2011). This genetic variation in native Chinese animals, which evolved across thousands of years under different natural and environmental conditions, which led to the appearance of wonderful genetic characteristics that the Chinese peoples have preserved and improved it through successive generations to the present time (Food and Agriculture Organization 2015). These indigenous Chinese breeds had performed a major role in history and many cultural activities, for example, when the original Chinese pig strains were imported to Rome early more than two thousand years ago, the chicken of Langshan was also imported from China to England 50 years ago. In addition, more than 30 varieties of native animals and birds of different characters and features such as, Guan Zhong donkey, Qinchuan cattle, Beijing duck and Meishan pig have been distributed to several countries in America, Asia, Oceania and Europe. These Chinese indigenous species had a profound and a fundamental impact in the phases of development and domestication, including in the hereditary diversity of most animal and bird breeds and the livestock industry in general all over the world. Where they are considered important sources when it comes to developing or improving new breeds, as well as will contribute to the maintainable expansion of the animal wealth industry in the foreseeable future because of its genetic material characteristics, capable of living in harsh conditions in terms of bad weather, food scarcity and disease spread. According to “Animal Genetic Resources in China and Asia” by Wu (1998), genetic resources of domestic animal and bird in China generally comprise the next species, sheep, water buffaloes, pigs, horses, yellow cattle, goats, donkeys, yaks, ducks, geese, poultry and special birds, in total more than 282 breeds, for approximately 194 local breeds, 45 developed breeds and 43 exotic breeds.

## Indigenous chicken breeds

Domestic animal breeds are an important and sustainable genetic resource for future genetic improvementand breeding of animals (Taberlet *et al*. 2008). Nevertheless, many native breeds are still unknown, living in their original location, not undergone to any study or any evaluation and are threatened with extinction and disappearance due to the introduction of commercial breeds that have become favored by breeders and the random crossbreeding between imported breeds with the original breeds, which will lead to a serious challenge to poultry genetic and breeding in the future (Besbes 2009). Compared to other livestock, genetic resources of chickens are considered more vulnerable, as it was found that about 33% of chicken breeds are threatened with extinction (Hoffmann 2009). Therefore, the greater effort, time and money should be spent to preserve this genetic wealth throughout the world.

According to the report of the Food Agricultural Organization, (2015) the total number of local breeds of chicken is about 1077 breeds around the world, including approximately 243 breeds in the mainland of Asia and mor than 107 breeds in China. Over time, these local breeds acquired many distinctive and beneficial characteristics during the process of evolution, for example, resistance against disease, wide environmental adaptation and several excellent economic characteristics. Nevertheless, single-lineage assortments and manufacturing nourishing challenge, the unique characteristics of different animals’ breeds and have propelled to a decrease within the hereditary assets of poultry (Fulton 2006; Hodges 2006; Muchadeyi, *et al*. 2009; Scherf and Pilling 2015). Moreover, the decrease in breeds of native chicken complemented by a decline in their variation of genetic, which has led to an increase exposure to infection. Additionally, exotic invasive breeds have led to a decrease in the quantity and quality of local breeds. Therefore, the protection of the gene pool is an urgent issue (Muir *et al*. 2008). Local chickens are characterized by their ability to adapt to harsh environments, poor nutritional conditions and resistance to diseases, but their production is less compared to commercial chicken. Nevertheless, there are special preferences for these chickens may well be recognized to taste, firmness, increased content of protein, leanness and multicolor of pigmentation (Bhuiyan 2011; Wattanachant *et al*. 2004). To ensure and secure the genetic resources needed for any future reproduction and breeding process, it is necessary to identifying, collecting, evaluating and preservation genotypes of these breeds (Dorji *et al*. 2012). From this perspective, local randomly mated chickens are considered a valuable treasure and an important source of known and unknown genotypes that will be useful in the future for providing additional features for poultry production.

## Chinese indigenous chicken breeds

China is characterized by very diversified geographical, environmental and a long history with animal farming, which has led to the existence a large variety of indigenous poultry breeds. There is a richness of genetics resources with higher than 107 different native chicken breeds. Most of these breeds are raised in small groups in villages and rural areas and possess good eggs and meat qualities. However, local breeds are characterized by low performance, slow to

moderate growth and late maturity (Chen *et al*. 2004). Most of indigenous Chinese chicken breeds are dual breeds (eggs and meat production), while some chicken breeds have their distinctive traits such as Huiyang and Beijing You breeds that are characterized by good meat quality and flavor then could use for production of meat (Rischkowsky and Pilling 2007). One apparent attribute of the Chinese native chicken breeds is their wide-ranging phenotypic and morphological variation in comb types, colors (comb, plumage, skin, earlobe and shank), body size and morphology. Each breed has a specific feature such as the appearance is beautiful, the shell eggs color is green, meat flavor is good (Wu *et al*. 2014). In China, indigenous chicken meat consumption has been growing together with the chicken industry. Chinese consumers favor the meat of local because it has a distinctive flavor in comparison to meat of modern broiler. In additionally, most of the local chickens are sold live, which constitutes about 20% of the chicken market and this market is quickly increasing by 5% to 10% annually (Tang *et al*. 2009). Nevertheless, in accordance to previous reports by Chang *et al*. (2012) and Chen (2012), the local chicken population numbers and count have been rapidly declining. This reduction in population is mostly credited to resource-limited which are accessible for preservation measures and imported commercial breeds. However, preservation procedures are costly to the implementation and therefore not each population will be contained, therefore naturally as well as unique varied individuals need to be identified and covering the broadest variety of variations. An accurate evaluation of all individuals regarding their contribution to genetic variety is an imperative step towards preserving genetic origins and genetic diversity (Weigend *et al*. 1995).

In China, during the past decades, many poultry research centers have been established according to their geographical distribution in order to develop strategies to preserve the domestic chickens diversity, as it is essential to conduct the quantitative evaluation of genetic individuality that a given individual by studying molecular markers and genetic distances and that can play as a an essential guideline for assessing varieties as resources of genetic (Barker 1994; Ruane 1999; Weigend and Romanov 2001). Local chicken breeds are having an important and fundamental role in agricultural economics in most countries and they are playing to improve farmers 'incomes in addition, providing them with food such as eggs and meat for their personal consumption. The productivity of domestic poultry can be improved by introducing modern technology in nutrition, housing, genetic and health (Padhi 2016). Improved the performance of local chicken breeds genetically has been become the biggest concern in China and many developing countries, especially the Asian countries, that is the main source of local chickens diversely, it is very important to enhancing farm incomes and enabling them to excellent breeding practices which will lead to the development of industries based on animal husbandry.

## Commercial breeds of chicken

Several of local chickens' breeds are distributed all over the world and within a hundred years, local chickens were developed and hybridized to be a source of food by adapting the genome to specialize in the production of eggs or meat, which outperforms its existing wild ancestors, as well as the local chickens that evolved from them within 100 years. The Red jungle fowl that wildly lives in South Asia and its considered as an ancestor of domestic chicken is produced about 5 to 10 eggs per year and the body weight of adult male reach to 1 kg while the most of layer chicken breeds are produced about 300 eggs per year and the body mass of adult chicken reach to 4 to 5 kg per year (Brooke and Birkhead 1991). The current production of chicken birds reaches more than 70 billion birds per year that produce by layer and broiler chicken to meet the increasing global demand for chicken meat (120 million tons) and eggs (1.2 trillion eggs) (Faostat 2019). Since the end of the twentieth century, chickens have been exposed to strong and intense selection to improve their production performance of eggs and meat and the result was the formation of the commercial chicken strains that we see today. In the period of the Roman Empire, the selective breeding of chickens for obtain food has been reported, nevertheless, the intensive selection of chickens has not occurred until the beginning of the 12th century, after the emergence of massive commercial companies for poultry breeding, in which chickens were selected on the basis of production of meat (growth traits) and eggs (reproductive traits) (Burt 2005; Crawford 1990; Hanke *et al*. 1973). Currently, the commercial chicken breeds in word are four breeds: white and brown egg-layers (eggs production) and two line of meat production chickens (broiler sire lines and broiler dam lines). The breed of white leghorn is the base of white egg-layers breed, while the breeds of Rhode Red and Plymouth rock are the base of brown egg layers. The broiler breeds are two lines dam and sire, the dam line has selected for fertility and growth and sire line has selected only for growth traits and the breed of Cornish is the base of sire lines, while a several breeds are the base of dam lines (Muir *et al*. 2008).

Unfortunately, with the revolution that has been occurred in chicken breeding and selection, which was reflected generally on the poultry industry through the intensive selection of meat and eggs production traits, but it was accompanied by many undesirable traits that directly affected poultry production, the most important of which are decreased the fertility and immunity to resist the disease (Decuypere *et al*. 2003; Zekarias *et al*. 2002). In addition to many phenomena such as osteoporosis, deformities of skeletal and disorders of congenital (Burt 2005; Julian 1998; Whitehead and Fleming 2000).

## Chicken origin and domestication

Darwin indicated that the origin of domestic chicken is *Gallus gallus*, additionally, the evidence of molecular genetics and Archeological results supported that multiple regions and events were contributed in the creation of chicken evolution from Red Junglefowl and the findings proposed that one of events happened in domestication of chicken 8000 BP in Southeast of Asia (Baker 1968; Darwin 1894; Eriksson *et al*. 2008;

Liu *et al*. 2006; West and Zhou 1988). The purpose of domesticated chicken maybe have been used at the beginning for entertainment and religion instead of being a source of food and as the chickens spread throughout the world according to environment and culture and it was used for the purpose of the hobbies of people in Europe and were developed in that period (Crawford 1990; Gordy and Skinner 1974).

Many sciences are involved in exploring the evolution and domestication of chickens and the most important of these sciences are historical, genomic and archeology data. Several investigations have been determined the center of chicken's domestication in the South and Southeast Asia. The major of ancestor species of chickens are *Gallus gallus*, on the other hand, *Gallus sonneratii* has additionally made a significant contribution to the hereditary materials of the chicken domestication. Currently, the genetic variety is distributed between the standardized breeds, traditional and extremely breeding lines. Revolution that has been happened on the basis the discovery of the genome sequence had a significant effect on the study of evolution, domestication of chickens and its genetic diversity, in addition to identifying the mutations responsible for the main differences between the domestic and wild breeds and finding that genes liable of quantitative traits loci the consequences in lines that are selected (Tixier-Boichard *et al*. 2011). Birds and mammals share many metabolic characteristics such as thermoregulation and belonging to tetrapod vertebrates, however, they are not so strongly associated. In Fact, birds are released from diapsid amniots, while mammals are released from synapsid amniots (Fig 1). Where crocodilians are the nearest relatives to birds along with all living species, birds and reptiles are the sister-group of mammals (Lecointre and Le Guyader 2001). Except pigeons, almost Galloanserae is the order of all domestic (chicken, turkey guineafowl, quail, goose duck) birds' basal phylogenetic tree, whereas mammals are dispersed in numerous orders (Mason and Mason 1984). Through ancient times, the history of bird domestication can be divided into three periods, which are the following: i) the evolutionary phase, ii) the domestication phase, iii) the intensive selection phase (Tixier-Boichard *et al*. 2011). Moreover, the domestication chicken history in the world can be summarized as follows: First, the appearance of domesticated chickens in South Asia, second, these chickens spread in the world and many breeds appeared according to the geographical location and finally, in the twentieth century, the breeders worked on chicken selection according to the desired characteristics and appearance the modern chicken (Piégu *et al*. 2020).

## China as a center of origin and domestication of chicken

In China, there is a very well-known stating that it says "wugu fengdeng, liuchu xingwang and its translation in the English language is (Five grains of abundant yield, six animals of the wealth). Here is the stating is originating from (Zuozhuan) the Confucian classic, a narrative historical writing documented the history of China in the period from 731-470 BCE. Inside the script for the nineteenth annual of Duke Xi (640 BCE), it has been argued that "anciently, the six domestic animals were not used at the same sacrifice. In China, there are six farm animals that are following: cattle, horses, goats, sheep, pigs, dogs, chickens and pigs. Owing to a previous mention previously written in Zuozhuan, which confirms that these six animals have previously been domesticated in the year 640 BC in China (Deng *et al*. 2014).

Even though the chickens (*Gallus gallus domesticus*) are the important species of poultry to a considerable extent,

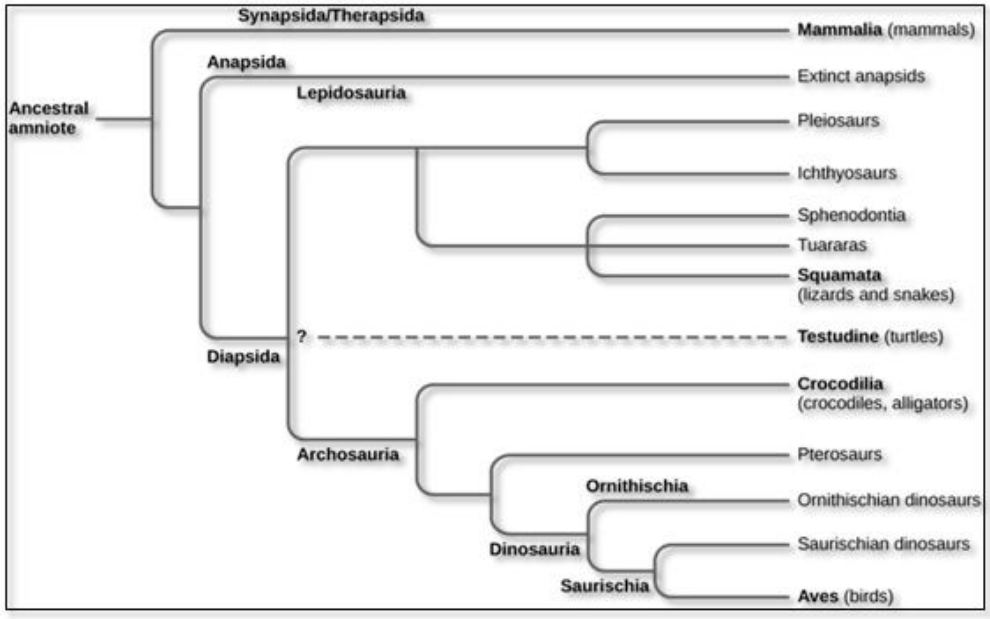


**Fig 1:** The evolution of amniotes (Lecointre and Le Guyader 2001).

the locations, number and time of domestication have remained controversial for greater than a hundred years. Though, the commonly recognized to have to be the main ancestor of poultry is the red jungle fowl (Darwin 1894; Moiseyeva *et al*. 2003). Domestic chickens (*Gallus gallus domesticus*) are the most prevalent birds around the globe, supplying eggs and meat, entertainment (cockfighting, cockcrowing, *etc*.), religious occasions, in the early stages of their domestication in the worldwide (Serjeantson 2009). As we mentioned previously, the local chicken created mostly from the Red junglefowl, which is found in the regions of Southeast Asia and China, especially in northern China, where it was domesticated in different places from this region and then these birds moved to India in the year 2000 B.C. additionally, these birds moved from China to Russia, later they relocated to Europe during the period 750 BC (Miao *et al*. 2013). Moreover, the southwest of China comprising Yunnan province and the surrounding countries functioned as domestication facilities of domestic chickens, Indian also used to be a new center of domestication, as well as all the current chickens are developed during several processes of evolution and expansion that are occurring at various times (Liu *et al*. 2006).

## Chicken domestication and archeology

Several researchers confirmed that China was declared as most important of the world's first centers for the chicken's domestication and these chickens have remained in many archaeological sites. Until this moment, the remains of poultry bones have been found in 51 archaeology layers in 43 locations and it dates back to the Stone Age, in addition to 18 layers in 12 A site which dates back to the Bronze Age (Li *et al*. 2015; West and Zhou 1988). Furthermore, the newest available archaeological discoveries suggest that northern of China is as well as one of the locations for training and development of poultry (Eda *et al*. 2016; Huang *et al*. 2018). In addition to all the above, the most ancient bones of domestic chicken in the globe have been discovered at Peiligang and Cishan sites in Henan and Hebei in China (Zhou 1981).

When scientists have studied the radioactive carbon analysis of the layers in which the chicken bone had been uncovered, they found that its history dates to 6000 BC. A supplement to the newest studies of DNA for centuries have revealed various patterns of mtDNA for *Gallus gallus* chicken in Wangyin site, Shandong Province several locations in China. this indicates that the process of domestication has begun about more than 10, 000 years ago in China and this study clearly have been demonstrated that its results as all the bones examined are derived from the Gallus and their analyzes also suggested that the area located in northern of China is the oldest area to domesticate chickens in the world, dating back more than 10,000 years, is similar to the proof from the domestication of pig and to suggest that those are the early domesticated poultry was making a donation to a center of gene pool for poultry populations (Xiang *et al*. 2014). Nevertheless, some findings demonstrate that local poultry's have a minimum following three domestication centers, Southeast of Asia, China and the neighboring country and Indonesia, that are based on historical records, genetics and monuments (Kanginakudru *et al*. 2008). Moreover, in northern and central China, Eda *et al*. (2016) in his study, he examined the skeletal remains of 1832 birds from 18 sites dating back to the Neolithic and Bronze Age. Where the researcher combined the morphological definition and the histological assessment of the bones and found that chickens and the red junglefowls were not present or at most extremely rare, the researcher also discussed the major discrepancies between the current study and earlier studies and concluded in accordance with the reassessment no skeletons remained derived from chickens. However, the bones that were found may be candidates for chicken bone in two from of a total of 18 sites, indicating that the chicken was neither generally preserved and neither distributed for the duration of the initial and intermediate period of Holocene in northern and central of China.

## Chicken classification

Nearly 300 million years ago birds and mammals separated evolutionarily from their common ancestor. and generally, the chicken is a multiple-species animal, where higher than 201 types of chickens are being raised up around the globe. Currently, there are four species of the genus Gallus are residing wildly in South Asia (Crawford 1990; Hedges 2002). Genus Gallus include four species: *Gallus sonneratii*, *Gallus varius*, *Gallus gallus* and *Gallus lafayetii* (Grey, Green, Red and La Fayette's jungle fowl), (Fig 3) and residing wildly in India (southern and western), Indonesia (Java), South Asia (South-western of china, Vietnam, Myanmar and North of India) and Sri lank a, respectively (Crawford 1990; Lawal *et al*. 2020), (Fig 2).

There are two suggested theories when we are discussing about the origin and ancestor of poultry, the first theory says that the ancestor of the native chicken is Red

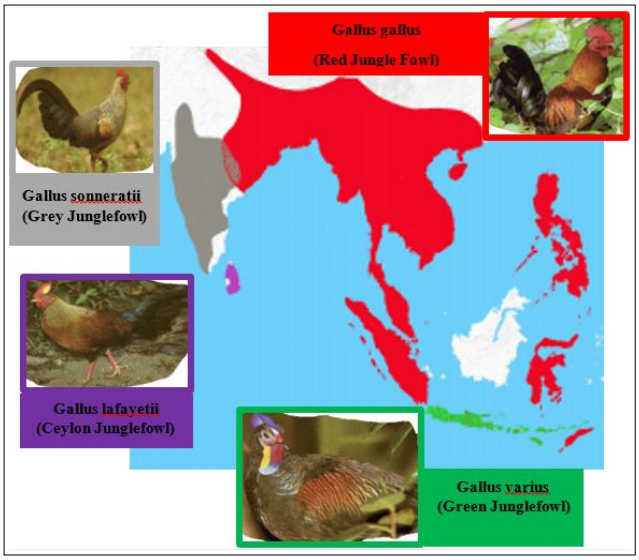


**Fig 2:** The geographic distribution of the four jungle fowl species (Lawal *et al.* 2020).


**Fig 3:** Chicken classification (Al-Nasser *et al.,* 2007).

jungle fowl and only one origin of domestic chicken (monophyletic) and the second theory says that the origin is multiple and not only one species, but more than types of jungle fowl has contributed to chicken evolution (Al-Nasser *et al*. 2007; Sawai *et al*. 2010). As well as this Al-Nasser *et al*. (2007), has been informed that the current chickens that are currently being utilized for eggs and meat production that are readily available on the marketplace represent the offspring of red junglefowl species.

## CONCLUSION

Over the past decade, the scientific research techniques have evolved greatly, especially in the field of molecular genetics and archeology and this has led to obtaining many indications that confirmed that China is one of the centers of chicken domestication in the world. The ancestor of chickens that we reared now still live wild in southeast of Asia, including Yunnan Province in China. Archaeologists have recently discovered evidence confirming the remains of chicken traces in northern China, dating back thousands of years. China has more than 107 chicken breeds, which are characterized by a wide range of phenotypic and genetic variation.

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