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«Review»

Historical Overview of Poultry in Japan

Atsushi Tajima

Faculty of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki 305-8572, Japan.

To meet the strong quantitative demands for poultry products with high sanitary standards soon after World War II, the Japanese poultry industry experienced a rapid expansion period. However, it should be remembered that the post-war flourishment of the Japanese poultry industry was built on a solid academic and educational platform that took several pre-war decades to construct. In addition, poultry play a special cultural role in Japanese society.

In this review, poultry in Japan is illustrated from the following three historical viewpoints: 1) development of the Japanese poultry industry; 2) academic and educational contributions to the poultry industry in Japan; and 3) ritualistic, mythic, and artistic attributes of poultry that are deeply embedded in Japanese society.

Key words: Cultural Aspects, Industrial Aspects, Japan, Poultry

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Introduction

Poultry science is a specialized discipline in animal production science that conducts research, education, and extension of domesticated avian species to provide a wide range of products and benefits for human society.

From a nutritional point of view, poultry products are not just tasty, but broiler meat is low in cholesterol and poultry eggs are high in protein quality, as they contain well-balanced essential amino acids for humans (USDA Food Dada Central, 2019). The poultry industry in Japan grew rapidly after World War II (WWII) through the introduction of a systematic Western poultry management system. Within a few decades after WWII, the poultry industry in Japan became a major agricultural production sector that efficiently and economically supplied hygienically safe meat and eggs to consumers. There is no doubt that a wide range of research outcomes in poultry science significantly contributed to the current thriving Japanese poultry industry.

Furthermore, many of the physiological and anatomical characteristics of poultry make it an ideal animal model for conducting basic research, such as phylogenetics and embryological and experimental biology studies. One of the keys to ensuring the reproducibility of research outcomes is the constant supply of experimental animals with well-characterized genetic properties. Considerable efforts have been made in Japan to develop, conserve, and disseminate invaluable poultry genetic resources at the national, local, industrial, and private levels.

Another prominent aspect of poultry in Japan is its symbolic, ritualistic, mythic, and artistic attributes, which are deeply embedded in Japanese society.

The objective of this review is to illustrate poultry in Japan from the following three historical viewpoints: 1) development of the Japanese poultry industry; 2) academic and educational contributions to the poultry industry in Japan; and 3) the ritualistic, mythic, and artistic attributes of poultry that are deeply embedded in Japanese society.

1. Historical development of the poultry industry in Japan

Egg production in Japan.

As shown in Fig. 1, the number of layer farms in Japan increases sharply after WWII, peaks in 1955 (approximately 4.5 million farms), and decreases rapidly afterward. The number of layer chickens increased initially in parallel with the increase in the number of layer farms, but continued to increase until the beginning of 1990, and plateaued afterward. According to the February 1st, 2022 survey by Ministry of Agriculture Forestry and Fishery, Japan (MAFF), there are 1,810 layer farms and approximately 137 million layer chickens have been raised in Japan (MAFF 2022a).

According to "The Plan Concerning Improvement and Increased Production of Livestock (Chicken)", the indices of layer

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Correspondence to: Atsushi Tajima, Professor Emeritus, Faculty of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki 305-8572, Japan (E-mail: tajima.atsushi.gb@u.tsukuba.ac.jp)

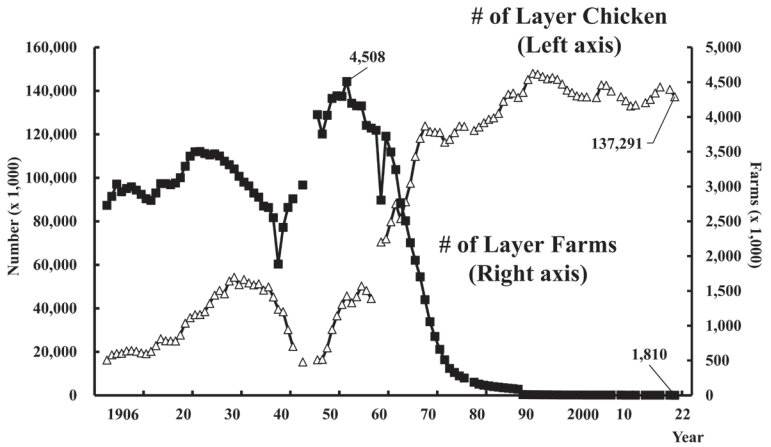
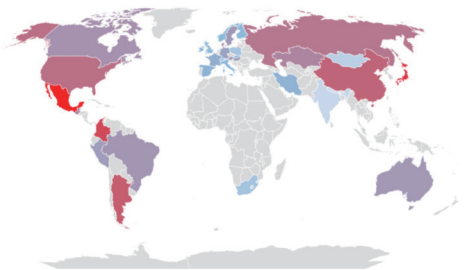


Fig. 1. **Egg production in Japan**



		Eggs /Capita/Year
1.	Mexico	409
2.	Japan	337
3.	Colombia	334
4.	Argentina	298
5.	USA	285
6.	Russia	283
7.	China	274
8.	Korea	270
9.	Austria	260
10.	Brazil	257

Fig. 2. **Global egg consumption per capita (2021)**
Source: International Egg Commission (2022), cited in Keimei Newspaper, August 25th, 2022.

chicken performance in Japan as of 2020 and target values in 2030 for feed requirements are 1.97 and 1.90, laying rates are 88.2% and 89%, average egg weights are 62.5 and 61.65 g, and age at 50% lay is 144.9 days and 143 days, respectively (MAFF 2020).

As shown in Fig. 2, the number of eggs consumed in Japan is 337 eggs/capita/year in 2021, which is the 2nd highest after Mexico, which consumed 409 eggs/capita/year (International Egg Commission 2022). These data indicate that eggs are among the most preferred and popular food resources in Japan.

As shown in Fig. 3, egg retail prices surge in the late 1970's and remain high until the early 1980's (Keimei Newspaper, 2023). This period corresponded to rapid economic growth in Japan. However, egg retail prices between 1950 to the early 1970's and after 1990 remained amazingly stable, at around 200 yen per kilogram. Annual egg production increased from 0.9×10^6 ton/year in 1961 and plateaued at 2.6×10^6 ton/year in 1990 (FAOSTAT, 2021), and the price remained within this range until the

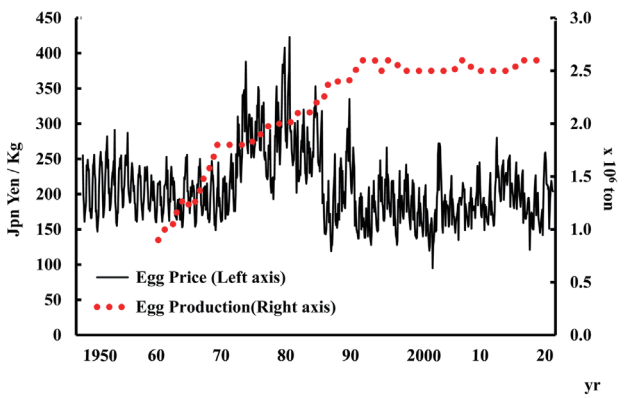


Fig. 3. **Egg production quantity and retail price in Japan** (M size, Tokyo Market)

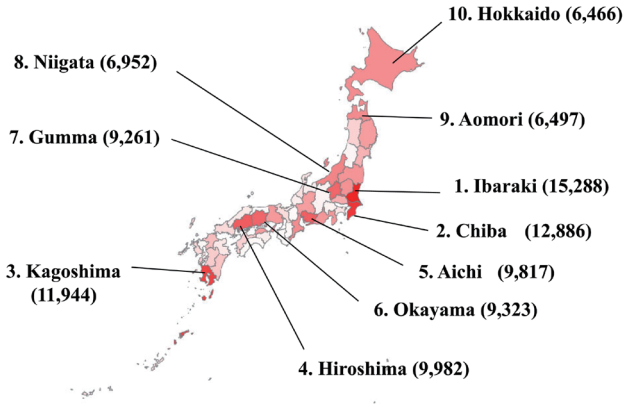


Fig. 4. **Top 10 prefectures for laying hen numbers in Japan (2022)**
(× 1,000 heads, as of February 1, 2022)

present. Considering that the per capita Gross Domestic Product in Japan in 1950 (3,053 USD) was less than one-tenth of that in 2021 (39,285 USD), egg price was extremely expensive for an average-income family from 1950–1970.

As shown in Fig. 4, the top 10 prefectures for layer chicken numbers in Japan (× 1,000) are 1. Ibaraki (15,388), 2. Chiba (12,886), 3. Kagoshima (11,944), 4. Hiroshima (9,982), 5. Aichi (9,817), 6. Okayama (9,323), 7. Gumma (9,261), 8. Niigata (6,952), 9. Aomori (6,497), and 10. Hokkaido (6,466). The egg-producing areas are scattered throughout the country. The total number of laying hens raised in these top ten prefectures was 98,416 × 10^3 hens, which accounted for 53.9% of the total number of laying hens in Japan. Among the 1,810 layer farms in Japan, 334 layer farms (18.6%) are raising more than 100 × 10^3 laying hens (MAFF 2022a).

Broiler production in Japan

As shown in Fig. 5, the meat supply from the three main livestock sectors in Japan is limited before WWII. The post war expansion of meat production began with the pork sector, followed by the broiler sector, whereas the expansion of the beef sector started from the 1960's and the rate of increase was slower than that of the pork and broiler sectors. It should be noted that by the early 1980's, chicken meat production had exceeded pork production. The annual production of chicken, pork, and beef in Japan in 2021 was 2,216 × 10^3, 1,318 × 10^3, and 477 × 10^3 tons, respectively (MAFF 2022b).

As shown in Fig. 6, the number of broiler farms is the highest in 1964 (21,100 farms) and decreases rapidly thereafter. In contrast, the number of broiler chickens rapidly increased from the 1960's and peaked in 1986 (156 × 10^6 heads). As of February 1, 2022, there are 2,100 broiler farms and approximately 139 million broiler chickens in Japan (MAFF 2022a, 2022b).

According to "The Plan Concerning Improvement and Increased Production of Livestock (Chicken)", the production performance in 2020 and target values in 2030 of an average broiler chicken in Japan for feed requirements are 1.73 and 1.6, finishing dates are 47.1 days and 45 days, and finishing body weights are 2,970 g and 2,970 g, respectively (MAFF 2020).

As shown in Fig. 7, the top five prefectures for broiler numbers in Japan (× 1,000) are 1. Kagoshima (28,090), 2. Miyazaki (27,599), 3. Iwate (21,095), 4. Aomori (8,058), and 5. Hokkaido (5,180). Broiler producing areas are scattered throughout the country and the total number of broiler chickens in these top five prefectures is 90,022 × 10^3, which accounts for 65.8% of all broiler chickens in Japan. Among the 2,100 broiler farms in Japan, 683 farms (32.5%) are raising more than 300 × 10^3 broiler chickens (MAFF 2022a).

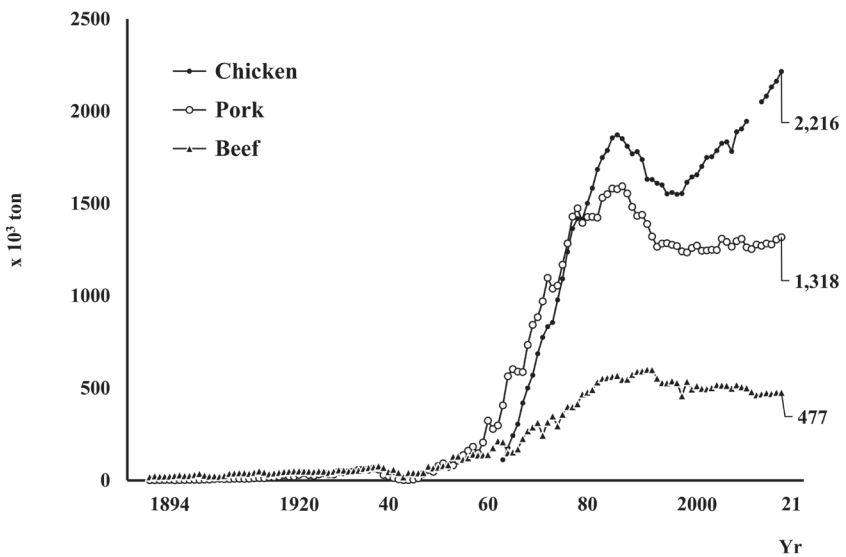


Fig. 5. **Meat production in Japan (1877–2021)**

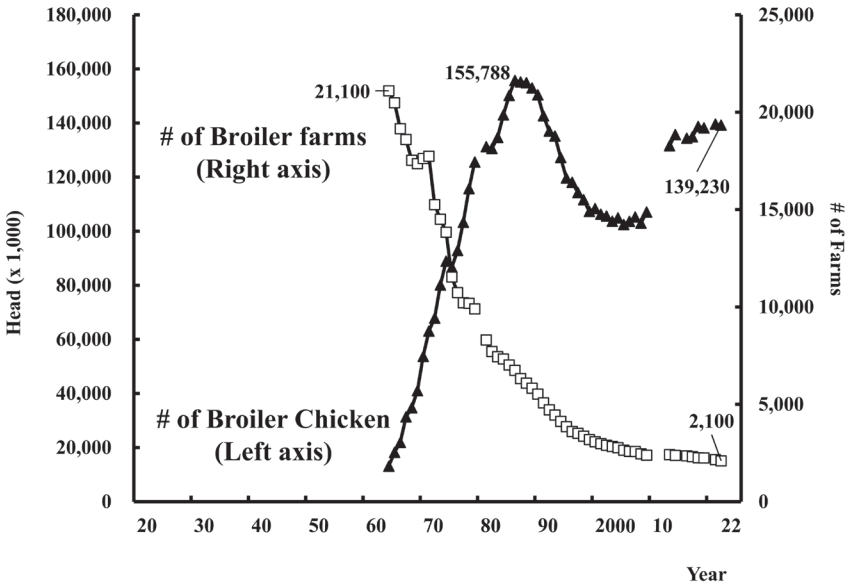


Fig. 6. **Broiler production in Japan**

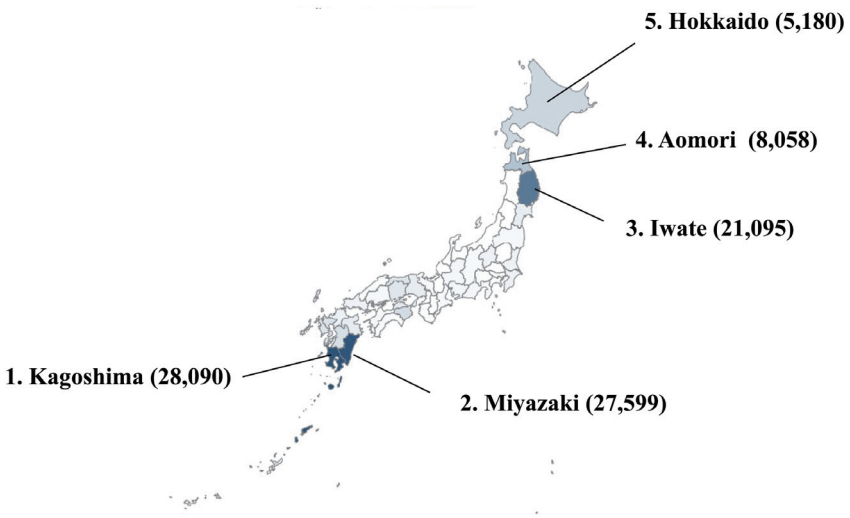


Fig. 7. **Top five prefectures in terms of broiler numbers in Japan**
(× 1,000 heads/year, as of February 1, 2022)

The number of Japanese quail is shown in Fig. 8. The total number of Japanese quails in Japan peaked at $7{,}129 \times 10^3$ in 1985 and gradually decreased thereafter. The location of Japanese quail farms is heavily concentrated in Aichi Prefecture, which contains approximately 60%–70% of the total number of Japanese quail in Japan. In 2021, the total number of Japanese quails was $3{,}819 \times 10^3$, of which $2{,}237 \times 10^3$ (58.6%) were located in Aichi Prefecture (Aichi Prefecture).

Poultry production other than chicken in Japan

Poultry production in Japan, other than chicken, is listed in Table 1. Duck, Japanese quail, pheasant, ostrich, guinea fowl, and turkey are listed in the "Report on the Management of Animal Hygiene 2021" to monitor and control highly pathological avian influenza. Except for the aforementioned Japanese quail, the number of non-chicken poultry in Japan is limited (MAFF 2022c).

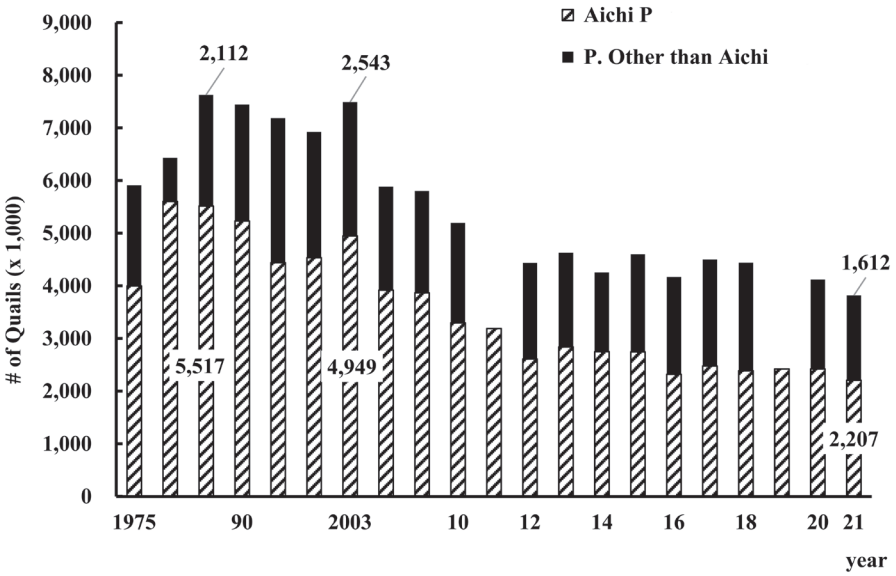


Fig. 8. **Japanese quail production in Japan**

Table 1. **Poultry production other than chicken in Japan**
(As of February 1, 2021)

Poultry	# of Farms	# of animals
Duck	797	262,457
Japanese Quail	456	3,819,011
Pheasant	222	45,538
Ostrich	152	4,249
Guineafowl	69	17,120
Turkey	113	2,442

2. Academic and educational contributions to the poultry industry in Japan

Sexing new born chicks

Sexing newborn chicks has been one of the top priority issues for both economic and ethical reasons, particularly in the layer industry. In this respect, April 1, 1925 should be remembered by everyone in the poultry industry as the day when a new chick sexing technique, termed "vent sexing", was presented by Drs. Kiyoshi Masui, Shigeo Hashimoto, and Isamu Ono at the inaugural meeting of the Japan Animal Science Association held in Tokyo, Japan. The authors observed that male chicks have a slight bump on their vent and an opening below the tail, which does not exist in female chicks (Masui *et al*., 1925).

By 1929, the first chick sexing association was established in Aichi Prefecture, which led to the development of the "National Association of Chick Sexers". Since then, skilled Japanese chick sexers have been sent worldwide to assist and train new chick sexers. Consequently, the vent-sexing technique is now widespread worldwide. Although many of these countries now educate their own chick sexers, Japanese chick sexers are still sent overseas every year. A detailed explanation of vent sexing and demonstration videos is available from HP of the Japan Poultry Science Association (JPSA).

Publication of poultry textbooks in the Japanese language

The first comprehensive poultry textbook was published in 1902 (Tsukita, 1902). This book consists of 16 chapters that cover almost all major areas of poultry science, including history, egg composition, hatching, chick management, physiology, nutrition, poultry barns, layer management, genetics and breeding, chicken breeds, evaluation, pathology, and surgery. In 1921, a 13 volume series of textbooks termed the "Poultry Science Lecture Series" on practical poultry management were published (Japan Poultry Research Society, 1921a-h). These invaluable efforts to publish textbooks that contributed to standardizing and upgrading the poultry industry in Japan are deeply appreciated.

Japanese native fowls

Many native chicken breeds are found throughout Japan, among which 17 are designated as "Natural Monuments of Japan" by the Japanese government (Table 2). Most of these breeds were likely brought into Japan several hundred or more than one thousand years ago from multiple places on the Eurasian Continent. Since then, phenotypes and other genetic characteristics were selected for various purposes, such as display, timekeepers, game fighters, and meat production. Pictures of the 17 Japanese fowls designated as "National Monuments of Japan" are available from Hiroshima University HP (Hiroshima University, 2010a).

Conservation of avian genetic resources

The mammalian system of genetic resource conservation pro-

Table 2. **Seventeen Japanese native fowls designated as National Monuments of Japan**

	Name of the Japanese Native Fowls	Year of designation as "Natural Monument of Japan"
1	Japanese Silkie (Ukkokei)	1942
2	Japanese Small Rumplessness (Uzura-Chabo)	1937
3	Japanese Brave (Kawachi-Yakko)	1943
4	Japanese Black (Kuro-Kashiwa)	1951
5	Japanese Good Crower (Koeyoshi)	1937
6	Kagoshima Game (Satsuma-Dori)	1943
7	Japanese Creeper (Jitokko)	1943
8	Japanese Elegancy (Shoukoku)	1941
9	Japanese Bantam (Chabo)	1941
10	Japanese Long Tailed Fowl (Tosa-no-Onagadori)	1923 *)
11	Japanese Red Crower (Toutenkou)	1936
12	Japanese Black Crower (Toumaru)	1939
13	Japanese Dainty (Hinai-Dori)	1942
14	Japanese Saddle Hackle Dragger (Minohiki)	1940
15	Japanese Small-sized Hackle (Minohiki-Chabo)	1937
16	Japanese Old Type (Jidori)	1941
17	Japanese Game(Shamo)	1941

*) Redesignated as "Special Natural Monument of Japan" in 1952
Pictures of 17 Japanese fowls are available from following URL: https://www.hiroshima-u.ac.jp/en/research/now/no27/no27_1

grams that uses cryopreservation of sperm and eggs cannot be applied directly to avian species, primarily because of the megalecithal nature of avian eggs. Therefore, an alternative method suitable for avian genetic conservation must be devised. Intensive research has shown that avian genetic resources can be conserved by using germ line chimera technology, which includes collection, culture, cryopreservation, and transplantation of germline stem cells, such as primordial germ cells (PGCs) and gonadal germ cells (see Tajima 2013 for review). It is now possible to conserve and retrieve poultry genetic resources by inseminating cryopreserved semen into female germline chimeras (Nakajima *et al*, 2022). Furthermore, the successful production of cross-species germline chimeras has been reported (Li *et al*., 2002; Liu *et al*., 2012). In addition, genome-edited chickens have been produced using germline chimera technology (Oishi *et al*, 2016). A wide range of technologies are now available to conserve, proliferate, and genetically modify avian genetic resources.

Institutional efforts to conserve poultry genetic resources

The development of germline chimera technology together with semen cryopreservation technology (see Tajima 2013 for review) has enabled the conservation of genetically important poultry breeds and foundation stocks at various levels.

National government level

The National Agriculture and Food Research Organization, Japan (NARO) GeneBank project conserves a wide range of agricultural genetic resources, including poultry. As of December 1, 2022, 65 chicken lines have been registered in GeneBank under the keyword "chicken", among which frozen semen and frozen PGCs are stored in 44 lines and 1 line, respectively (NARO).

The National Livestock Breeding Center, Japan (NLBC) maintains and improves breeder stocks to promote the development of original Japanese commercial lines. The NLBC Hyogo Station is in charge of meat-type chickens (NLBC, 2022a), whereas the NLBC Okazaki Station (NLBC, 2022b) is in charge of layer chickens.

Local government level

In many cases, local government poultry experimental facilities belong to prefectural agricultural experiment stations (PAES). In these poultry experimental facilities, a wide range of management technologies for layer and/or broiler chickens are constantly tested, modified, and disseminated to local poultry farms through the extension system of the PAES. In addition, the aforementioned 17 Japanese native chicken breeds, designated as "National Monuments of Japan," are maintained at the prefectural poultry experimental facilities for industrial use and risk management purposes. Many local poultry brands have been established by introducing the genetic characteristics of these native chickens into commercial lines.

University level

Nagoya University, Avian Bioscience Center (ABRC)

The ABRC was founded in 2007 and adopted into the core facility upgrading program of the National BioResource Project in 2012. The center conducts the collection, preservation, and provision of chicken and quail resources (Nagoya University).

Hiroshima University, Japanese Chicken Resource Development and Research Center

The Japanese Chicken Resource Development and Research Center was founded in 2010 (Hiroshima University, 2010b). The

center conducts research on the preservation and genetic analysis of Japanese native chickens (Nihonkei) to improve and stabilize the supply of quality poultry products (Hiroshima University, 2010a).

Shell-less culture of avian embryos

The development of avian embryos *in ovo* during incubation until hatching remains largely unexplored, primarily because of the inability to observe developing embryos through non-transparent eggshells. A normal quail chick successfully hatched from a complete shell-less culture system (cSLCS), which uses opaque polytetrafluoroethylene wrap as an artificial shell membrane (Kamihira *et al,* 1998). In this system, embryo development is observed from the top of the culture system; however, the vascular system that develops along the side of the culture system is not visible. More recently, the successful hatching of normal chicks from cSLCS, which uses transparent polymethylpentene wrap, has been reported (Tahara and Obara 2014; Tahara and Obara 2021). Even though the hatchability of the cSLCS remains low, it may be used to continuously monitor the phenotypic outcome of experimental treatments from any direction throughout the incubation period until hatching.

3. Historical and cultural aspects of poultry in Japan

The role of poultry as a livestock has been considerably different from that of its mammalian counterparts in many respects, which are primarily used for meat, dairy, and/or draft purposes. Historically, the fowl, particularly roosters, have been given a special status in many regions of the world. Fowl carry with them a certain mystique with their high-pitched crowing and are viewed as sacred, acting as a symbol for the end of the terrifying and dangerous sightless night and the announcement of the dawn (Okamoto, 2001). In addition, they have been used in cockfighting rituals (Okamoto, 2001). From an industrial viewpoint, the Japanese poultry industry has constructed a highly sophisticated supply chain to meet very high sanitary standards. This section discusses the historical and cultural aspects of poultry in Japan.

Eating raw eggs

Raw eggs are abundant in proteins, fats, vitamins, minerals, and antioxidants that protect human eyes, brain, and heart (USDA Food Data Central, USA, 2019).

However, the "avoidance of eating raw eggs" is a common consensus in most parts of the world to prevent *Salmonella* infection, which causes diarrhea, fever, and stomach cramps (Litin, 2018).

In this respect, when Rocky Balboa (Sylvester Stallone) cracked four eggs into a cup and "drank" it in the famous movie film "Rocky" (Rocky, 1976), typical responses of audiences who watched the scene were "unbelievable" or "skeptical" on whether the actor really "drank" it. Even today, more than 40 years after the release of "Rocky," the Centers for Disease Control (CDC) and Prevention of the US government warns consumers to handle and cook eggs properly to prevent *Salmonella* infection (CDC, 2023). In broilers, *Salmonella* percent positive for routine sampling on FY2022 Q2 of comminuted chicken, mechanically separated chicken, and young chicken are 24.8%, 86.2%, and 50.9%, respectively (USDA-FSIS, 2022). In Europe, the European Food Safety Authority (EFSA) announced a "Multi-country outbreak of *Salmonella enteritidis* sequence type (ST11) infections linked to eggs and egg products" on February 8, 2022 (EFSA, 2022). In this report, an increase in *Salmonella enteritidis* infections among EU countries was documented. By January 11, 2022, 272 confirmed cases had been reported in five European Union/European Economic Area (EU/EEA) countries and the United Kingdom (UK) for 2021: Denmark (n = 3), France (n = 216), the Netherlands (n = 12), Norway (n = 7), Spain (n = 22), and the UK (n = 12). Two deaths were recorded in adult men. Twenty-five patients were hospitalized and sixty patients reported the consumption of eggs/egg products.

However, those who have visited and spent time in Japan might have encountered eating raw eggs as a topping of dishes, such as a hot bowl of buck wheat noodles (Tsukimi-Soba). The word "Tsukimi" is a combination of two words, "Tsuki" (moon) + "mi" (viewing), which indicates the action of people to enjoy viewing the beautiful full moon. Therefore, "Tsukimi-Soba" is the resemblance of raw egg topping on a hot bowl of buckwheat noodles as a metaphor for the full moon.

Another example of eating raw eggs is Sukiyaki, where thinly sliced beef is boiled in a dashi soup with vegetables and is eaten after dipping it into a small bowl of raw, beaten eggs. The ultimate way of eating raw eggs is Tamago-kake-gohan (TKG: literally "egg topping rice"), which is a bowl of rice topped with raw eggs and a few drops of soy sauce. This is indeed a comfort food and is an all-time favorite recipe for many Japanese people. TKG is a typical and important component of breakfast when staying at a traditional Japanese-style hotel.

These examples indicate that raw eggs are an indispensable component of the Japanese cuisine.

The question arises then as "Aren't there any concerns of *Salmonella* infection when eating raw eggs in Japan?". As shown in Fig. 9, the proportion of *Salmonella* infections due to egg and egg products against the total number of *Salmonella* infections is between 10%–20% before 2000, but it continually decreases afterwards. In 2015, there were no reported incidences of *Salmonella* infection due to eggs and egg products and the incidence has been sporadic since then (The Ministry of Health, Labour and Welfare, Japan; MHLW, 2022).

On June 14, 2021, MAFF released a report on *Salmonella* contamination of retail eggs and layer chickens in Japan. Packaged eggs, containing 20 shelled eggs per package, were purchased from 1,870 retail stores throughout the country in 2020 (Fig. 10). Levels of *Salmonella enteritidis* detected from the eggshell surface and egg contents are 0.3% (6/1,870) and 0.05% (1/1,870), respectively (MAFF, 2021).

As you can see from these data, the sanitary conditions of the egg supply chain in Japan (i.e., egg farms, GP centers, storage and transportation systems, retail stores, and consumers) have achieved a very high standard of controlling infectious pathogens. Rather, supplying *Salmonella enteritidis*-free eggs is oblig-

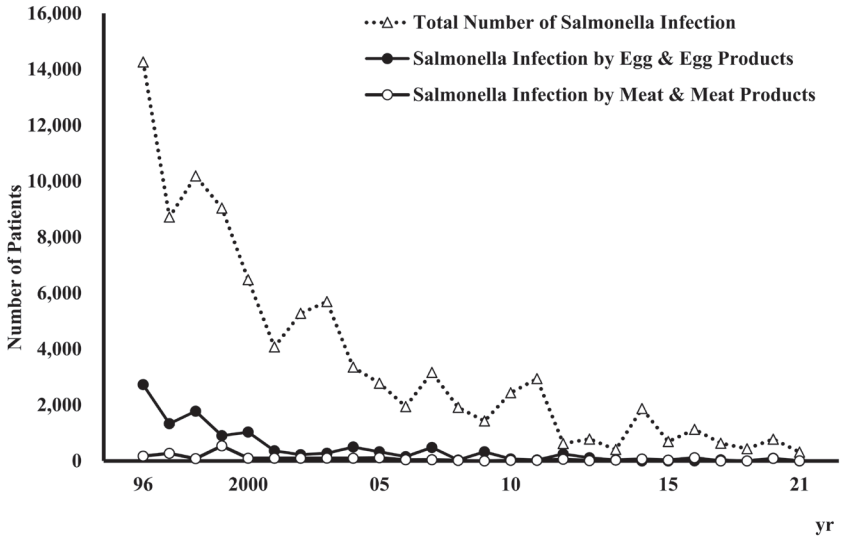


Fig. 9. ***Salmonella*** **infections caused by eggs and egg products in Japan**

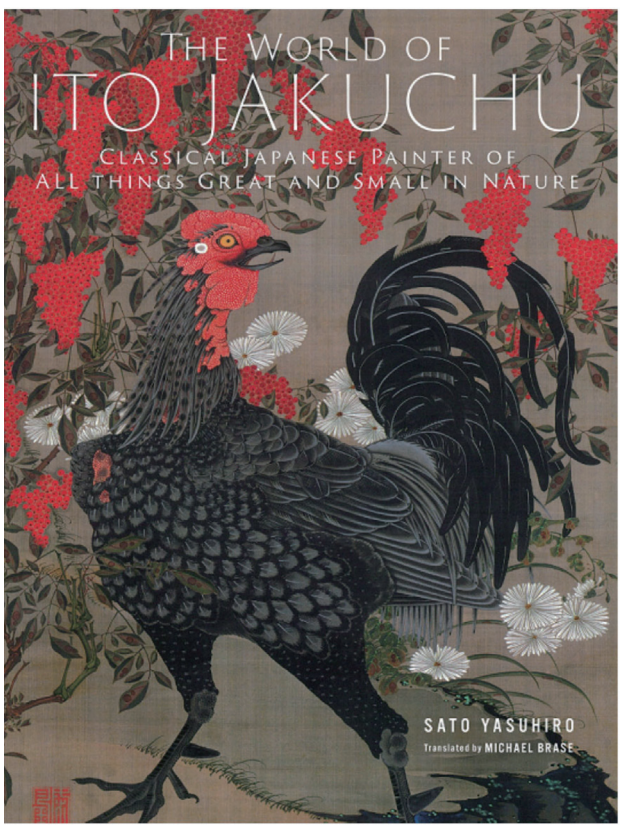


Fig. 10. The world of Ito Jyakuchū

atory for egg producers and retail stores in Japan.

In 2020, 1.4% (10,587,960/734,944,698) of broilers were discarded during slaughterhouse inspections in Japan (MHLW, 2020). The top three reasons were as follows: 1. *Escherichia coli* infection (38.8%); 2. emaciation (18.8%); 3. ascites formation (15.8%). *Salmonella enteritis* was detected in 25 birds (0.0%) (MHLW, 2020). It should be stressed that successful control of infectious diseases, such as *Salmonella enteritis*, has been a large challenge in Japan, which is geographically located in moderate to subtropical weather zones with high humidity.

Under warm and humid environments, the necessity of controlling microbial infection is not limited to *Salmonella enteritis*, but rather to a wide variety of infectious diseases that result in economic losses, adverse AW, and food safety (i.e. *Staphylococcus aureus*).

Symbolic, ritualistic, mythic, and artistic attributes of poultry in Japan

Ho-Oh (phoenix) as a symbol of peace

Sculptures or paintings of Ho-oh are found in many places in Japan, including the Ho-Oh-Do Hall (Phoenix Pavilion) of Byo-Do-In Temple in Kyoto and the Royal Palace in Tokyo. The most profound example in Japan is Takamikura (the Emperor's seat and its housing), which is solely used at the Enthronement Ceremony of the Emperor and is decorated with Ho-Oh on the rooftop of Takamikura. Takamikura was most recently used on October 22, 2019, when His Majesty the Emperor Naruhito (the 126th Emperor) ascended to the throne (Prime Minister's Office of Japan, 2019).

The contest of long-crowing fowl

A contest for long-crowing fowl is held in many places in Japan. Among the 17 native Japanese breeds of chickens, Koeyoshi, Toutenkou, and Tomaru are famous for their ability to crow for an extended time, and are called "Three major long-crowing chicken breeds." A contest for long-crowing chickens is held periodically by chicken lovers, such as at Yahiko Shrine in Niigata (Yahiko Shrine, 2017).

Recently, the secret of the rooster crowing order to announce the break of the dawn has been studied; the highest-ranking rooster has priority to announce the break of dawn (Shimmura *et al*, 2015).

Long-crowing fowls in the "Kojiki" (a record of ancient matters)

Regarding written materials, an interesting and unique description is found in Chapter 17 of the Kojiki (Records of Ancient Matters), Japan's oldest book, written by Oh-No-Yasumaro in the 8th century. In this book, early Japanese chronicles of myths and semi-historical events are described.

A story of a long-crowing fowl is as follows: "At this time, AMA-TERASU-OPO-MI-KAMÏ (God Sun), seeing this, was afraid, and opening the heavenly rock-cave door, went in and shut herself inside. Then TAKAMA-NÖ-PARA was completely dark, and the Central Land of the Reed Plains was entirely dark. Because of this, constant night reigned, and the cries of the myriad deities were everywhere abundant, like summer flies; and all manner of calamities arose. Then the eight-hundred myriad deities assembled in a divine assembly in the river-bed of the AMË-NÖ-YASU-NÖ-KAPA. They caused the child of TAKAMI-MUSUBI-NÖ-KAMÏ, OMÖPI-KANE-NÖ-KAMÏ, to ponder. They gathered together the long-crying birds of Toko-yo and caused them to cry." (Oh-No-Yasumaro 712). Thus, long-crowing fowl were given a critical mythic role in the Kojiki.

Another approach is to develop a database of the Kojiki and quantitatively analyze the attributes of this publication. Accordingly, a database of the Kojiki was developed, and the frequency of animal names appearing in the text (in Chinese characters) was counted and ranked (Table 3). The most frequently used animal name in the Kojiki was "Tori (bird)" (43 times). Furthermore, the most frequently used combination word containing "Tori" was AMË-NÖ-TÖRI-PUNE (four times), which is a bird-vehicle that conveyed the heavenly deities from one place to another. These data suggest that birds have been given special symbolic status in Japan since ancient times.

Goryo Ukai (Imperial cormorant fishing)

Goryo Ukai (Imperial cormorant fishing) on the Nagara River, Gifu, Japan, is another interesting example. Every year, from mid-May to mid-October on the Nagara River in Gifu Prefecture, a 1300-year tradition of cormorant fishing is conducted that has been passed down through the ages and preserved by the Imperial Family as Goryo Ukai (Imperial cormorant fishing). However, protection of the feudal lords ended with the Meiji Restoration and the ancient practice of cormorant fishing was in danger of extinction. Thus, in 1890, based upon a request from the Governor of Gifu Prefecture, the Imperial Household Ministry appointed a number of Imperial cormorant fishermen and established three fishing sites on the Nagara River for Goryo Ukai, which resulted in the continuation of the ancient fishing art (Goryo Ukai. Another example indicates that poultry are gracious beings in Japan.

Painting

Itō Jakuchū (1716–1800) was a well-known Japanese painter in the mid-Edo period (Sato 2020). Many of his paintings concern traditional Japanese subjects, particularly chickens and other birds (Fig. 10). He drew numerous chicken paintings and his representative paintings include: "Rooster and Hen with Hydrangeas," "Old Pine Tree", and "White Phoenix", part of the series Dōshoku sai-e.

Everyone who appreciates chicken paintings by Jakuchū is fascinated by the very sensitive and fine touch of his works.

Table 3. **Frequency of animal names that appear in the "Kojiki" (712 AD)**

Animal	# of Appearance
Bird	43
Horse	34
Sparrow	34
Wild boar	30
Deer	17
Cattle	9
Monkey	9
Snake	7
Insect	7
Elephant	1

Tajima (Original)

Conclusions

In this review, poultry in Japan are illustrated from the following three historical viewpoints: 1) development of the Japanese poultry industry, 2) academic and educational contributions to the poultry industry in Japan, and 3) ritualistic, mythic, and artistic attributes of poultry that are deeply embedded in Japanese society.

From an industrial perspective, constant improvement in productivity is essential to maximize profit. In this respect, the Japanese poultry industry grew after WWII, initially by introducing a systematic Western poultry management system and subsequently by continuous technical renovation.

Simultaneously, considerable institutional efforts have been made to conserve the 17 Japanese native chicken breeds designated as "National Monuments of Japan." Many local poultry brands have been established by introducing the genetic characteristics of these native chickens into commercial lines.

Another prominent aspect of poultry in Japan is its symbolic attributes, which are deeply embedded in Japanese society.

Poultry science in Japan should be directed toward establishing an original poultry management system that is profitable and inherits the long-standing poultry heritage.

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Conflicts of interest

The authors declare that there are no conflict of interests.

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