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Pathology

Chronological transition of necropsy cases of animals in Tokyo, Japan

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ABSTRACT. There is no nationwide necropsy database of animals in Japan, and most of the records are available from the postwar period. To clarify the chronological transition of animal necropsy cases in Tokyo, Japan, the records accumulated in The University of Tokyo from 1902 were investigated. Of necropsy records on paper or electronic from 1902 to 2021 kept at the Laboratory of Veterinary Pathology, The University of Tokyo, totally 3,137 cases including 572 in 1903–1914 (the Meiji-Taisho period), 1,258 in 1956–1969 (the Showa period) and 1,307 in 2006–2020 (the Heisei-Reiwa period), respectively, were examined for species, breed, age and pathological diagnosis. Dogs (44.6%) and horses (34.8%) in the Meiji-Taisho period, dogs (62.9%) and cats (17.3%) in the Showa period, and dogs (46.0%), cats (26.1%) and exotic animals (20.5%) in the Heisei-Reiwa period were the most necropsied animal species. With the passage of time, the number of animal species increased, and the breeds of dogs and cats came to be more various. The median ages of death were 2 years, 3 years and 10 years old in dogs in the Meiji-Taisho, Showa and Heisei-Reiwa periods, respectively, and 2 years and 10 years old in cats in the Showa and Heisei-Reiwa periods, respectively. Viral, bacterial and parasitic infections were decreased, and inversely tumor cases increased due to the prolonged lifespan.

KEYWORDS: animal, cause of death, chronological transition, Japan, necropsy case

Inoue *et al*. [5] recently analyzed the cause of death in dogs using data from pet cemeteries in Tokyo area and reported that senility was the most common cause of death, followed by neoplastic, cardiovascular and urinary diseases. In addition, the odds ratio for death obtained from the data [5] was significantly higher in Labrador Retriever and Shiba, as well as aged dogs, and significantly lower in Chihuahuas, indoor dogs and castrated or spayed dogs. They [4] also examined the data from pet cemeteries for the longevity of dogs and found that the overall life expectancy was 13.7 years, a 1.67-fold increase from 8.6 years in the past 30 years. The life expectancy of cross breed dogs (15.1 years) was significantly longer than purebreds (13.6 years), and there was no sex difference (females 13.5 years, males 13.6 years). Among dog breeds, Shiba had the longest median age of death (15.7 years) and life expectancy (15.5 years), and French Bulldog had the shortest median age of death and life expectancy (both 10.2 years).

They [6] also examined medical record data from 40 veterinary hospitals in Japan and revealed the average life expectancy was 13.6 years in dogs and 12.3 years in cats. The most common cause of death in dogs was neoplasia (18.4%), followed by cardiovascular diseases (17.4%) and urinary diseases (15.2%). In contrast, that in cats was urinary diseases (29.4%), followed by neoplasia (20.3%) and cardiovascular diseases (11.8%).

A report published in the United Kingdom [9] revealed that the most commonly reported causes of death in dogs were old age (=senility) followed by unspecified cancers and heart failure as reported in Japan. Overall median age at death was 10.33 years, and the breed that had the longest median longevity was the West Highland White Terrier (12.71 years) and the shortest was the Dobermann Pinscher (7.67 years). The results indicated the longer lifespan in dogs in Japan than that in the UK. However, studies [1, 7, 11] on the longevity of dogs and cats in Japan and UK including abovementioned reports [4–6, 9], analyzed only records obtained since 1990. To our knowledge, there is only 2 epidemiological studies on the expectation of life for dogs [2] and cats [3] in Japan before 1990, in which the authors revealed the expectation of life of the dog at age 1 was 8.6 years [2], and that of the cat was 5.0 years [3], respectively.

Regarding accumulated records on human autopsy cases, the Japanese Society of Pathology has collected autopsy data performed in Japan since 1958 and has published as "Nihon Byouri Bouken Shuuhou (Annual of the Pathological Autopsy Cases of Japan)" [12].

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In the field of veterinary medicine, however, there has been no such nation-wide necropsy database in Japan, as neither world-wide. To our knowledge, only some veterinary schools or institutions in Japan have accumulated such records, whereas most of them were obtained probably since the middle of 20th century (after the World War II). However, necropsy records have been accumulated even since 1902 in the Laboratory of Veterinary Pathology, The University of Tokyo, because the veterinary school is the oldest one in Japan. We then analyzed the records to elucidate a chronological transition of necropsy cases of animals in Tokyo, Japan.

MATERIALS AND METHODS

Necropsy records written on paper or kept electronically from 1902 to 2021 in the Laboratory of Veterinary Pathology, Graduate School of Agricultural and Life Sciences, The University of Tokyo, were examined regarding animal species, breed, age and pathological diagnosis. Among the records, total 3,137 cases including 572 necropsied between 1903 and 1914 (the Meiji-Taisho period), 1,258 between 1956 and 1969 (the Showa period), and 1,307 between 2006 and 2021 (the Heisei-Reiwa period) were totally examined. Final diagnoses of the necropsied cases were determined basically with the histopathological diagnosis, or with the gross diagnosis in cases without histopathological examination. In cases without any description of diagnosis or with more than 2 diagnoses, the final fundamental diagnosis was obtained by reconsidering the pathological findings.

A commercial software (IBM SPSS Statistics, Version 27.0, Armonk, NY, USA) was used for the statical analyses. To confirm the normal distribution of age at death in dogs and cats, Kolmogorov-Smirnov test was performed. Then, to compare the median ages of death among the periods in dogs, Kruskal-Wallis *H*-test and Mann-Whitney *U*-test with Bonferroni correction were used. To compare those in cats, Mann-Whitney *U*-test was performed. Statistical significance was set at $P<0.001$.

RESULTS

The ratios of animal species necropsied were summarized in Fig. 1. The ratio of dogs was 44.6% of the total necropsy cases and followed by horses (34.8%), goats (6.3%), and chicken (4.7%) in the Meiji-Taisho period. Only 3 cats (0.5%) were necropsied in the period. The ratio of dogs was increased to 62.9% and followed by cats (17.3%) in the Showa period. The ratios of dogs and cats were 46.0% and 26.1%, respectively, and followed by exotic animals (20.5%) in the Heisei -Reiwa period. The more numbers of animal species and more various breeds of dogs and cats were necropsied in more recent periods (Figs. 1 to 6, and Table 1).

The median ages of death of the animals necropsied were 2, 3 and 10 years in dogs in the periods of the Meiji-Taisho, Showa and Heisei-Reiwa, respectively, and 2 and 10 years in cats in the periods of the Showa and Heisei-Reiwa, respectively, becoming significantly older as the times went down (Figs. 7 and 8). Significant differences were observed in the median ages of death among the three period groups in dogs, and between the two periods in cats.

Pathological diagnoses of the dogs and cats were indicated in Figs. 9 and 10, respectively. The number of cases affected with infectious diseases including parasitic diseases that had been high in the periods of the Meiji-Taisho and Showa, were drastically decreased in the Heisei-Reiwa period, but that of tumor cases were inversely increased (Figs. 9 and 10, Tables 2 and 3). Beside tumors, degenerative and chronic inflammatory diseases (indicated as “Others” in the Figures) were recorded to be 24.7%, 35.7% and 53.2% in dogs in the Meiji-Taisho, Showa and Heisei -Reiwa periods, respectively (Fig. 9), and 44.5% and 49.1% in cats in the Showa and Heisei -Reiwa periods (Fig. 10), respectively. Individual diseases were indicated in Tables 2 and 3. Diagnoses of horse cases in the Meiji-Taisho period were shown in Table 4. Infectious diseases occupied about a half of the necropsied cases.

Diagnoses of samples from slaughterhouses in Tokyo area was shown in Fig. 11. Approximately half of the samples of cows, horses and pigs were diagnosed as infectious diseases including tuberculosis, bacterial pleuropneumonia and parasitic diseases in the Meiji-Taisho period.

Ratio of dogs infested with parasites including filaria and enteric parasites were drastically decreased from the Meiji-Taisho period to the Heisei-Reiwa period (Table 5). That of cats were also decreased from the Showa period to the Heisei-Reiwa period (Table 6).

DISCUSSION

In the records examined in the present study, there were many pathological necropsy cases of dogs and horses in the Meiji-Taisho period, and cases of dogs and cats in the Showa period, when economic status in Japan grew higher, and in the Heisei-Reiwa period. The number of necropsied species including exotic and zoo animals also increased in the Heisei-Reiwa period because a more variety of animal species have come to be reared as pets [1, 7]. Various breeds of dogs and cats also came to be bred in the Showa and Heisei-Reiwa periods [1, 7].

The ages of dog and cat cases necropsied have increased with time. The median ages of the dogs were 2 years, 3 years and 10 years old in the Meiji-Taisho, Showa, and Heisei-Reiwa periods, respectively, and those of the cats were 2 years and 10 years, in the Showa and Heisei-Reiwa periods, respectively. One of the reasons was the extended lifespan of pet animals [4] due to the progression of veterinary medicine such as breeding techniques, environmental hygiene, and spread of vaccines. The result on the age of death obtained in the present necropsy study was comparable to those in some reports published in Japan [1–7] and in some other countries [9, 11], which were calculated using data from an insurance company [1], a pet food association [7], animal cemeteries [2–5], or veterinary hospitals [6].

The number of cases with infectious diseases decreased and instead that of tumor cases increased in both dogs and cats when compared cases of the Heisei -Reiwa period with those of either Meiji-Taisho or Showa periods. The number of cases suffered from

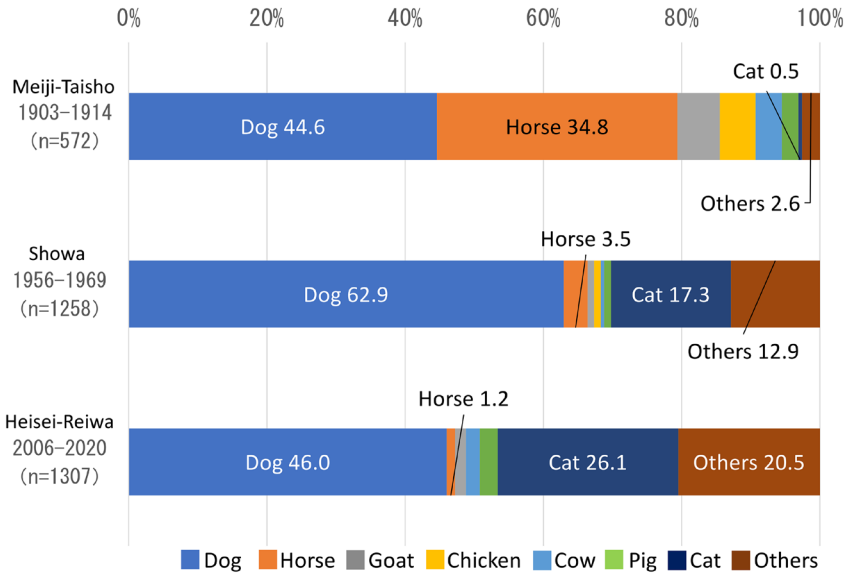

Fig. 1. Transition of animal species necropsied.

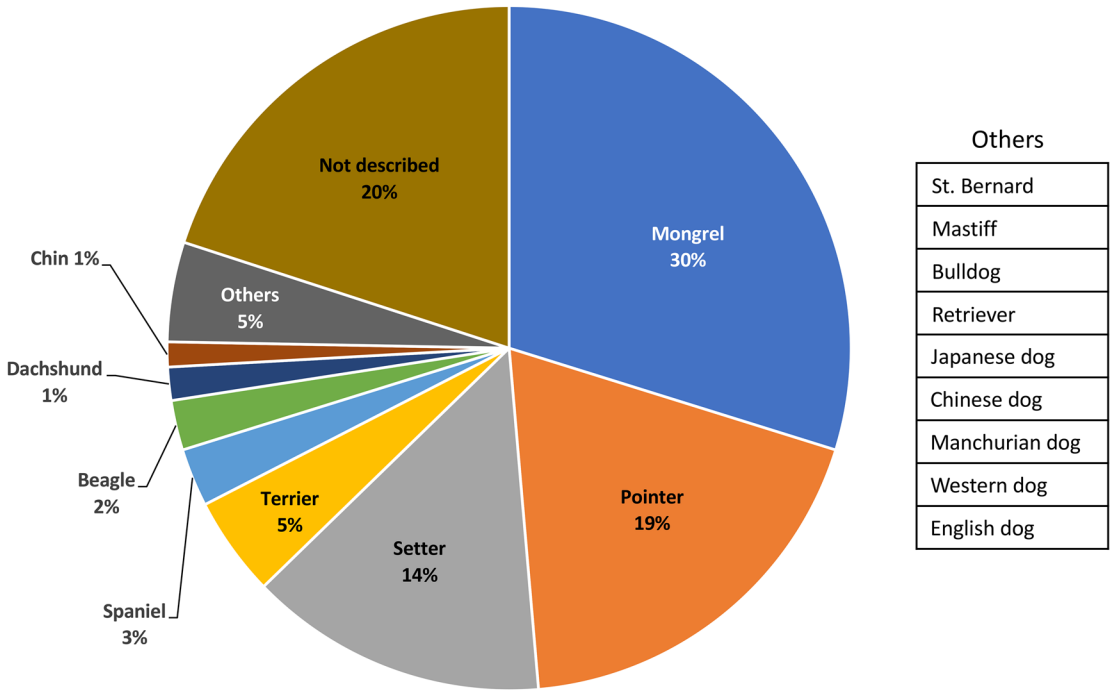

Fig. 2. Dog breeds necropsied in the Meiji-Taisho period (1903 to 1914). n=255.

parasitic infections was greatly reduced due to the improvement of the rearing environment, development of antiparasitic drugs and widespread use of vaccines. The number of viral and bacterial diseases were also decreased due to the same reasons. Instead, the number of tumor cases were increased in the Heisei-Reiwa period due to the prolonged lifespan of dogs and cats.

From the results of the present chronological study regarding necropsy records in Japan, historical backgrounds and social situations in each period can also be glimpsed. In the Meiji-Taisho period, namely 1900 to early 1910, most of the dogs necropsied were Western hunting breeds such as Setters and Pointers, and their owners belonged to a wealthy class population like aristocrats or successful businesspeople. There were very few pet cats, but could be many stray cats, accordingly very small number of cats were necropsied in the period. Most of the necropsy cases of the horse were requested by the army that reared the predominant number of horses at the Meiji-Taisho period. There were a considerable number of dogs suspected of rabies in the period because of still high incidence of rabies in Japan [8]. A significant number of cattle suffered from tuberculosis and a lot of horses and pigs were affected with parasitic

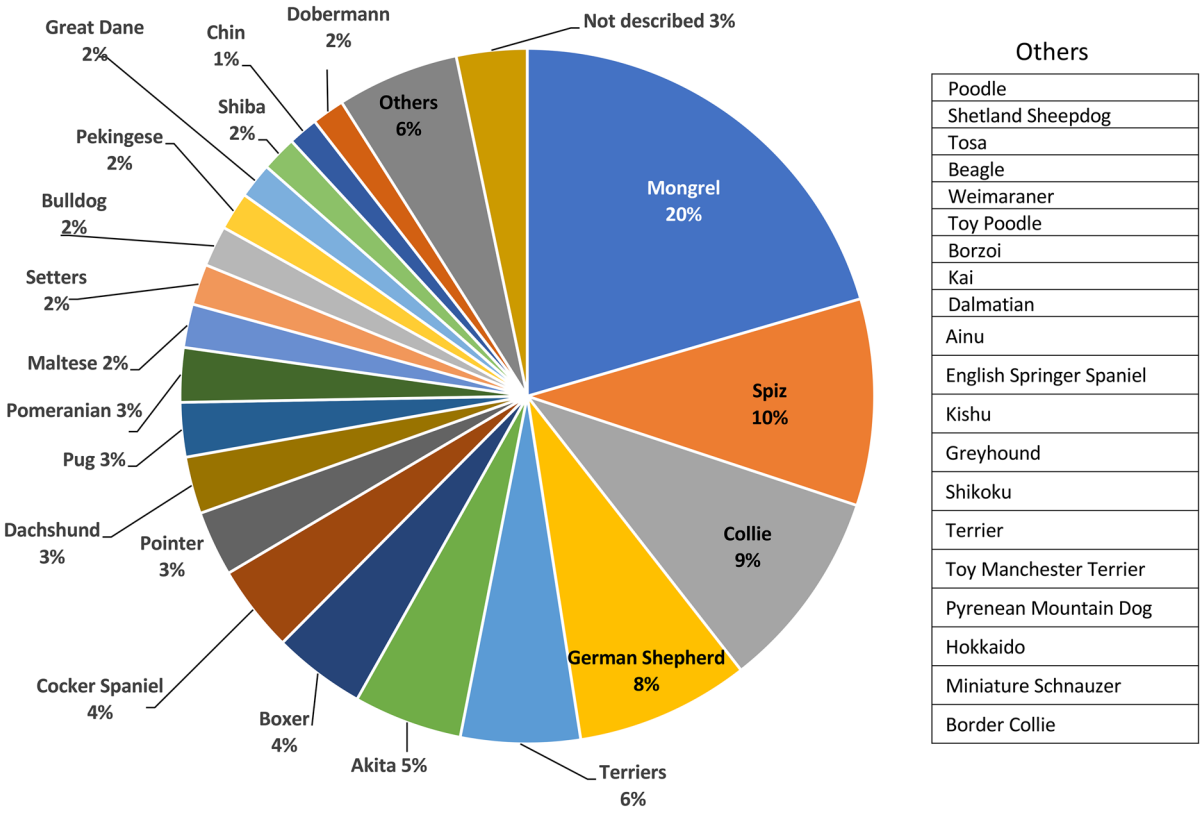

Fig. 3. Dog breeds necropsied in the Showa period (1956 to 1969). n=791.

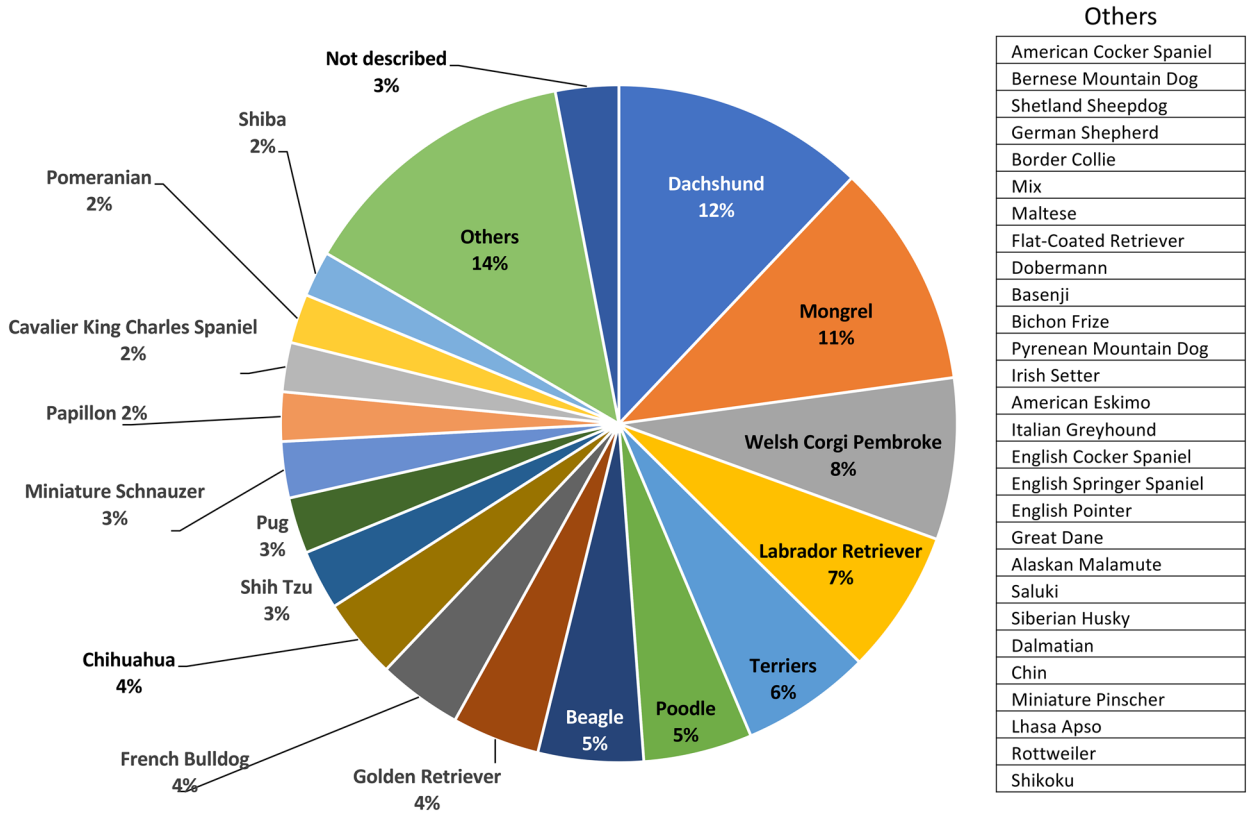

Fig. 4. Dog breeds necropsied in the Heisei-Reiwa period (2006 to 2020). n=596.

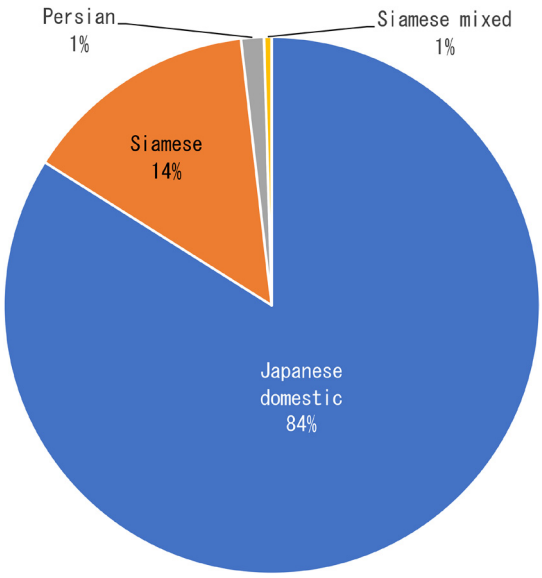

Fig. 5. Cat breeds necropsied in the Showa period (1956 to 1969). n=218.

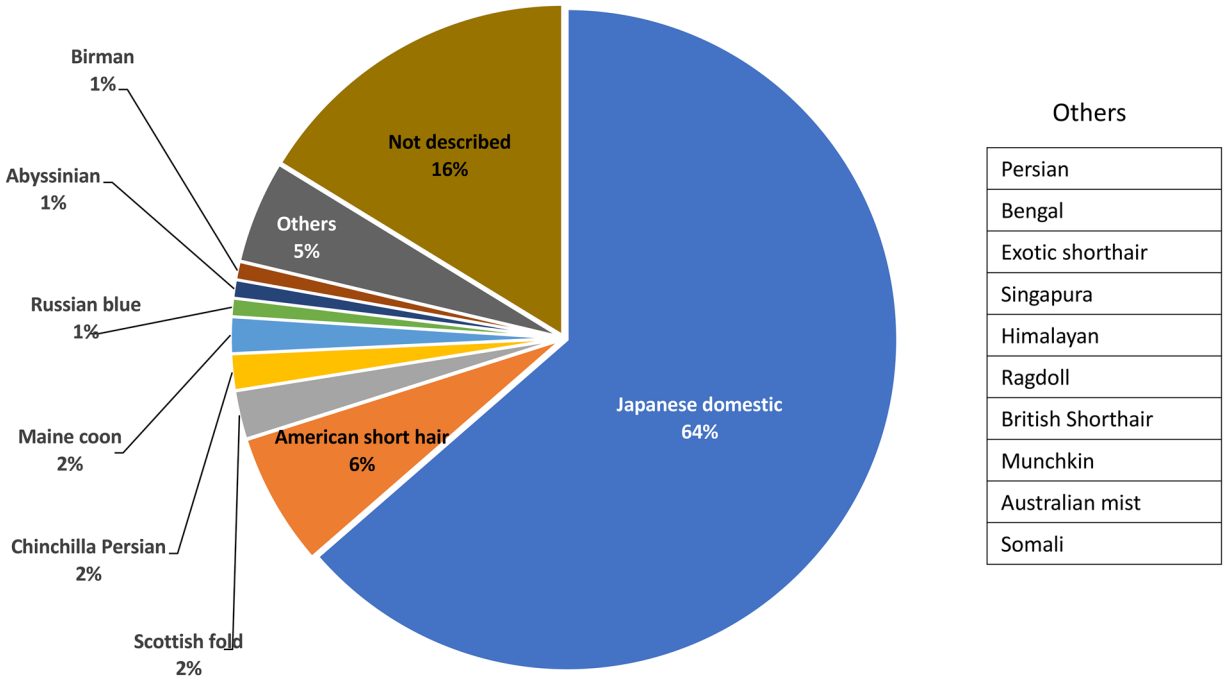

Fig. 6. Cat breeds necropsied in the Heisei-Reiwa period (2006 to 2020). n=338.

infections, which were detected at slaughterhouses.

From the Showa period that was included in the term of the postwar high economic development in Japan to the present Heisei-Reiwa period, namely 1956 to 2020, the number of dogs [1, 7, 10] and cats [1, 7] reared has increased, and their breeds have become more various, because the number of nuclear families has risen in Japan and considerable number of them tended to rear pet animals during the period. In addition, the longevity of dogs and cats has extremely extended during these periods.

In the present study, chronological transition of necropsy cases of animals in Japan was clarified. The records examined in the study are extremely valuable to know the social background at each era as well as history of veterinary pathology in Japan. Further studies to compare the present results with those in foreign countries or with the results of similar analyses concerning human autopsy records, will be performed by using the present results.

Table 1. Other animal species necropsied

Years	Animal species
Meiji-Taisho 1903–1914	[Mammals] Sheep 6, Bear 4, Rabbit 1, Guinea pig 1. [Birds] Domestic goose 1, Turkey 1.
Showa 1956–1969	[Mammals] Weasel 14, Mage sika deer 8, Axis deer 6, Fur seal 3, Desert warthog 3, Kangaroo 3, Hokkaido sika deer 3, African green monkey 3, Japanese macaque 3, Hippopotamus 2, Cheetah 2, Tapir 2, Beaver 2, Mink 2, Fox 2, Yaku sika deer 2, Deer 2, Crab-eating macaque 2, Taiwan macaque 2, Monkey 2, Rhinoceros 1, Black rhinoceros 1, Sea lion 1, American bison 1, Rabbit 1, Clouded leopard 1, Galago 1, Spotted seal 1, Genet 1, Agile wallaby 1, Pangolin 1, Elephant 1, Elephant seal 1, Gnu 1, Gray fox 1, Puma 1, Bengal tiger 1, Camel 1, Llama 1, Donkey 1, Barbary sheep 1, Pigtail macaque 1, Woolly monkey 1, Chimpanzee 1, Rhesus macaque 1, Mona monkey 1, Gelada baboon 1, Lion tamarin 1, Cotton-top tamarin 1, Gibbon 1. [Birds] Mandarin duck 15, Rock dove 6, Northern pintail 4, Spot-billed duck 4, Eurasian wigeon 4, Baikal teal 2, Night heron 2, Great egret 2, Malabar pied hornbill 2, Common teal 1, Mallard 1, Falcated duck 1, Gadwall 1, Bean goose, Canada goose 1, Snow goose 1, Greater white-fronted goose 1, Palawan peacock-pheasant 1, Common pheasant 1, Ostrich 1, Japanese crested ibis 1, Steller's sea eagle 1, Swan 1, Peafowl 1. [Reptiles] Iguana 1, Indigo snake 1.
Heisei-Reiwa 2006–2020	[Mammals] Hedgehogs 21 (Hedgehog 13, Four-toed hedgehog 8), Ferret 18, Primates 17 (Japanese macaque 3, Slow loris 3, Pygmy marmoset 2, Mandrill 2, Abyssinian colobus 1, Crested macaque 1, Common marmoset 1, De Brazza's guenon 1, Bornean orangutan 1, Bolivian squirrel monkey 1, Lesser slow loris 1), Hamsters 10 (Hamster 4, Djungarian hamster 3, Golden hamster 2, Chinese hamster 1), Lion 10, Capybara 6, Mouse 5, California sea lion 4, Kangaroo 4, Guinea pig 4, Asian short-clawed otter 3, Reindeer 3, Prairie dog 3, Degu 3, Rat 3, Steller sea lion 2, Seal 2, Meerkat 2, Chinchilla 2, Amami rabbit 1, Raccoon 1, Egyptian fruit bat 1, Australia sea lion 1, Bighorn sheep 1, Oryx 1, Mongolian gerbil 1, Spotted seal 1, Common treeshrew 1, Walrus 1, Harbor seal 1, Russian flying squirrel 1, Tasmanian devil 1, Raccoon dog 1, Cheetah 1, Tsushima leopard cat 1, Tiger 1, Fossa 1, Sugar glider 1, Bengal tiger x White tiger 1, Eurasian wolf 1. [Birds] Rock dove 7, Ostrich 4, Tree sparrow 3, Humboldt penguin 3, Penguin 2, Java sparrow 2, Emu 1, King penguin 1, Cockatiel 1, Oriental turtle dove 1, White stork 1, Peach-faced lovebird 1, Chinese bamboo partridge 1, Barred parakeet 1, Turkey 1, Bengalese finch 1, Budgerigar 1, Bird 1, Satyr tragopan 1, Broad-billed roller 1, Green-winged macaw 1, White-necked crane 1, Pacific parrotlet 1, Snowy owl 1, Falcon 1, Ural owl 1, Barn owl 1, Eurasian eagle owl 1. [Reptiles] Leopard gecko 4, Ball python 3, Central bearded dragon 3, California kingsnake 2, Bluetongue skink 1, Olive python 1, Turtle 1, Crested gecko 1, Savannah monitor 1, Western hognose snake 1, Fat-tailed gecko 1, Soft-shelled turtle 1. [Amphibians] Axolotl 8, Frog 2, Salamander 1, Cranwell's horned frog 1, Japanese tree frog 1.

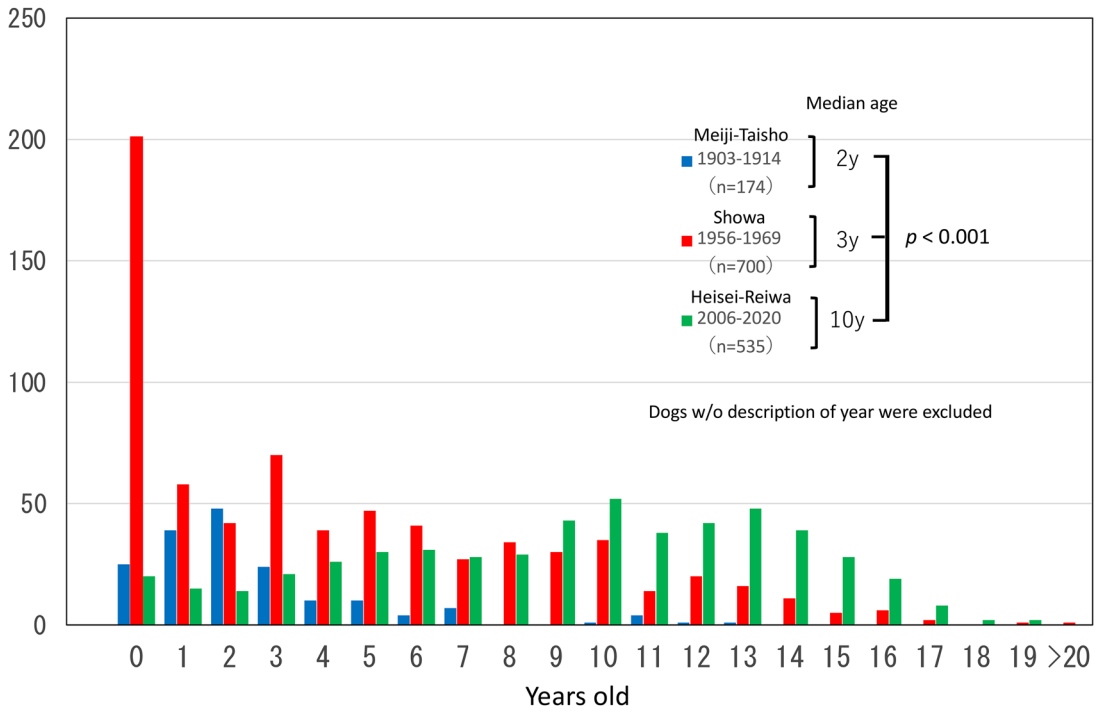

Fig. 7. Age distribution of necropsied dogs. Dogs without any description of years were excluded.

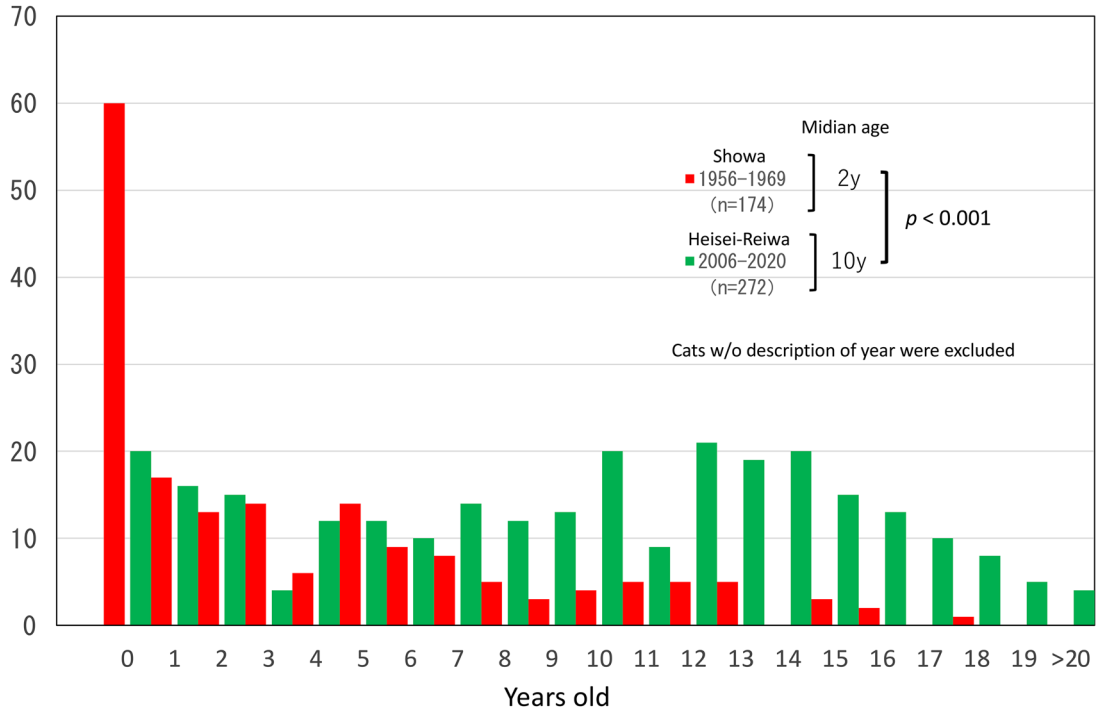

Fig. 8. Age distribution of necropsied cats. Cats without any description of years were excluded.

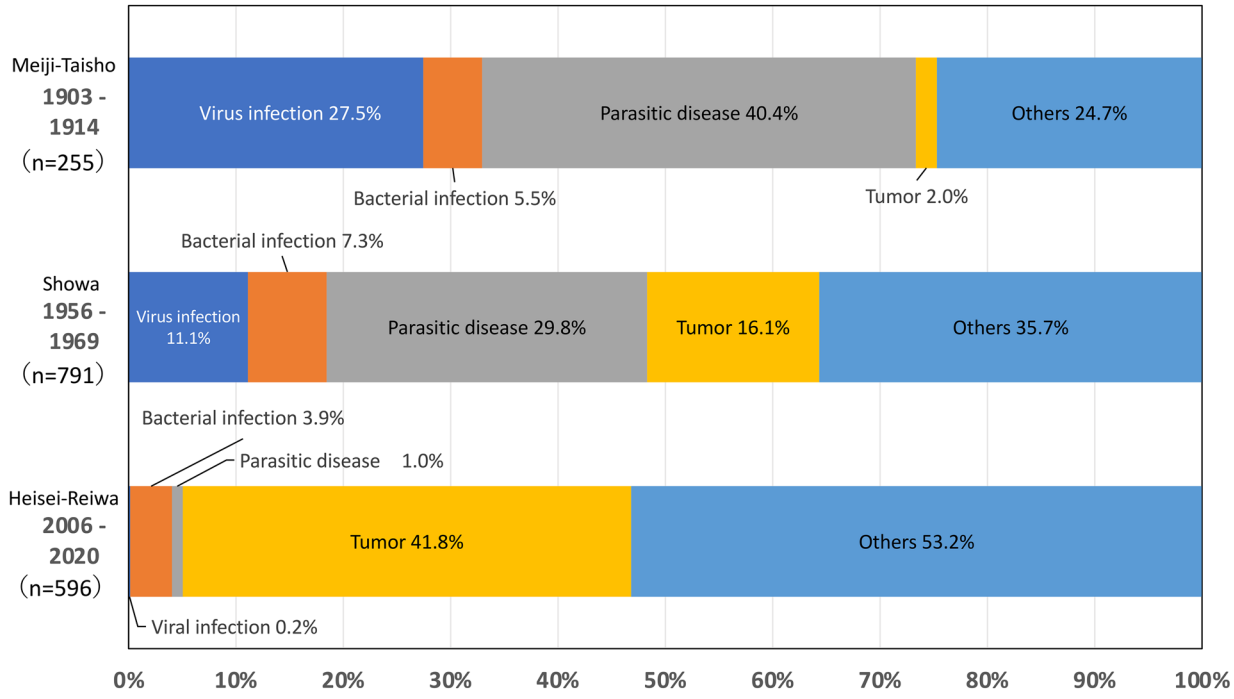

Fig. 9. Transition of pathological diagnoses of necropsied dogs.

Table 2. Transition of diagnoses in dogs

1903–1914		1956–1969		2006–2020	
Tumor	5	Tumor	127	Tumor	249
		Mammary tumors	25	Lymphoma/Leukemia	62
		Lymphoma	21	Neuronal tumors	24
		Skin/Subcutaneous tumors	13	Histiocytic tumors	22
		Mast cell tumor	8	Mammary tumors	15
		CTVT	7	Endocrine tumors	12
		Liver/Bile duct tumors	7	Hemangiosarcoma	12
		Bone/Cartladge tumors	6	Myeloid leukemia	11
		Kidney/Bladder tumors	6	Liver/Bile duct/pancreatic tumors	11
		Malignant melanoma	5	Nasal/respiratory tumors	11
		Nasal tumors	5	Bone/Cartladge tumors	9
		Reproductive tumors	4	Kidney/Bladder tumors	9
		Lung tumors	3	Cardiac paraganglioma	7
		Endocrine tumors	2	Alimentary tumors	7
		Other tumors	15	Malignant melanoma	5
				Mast cell tumor	4
				Mesothelioma	2
				Perianal gland tumor	2
				Thymoma	2
				Carcinoid	2
				Other tumors	20
Viral infection	70	Viral infection	88	Viral infection	1
Distemper	35	Distemper	71	Parvovirus infection	1
Rabies	32	Infectious hepatitis	17		
Other viral infection	3				
Bacterial infection	14	Bacterial infection	58	Bacterial infection	23
		Leptspirosis	21	Suppurative inflammation	23
		Mycobacteriosis	4		
		Nocardiosis	2		
		Bordetallosis	1		
		Pleuropneumonia	23		
		Other bacterial infection	7		
				Mycotic infection	9
				Aspergillosis	1
				Cryptococcosis	1
				Pneumocystis infection	1
				Mycotic infection not identified	6
Parasitic disease	103	Parasitic disease	236	Parasitic disease	6
Enteric parasites	50	Dirofilariasis	195	Strongyloidiosis	3
Dirofilariasis	53	Enteric parasites	29	Dirofilariasis	2
		Demodicosis	9	Trichuriasis	1
		Mange	2		
		Hepatic capillariasis	1		
		Systemic diseases	9	Systemic diseases	14
		Circuratory diseases	12	Circuratory diseases	42
		Digestive diseases	43	Digestive diseases	26
		Neuronal diseases	24	Neuronal diseases	107
		Respiratory diseases	33	Respiratory diseases	22
		Hepatic/Pancreatic diseases	43	Hepatic/Pancreatic diseases	21
		Urinary/Reproductive diseases	44	Urinary/Reproductive diseases	14
		Musculoskeletal diseases	9	Musculoskeletal diseases	4
Others	54	Others	26	Others	4
Not described	9	Not described	39	Not described	54
Total	255	Total	791	Total	596

Table 3. Transition of diagnoses in cats

1956–1969		2006–2020	
Tumor	37	Tumor	128
Mammary tumors	14	Lymphoma/Lymphoid leukemia	55
Lymphoma/Leukemia	8	Nasal/respiratory tumors	17
Skin/Subcutaneous tumors	2	Myeloid leukemia	7
Mast cell tumor	4	Liver/Bile duct/pancreatic tumors	6
Other tumors	9	Alimentary tumors	6
		Neural tumors	5
		Histiocytic tumors	5
		Mammary tumors	3
		Endocrine tumors	4
		Kidney/Bladder tumors	4
		Carcinoid	3
		Bone/Cartladge tumors	2
		Mesothelioma	2
		Malignant melanoma	2
		Lymphangiosarcoma	2
		Other tumors	5
Viral infection	21	Viral infection	20
Parvovirus infection	11	Infectious peritonitis	18
Infectious peritonitis	8	Parvovirus infection	2
Infectious rhinotrachitis	2		
Bacterial infection	32	Bacterial infection	23
Pleuropneumonia	26	Suppurative inflammation	20
Enteritis	2	Tyzzer's disease	2
Inflammation of other organs	4	Mycobacteriosis	1
Mycotic infection	2	Mycotic infection	4
Cryptococcosis	2	Cryptococcosis	2
		Chromomycosis	1
		Mycotic infection not identified	1
Parasitic disease	31	Parasitic disease	1
Enteric parasites	22	Toxoplasmasis	1
Toxoplasmosis	5		
Others	4		
Systemic diseases	9	Systemic diseases	20
Circuratory diseases	4	Circuratory diseases	30
Digestive diseases	15	Digestive diseases	5
Neuronal diseases	1	Neuronal diseases	21
Respiratory diseases	13	Respiratory diseases	9
Hepatic/Pancreatic diseases	9	Hepatic/Pancreatic diseases	11
Urinary/Reproductive diseases	11	Urinary/Reproductive diseases	19
Musculoskeletal diseases	3	Musculoskeletal diseases	0
Others	19	Others	3
Not described	12	Not described	44
Total	218	Total	338

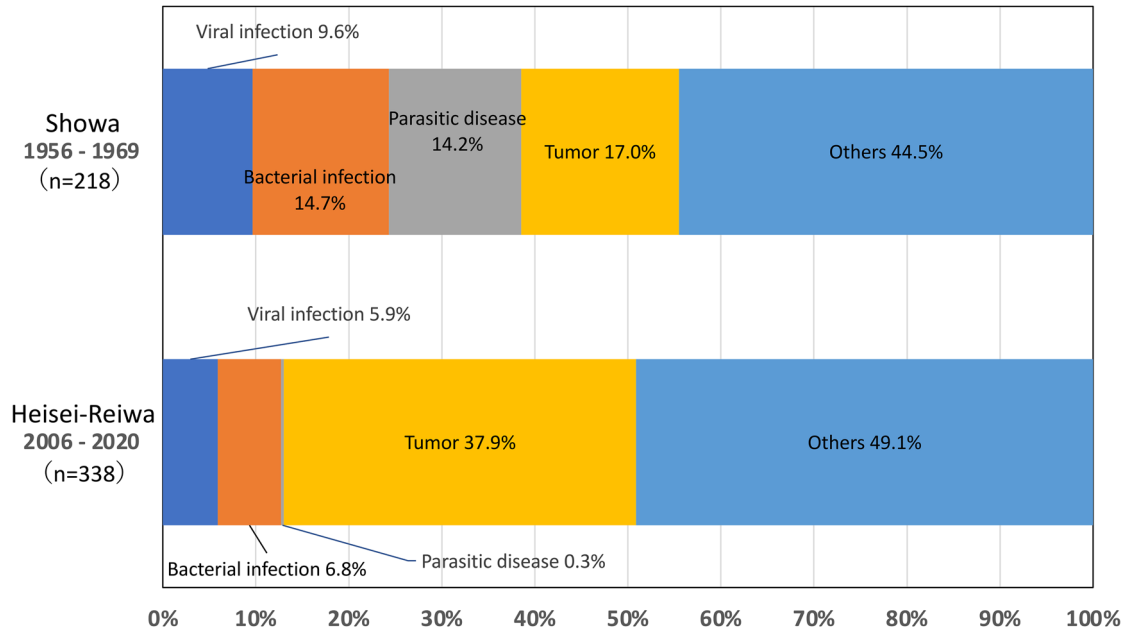

Fig. 10. Transition of pathological diagnoses of necropsied cats.

Table 4. Diagnoses in horses 1903–1914

Tumor	3
Viral infection	31
Infectious anemia	29
Epizootic fever	2
Bacterial infection	46
Parasitic disease	13
Verminous aneurysm	7
Enteric parasites	5
Hepatic calicosis	1
Others	48
Not described	58
Total	199

Table 5. Transition of canine parasitic infection

Parasite	1903–1914 (n=255)		1956–1969 (n=791)		2006–2020 (n=596)	
	No. of cases	Percent	No. of cases	Percent	No. of cases	Percent
Dirofiralia alone	34	13.3%	177	22.4%	3	0.5%
Enteric parasites alone	90	35.3%	119	15.0%	9	1.5%
Dirofiralia + Enteric parasites	48	18.8%	98	12.4%	0	0.0%
No parasite	83	32.5%	397	50.2%	584	98.0%
Total	255	100.0%	791	100.0%	596	100.0%

Table 6. Transition of feline parasitic infection

Parasite	1956–1969 (n=218)		2006–2020 (n=338)	
	No. of cases	Percent	No. of cases	Percent
Enteric parasites	52	23.9%	9	2.7%
No parasite	166	76.1%	329	97.3%
Total	218	100.0%	338	100.0%

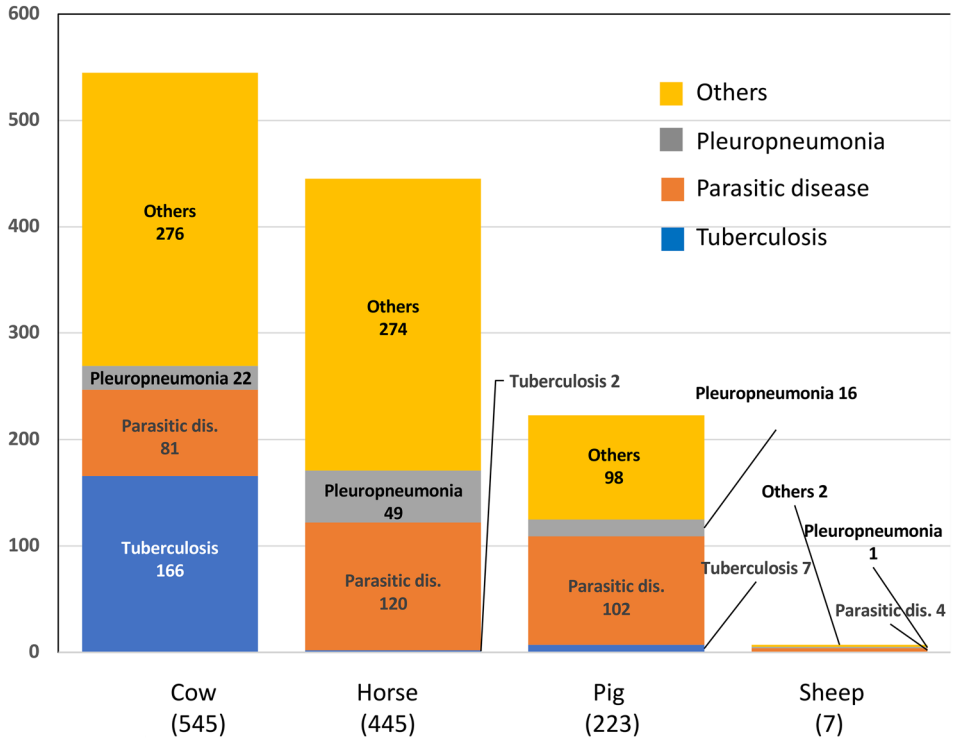

Fig. 11. Diagnoses of samples from slaughterhouses in the Meiji-Taisho period (1903–1914).

CONFLICT OF INTREST. The authors declare no conflicts of interest to accomplish the study.

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