

# The Issues of Pet Waste (Canine Feces) – Environmental Problems, Human Behavior and Knowledge of Public Health

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**Abstract:** Pet waste (canine feces left in public places while a dog is being walked) has become an environmental problem. It is reported that the solution to pet waste is simple – enact legislation to make dog fouling illegal; however, a case study in Izumisano (Japan) shows that such a countermeasure cannot effectively abolish the problem of pet waste. When pet waste is left in public areas, humans and their pets are most at zoonosis risk. However, a majority of dog walkers are not aware of this risk. Since the behavior of pet owners regarding their pets' waste can be influenced by their knowledge of risk and their strong willingness to protect their pets from risk, it is advisable to comprehensively provide risk information to general citizens in order to reduce pet waste.

**Keywords:** Dog fouling, Environmental behavior, Izumisano, Pet animals, Risk information, Zoonosis risk.

## I. INTRODUCTION

There are approximately as many pets in the United States as there are adult humans: 60 million dogs and 70 million cats. The situation is similar in Europe, with half of households in France having at least one pet (cf. [1]). In 2014, 18.3% of Japanese households owned a pet, representing 12.3 million dogs and 10 million cats, up from 9.1 million and 6.2 million respectively in 1994. In fact, there are now more pets than children in Japan (review in [2]). There is little in history to show any large numbers of animals having been kept as pets, or that pet ownership was common [1].

Animal welfare has increasingly become a global issue, especially since the turn of the 21st century [3]. This concept includes the responsible care of animals used by humans (review in [4]). In short, the concept of animal welfare suggests that pet owners are obliged to care for their pets properly. It is necessary for a dog to exercise outdoors every day and urinate and/or defecate every few hours [5]. Although most owners must be fond of walking with their dogs in urban settings, they do not always pick up their dogs' fecal matter in the street (see Figure I, pictures taken in January and February 2017). This pet waste (i.e. dog feces) may be an environmental problem to be dealt with on a daily basis because there is a possibility that pet waste left on the ground may be washed into waterways by rain or melting snow [6].

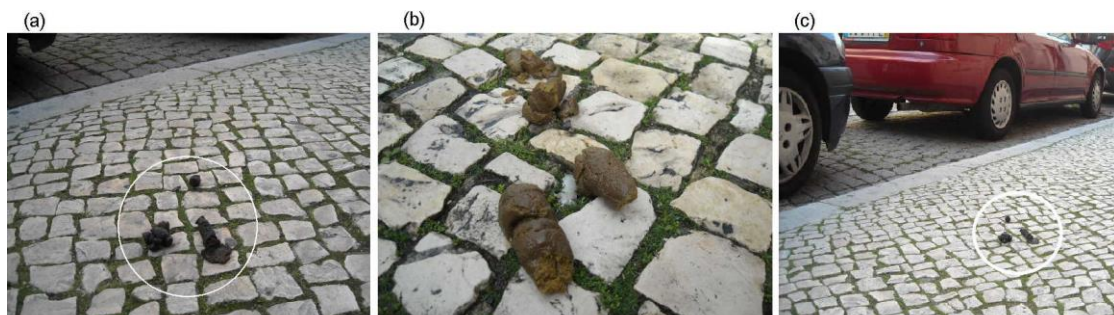
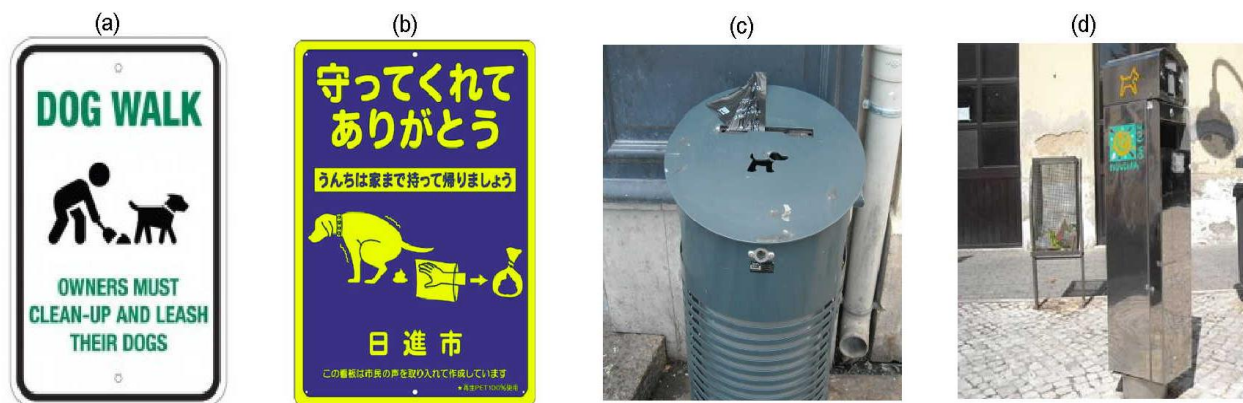


Figure I: Pet waste in Lisbon (Portugal) – (a) Rua de O Século, (b) Rua Custódio Vieira, and (c) Rua Dom João V

Pet waste in the urban environment can be considered in light of three interdisciplinary factors: (i) *animal welfare* – since dog owners respect the concept of animal welfare, they take their dogs out to exercise and urinate/defecate; (ii) *lack of human ethics (social conscience)* – though there are pet waste signs (e.g. notice boards) and pet waste stations providing bag dispensers and disposal bins in urban settings (Figure II), some owners are not in the habit of removing dog feces from the street (review in [7]); and (iii) *environmental degradation* – about 200 thousand dogs produce 16 tons of pet waste daily on the streets of Paris (review in [8]), and 125 thousand dogs and 60 thousand cats produce 22 tons of pet waste every day in Seattle [9]. Dog feces may be a serious hazard because they may contain microorganisms that are both pathogenic to humans and resistant to several classes of antibiotics [7]. In 1991, dog waste was classified as a non-point source pollutant by the Environmental Protection Agency (EPA), which placed it in the same category as herbicides and insecticides: oil, grease and toxic chemicals, and acid drainage from abandoned mines (review in [10]).



**Figure II: Public facilities for prevention of pet waste – (a) pet waste sign in the USA, (b) pet waste sign in Japan, (c) pet waste station in France, and (d) pet waste station in Portugal**

This manuscript aims to outline some basic concepts and provide information regarding the relationship between humans and pets, point out the potential health risk and environmental problems, and discuss potential methodologies to mitigate the problem of pet waste in urban settings based on a case study in Japan. An interdisciplinary approach seems to be necessary to solve the pet waste issue.

## II. BACKGROUND INFORMATION

While the reason that pet keeping has become a widespread phenomenon is unclear, it is evident from the viewpoint of human psychological well-being that companion animals are important in the lives of many people [11]. Psychological and moral complexities characterize our relationships with other species. It seems to be worthwhile to discuss how animals and human beings can safely and harmoniously coexist in a society that includes a large number of pets. Some basic concepts and information are briefly reviewed in this section.

### A. Pet animals:

Pet (companion) animals are animals kept primarily for company or protection, as opposed to working animals, sport animals, livestock and laboratory animals. In the United States, over two thirds of households include a pet, most of which are regarded by their owners as family members. Considering that the lifetime costs of owning a pet are about US\$8,000 for a medium-sized dog and US\$10,000 for a cat (cats tend to live longer than dogs), devoting resources to a creature with whom you share no genes and who is unlikely to ever return the favor seems to make little evolutionary sense [11]. In the United States, a person is 100 times more likely to be seriously injured or killed by a dog than by a venomous snake, and over 85,000 Americans are taken to emergency rooms each year because of falls caused by their pets [11]. When asked what pet owners specifically get from relationships with their pets, the owners typically mention companionship, having a play partner, and the need to love and care for another creature. The idea that living with an animal can improve human health, psychological well-being, and longevity has been called the “pet effect” [12]. Most pet owners believe that their companion animals are good for them (personal convictions).

**B. Animal rights and animal welfare:**

The term “animal rights” means the movement to protect animals from being used or regarded as property by humankind. Supporters believe that it is morally wrong to use or exploit animals in any way. This is often considered to be a very radical social movement [13]. Animal welfare is concerned with ensuring that animal suffering for unnecessary purposes is eliminated or minimized and that the usage of animals is a last resort [13]. The complexity involved in animal welfare is the need to protect animals and their present and future existence while at the same time trying to find answers to medical mysteries and possible life-saving cures for mankind.

In terms of legislation, protections under the law against cruelty to animals and so forth do exist, yet there are no laws protecting the individual or moral rights of animals. Animal rights activists and conservationists continue to advocate using political, physical and educational means to draw attention to the inhumane conditions and suffering of animals. Without this focus, mankind might not be aware of the negative impact that human behaviors such as factory farming, scientific research and so on can potentially have on our environment.

The difficulty in creating international rules on animal welfare stems from the fact that some nations cannot agree on the standardization of animal welfare [14]. Such nations have vigorously resisted suggestions that animal welfare standards be granted the same standing as health and welfare standards in the interpretation of international law.

**C. Pet waste, public health risk and environmental degradation :**

Dog feces may contain several types of microorganisms that are potentially pathogenic to humans, and if inappropriately disposed of, human health may be at risk [6]; i.e. children who play outside and adults who work in gardens are most at risk of infection from some of the bacteria and parasites found in pet waste (refer to section II-C).

Flies may also spread diseases from animal waste [6]. Diseases or parasites that can be transmitted from pet waste to humans include: *Campylobacteriosis* – a bacterial infection that frequently causes diarrhea in humans; *Cryptosporidium* – common symptoms include diarrhea, stomach cramps, nausea and dehydration. Other bacteria that are pathogens to the intestinal tract and cause diarrhea include *Salmonella*, *Yersinia* and *E. coli* [15]. These bacteria may be fatal to people with depressed immune systems. Pet feces may also contribute to the diffusion of protozoa such as *Giardia* and *Cryptosporidium* [16] and of roundworms such as *Toxocara canis* [17]. The latter represents roundworms that are usually transmitted from dogs to humans, often without noticeable symptoms, but may cause vision loss, a rash, fever or cough (cf. section II-C and [6]).

Recently, there has been increased evidence that pets and their stools may be a reservoir for antibiotic-resistant bacteria [18], posing a new threat to public health. In particular, the presence of vancomycin-resistant enterococci (VRE) in pet animals, including dogs, has been reported [19]. A relatively high occurrence (7–23%) of VRE, mainly *E. faecium*, in dogs living in urban areas has also been reported in Europe [20].

Furthermore, *enterococci* with high-level aminoglycoside resistance (HLAR) have been described in strains isolated from both humans and animals [21]. In addition, methicillin-resistant *Staphylococcus aureus* (MRSA) has been found in the stools of dogs and has been isolated from both infected and colonised pet animals [22].

Thus, dog feces left on the streets may represent a risk factor for transmission of microorganisms and a reservoir of multidrug-resistant bacteria, thus contributing to the spread of resistance genes into an urban area. Furthermore, contamination of waterways with fecal material leads to the dissemination of pathogens, antibiotic-resistant bacteria, and excess nutrients that pose serious environmental problems [6]. Major sources of contaminants include human sources such as sewage leaks and sewer overflows, animal feeding operations, and manure amendment of agricultural fields [6] & [23]. One study estimates that in the United States 39.1% of human pathogens also infect domestic animal hosts [24], meaning that dogs can be reservoirs for antibiotic resistant *Enterococci spp* [7].

It is reported that canine fecal pollution must be a key manageable source of fecal contamination [23]. This suggests the need for identification methods of canine fecal sources because the microbiota of humans and that of canine pets often overlap. An analytical technique using polymerase chain reaction (PCR) has recently been developed to specifically detect canine fecal contamination in water [23]. These PCR-based assays make it possible to identify 11 genetic markers that were common among most of the dog samples but missing from the human ones. In Cincinnati (United States), storm

water was sampled from a rain garden where people often walk their dogs, in order to determine whether this method would work for real-world monitoring [23]. The applied technique successfully detected some of the markers identified as evidence of canine waste [23].

#### ***D. Waste and human behaviors:***

Waste is closely related to the daily lives of humans as the party that generates the waste. A healthy living environment can be achieved only if the waste is managed well. Although much has been written on the subject of waste management, little attention has been given to the psychology behind decisions that affect the environment [25].

Litter is any piece of misplaced solid waste, and this waste commonly refers to items that are discarded by an individual [26]. For example, a total of 200 million cigarette butts and 20 million cigarette packets are discarded in the United Kingdom each day, many onto the ground, accounting for 40% of street litter [27]. The widely accepted conclusions from previous studies are that littering is more common among males, younger adults, and individuals living in rural communities rather than in cities (review in [27]). However, the research results on these characteristics of the “litter bug” are far from conclusive and many studies have failed to find significant demographic predictors [27].

One important area of interest in psychology is so-called “environmental or pro-environmental behavior” [28]. Most cases of environmental behavior can be based on a knowledge of environmental science or ecology, judged according to their impact on the environment, and labeled as environmentally friendly or unfriendly [28]. Each person has reasons why they behave the way they do, and a person’s behavior towards the environment is influenced by a wide range of factors [28]. Messick and Brewer propose three essential factors influencing the environmental behavior of an individual [29]: (i) factor arising from external conditions – culture, mass media, social group, etc., (ii) factor of the personality of an individual – ability, lifestyle, etc., and (iii) factor of the personal relationship of an individual to nature.

### **III. CASE STUDY IN JAPAN**

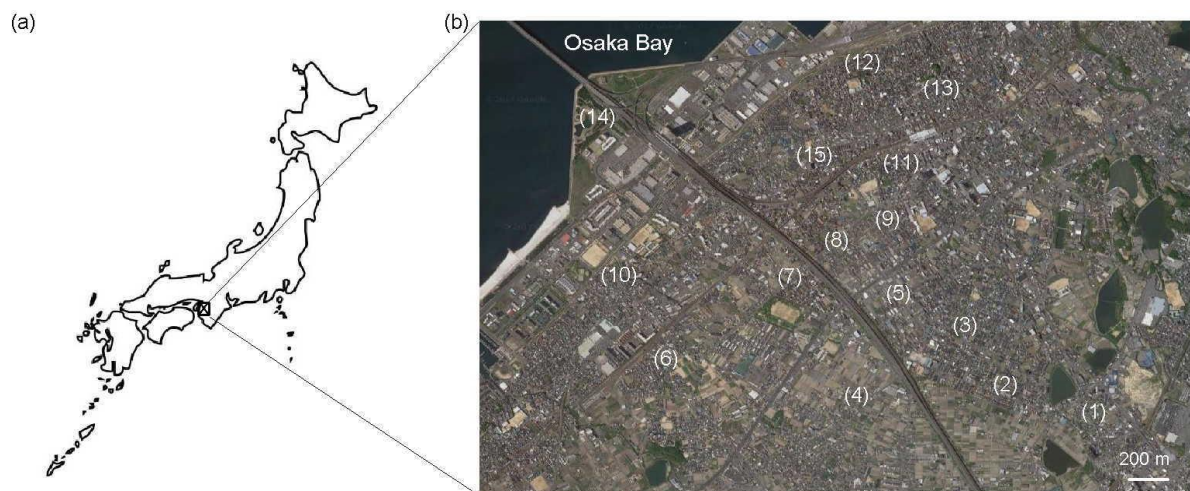
Japan is one of the most economically developed, wealthy and technologically advanced nations in the world. However, animal welfare has historically not been a significant issue, so there is no governmental department that oversees animal welfare issues in Japan (review in [30]). According to the Japanese regulation on welfare and management of animals (Act No. 105, Article No. 35), local autonomies should take custody of a dog or cat when requested by its owner, and the national government may, within the scope of the budget, grant a subsidy to a local autonomy for a part of the costs related to animal custody.

There are about 22 million pet animals (including 12.3 million dogs) in Japan; that is, there are more pets than children in Japan (see the introduction). Japan is a lucrative market for pet animals, so it is possible to buy almost any animal such as a dog, cat, pony, pig, wallaby, eagle, owl, rare reptile, monkey and so on [31]. When these animals are no longer enjoyable to look after or become unmanageable, they are often abandoned [31]. Most abandoned pets were clubbed to death by local autonomies about 30 years ago [32] – cf. the autonomies could not reject an owner's request according to the legislation for animal management, and animal euthanasia was not common. As the clubbing method was considered inefficient, today the following method is legally and frequently applied [32]: dumped animals are collected and placed in sealed chambers into which carbon dioxide (CO<sub>2</sub>) is pumped, and then the suffocated animals are immediately burned in incinerators. The above-mentioned system is euphemistically called a “dream box” in Japan [32], and about 44 thousand live dogs and cats are annually dumped and then incinerated as waste in dream boxes [33].

#### ***A. Characterization of the study site:***

Izumisano is a city located in Osaka Prefecture, Japan, comprising an area of 55.03 km<sup>2</sup> [34]. As of 2014, the city has an estimated population of 101,444 inhabitants and a population density of 1,843 inhabitants per km<sup>2</sup>.

All dog owners in Japan are required to register their dogs and have them vaccinated against rabies (cf. the Rabies Prevention Law No. 247, August 1950). An owner must register their dog with the head of the nearest local government once during the animal’s lifetime. According to the 2015 registration data [34], there are 5,232 dogs in Izumisano. The Municipal Ordinance relating to environment beautification (approved in 2013) makes dog fouling illegal in Izumisano; i.e. this ordinance (Act No. 40, Article No. 5) can penalize a dog owner who does not pick up after their pet in public places such as parks and streets. Violators have to pay a fine of JPY10,000 (ca. 85 EUR or US\$90).



**Figure III: Location of the field survey – (a) map showing Izumisano in Japan, and (b) numbers showing the observation points in Izumisano**

### ***B. Methodology:***

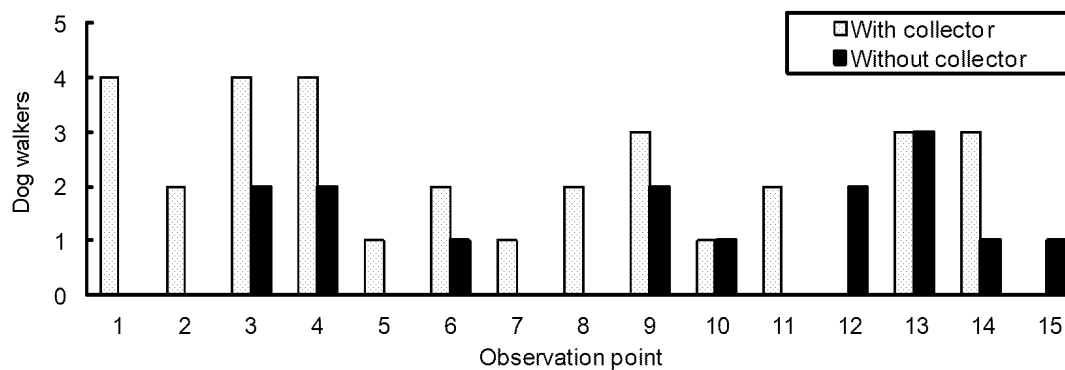
Dog owners in this city are subject to the above-mentioned municipal ordinance. A field survey was carried out in the residential areas of Izumisano in order to observe dog owners' behavior with regard to pet waste and to evaluate whether the municipal ordinance would be observed by pet owners in order to reduce pet waste in public spaces.

In Izumisano, 15 observation zones were randomly selected (see Figure IIIb). Considering the feasibility of dog walking, an observation route (public road) was determined beforehand in each zone. Each route was at least about 5 m wide and about 2 km long. Narrow lanes, blind alleys and traffic-laden streets were excluded in the pre-determination of routes. An observer slowly walked over the pre-determined route twice per day (ca. 7:00 and 16:30 o'clock) to check for dogs' feces. Whenever meeting a dog walker, the observer checked whether the dog walker had any materials (e.g., bag, scoop) for cleaning up after their dog. This field survey was carried out in each area over three periods – July, August and September 2015. The non-parametric Wilcoxon signed-rank test [35] was used in order to statistically verify the locational difference of dog fouling.

### ***C. Results and consideration:***

Since grasses and bushes were dotted along the observation routes (streets), the locational conditions were roughly classified into two types: visually inconspicuous places for dog fouling such as thick grass and behind a traffic signboard, and visually conspicuous places for dog fouling such as the road surface and bare ground. A total of 114 incidents of dog fouling were observed during the field study – 74 incidents in inconspicuous places and 40 incidents in conspicuous places. The number of dog fouling incidents in inconspicuous places is significantly greater than that in conspicuous places ( $p < 0.05$ ).

This tendency may arise because: (i) street dogs may defecate and/or these dogs may use their feces to mark out their territories: (ii) dog walkers may allow their dogs to defecate: or (iii) they may dump their dogs' waste in a visually inconspicuous place so as not to attract public attention. Considering Japanese animal control practices such as the custody of pariah dogs (section III) and dog registration (section IIIA), it is difficult to consider hypothesis (i) that suggests mainly street dogs cause the fouling problem. Hypotheses (ii) and (iii) are possible. Garbage cans are rare on the streets in Japan because of recycling laws. Garbage is basically separated into burnable, non-burnable and recyclable items; therefore, citizens should dispose of garbage properly at the designated collection sites on the designated collection times/days. The days/times for garbage collection vary depending on the local community. Some dog walkers feel that the above-mentioned waste regulation is disagreeable or they do not want to carry the dog feces to their houses; therefore, they may allow their dogs to defecate in public places. Even if they pick up the dog feces, they may dispose of the feces in inconspicuous places. However, there is no positive proof because the observers could not witness dog walkers letting their dogs defecate and/or dumping dog feces in inconspicuous places.



**Figure IV: Field survey to see whether dog owners have fecal collectors (e.g. scoop, bag and bin) during dog walking at observation points numbered in Figure III-b**

Figure IV shows the results of observing pet owners' behavior in terms of their measures to prevent dog fouling. Each observer visually checked whether pet owners had their fecal collectors (i.e. bag, scoop) during dog walking. Forty-six dog walkers were observed during the survey period, and of those, 15 dog walkers did not have their collectors for cleaning up after their pets. Furthermore, dog walkers were not observed removing pet waste. Doubts still remain as to whether pet owners let their dogs excrete outside, and whether owners may dump their dogs' waste in a hiding place. It is reported that the solution to pet waste seems simple – enact legislation to make dog fouling illegal and penalize those who break the law [36]. In Izumisano there is an ordinance that makes dog fouling illegal and penalizes those who do not clean up after their dogs. The Japanese case study indicates that the solution to pet waste is not simple.

#### IV. DISCUSSION AND RECOMMENDATION

There is little in history to show any large numbers of animals having been kept as pets. In tandem with the growth of such a phenomenon, animal welfare has increasingly become a global issue. This concept includes the responsible care of animals used by humans, and especially those animals kept by pet owners (cf. sections I and II-B); on the other hand, dog feces are frequently deposited in public areas, constituting a form of environmental problem because dog feces left in public areas may represent a risk factor for transmission of microorganisms (cf. section II-C). Paris city hall surveyed 4 thousand citizens about the degradation of the municipal environment (review in [8]). According to this questionnaire survey, 70% of citizens and 55% of pet owners think that pet waste is a serious environmental problem in Paris. The case study presented in section III indicates that the ordinance/penalty that makes dog fouling illegal cannot effectively solve the problem of pet waste in public areas. An alternative solution is discussed below.

##### **A. Pet owners' willingness to protect:**

The concept of animal welfare suggests that pet owners are obliged to care for their pets properly; hence, pet owners take their dogs out for exercise and toileting almost every day. Furthermore, companion animals are now considered by a high proportion of households to be "members of the family" [37]. The willingness of people to risk their own lives during disasters to save those of animals has been well documented; for example, Mr. Chris Towie died saving his pet dogs, and sisters Melanie and Penny Chambers died trying to save their horses in Victorian bushfires (Australia) in 2009 [38]. It can be generalized that owners love their companion animals and have a strong willingness to protect their companion animals from risk.

##### **B. Pet owners' knowledge:**

As stated in section II-D, environmental behavior can be based on a knowledge of environmental science or ecology, judged according to their impact on the environment, and labeled as environmentally friendly or unfriendly. From this viewpoint, an important consideration is pet owners' environmental knowledge. According to a field survey in Exeter and Dorset (England) [36], 101 incidents of dog fouling were found during 120 hours of observation. The irresponsible owners were generally (41%) tolerant of fouling (dog feces were seen as natural waste and biodegradable), and they were likely to agree that the laws were illegitimate and restrictive.

It is considered that a majority of pet owners do not know the environmental risk caused by pet waste. For example, *Toxocariasis* is a zoonotic infection caused by the parasitic roundworms commonly found in the intestines of dogs and cats. Symptoms of zoonosis are wide and varied, but can include strong inflammatory immune responses (cf. sections II-C). The most common route of transmission is through the ingestion of eggs from contaminated dog feces [39]. Studies consistently show widespread contamination of public parks with the eggs of *Toxocariasis* (*Toxocara canis*), and emphasize the significant health risks posed by untreated feces [40]. A questionnaire survey was carried out among 355 cat owners, 247 dog owners and 421 non-pet owners to study the public's understanding of this zoonosis risk in England, Scotland and Ireland [41]. A weak majority (51.7%) of participants believe that pet waste can pose a hazard to human health. Awareness of *toxocariasis* does not differ significantly between the sexes or across geographic locations. This study suggests that public awareness of *toxocariasis* is poor.

### C. Alternative solution to pet waste:

The following points are derived from the above sections: (i) statistically most pet owners do not have sufficient knowledge of the environmental risk caused by pet waste; (ii) environmental behavior is based on knowledge; and (iii) pet owners have a strong willingness to protect their pets from risk.

As stated in section IV-B, pet owners are tolerant of fouling because they consider that dog feces are natural waste and biodegradable. When pet waste is disposed of improperly, not only children who play outside and adults who garden (section II-D) but also pets themselves [6] are most at risk of infection from parasites (e.g. zoonosis risk) found in pet waste. It is currently impossible for dog walkers to glean such risk information from public signs such as those shown in Figures IIa and IIb. Therefore, local government should better provide information about the environmental risk associated with pet waste to the public in an understandable manner. If dog walkers, knowing the health risk of pet waste to both humans and animals, do not clean up their pet waste and/or pretend not to see other walkers' leaving pet waste in public areas, they become aware of losing a safe place for their dog walking. Since pet owners generally have a willingness to protect their pets from risk, they feel obliged to keep their pets in their homes all day without taking them for a walk outside. This situation must be unpleasant for both owners and dogs from the viewpoint of animal welfare.

## V. CONCLUSION

Our human society (developed countries in particular) is coexisting with a great number of companion animals, and there is little in human history to show such coexistence occurred in the past: hence, it may be no surprise that the problem of pet waste has become serious.

This issue straddles a number of topics: (i) *environmental behavior and strategy* – since environmental behavior is based on knowledge and pet owners have a strong willingness to protect their pets from risk, it is advisable to comprehensibly provide risk information (e.g. contamination with *Toxocara canis*) to the public rather than to enact legislation and fines for dog fouling; (ii) *animal welfare* – although this concept includes the responsible care of animals, it is desirable to extend the scope of the concept from animal care to pet waste management because the latter leads to healthier surroundings for dog walking outside; and (iii) *phenomenon of pet keeping* – the huge numbers of companion animals around the world are a relatively recent phenomenon [1]. The reasons why pet keeping has become such a widespread phenomenon are unclear [41]. If it can be supposed that pet animals contribute to their owners' sense of psychological well-being, this phenomenon suggests that a large number of people psychologically need their companion animals. A pet animal's life span is shorter than a human one. When a pet dies, it is not unusual for the owner to feel overwhelmed by the intensity of their sorrow [42]. Coping with the loss of a pet can be particularly hard for seniors, and those who live alone may feel a loss of purpose and an immense emptiness [42]. In our society where so many people live together with pet animals, it is important to discuss not only the management of pet waste but also scientific analysis of the pet-keeping phenomenon and psychological care following pet loss.

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