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Angga Yuka Alta Nasution
Post Graduate Student of Entomology Magister Program, Division of Parasitology and Medical Entomology, Department of Animal Infectious Diseases and Veterinary Public Health, Faculty of Veterinary Medicine, Bogor Agricultural University. Jl. Agatis Darmaga, Bogor, Indonesia

Upik Kesumawati Hadi
Division of Parasitology and Medical Entomology, Department of Animal Infectious Diseases and Veterinary Public Health, Faculty of Veterinary Medicine, Bogor Agricultural University, Jl. Agatis Darmaga, Bogor, Indonesia

Elok Budi Retnani
Division of Parasitology and Medical Entomology, Department of Animal Infectious Diseases and Veterinary Public Health, Faculty of Veterinary Medicine, Bogor Agricultural University, Jl. Agatis Darmaga, Bogor, Indonesia

Correspondence
Upik Kesumawati Hadi
Division of Parasitology and Medical Entomology, Department of Animal Infectious Diseases and Veterinary Public Health, Faculty of Veterinary Medicine, Bogor Agricultural University, Jl. Agatis Darmaga, Bogor, Indonesia

Prevalence of ectoparasites and endoparasites on companion dogs which visit animal clinic at north Jakarta

Angga Yuka Alta Nasution, Upik Kesumawati Hadi and Elok Budi Retnani

Abstract
The purpose of this study to analyze species, abundance, distribution, and the infestation degree of ectoparasites and endoparasites on Companion Dogs at North Jakarta Animal Clinic from July to October 2017. Thirty dogs were observed during this study. Ectoparasites were collected manually on body, skin and ear, meanwhile endoparasites observed used Snap test kit, flotation, sedimentation and Bearman-Wetzel Technique. *Riphicephalus sanguineus* was the highest abundance and dominant species found on the dog (77.22% and 28.31% respectively). *R. Sanguineus* the only species which have high degree infestations, with prevalence 36.67%. 79 individual of ectoparasites was found in this study 2 individual fleas, 61 individual ticks, and 16 individual lice. Endoparasites that found in this study were 5 species (*Anaplasma* spp., *Ehrlichia* spp., *Strongyloides* sp., *Trichuris* sp., and *Ancylostoma*), with prevalence 23.33%, 23.33%, 3.33%, 3.33%, and 3.33%, respectively.

Keywords: Ectoparasites, endoparasites, companion dog

1. Introduction
Parasitic-zoonotic was an infectious disease caused by parasites. Parasites divided into ectoparasites and endoparasites which caused health problems for human and animal, especially on dog [1, 2, 3, 4]. Parasitic infections in this animal could be found in wild, and companion's dog. Endoparasite infections almost found infected on a dog, could be caused by several kind diseases on it, Leishmaniasis, Anaplasmosis, Ehrlichiosis, Dirofilariasis, Toxocariasis, Ancylostomiasis, and Thelaziasis. Meanwhile, others ectoparasites infections caused Otocariasis, Demodicosis, and Scabies [2, 5, 6, 7].
Vector-borne pathogens contributed spread zoonotic diseases in East Asia and Southeast Asia region [8]. Filariasis disease commonly occurred on the dog caused by *Brugia malayi*, *B. pahangi*, and *Acanto celonemarecinditum* but sometimes could found in human [8]. Leishmaniasis was also found in human, Guerin *et al.* [9] reported 500 000 people each year on 62 countries infected by *Leishmania* spp.
Parasitic-zoonotic diseases could be transmitted through vector bites such as ticks, mites, and lice. Hadi *et al.* [10] reported 8% of dogs in Baharkam Polri, Depok, positive for *Babesia* sp., meanwhile in Atang sanjaya, Bogor 16% positive for *Anaplasma* sp., with the prevalence of *Rhipicephalus sanguineus* in both area was 67.90% and 100% respectively.
The parasitic-zoonotic disease could be high risk transmitted by companion dog and cat. Both of them live around human's neighborhood, as pets or live wildly [5, 11]. Environmental factors and habits of human lifestyle become one of the factors that caused the existence and sustainability of ectoparasites and endoparasites lifecycle better. East Asia and Southeast Asia countries have the highest number of wild dogs and cats compared to those become pets [12]. At some of the tropical countries, about 75% of dogs were classified as wild dogs [13]. On the other hand, increased the ownership of dogs and cats was a risk of parasitic-zoonotic disease in animals and humans. Companion and the feral dog could be as the provenance of parasitic-zoonotic disease [14]. Dogs and cats were representative of many hosts and reservoirs of ectoparasites that become vectors for humans and animals.
Prevalence and degree of ectoparasites and endoparasites infestation reports in dogs at Jakarta, still rarely reported. Consequently, studies about the prevalence and degree of ectoparasites and endoparasites infestation in dogs were very important. The purpose of this study was to

investigate the status of dogs infestation by ectoparasites and endoparasites, reports of this study expected to be a reference for veterinarians to prevention, control, and treatment of ectoparasites and endoparasites on dogs.

2. Materials and Methods

Ectoparasites identification by using compound microscope and with a help of morphological each species ectoparasites identification keys based on Communicable Disease Center (CDC) [15], Walker *et al*. [16], Hadi and Soviana [17]. Endoparasites identification (serological analysis) based on Johansson [18], IDEXX Laboratories [19]. Meanwhile, helminth identification with a help of morphological identification keys based on Hendrix and Robinson [20].

2.1. Collection and Identification Ectoparasites

Collecting ectoparasites on dogs were conducted from July to October 2017 at Sunter Animal Clinic, North Jakarta. Samples were taken from patients who came to the clinic that filled sample requirements, such as: having access out of the cage, did not give anthelmintic within two months and did not give anti-ectoparasites within a month.

2.1.1. Ticks, Fleas, and Lice Collection

Ticks, fleas, and lice obtained by manual inspection throughout the part of the animal body used a comb and hand or finger for 5 minutes, placed paper or white clothes at base on the animal. In addition, also performed checks on the finger and skin folds. The ticks, fleas, and lice placed into an eppendorf tube containing 70% alcohol.

2.1.2. Skin Mites Collection (*Demodex* spp. and *Sarcoptes scabiei*)

Demodex spp. and *Sarcoptes scabiei* were obtained by examination of animals showing symptoms and lesions, made skin scrap (at a location indicated lesion) using object glass, added 10% NaOH or KOH and observed by microscope 40X.

2.1.3. Ear Mites Collection (*Otodectes cynotis*)

Ear mites (*Otodectes cynotis*) collection done by examined on ear wax with cotton swab method [17, 21]. Ear wax with black color used to be as a sign of the ear mites. Ear wax placed into object glass and covered by another object glass and observed by microscope 40X.

2.2. Serological, Faecal, and eyeworm Analysis

The blood was analysed by using SNAP 4Dx Plus test kit (*Dirofilaria immitis* antigen, and antibody of *Anaplasma phagocytophilum*, *A. platys*, *Borrelia burgdorferi*, *Ehrlichia canis*, and *E. ewingii*) and SNAP *Leishmania* (antibody of *Leishmania* spp.) [18, 19]. The faecal analysis observed used, flotation, sedimentation and Bearman-Wetzel Technique [20]. Meanwhile, eyeworm examined and inspected on both conjunctival sac and flushing used saline solution [20, 22].

2.3. Statistical Analysis

Infestation prevalence calculated used the following formula Nuchjangreed and Somprasong [23]:

$$\text{Prevalence of infestation} = \frac{\text{No. of animal infested with an ectoparasite}}{\text{No. of animal examined}} \text{ X } 100$$

Result for ectoparasites analyzed descriptive used Microsoft Excel. Ectoparasites counted for total infestation. Relative Abundance and species dominance determined used the formula [24]:

$$\text{Relative Abundance (RA)} = \frac{\text{No. of individuals of the species of ectoparasites}}{\text{No. of individuals of all species}} \text{ X } 100$$

$$\text{Species Frequency (SF)} = \frac{\text{No. of the kind animals with ectoparasites}}{\text{No. of the animals all observed}} \text{ X } 100$$

$$\text{Species Dominance (SD)} = \text{RA X SF}$$

Degree of ectoparasites infestations was five categorized: 1.(-) = no ectoparasites, 2. (+) = 1-5 ectoparasites (mild), 3. (++) = 6-10 ectoparasites (moderate), 4. (+++) = 11-20 ectoparasites (high) and 5. (++++) = > 20 ectoparasites (very high) [25]

3. Results and Discussion

3.1. Species of Ectoparasites on dogs

Species and number of ectoparasites infestations in dogs are presented in Table 1. Ectoparasites species collected in dogs were 3 species (*Rhipicephalus sanguineus, Trichodectes canis,* and *Ctenocephalides canis*). From targeted species ectoparasites, 3 species were not found in dogs (*Otodectes cynotis, Sarcoptes scabiei,* and *Demodex* spp.). Research conducted by Mosalanejad *et al*. [26] at Iran recorded 7 species ectoparasites in dogs (*Heterodoxus spinigera, R. sanguineus, S. scabiei, O. cynotis, Xenopsylla cheopis, C. canis,* and *C. felis*). Meanwhile, another study recorded 2 species (*R. sanguineus* and *C. canis*) at Iran Mirzaei *et al.* [27]; 9 species (*Ixodes ricinus, R. sanguineus, Demodex canis, O. cynotis, S. scabiei, C. canis, C. felis, Pulex irritans* and *T. canis*) at Albania [28]; 6 species (*O. cynotis, Ctenocephalides* spp., *Felicola subrostratus*, *Cheyletiella blakei*, and *Notoedres cati*) at Europe [29]. Mateescu *et al*. [30] showed 7 species of dogs (*C. canis, C. felis, R. sanguineus, Dermacentor reticulatus, T. canis, D. canis* and *S. scabiei*) at Targoviste-Dambovita.

The highest species of ectoparasites found on dogs were the tick, (*R. sanguineus*, 61 individuals), followed by louse (*T. canis*, 16 individuals), and flea (*C. canis*, 2 individuals). Research conducted on dogs at Thailand recorded infestations of the ticks (*R. sanguineus*, 356 individuals, *Boophilus microplus*, 50 individuals) and flea (*C. canis*, 54 individuals) [23]. Omudu *et al*. [31] reported tick infestation on dogs were (*Rhipicephalus* sp., 203 individuals, *Boophilus* sp., 119 individuals, and *Amblyomma* sp., 32 individuals); flea (*Ctenocephalides* sp., 4 individuals) and lice (*Linognathus* sp., 21 individuals).

Table 1: Species and number of individual ectoparasites based on breed on dogs in North Jakarta Animal Clinic (July-October 2017)

Ectoparasites	Breed													Total Individual
	A	B	C	D	E	F	G	H	I	J	K	L	M	
Flea:														
Ctenocephalides canis	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Tick:														
Rhipicephalus sanguineus	0	18	20	0	10	2	3	0	0	0	0	0	8	61
Lice:														
Trichodectes canis	0	0	3	0	0	0	0	0	0	0	0	0	13	16
Mite:														
Sarcoptes scabiei	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demodex spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Otodectes spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	18	23	0	10	2	3	0	0	0	0	0	23	79

*A: Siberian Husky, B: Shih Tzu, C: Pomeranian, D: Alaskan Malamute, E: Poodle, F: Golden retriever, G: Beagle, H: Toy Poodle, I: Teckel, J: Mini pincher, K: French bulldog, L: Schnauzer, M: Mixed

Based on breed classification, the highest ectoparasites infestation in dogs were found in mixed breed and Pomerian (23 individuals), respectively. Total of 4 dog breeds (Shih tzu, Pomeranian, Poodle, and mixed) was predominant infested by ectoparasites. Mosallanejad *et al*. [26], noted *R. sanguineus* infestation was the dominant species in two dog breeds (mixed and terrier) in South-west Iran. Hadi *et al*. [10] also showed 8 dogs breed (Beagle, Doberman, Dutch Shepherd, German Pointer, German Shepherd, Labrador, Malinois, and Rottweilers) in Kelapa Dua, Depok dominantly infested by *R. sanguineus*. Its ectoparasite was also infested in local dogs at Bubaneshwar and Thailand [23, 32].

A **B**

Fig 1: A. *Rhipicephalus sanguineus* found from a dog, B. Dog infested by louse egg.

The species of ectoparasites infestation were different, both dog breeds, as seen in Table 1. Ectoparasites infestation of *R. sanguineus* were found almost half of the total examined breeds in dog, followed by *T. canis* 2 breeds and *C. canis* only 1 breed. Researched did by Bahrami *et al*. [33] on the Iran and Iraq Border, delivered *R. sanguineus, C. canis, C. felis, Heamaphysalis flava, Heterodoxus spindera, Linognathus setosus*, and *Otodectes cynotiscanis* in 5 dog breeds. Erwanas *et al*. [34] reported *R. sanguineus, D. canis, R. microplus*, and *C. canis* infestations at Malaysia in 1 dog breed.

3.2. Relative abundance and species dominance on dogs

Ectoparasites relative abundance and species dominance on dogs were presented in Fig. 2. The highest abundance and species dominance were *R. sanguineus* (77.22%, 28.31%), followed by *T. canis* (20.25%, 2.03%), and *C. canis* (2.53%, 0.08 %). Bahrami *et al*. [33] presented the highest species abundance in cross-border Iraq and Iran were *R. sanguineus* (29.39%), followed by *C. canis* (28.89%), *L. setosus* (20.57%), *H. spindera* (10.57%), *H. flava* (6.1%), *C. felis* (2.44%), *O. cynotiscanis* (1.83%). Research done by Omudu *et al*. [31] at Nigeria, the highest abundance were *Rhipicephalus* sp. (53.5%), followed by *Boophilus* sp. (31.4%), *Amblyomma* sp. (8.4%), *Linognathus* sp. (5.5%), *Ctenocephalides* sp. (1.1%). While Abarca *et al*. [35] showed *C. canis* and *C. felis* on dogs were the highest abundance ectoparasites in Chile (66% and 54%, respectively).

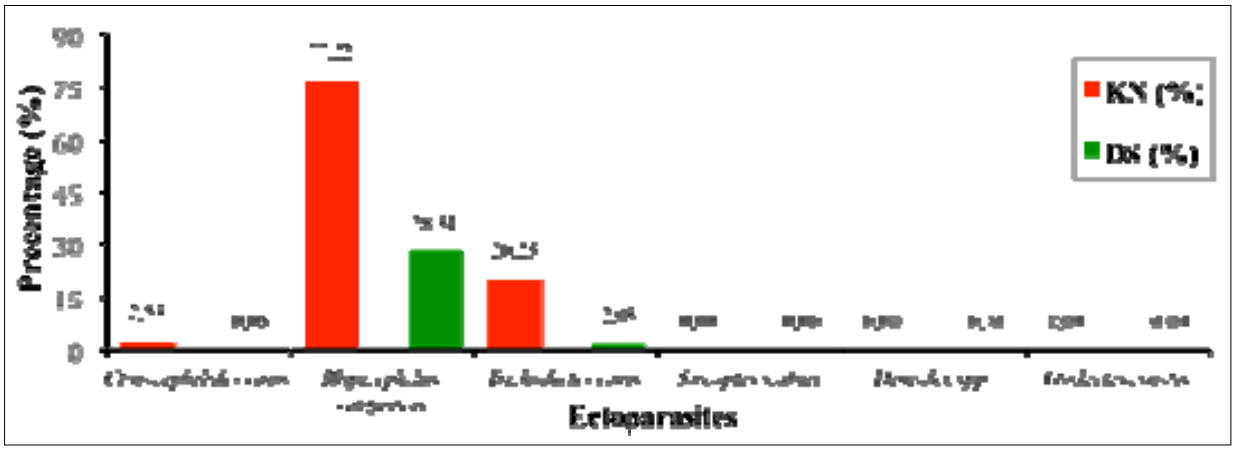

Fig 2: Relative abundance and species dominance ectoparasites on dogs in North Jakarta Animal Clinic (July-October 2017)

3.3 Prevalence of ectoparasites infestation on dogs

Table 2 showed the highest prevalence of ectoparasites infestation on dogs was tick (*R. sanguineus*, 36.67%), followed by lice (*T. canis*, 10%), flea (*C. canis*, 3.33%). Research in Thailand reported the highest prevalence of ectoparasites infestation was *R. sanguineus* (79.5%), followed

by *C. canis* (26.5%) [23]. Research reported by Mosalanajed [26] prevalence of *R. sanguineus* and *C. canis* on pet dog in Iran were 7.14% and 2.38% respectively. Meanwhile, Neagu *et al*. [36] in Dambovita conveyed the highest prevalence was *C. canis* (88.18%), then *T. canis* (26.36%), *Ixodes ricinus* (19.09%), *Dermacentor reticulatus* (14.54%), *Demodex canis* (17.27%), *S. scabiei* (0.90%).

Table 2: Ectoparasites prevalence on dogs in North Jakarta Animal Clinic (July-October 2017)

Ectoparasites	Number examined	Number positive	Prevalence (%)
Flea:			
Ctenocephalides canis	30	1	3.33
Tick:			
Rhipicephalus sanguineus	30	11	36.67
Lice:			
Trichodectes canis	30	3	10.00
Mite:			
Sarcoptes scabiei	30	0	0.00
Demodex spp.	30	0	0.00
Otodectes cynotis	30	0	0.00

3.4. Infestation degree of dog ectoparasites

The degree of infestation *R. sanguineus* was found very high (++++) on dogs, followed by *T. canis* medium (+++), *C. canis* low (+). Previous research in Indonesia by Hadi *et al*. [10], recorded degree of infestation *R. sanguineus* was very high (++++) on dogs in Baharkam, Depok, while in Atang Sanjaya (ATS), Bogor low (+). Another side Bahrami *et al*. [33] showed at cross-border Iraq and Iran, the degree of *C. canis* infestation on dogs was low (+). Shukullari *et al*. [28] conveyed on dogs in Albania degree of infestation in 4 species (*Ctenocephalides* spp., *Pulex irritans*, *I. ricinus*, *R. sanguineus*) were low (+).

Table 3: Infestation degree of dog ectoparasites in North Jakarta Animal Clinic (July-October 2017)

Ectoparasites	Degree of Infestation
Flea:	
Ctenocephalides canis	+
Tick:	
Rhipicephalus sanguineus	++++
Lice:	
Trichodectes canis	+++
Mite:	
Sarcoptes scabiei	-
Demodex spp.	-
Otodectes cynotis	-

(-) = no ectoparasites, (+) = 1-5 ectoparasites (mild), (++) = 6-10 ectoparasites (moderate), (+++) = 11-20 ectoparasites (high) (++++) = > 20 ectoparasites (very high).

3.5. Species of dog endoparasites

Endoparasites were found 5 species from 17 positive dogs (Table 5). 2 species identified as blood parasites (*Rickettsia*) (*Anaplasma* spp. and *Ehrlichia* spp.) and 3 species helminth (*Strongyloides* sp., *Trichuris* sp., and *Ancylostoma*) that infection on 17 dogs. Table 4 showed that *Anaplasma* spp. and *Erlichia* spp., found on 7 dogs, respectively with 23.33% prevalence. Meanwhile prevalence of *Strongyloides* sp., *Trichuris* sp., and *Ancylostoma*, 3.33% and found on 1 dog, respectively. 4 species targeted in this study not found on dog (*Borrelia burgdorferi*, *Leishmania*, *Dirofilaria immitis,* and *Thelazia callipaeda*). The previous study at Italia found 102 number of dogs infected by *E. canis* and 59 dogs infected by *Anaplasma* spp. [37].

Table 4: Prevalence of endoparasites on dogs in North Jakarta Animal Clinic (July-October 2017)

Endoparasites	Number examined	Number positive	Prevalence (%)
Blood parasites/Rickettsia:			
Anaplasma spp.	30	7	23.33
Ehrlichia spp.	30	7	23.33
Borrelia burgdorferi	30	0	0
Leishmania	30	0	0
Helminths infection:			
Dirofilaria immitis	30	0	0
Strongyloides sp.	30	1	3.33
Trichuris sp.	30	1	3.33
Ancylostoma	30	1	3.33
Thelazia callipaeda	30	0	0

3.6. Prevalence of dog endoparasites

Prevalence of endoparasites (*Anaplasma* sp. and *Ehrlichia* sp.) higher than other endoparasites (Table 4). A dog that already infected by blood parasites rarely has medicated. The infected dog will be taken to the veterinarian if the only clinical symptom has developed and caused physical harm

and economic loss (breeder) or the dog already in very bad condition (anemia).

Helminth case infection usually by the owner has always done with prevention used anthelmintic frequently two times a year. Helminth infection spread from the contacted dog with the environment that infected by infective stage of helminth. Another side, helminth infection done by transplacental transmission. *Ancylostoma caninum* higher prevalence than the other endoparasites in Russia [38].

Table 5: Prevalence of infestation and infection on dogs in North Jakarta Animal Clinic (Juli-Oktober 2017)

Infestation and Infection	Number examined	Number positive	Prevalence (%)
Mixed infection			
Anaplasma spp. + *Ehrlichia* spp.	30	4	13.33
Strongyloides sp. + *Trichuris* sp.	30	1	3.33
Infestation and Infection			
Ancylostoma + *Rhipicephalus sanguineus*	30	1	3.33
Anaplasma spp. + *Ehrlichia* spp.+ *R. sanguineus* + *Tricodectes canis*	30	5	16.66
Anaplasma spp. + *Ehrlichia* spp.+ *Strongyloides* sp. + *Trichuris* sp. + *R. sanguineus*	30	1	3.33

Endoparasites could be caused by vector transmission. Vector transmission, such as: mosquitos, flies, ticks, fleas, louse, and mites. Endoparasites infection on dogs might be caused by re-infection incidence. Campos *et al.* [39] reported, used of anthelmintic could not stop transmission of helminth life cycle stages when re-contamination occurs.

The result of this study also showed mixed infection and infestation on the dog, either endoparasites and ectoparasites (Table 5). Prevalence of mix infection *Anaplasma* sp. + *E. canis* was 13.33%, *Strongyloides* sp. + *Trichuris* sp., and mix infestation *R. sanguineus* + *C. canis* was 3.33%, respectively. Other showed, mix infection with infestation prevalence *Anaplasma* spp. + *Ehrlichia* spp.+ *R. sanguineus*+ *T. canis* was 16.66%, *Ancylostoma* + *R. sanguineus, Anaplasma* spp. + *Ehrlichia* spp.+ *Strongyloides* sp. + *Trichuris* sp. + *R. sanguineus* was 3.33% respectively.

Endoparasites infection on dogs caused by direct contact of the host with invective agents or through the vector. Dogs that already infected by endoparasites will remain became the host or breeding and feeding place for endoparasites. Ectoparasites also made the dog as a host for feeding and breeding place, ectoparasites such: lice, mites, fleas, and ticks needed nutrition from host blood to continue its lifecycle stage.

The result of this study showed the incidence of infestation and infection could occur due to no competition between endoparasites and ectoparasites to obtained nutrition from the host. As found in gastrointestinal helminth, only feed nutrition from the host digestive tract, whereas the blood parasites only feed nutrition from host red blood cells. This condition also applies to ectoparasites (ticks, lice, and fleas) that only feed nutrition from the blood on the host skin surface, meanwhile other ectoparasites (mites) found feed skin tissue by the made tunnel for feeding and breeding place.

4. Conclusion

The study found 3 species ectoparasites infestations on dogs were (*Rhipicephalus sanguineus, Trichodectes canis, Ctenocephalides canis*), with prevalence 36.67%, 10.00%, and 3.33% respectively. Meanwhile for endoparasites found 5 species (*Anaplasma* spp., *Ehrlichia* spp., *Strongyloides* sp., *Trichuris* sp., and *Ancylostoma*) with prevalence 23.33%, 23.33%, 3.33%, 3.33%, and 3.33%. The result of the present study expected becomes information for the owners and veterinarians to prevent and control ectoparasites infestation.

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6. References

1. Mullen GR, Durden LA. Introduction. In: Medical and Veterinary Entomology (Mullen GR, Durden LA, Eds). Elsevier Science, USA, 2002, 1-13.
2. Acha PN, Szyfres B. Zoonoses and Communicable Diseases Common to Man and Animals. Ed. Pan American Health Organization, Washington DC. 2003; 3(3):1-395.
3. Service M. Medical Entomology for Students. Ed 5. Cambridge University Press, Cambridge, 2012, 1-303.
4. Meijer C, Massar R. Prevalence and awareness of zoonotic parasites of dogs on Curaçao. Faculty of Veterinary Medicine, Utrecht University, Utrecht, 2012, 1-28.
5. Chen J, Jun Xu M, Hui Zhou D, Qun Song H, Ren Wang C, Quan Zhu X. Canine and feline parasitic zoonoses in China. Parasites & Vectors. 2012; 5(152):1-8.
6. Langaanes PE. Survey of endoparasitic infections of dogs in a region of Norway [Thesis]. University of Veterinary Medicine Budapest (UVMB), Budapest, 2016, 1-43.
7. Pereira A, Martins A, Brancal H, Vilhena H, Silva P, Pimenta P *et al*. Parasitic zoonoses associated with dogs and cats: a survey of Portuguese pet owners' awareness and deworming practices. Parasites & Vectors. 2016; 9(245):1-9.
8. Irwin PJ, Jefferies R. Arthropod-transmitted diseases of companion animals in Southeast Asia. Trends in Parasitology. 2004; 20(1):27-34.
9. Guerin PJ, Olliaro P, Sundar S, Boelaert M, Croft SL, Desjeux, *et al*. Visceral leishmaniasis: current status of control, diagnosis and treatment, and a proposed research and development agenda. The Lancet Infectious Diseases. 2002; 2(8):494-501.
10. Hadi UK, Soviana S, Pratomo IRC. Prevalence of ticks

and tick-borne diseases in Indonesian dogs. Journal of Veterinary Science and Technology. 2016; 7(3):1-7.
11. Baneth G, Thamsborg SM, Otranto D, Guillot J, Blaga R, Deplazes P, *et al*. Major Parasitic Zoonoses Associated with Dogs and Cats in Europe. J Comp. Path. 2016; 155:S54-S74.
12. Su BL, Shin SS. In Panorama of cat parasitic & vector borne diseases in Asia. Parasitoses & vector borne diseases of cats. Merial, Lyon, 2015.
13. Traub RJ, Inpankaew T, Sutthikornchai C, Sukthana Y, Thompson RA. PCR-based coprodiagnostic tools reveal dogs as reservoirs of zoonotic ancylostomiasis caused by Ancylostoma ceylanicum in temple communities in Bangkok. Veterinary Parasitology. 2008; 155(1):67-73.
14. Paul M, King L, Carlin EP. Zoonoses of people and their pets: a US perspective on significant pet-associated parasitic diseases. Trends in Parasitology. 2010; 26(4):153-154.
15. Communicable Disease Center (CDC). Pictorial keys to arthropods, reptiles, bird and mammals of public health significance. Public Health Service, Georgia, Atlanta. 1966; 30333:1-192.
16. Walker AR, Bouattour A, Camicas JL, Estrada-Peña A, Horak IG, Latif AA, *et al*. Ticks of Domestic Animals in Africa: a Guide to Identification of Species. Bioscience Reports, Scotlandia, 2003, 1-221. ISBN: 0-9545173-0-X.
17. Hadi UK, Soviana S. Ektoparasit: Pengenalan, Identifikasi dan Pengendaliannya, IPB Press, Bogor. 2013, 1-211.
18. Johansson S. General health conditions in the dog population of Lilongwe. Examensarbete, Upsala, Sweden, 2015, 1-31. ISSN: 1652-8697.
19. IDEXX Laboratories. The SNAP® 4Dx® Plus Test provides sensitive and specific detection of tick-borne diseases, Abaxis® Vet Scan® Canine Ehrlichia Rapid Test demonstrates poor sensitivity compared to reference methods. IDEXX, United States, 2016, 1.
20. Hendrix CM, Robinson Ed. Diagnostic parasitology for veterinary technicians. Ed 3. Mosby Elsevier, St. Louis, Missouri. 2006, 1-285. ISBN-13: 9780323036146.
21. Maazi N, Jamshidi Sh, Hadadzadeh HR. Ear Mite Infestation in Four Imported Dogs from Thailand; a Case Report. Iran J Arthropod-Borne Dis. 2010; 4(2):68-71.
22. Colella V, Kirkova Z, Fok E, Mihalca AD, Tasić-Otašević S, Hodžić A, *et al*. Increase in eyeworm infections in Eastern Europe. Emerg. Infect. Dis. 2016; 22:1513-1515.
23. Nuchjangreed C, Somprasong W. Ectoparasite species found on domestic dogs from Pattaya district, Chon Buri province, Thailand. Southeast Asian Journal of Tropical Medicine and Public Health. 2007; 38:203.
24. Sigit SH. Studies on the organization of oribatid mite communities in three ecologycally different grasslands [Dissertation]. Oklahoma State University, Oklahoma, 1968, 1-97.
25. Hadi UK, Rusli VL. Infestasi caplak anjing Rhipicephalus sanguineus (Parasitiformes: Ixodidae) di daerah Kota Bogor. Jurnal Medis Veteriner Indonesia. 2006; 10(2):55-60.
26. Mosallanejad B, Alborzi AR, Katvandi N. A survey on ectoparasite infestations in companion dogs of Ahvaz district, south-west of Iran. Journal of Arthropod-Borne Diseases. 2012; 6(1):70-78.
27. Mirzaei M, Khovand H, Akhtardanesh B. Prevalence of ectoparasites in owned dogs in Kerman city, southeast of Iran. Journal of parasitic diseases. 2016; 40(2):454-458.
28. Shukullari E, Rapti D, Visser M, Pfister K, Rehbein S. Parasites and vector-borne diseases in client-owned dogs in Albania: infestation with arthropod ectoparasites. Parasitology Research. 2016; 1(116):399-407.
29. Beugnet F, Bourdeau P, Monfray CK, Cozma V, Farkas R, Guillot J. Parasites of domestic owned cats in Europe: co-infestations and risk factors. Parasites &Vectors. 2014; 7(1):291.
30. Mateescu R, Tudor P, Mateescu C. Study concerning ectoparasites infestation in dogs and cats in the Târgovişte-Dâmboviţa Area. Scientific Works. C Series. Veterinary Medicine. 2012; 58(4):262-271. Print ISSN: 1222-5304.
31. Omudu EA, Okpe G, Adelusi SM. Studies on dog population in Makurdi, Nigeria (II): A survey of ectoparasite infestation and its public health implications. Journal of Research in Forestry, Wildlife and Environment. 2010; 2(1):94-106.
32. Sahu A, Bijayendranath M, Panda MR, Sardar KK, Manaswini D. Prevalence of tick infestation in dogs in and around Bhubaneswar. Veterinary World. 2013; 6(12):982-985.
33. Bahrami AM, Doosti A, Ahmady AS. Cat and dogs ectoparasite infestations in Iran and Iraq boarder line area. World Applied Sciences Journal. 2012; 18(7):884-889.
34. Erwanas AI, Chandrawathani P, Premaalatha B, Zaini CM, LILY RM, Jamnah O, *et al*. Parasitic infections found in pet and stray dogs in Ipoh, Malaysia. Malaysian Journal of Veterinary Research. 2014; 5(1):27-34.
35. Abarca K, Gárate D, López J, Jamett AG. Flea and ticks species from dogs in urban and rural areas in four districts in Chile. Archivos de Medicina Veterinaria. 2016; 48(2):247-253.
36. Neagu A, Tudor P, Vlagioiu C. Prevalence of ectoparasites infestation in dogs from moreni-dambovita area. Scientific Works. Series C. Veterinary Medicine. 2013; 59(3):135-138.
37. Piantedosi D, Neola B, Alessio ND, Prisco FD, Santoro M, Pacifico L, *et al*. Seroprevalence and risk factors associated with *Ehrlichia canis*, *Anaplasma* spp., *Borrelia burgdorferi sensu lato*, and *D. immitis* in hunting dogs from southern Italy. Parasitol Res, 2017, 1-10.
38. Moskvina TV, Zheleznova LV. A survey on endoparasites and ectoparasites in domestic dogs and cats in Vladivostok, Russia. Veterinary Parasitology: Regional Studies and Reports. 2015; 1:31-34.
39. Campos DR, Oliveira LC, Siqueira DF De, Perin LR, Campos NC, Aptekmann KP, *et al*. Prevalence and risk factors associated with endoparasitosis of dogs and cats in Espírito Santo, Brazil. Acta Parasitologica. 2016; 61(3):544-548.