PREVALENCE OF ECOTOPARASITES IN PET ANIMALS (DOG, CAT AND RABBIT) OF TANSEN MUNICIPALITY, PALPA

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Batch: 2018

A thesis submitted in partial fulfillment of
the requirements for the award of the degree of Master of
Science in Zoology with special paper Parasitology

Submitted to

Central Department of Zoology
Institute of Science and Technology
Tribhuvan University
Kirtipur, Kathmandu
Nepal

April, 2021

DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

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RECOMMENDATIONS

This is to recommend that thesis entitled "**Prevalence of ectoparasites in pet animals (dog, cat and rabbit) of Tansen Municipality, Palpa**" has been carried out by Miss Amrita Saru for the partial fulfilment of Master's Degree of Science in Zoology with special paper Parasitology. This is her original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions.

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LETTER OF APPROVAL

On the recommendation of supervisor "Mr. Janak Raj Subedi" thesis submitted by Amrita Saru entitled "**Prevalence of ectoparasites in pet animals (dog, cat and rabbit) of Tansen Municipality, Palpa**" is approved for the examination in partial fulfilment of the requirements for Master's Degree of Science in Zoology with special paper Parasitology.

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CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Amrita Saru entitled "**Prevalence of ectoparasites in pet animals (dog, cat and rabbit) of Tansen Municipality, Palpa**" has been accepted as a partial fulfilment for the requirements of Master's Degree of Science in Zoology with special paper Parasitology.

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to Central Department of Zoology for providing me the opportunity to conduct this research.

I am extremely thankful to my supervisor Mr. Janak Raj Subedi for his tremendous support, persistent guidance and encouragement throughout the research without which the study would have been incomplete.

I am thankful to Laboratory Officer Mrs. Kamala Mishra, Office Assistant Mr. Basanta Kumar Khanal and Technical Assistant Mr. Ganesh Lama for providing laboratory equipment to carry out the laboratory works. Similarly, I would also like to thank administration staff.

I would like to thank Dolma Resmi, Deepak Bashyal and my family for their help during my field work.

I am grateful to Central Department of Zoology, Palpa for providing help to conduct my lab work.

Finally, I would like to express my sincere thanks to my parents, my sisters Apsara Saru and Priyanka Saru for their support, encouragement and motivation throughout the research.

Amrita Saru

T.U. Registration No.:5-2-49-228-2013

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ABSTRACT

Pet is kept for pleasure, enjoyment and companionship instead of its utility. They may harbor many ectoparasites such as tick, flea, mite etc. Various ectoparasites cause significant infestations in pet animals. The purpose of study was to determine the prevalence of ectoparasites on pet animals of Tansen Municipality, Palpa. Ectoparasites were collected from 134 pet animals (88 dogs, 36 cats and 10 rabbits). They were collected by hand picking method from June to September, 2019. They were preserved in vials containing 70% alcohol, slides were prepared and identified by using different keys. Data analysis was done by using MS-Excel 2010. Among 134 pets examined, 92 were found to be infested with ectoparasites such as tick, flea and lice. The identification was done upto species level. Among total dogs examined, 65 were found to be infested with *Rhipicephalus sanguineus* (42.04%) *Ctenocephalides canis* (29.54), *Ctenocephalides felis* (31.81%), *Linognathus setosus* (3.4%). Among total cat examined, 21 were found to be infected with *Rhipicephalus sanguineus* (11.11%), *Ctenocephalides canis* (5.55%), *Ctenocephalides felis* (52.7%). Among total rabbit examined, 6 were found to be infested with *Ctenocephalides canis* (10%), *Ctenocephalides felis* (50%). Single infestation was found highest among all pet animals and the finding revealed that dogs were more susceptible to ectoparasite infestation than cats and rabbits. A semi- structured questionnaire was set up to achieve the information from 68 pet owners. Only few of the respondents knew about the parasitic disease. Considering the level of awareness, pet related zoonotic diseases are the major threat of public health in the present study. Extensive public education about pet related zoonoses is needed to create awareness on the public and minimize the risk disease.

1. INTRODUCTION

1.1 Background

There has been a long history of relationship between human and domestic animals (Grandgeorge and Hausberger 2011). Human has brought some animal species in their home. This domestication helps to induce the establishment of relationship between human and animals (Hinde 1979). A domesticated animal which is kept for pleasure rather than the utility is known as pet animal (Rollin and Rollin 2003). Pet animal is kept by man, in particular in household, for private enjoyment and companionship (Council of Europe 1987 article 1). People treat the pet animals similar to their children (Franklin 1999). Man's emotional relationship to pets was present before industry, advertising and publishing discovered them. Pets provide love, loyalty and companionship to their master. Since the beginning of his existence, man has kept pets, but the quality of the interaction between man and his pet is changing (Szasz 1968). The role of pets (dogs and cats in particular) in human society has changed in recent years. Nowadays pets are an integral part of the human family and this aspect has many social and emotional impacts. For the positive effects on human health, pets are also employed in some special and therapeutic activities known as "Pet Therapy" (Verga and Michelazzi 2009). Pet keeping provides physical and psychological benefits to man (Friedman and Thomas 1995). Pet animals provide social support (Allen et al. 2002), reduce depression (Souter and Miller 2007). They create opportunities for their owners to make new social relationships among different people (Eddy et al. 1988). Pets can act as friends and offer unconditional love to their owners (Hill et al. 2008). Pets stimulate positive emotions such as pleasure and promote the feeling of being protected and safe both inside and outside the home (Siegel 1990).

Worldwide, the importance of pet animals has grown. High percentages of the populationsu are owners of pet animals particularly in towns with different percentages from country to country. The industry of animal feed and pet animal equipment as well as the number of pet animal shops is growing (Steiger 2006). In today's society, the variety and number of pets have increased (Caya 2015). The popular species of pets are dogs, cats, fishes, birds, rabbits, hamsters and guinea pigs (Alderton et al. 2011). But non-domesticated animals such as reptiles, exotic mammals, amphibians and exotic birds have become popular as pets nowadays. (Mitchell and Tully 2008). However, dogs and cats are the most common pet animals worldwide (Anderson 2003). The benefits of having a pet animal are undisputed

(McConnell et.al 2011) but they may harbour many parasites potentially transmissible to humans, which may represent a health risk, especially to children, the elderly and the immunocompromised (Irwin 2002). A parasite is an organism that takes benefit from another (the host), without giving something back and usually cause some damage to the host. Parasites constitute a diverse group of organisms that may affect a wide range of animal hosts, including amphibians, birds, fishes, mammals, and reptiles. They may be generally subdivided as endoparasites and ectoparasites, according to their location in the host. Ectoparasites may also be classified as permanent (e.g., lice and mites) or nonpermanent (e.g., ticks and mosquitoes), depending on the relationship with their host; i.e., whether their life cycle takes place solely on their hosts or also in the environment (Dantas-Torres and Otranto 2014). Ectoparasites are organisms which inhabit the skin or outgrowths of the skin of another organism (the host) for various periods and may be detrimental to the latter. Ectoparasites can parasitize a wide range of organisms. In many cases, infestations cause little damage to the host and do not require treatment, but in others the arthropod ectoparasite can cause serious disease, either directly by the physical damage they cause, or indirectly by transmitting microorganisms or encouraging secondary infection (Nair 2014).

Various ectoparasites cause significant infestations in many kinds of domestic animals including livestock, pets, laboratory animals, poultry, fish and bees (Marshall 1981). Many of these ectoparasites (e.g. most lice) are host-specific, while others (e.g. many ticks) parasitize a wider range of hosts. The vast majority of ectoparasites are invertebrates. Most invertebrate ectoparasites are arthropods; insects and arachnids typically parasitize terrestrial domestic animals, while crustaceans are associated with fish (Hopla et al. 1994). The members of the class Arachnida include the order Ixodida (ticks) and Mesostigmata (mites) whereas class Insecta comprises Phthiraptera (lice) and Siphonaptera (fleas) (Razali et al. 2018). Ectoparasites including lice, ticks and mites play an important role in the transmission of certain pathogens (Loomis 1986). Insect and arachnid ectoparasites display a wide range of forms of association with their hosts and the activity of ectoparasite infesting pet animal results in a wide range of pathogenic effects (Wall 2007).

Ectoparasites, such as tick, flea, lice, and mite live on domestic dogs. Some ectoparasites of dogs such as fleas are moderately specific and the species *Ctenocephalides canis, Ctenocephalides felis, Pulex irritans and Echidnophaga gallinacea* (from poultry) are usually described in dogs (Alcaino et al. 2002). Different tick species infest dogs depending on the geographical area; however, one of the most widely distributed is *Rhipicephalus sanguineus* (Dantas-Torres 2008). Dogs can be infested by lice including the chewing lice *Heterodoxus spiniger* and *Trichodectes canis*, as well as the sucking louse *Linognathus setosus* (AbuZeid et al. 2015). Mites found in dogs are *Demodex canis*, *Sarcoptes scabiei* var. *canis*, *Otodectes cynotis* (Chee et al. 2008). Likewise, the cat flea, *Ctenocephalides felis*, is one of the most important ectoparasite of cat (Rust & Dryden 1997). *Felicola subrostratus* is the only louse that affects cats (Grant 1989).Cats can also be infested with ticks, *Rhipicephalus sanguineus*, *Rhipicephalus turan, Haemaphysalis adleri* as well as with mites such as *Notoedres cati*, *Cheyletiella blakei* and *Otodectes cynotis*, which causes direct damage to the infested animal (Salant et al. 2014). Similarly, *Spilopsyllus cuniculi* is a common flea that infests wild rabbits (Kraus et al. 1984) but *Ctenocephalides canis* or *felis* is the usual flea that is found on pet rabbits (Brown 2002). *Haemodipsus ventricosus* is a sucking louse found in wild rabbits but occasionally found on pet rabbits (Owen 1992). *Cheyletiella parasitivorax* is typically found on rabbits (Cohen 1980). *Sarcoptes scabies var. cuniculi* and *Psoroptes cuniculi* are most common mites prevailed in rabbits (Panigrahi et al. 2016).

1.2 Objectives

1.2.1. General objective

- To determine the prevalence of ectoparasites of pet animals (dag, cat and rabbit) in Tansen, Palpa.

1.2.2. Specific objectives

- To identify the ectoparasites of different pet animals (dog, cat and rabbit).
- To compare the prevalence of ectoparasites of different pet animals.
- To analyse the Knowledge, Attitude and Practice (KAP) of the owner about the ectoparasites of pet animals.

1.3 Significance

Pets are regarded as companions by people. Therefore, they depend on pets to prevent loneliness and to relax (Pauliuc and Fu 2018). Ectoparasites infestation is common in pet animals (Erwanas et al. 2014). A wide range of pathogens such as viruses, bacteria, protozoan, helminths are transmitted by various arthropods. Therefore, they may cause vector-borne diseases. Ticks, fleas may serve as vectors for these pathogens which not only may impact the health of the animals but are considered zoonotic leading to the serious problem in public health. But many people are not aware the effect of ectoparasites. So, this study aims to identify and know the prevalence of ectoparasites of pet animals of this study area which is helpful for the pet owners to improvise the hygienic condition of their pets.

2. LITERATURE REVIEW

Ectoparasites are a common cause of skin diseases in pet animals. In global context, many studies have been carried out regarding ectoparasite infestation among pet animals. But very few study has been done in national context of Nepal.

Global context

A survey was conducted among five domestic rabbits in Germany where fleas were collected between September and November. The fleas were further identified as *Ctenocephalides felis*, *Hystrichopsylla talpae* and *Spilopsyllus cuniculi* (Visser et al. 2001).116 dogs that lived in rural areas of Buenos Aires province, Argentina were examined from October 2001 to July 2002 for investigation of ectoparasite. The dog's skins was rubbed with a piece of cotton soaked in ether in order to facilitate the extraction of ectoparasites by making them drowsy. 5193 ectoparasites were collected by examining the animal directly and by using a fine comb. Then, ectoparasites were kept in 70% ethanol and identified as *Ctenocephalides canis*, *Rhipicephalus sanguineus*, *Linognathus setosus*, *Heterodoxus spiniger* (Gonzalez et al. 2004).

A total of 1026 fleas were sampled from 1922 dogs and 1838 cats from 12 different veterinary practices or clinics in three areas of Germany between July 2003 and June 2004. Dogs and cats were thoroughly combed with a stainless steel fine-toothed flea comb (12 points/cm) four times (two times each right and left paramedian sight) on the dorsal and on the ventral trunk, respectively. The comb was pulled through the hair coat from the neck until the origin of the tail dorsally and from the neck until the inguinal region ventrally. The captured specimens were counted, collected in small plastic containers (with the relevant host and time data) and preserved frozen until identification. The identification revealed the presence of *Ctenocephalides felis*, *Ctenocephalides canis*, *Archaeopsylla* erinacei, Pulex *irritans*, *Ceratophyllus gallinae*, *Ceratophyllus garei*, *Spilopsyllus cuniculi*, *Paraceras melis*, *Megabothris* sp. (Beck et al. 2006).

Sixteen adult rabbits from a rabbit husbandry in Germany were found to be infested by flea (*Ctenocephalides felis*) and mite (*Cheyletiella parasitovorax* and *Listrophorus gibbus*). All rabbits were thoroughly combed craniocaudal with a stainless steel fine-toothed flea comb for flea collection and by combing, obtained hair and skin samples were examined microscopically for detection of mites (Hansen et al. 2006). Skin scrapings were taken from

both pinnae of a 2-year-old female New Zealand rabbit and and hair was plucked from the ventral abdominal region. Both scrapped skin and hair were mixed with mineral oil and examined under the low power objective of a microscope. The observation revealed the presence of *Psoroptes cuniculi* (Acar et al. 2007). A total of 48 domestic dogs were inspected for ectoparasites at different seasons from October 2004 to July 2005 in Erzurum region of Turkey. *Ctenocephalides felis*, *Rhipicephalus sanguineus* were collected with the application of a fine comb in all areas of the body for 10 min (four times a day) as well as rubbing the dog's skin with a piece of cotton soaked in ether. *Sarcoptes scabiei* var. *canis* was collected with deep skin scrapings on the external ear (Aldemir 2007).

A study was conducted among two hundred and two domestic dogs with an age range of 1 month to 7 years for the examination of ectoparasitic infestations in some Ijebu communities of Ogun State, Southwest Nigeria, between January and December in 2007. 1358 specimens of ectoparasitic arthropods were recorded by checking and sometimes combing all the body regions beginning from the head, followed by the neck, dorsum, trunk, limbs and tail and then transferring specimens into bottles containing 70% ethanol. The specimens were identified as *Rhipicephalus sanguineus*, *Haemophysalis leachii*, *Ctenocephalides canis* and *Damalina* sp. The dog bathing 1 time/month with non-chemical treated water was the commonest practice, although the use of chemicals including kerosene, lindane, diazinon and coumaphos was also practised by some dog owners (Agbolade et al. 2008). A survey of ectoparasites on domestic animals (94 dogs and 6 cats) was conducted in Tak province, Thailand in 2009. Fleas were collected by combing the coats of the animals with flea combs. Ticks and lice were detected either by visual examination or by brushing the coat and collected them using forceps. *Rhipicephalus sanguineus*, *Ctenocephalides felis orientis*, *Echidnophaga gallinacea*, *Heterodoxus spiniger* were found in dogs whereas *Ctenocephalides felis felis*, *Echidnophaga gallinacea* were found in cats (Changbunjong et al. 2009).

A survey was carried out among 2267 dogs and 1000 cats in order to gain current information on flea species (Siphonaptera: Pulicidae) infesting dogs and cats living in urban and rural areas of Hungary from December 2005 to November 2006. Each dog and cat was visually examined thoroughly and combed with a stainless steel, fine-toothed flea comb. After combing, the flea comb was held over a white tray and any fleas in the comb or falling into the tray were collected with forceps and immediately transferred to individually labelled Eppendorf tubes containing 70% ethanol and stored at room temperature. The

identified ectoparasites were *Ctenocephalides felis*, *Ctenocephalides canis* and *Pulex irritans*. More than half (51.4%) of the owners of infested dogs and cats had not used flea control products in the past year or more. Rural owners were five times more likely than urban owners not to have done so. Most dog owners believed that their dogs had acquired fleas from other dogs (73.6%) or cats (21.1%), only 5.3% of them thought that the source of their pet's flea infestation was from the environment and less than a quarter of cat owners (22.8%) believed that their cats had become infested from their surroundings (Farkas et al. 2009).

A survey was conducted among 425 dogs in Makurdi, Nigeria to investigate the status of dog infestation by ectoparasites, compare infestation between stray and restricted dogs and investigate some beliefs and practices by dog owners. 379 ectoparasites were recovered from dogs by brushing and handpicking methods. *Rhipicephalus, Amblyomma*, *Boophilus*, *Linognathus*, *Ctenocephalides* species were identified by standard methods (Omudu, et al. 2010). A survey was conducted among 720 dogs to determine the distribution of ectoparasites in dogs in Panama. There was the collection of seven species of ticks (*Rhipicephalus sanguineus*, *Amblyomma cajennense*, *Amblyomma ovale*, *Amblyomma oblongoguttatum*, *Ixodes affinis*, *Ixodes boliviensis*, *Haemaphysalis juxtakochi*), four species of fleas (*Ctenocephalides felis*, *Ctenocephalides canis*, *Rhopalopsyllus cacicus*, *Pulex simulans*), two species of lice (*Heterodoxus spiniger*, *Trichodectes canis*) and one species of botfly (*Dermatobia hominis*)(Bermúdez and Miranda 2011).

A total number of 983 ectoparasites were collected from 802 dogs and 50 cats in Iran and Iraq border line area by combing and rubbing their skin with a piece of cotton sucked in ether and identified that infestation were from *Cetenocephalides canis* (the most predominant) *Rhipicephalus sanguineus*, *Linognathus setosus*, *Cetenocephalides felis*, *Otodectes cynotiscanis* (in dogs) and *Cetenocephalides felis* & *Otodectes cynotis* (in more than half of the cats).The observation revealed that dog with dark or black hair had more parasitic infestation then those with white/light hair as well as suggested that dogs and cats should be kept on cement or bricks carpet rather than the soil or grass (Bahrami et al. 2012). A study was conducted in order to determine the occurrence of ectoparasites on 194 dogs in rural regions of the state of Minas Gerais, Brazil from June to August 2004. Ectoparasites were randomly collected which included *Ctenocephalides felis*, *Ctenocephalides canis*, *Pulex irritans*, *Amblyomma* sp., *Rhipicephalus sanguineus*, *Rhipicephalus microplus*, *Amblyomma tigrinum*, *Amblyomma ovale*, *Heterodoxus spiniger*, *Dermatobia homini*

(Costa-Junior et al. 2012). A survey was conducted among 143 dogs to identify and estimate the frequencies of ectoparasites in Tehran, Iran from September 2006 to September 2007. Ticks, fleas and lice were collected respectively by using forceps, combing or brushing where as deep skin scrapings were collected from the head, pinnae, thoracic-abdominal areas, and elbows or paws for mite collection. 52 dogs were found to be infested with *Rhipicephalus bursa* and *Rhipicephalus sanguineus*, *Ctenocephalides canis*, *Pulex irritans*, *Sarcoptes scabiei* var. *canis*, *Otodectes cynotis*, *Demodex canis*, *Trichodectes canis* and *Linognathus setosus* (Jamshidi et al. 2012). Similarly, ectoparasites were collected from dogs by using comb and tweezer in 83 rural homes at five study sites on the Caribbean slope of Costa Rica. Specimens were identified and separated according to species. The frequency and coexistence of *Ctenocephalides felis*, *Pulex simulans*, *Trichodectes canis*, *Heterodoxus spiniger*, *Rhipicephalus* sanguineus, *Rhipicephalus (Boophilus) microplus and Amblyomma ovale* were determined and found out *C. felis* and *P. simulans* as the most common combination (Troyo et al. 2012).

A study was conducted among 212 domestic dogs in northwestern parts of Borneo in the state of Sabah, Malaysia in 2012 to determine ectoparasite infestation patterns of domestic dogs. By brushing the dorsal hair coat of dogs from the neck to the tail for 10 min with a flea comb, fleas, lice and ticks were collected and further identified as *Ctenocephalides orientis*, *Ctenocephalides felis felis*, *Heterodoxus spiniger*, *Hipicephalus* sanguineus, Haemaphysalis *bispinosa*, *Haemaphysalis cornigera*, *Haemaphysalis koenigsbergi and Haemaphysalis semermis* (Wells et al. 2012).The study was carried for investigating the prevalence of ectoparasite infestations in the 251 pet rabbits of Daejeon area, Korea by performing tape strip test, hair coat combing and otoscopy. Only three species of mites were detected: *Cheyletiella parasitovorax* (152 rabbits), *Psoroptes cuniculi* (7 rabbits) and *Ornithonyssus bacoti* (5 rabbits). The study was the first large scale survey of *C. parasitovorax, P. cuniculi* and *O. bacoti* in the pet rabbits of Daejeon area, Korea (Kim et al. 2013).

Twenty crossbreed (California x New Zealand White) rabbits aging from 6 to 11 months were studied in Brazil in 2015. They were infested by three mite species *Psoroptes ovis, Cheyletiella parasitivorax, and Leporacarus gibbus*. For the diagnosis of *P. ovis*, crusts from each ear canal were collected with tweezers and observation of clinical lesions remission was also performed. Diagnosis of *C. parasitivorax* and *L. gibbus* was performed by mite visualization, fur clipping, and superficial skin scrapping (Fernandes et al. 2013).

A cross-sectional study was conducted among 100 dog owners in city of Ithaca, New York for the first time in 2014. The study revealed that there was lack of awareness about zoonotic diseases vectored by mosquitoes, ticks and fleas. There was no practice of regular deworming and prophylactic control of fleas and ticks on pet dogs (Sandhu and Singh 2014). Skin scraped samples were collected with the help of scalpel blade from ear and head region of 189 affected rabbits from Gudli village of Udaipur district, India. Diagnosis was performed by clinical signs and microscopic examination of the skin lesions. *Psoroptes cuniculi* was the only species detected from the lesions and anthropozoonosis was observed (Swarnakar et al. 2014).

A study was carried out among 100 dogs in households that reared domestic dogs in two rural areas of Ebonyi State, Nigeria from October 2014 to February 2015. The ectoparasites were collected by careful examination of the body surfaces and by combing and scraping of the skin. 68% of the dogs were infested with different ectoparasites: *Rhipicephalus sanguineus, Amblyomma species, Ctenocephalides canis, Ctenocephalides felis, Ornithodoros* spp*., Otobius* spp., *Demodex* spp. (Elom et al. 2015). Similarly, a total of 312 interviews were conducted among 243 dog owners and 69 cat owners attending Small Animal Hospital, Faculty of Veterinary Medicine, University of Lisbon, Portugal from January to April 2013. Regarding external parasitic control, 92.2% of the dogs were being treated and 50.5% of these dogs were treated at monthly intervals (all-year round or seasonally). The most common ectoparasitic drug formulation used on dogs was the spot-on imidacloprid + permethrin (89%). Only 28.4% of the dogs were uninterruptedly protected throughout the year from the main canine vector borne diseases transmitted by fleas, ticks, sandflies and mosquitoes. Merely 63.6% of the cats were being controlled with ectoparasitic drugs, most at infrequent drug intervals. Imidacloprid was the most frequently used drug on cats (44.4%) (Matos et al. 2015).

A cross-sectional study was conducted among 921 dogs in four urban-rural paired sites at four districts in Chile in 2016 with the aim of identifying species of fleas and ticks. Four species of fleas (*Ctenocephalides canis, Ctenocephalides felis, Pulex irritans and Echidnophaga gallinacea*) and three species of ticks (*Rhipicephalus sanguineus, Amblyomma tigrinum and Amblyomma triste*) were identified (Abarca et al. 2016).The study was carried out to estimate the epidemic situation of mites, in rabbit dermatologic disease in and around Qena province, in the southern region of Egypt. Two hundred cases of dermatologic disease were investigated by conducting deep skin scraping between May

2011 and October 2012. The overall prevalence was found 25% and *Sarcoptic scabiei cuniculi* (22.5%) was the most frequent mite, followed by *Notoedres cati cuniculi* (2.5%). The study concluded that prevalence of mange mites was still high enough to cause significant economic losses as well as suggested strengthening of the control effort (Elshahawy et al. 2016). Among 204 cats aging from 6months to 15 years examined from Lipari and Vulcano in 2015, 375 ectoparasites were collected by flea combing and tick thumb method. The ectoparasites were further identified as *Ctenocephalides canis, Ctenocephalides felis, Nosopsyllus fasciatus, Ixodes ventalloi and Rhipicephalus pusillus* (Otranto et al. 2017).A cross sectional study was carried out for determining the prevalence of ectoparasites on dogs and cats in Ijurin and Moba LGAs, Nigeria by examining 200 dog and 200 cats. It was found that 170 dogs and 191 cats were infected with two fleas (*Ctenocephalidesfelis, and C. canis*), two mites (*Sarcoptes scabiei*, and *Otodecte scynotis*) and two ticks (*Rhipicephalus sanguineus* and *Haemophys alisleachi*) (Omonijo & Sowemimo 2017).

150 multiple-choice questionnaires were administered to dog and/or cat owners who attended two veterinary clinics in Doha from July to November 2017. 81 owners were aware of transmittable diseases between animals and humans. For external parasite control, only 24 treated their pets with ectoparasiticides on a monthly basis, 67 every 2 months to 1 year, 10 without periodicity and 37 had never done that (Alho et al. 2018).A study was carried out among 217 dogs to report the prevalence of fleas in north-central Mexico in 2016. Fleas were manually collected using entomologic forceps during June to September 2016 and deposited in vials containing 70% alcohol. The fleas were identified as *Ctenocephalides canis* and *Ctenocephalides felis* (Gonzalez-Alvarez et al. 2018). A study was conducted in two-year-old castrated male rabbit from the state of Espirito Santo, Brazil in 2018. Deep scraping of the lesions of the back and ear was performed and a hemostatic forceps was used to perform the trichogram by removing the fur from different parts of the dorsal region of the animal. Then presence of *Leporacarus gibbus, Cheyletiella parasitovorax* and *Psoropotes cuniculi* were detected by microscopic examination (Gorza et al. 2018).

A cross-sectional study was carried out among 164 male an 170 female domestic dogs to investigate the seasonal distribution and common management practices of dogs' ectoparasites in Ilorin, North-Central Nigeria in 2019. Each dog was placed on a white cardboard paper and carefully examined for the presence of ectoparasites. Ticks were

removed using forceps and fleas and lice were recovered by combing the dog's hair along the length of the body using a fine-toothed plastic comb. The identified ectoparasites were tick (Rhipicephalus sanguineus, Haemaphysalis leachii, Amblyomma variegatum) flea (Ctenocephalides canis) and lice (Heterodoxus spiniger). The analysis of seasonal distribution showed that ectoparasites were more abundant during the rainy season than the dry. Bathing of dogs with locally formulated chemicals significantly reduced infestation and handpicking, removal of ectoparasites by brush or application of kerosene were the best practices employed by the dog owners (Opeyemi et al. 2019). A study was carried out between July and December 2016 to detect ectoparasites among 50 New Zealand White Rabbits from North West of Iran. By performing the skin scraping and acetate tape method *Sarcoptes scabiei* and *Cheyletiella parasitivorax* were detected (Hajipour and Zavarshani 2020).

National context

A cross-sectional study was carried out from March 2014 to May 2014 to determine the prevalence of the demodicosis and its associated risk factors from 110 canines of Kathmandu valley including both sheltered and free-roaming. Samples were collected from suspected dogs by skin scrapping & dissolved in 10% KOH for the microscopic diagnosis of the mites. The overall prevalence of demodectic mange was found to be 29.1%. The study showed that demodectic mange was somewhat serious skin infection in canines of Kathmandu valley as well as suggested that the disease was more common in dogs which are left uncared and whose immune system was disturbed (Shrestha et al. 2015). A study was carried out in Chitwan District (central Nepal), to collect baseline data on free-roaming owned dog demographics, assess knowledge, attitudes and practices of dog owners concerning dogs & assess dog health through body condition scores and parasites. Household interview was conducted with owners of free-roaming 60 female dogs. Skin samples were collected for parasite identification and 40% of dogs were found infested by ectoparasites (Massei et al. 2017). A research done in a colony of rabbits in the mid hills of western Nepal revealed the presence of *Psoroptes cuniculi* in those rabbits (NASRI 2011).

3. MATERIALS AND METHODS

3.1 Study Area

The study was conducted from June to September, 2019 in Tansen Municipality. It lies at an altitude of 1372 meters on the southern slope of the Shreenagar hill and coordinates 27° 52′ 0″ N & 83° 33′ 0″ E. It is located on the highway between Butwal and Pokhara, on the crest of the Mahabharat Range or Lesser Himalaya overlooking the valley of the Kaligandaki River to the north. The highway bypasses the town center on the west, protecting pedestrian amenities in the central maze of steep, narrow, winding alleys lined with Newari shop, houses and temples. At an elevation of about 1350m (4430ft) above the sea level. The town experiences a pleasant climate throughout the year. The town enjoys a moderate climate with temperatures rarely exceeding 30 Celsius (86F) or going below freezing. The annual precipitation is about 1500 mm of which 90% falls in the monsoon time (Fig.1).

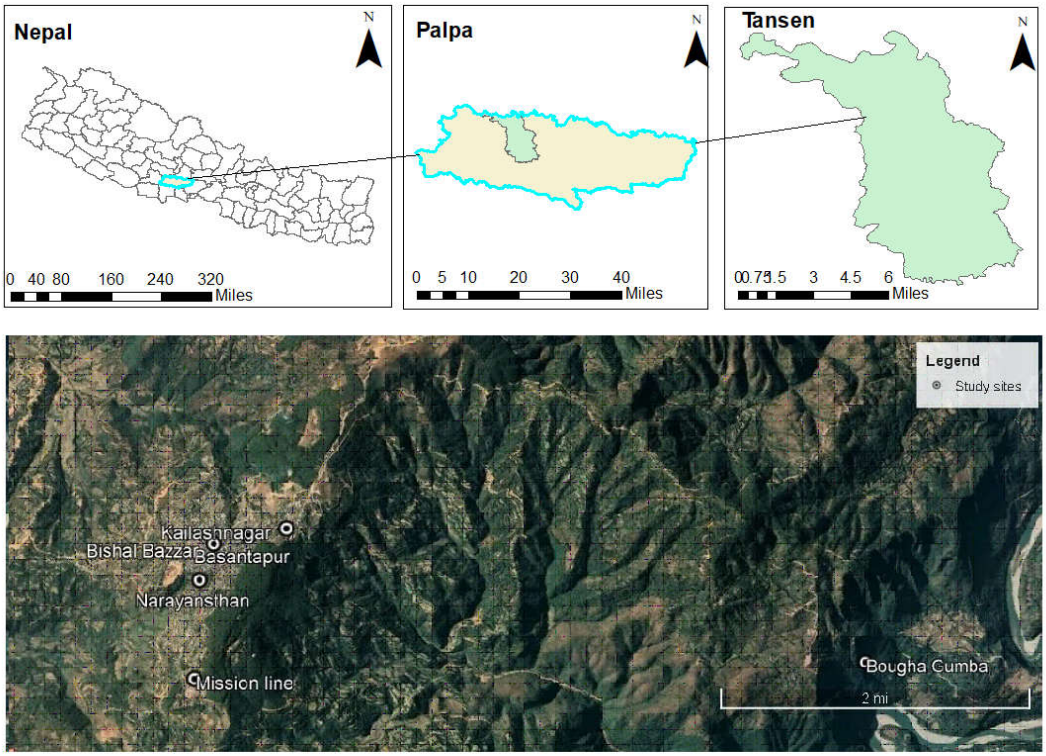


Fig 1: Map showing the study area, Tansen, Palpa

3.1.1 Selection of Study area

Among the 14 wards in Tansen Municipality, the study will be conducted in 6 wards (Ward no. 1, 2, 3, 4, 5 & 13).

3.2 Materials

3.2.1 Materials for laboratory

Camera	Test tube
Test-tube holder	Petridish
Spirit lamp	Slide
Forceps	Coverslip
Gloves	Watch glasses
Microscope	

3.2.2 Chemicals

a. Potassium Hydroxide (KOH) - 5%

b. Alcohol series (30%, 50%, 70%, 90%, 100%)

c. Dibutylphthalate Polystyrene Xylene (D.P.X.)

d. Xylene

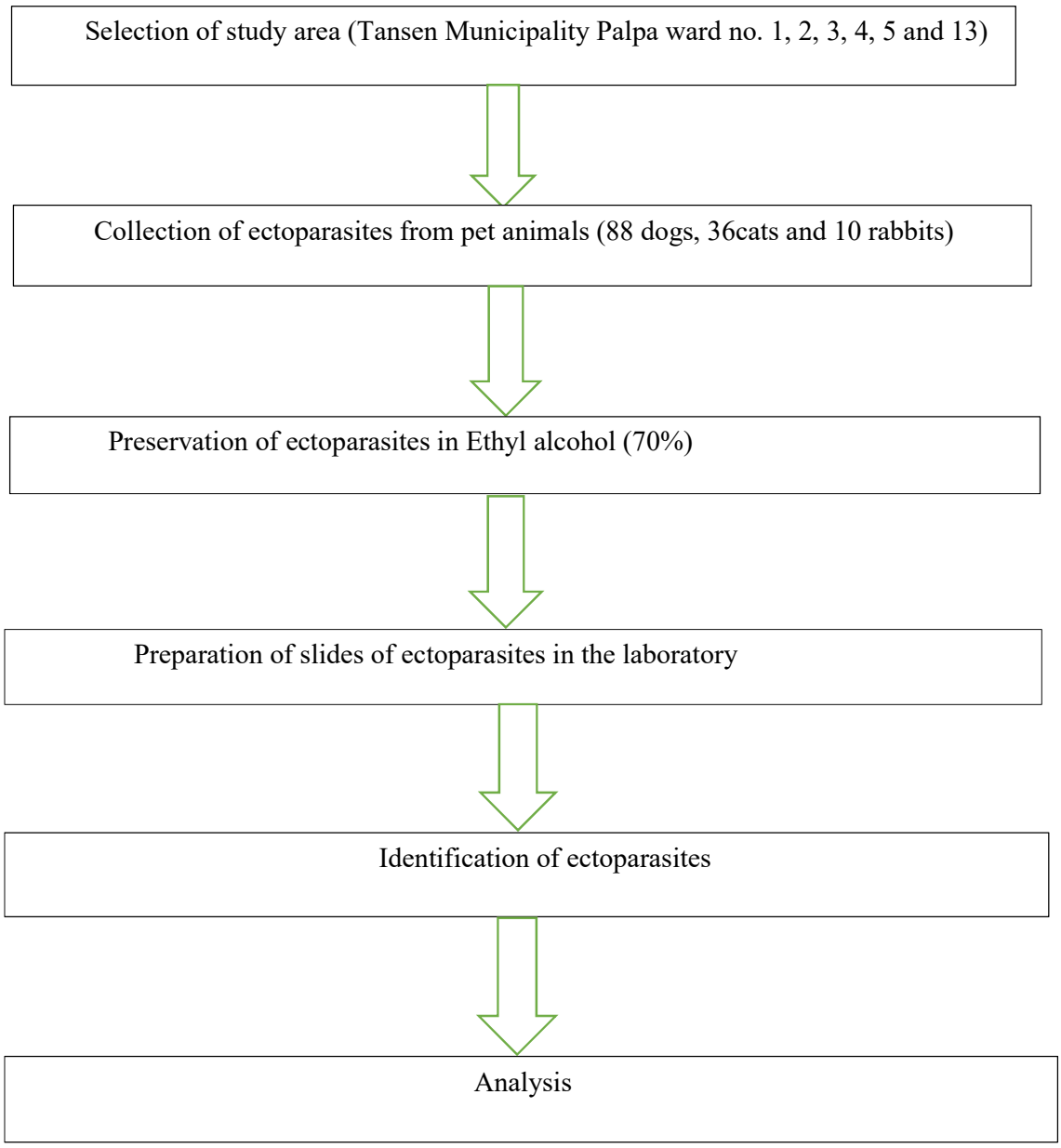
3.2.3 Materials for field

Gloves	Camera
Vials	70% ethyl alcohol
Tags	Field data sheet and questioner sheet

3.3 Method

3.3.1 Study Design

The study was designed to assess the ectoparasitic infestation in pet animals of 6 wards (ward no. 1,2,3,4.5, 13) of Tansen Municipality, Palpa. The study design includes:



3.3.2 Sample collection

The pet animals were inspected individually by a full body search. As the ectoparasites were observed, only adult ectoparasites were preferred for the collection. They were collected by handpicking method in aid with pet owner. Then, the obtained ectoparasites were kept in different vials labelled with tags containing 70% alcohol for identification and counting.

3.3.3 Preservation of Sample

Collected ectoparasites of pet animals were preserved in 70% Ethyl alcohol for further preservation.

3.3.4 Laboratory work

Ectoparasites collected from the study area was brought to the laboratory of Central Department of Zoology and slides were prepared.

3.3.5 Slide Preparation of Ectoparasites

The ectoparasites were boiled in Potassium hydroxide and they dehydrated by alcohol series. At first they were kept on 30% alcohol which was followed by 50%, 70%, 90% and 100% respectively. Then, they were kept on Xylene to confirm that they were dehydrated well or not. Later, by using D.P.X. they were mounted on the slides and covered by coverslips. Then these slides were observed upon 10x X 4x and photographs were taken (Cable 1967).

3.3.6 Identification of ectoparasites

Identification was done on the basis of published literature journals Sanford and Hays (1974), Tuff (1977), Keirans and Litwak (1989), Walker et al. (2003). The identification of ectoparasites were done only on the basis of morphological characteristics.

3.3.7 Questionnaire to the owner

A semi-structured questionnaires were set up to achieve the essential information from 68 pet owners of Tansen Municipality, Palpa. Single pet owner was selected from each household to respond the questionnaires. Questionnaires included knowledge about

zoonosis, mode of ectoparasite transmission, lifestyle of pet, medical history, treatment measures of ectoparasites.

3.4 Ethical, Legal & Social Implications (ELSI)

Verbal consent was obtained from the pet owner to carry out this research.

3.5. Data Analysis

For this study, prevalence was measured as the percentage of individual host infested with a particular parasite. The data were statistically analysed by using Microsoft Excel 2010. Inorder to show the association between different ectoparasites, chi square test and Fisher's exact test were used. In all the cases, 95% confidence interval (CI) and $p<0.05$ was considered for statistically significant difference.

4. RESULTS

4.1 Overall prevalence of ectoparasites

Out of 134 pet animals examined, 92 were found to be infested with ectoparasites (tick, flea, lice) (Fig. 2).

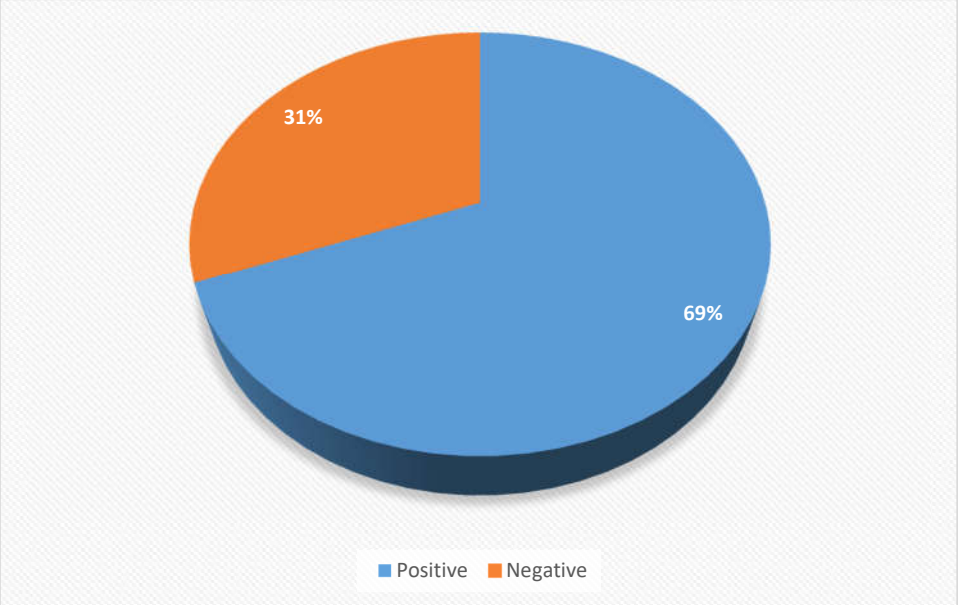


Fig 2: Overall prevalence of ectoparasites

4.2 Overall prevalence of tick, flea and lice

Among total pet animals examined, 41 were found to be infested with *Rhipicephalus sanguineus*, 28 were found to be infested with *Ctenocephalides canis*, 61 were found to be infested with *Ctenocephalides felis* and 3 were found to be infested with *Linognathus setosus*. Difference in distribution of these ectoparasites was found significant (χ^2= 39.78, df= 3, p-value= 1.18) (Fig.3).

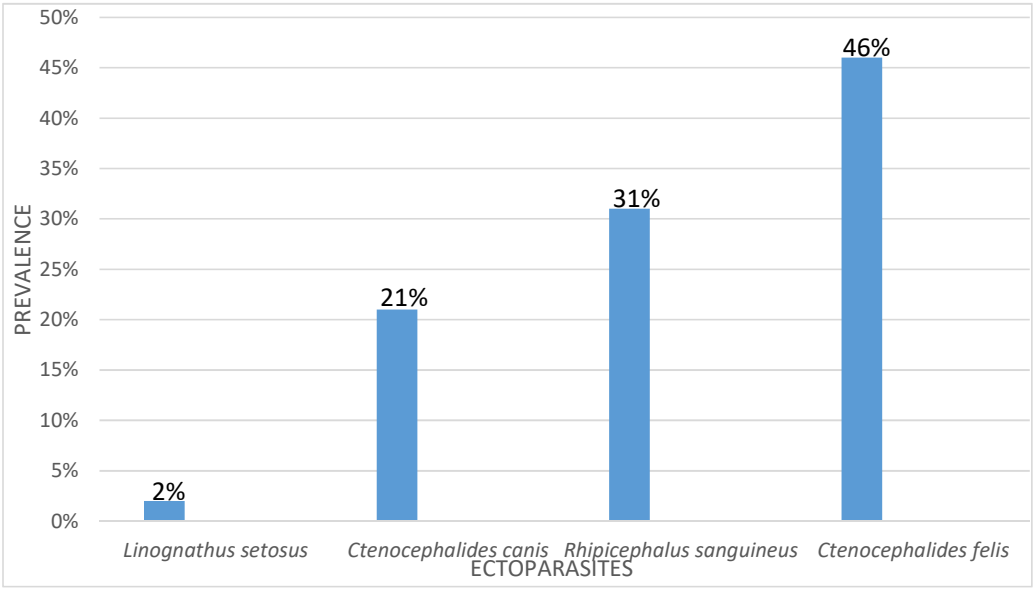


Fig 3: Overall prevalence of tick, flea and lice among pet animals

4.3 Prevalence of ectoparasites in dogs

Out of 88 dogs examined, 65 were found to be infested with different ectoparasites. The ectoparasites found were tick (*Rhipicephalus sanguineus*), fleas (*Ctenocephalides canis*, *Ctenocephalides felis*), lice (*Linognathus setosus*) with 42.04%, 29.54%, 31.81%, 3.4% respectively. There was siginificant difference in the distribution of these ectoparasites among dogs (χ^2= 30.429, df= 3, p-value= 1.12) (Table 1).

Table 1: Prevalence of ectoparasite in dogs

Host	Ectoparasite species	No. animal infected	Prevalence (%)	χ^2	P-value
Dog (n=88)	*Rhipicephalus sanguineus*	37	42.04	30.429	1.12
	Ctenocephalides felis	28	31.81		
	Ctenocephalides canis	26	29.54		
	Linognathus setosus	3	3.4		

4.4 Prevalence of ectoparasites in cats

Out of 36 cats examined, 24 were found to be infested with ectoparasites. The ectoparasites found were tick (*Rhipicephalus sanguineus*), fleas (*Ctenocephalides canis*, *Ctenocephalides felis*) with 11.11%, 5.55%, 52.7% respectively. There was siginificant difference in the distribution of these ectoparasites among cats (χ^2= 57.43, df= 2, p-value= 3.372) (Table 2).

Table 2: Prevalence of ectoparasite on cats

Host	Ectoparasite species	No. animal infected	Prevalence (%)	χ^2	P value
Cat(n=36)	*Ctenocephalides felis*	19	52.7	57.43	3.372
	Rhipicephalus sanguineus	4	11.11		
	Ctenocephalides canis	2	5.55		

4.5 Prevalence of ectoparasite in rabbits

Out of 10 rabbits examined, 6 were found to be infested with ectoparasites. The ectoparasites found were fleas (*Ctenocephalides canis*, *Ctenocephalides felis*) with the prevalence rate of 10% and 50% respectively. From There was significant difference in the distribution of these ectoparasites among rabbits (p-value=0.1409, calculated from Fisher's exact test) (Table3).

Table 3: Species wise prevalence of ectoparasite on rabbits

Host	Ectoparasite species	No. animal infected	Prevalence (%)	P- value
Rabbit (n=10)	*Ctenocephalides felis*	5	50	0.1409
	Ctenocephalides canis	1	10	

4.6 Comparision of overall prevalence of ectoparasites among pet animals

Among total dog, cat and rabbit examined, 65 dogs, 36 cats and 6 rabbits were positive for ectoparasite infestation which indicates that dogs were more susceptible to ectoparasites in comparision to cat and rabbit (Fig.4).

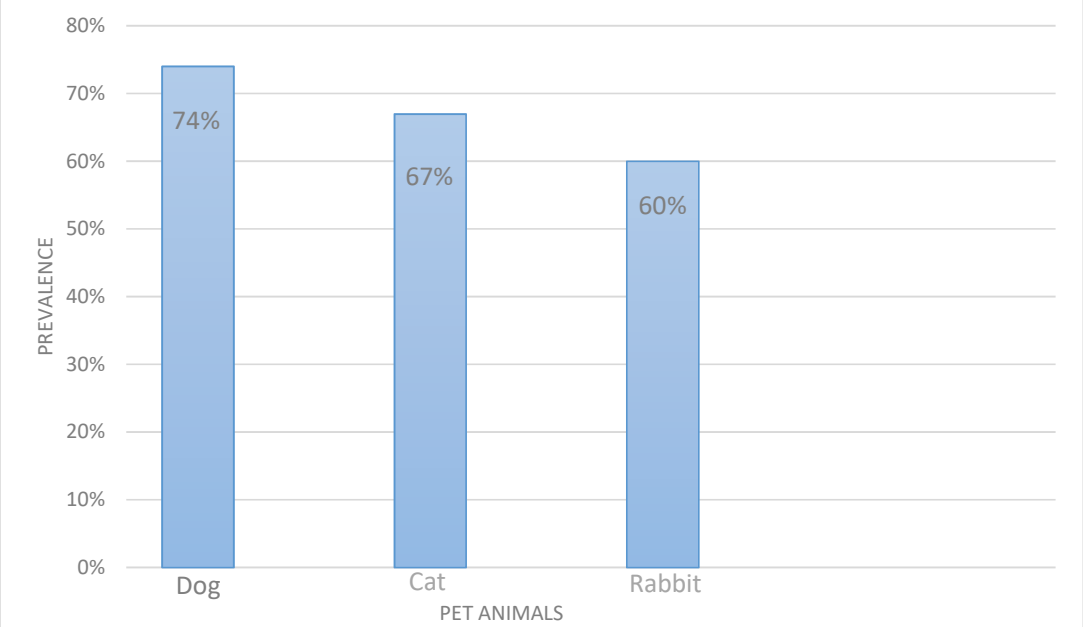


Fig 4: Comparision of overall prevalence of ectoparasites among pet animals

4.7 Concurrency of parasitic infestation in pet animals

The concurrency of parasitic infestation in dog revealed single infestation was found prevalent over double and triple infestation. Similarly, in the case of cat, the concurrency of parasitic infestation revealed that single infestation was found maximum as compared to double and triple infestation. But rabbit was found to have only single infestation. There was significant difference in the distribution of single, double and triple infestation (χ^2= 47.25, df= 4, p-value= 1.36) (Fig. 5).

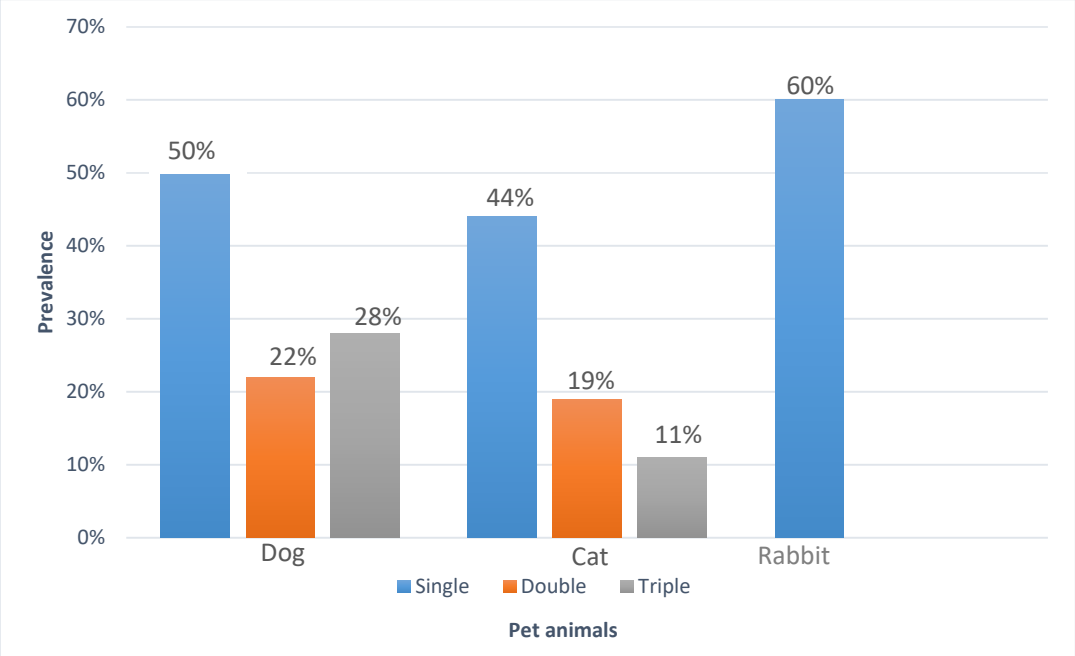


Fig 5: Concurrency of parasitic infestation in pet animal

4.8 Demographic character of respondents and Knowledge, Attitude and Practice of pet owners about ectoparasite infestation

The present study was carried out among 68 pet owners out of which 42 (62%) were female and 26 (38%) were male. Most of them (47%) had secondary level of education. More than half of the pet owners (54%) were house wives and 46% of pet owners were involved in business. All the pet owners (100%) knew the disease that is transmitted from pet to human among which 71% were aware of rabies and 29% were aware of rabies as well as parasites. More than half of the pet owners (69%) had received the information about disease from

friends and relatives where as 22% and 9% pet owners received the information from veterinarians and media/ internet respectively. Few pet owners (29%) knew that ectoparasites may act as vectors of various important pet animal diseases. More than half (75%) agreed that pet lifestyle may play a part in the likelihood of gaining external parasites.65% of the pet owners agreed that pet can be infected from ectoparasite while coming in contact with other infested animals and 35% of the pet owners agreed that grass or bush can be responsible for transmitting ectoparasite (tick) to the pet's body while walking through it. 71% of the pet owner had seen their pet to veterinarian on a regular basis (at least once a year). The percentage of pet owner who always and sometimes wash their hand after touching pet were 12% and 18% respectively. 59% of the pet owner revealed that their pet roamed within the compound only. According to the pet owner, the percentage of pet that sleep in the living room, pet house and in both in living room and pet house were 23%, 56% and 21% respectively. More than half (53%) of the pet owners gave their pet a bath once a month. 50% pet owner used shampoo and soap and 22% used Neem and Titepati treatment of ectoparasite control. The association was statistically significant with the product for treatment.

Table 4: Knowledge, Attitude and Practice of pet owners about ectoparasite infestation

Variables	Percentage (%)
Zoonotic disease	
Rabies	48(71%)
Both Rabies and Parasitic disease	20(29%)
Source of information about the diseases	
Friends and relatives	47(69%)
Veterinarians	15(22%)
Media/ Internet	6 (9%)

Ectoparasites act as vector of Zoonoses	Yes	20(29%)
	No	48(71%)
Role of pet's lifestyle for external parasites	Yes	51(75%)
	No	17(25%)
Mode of transmission of ectoparasite	Infested animal	44(65%)
	Grass or bush	24(35%)
Time interval of checkup	Once a year	48(71%)
	Never	20(29%)
Hand washing after touching pet	Always	8(12%)
	Sometimes	12(18%)
	Never	48(70%)
Pet roaming	Inside the house only	28(41%)
	Within the compound only	40(59%)
Sleeping place of pet	In the living room	16(23%)
	Pet house	38(56%)
	In the living room and pet house	14(21%)
Interval of pet a bath	Every two weeks	13(19%)
	Once a month	36(53%)
	Never	19(28%)
Products used for treatment	Soap and Shampoo	34(50%)
	Neem and Titepati	15(22%)
	None	19(28%)

5. DISCUSSION

A relatively small number of arthropods have developed the ability to live directly at the expense of another animal (host). Arthropods parasitize a wide range of hosts including the other arthropods. Most of the arthropods live in or burrow into the surface of their host epidermis while some of them may parasitize in the host body. Some of them are highly host specific and some of them exist only in a defined area of the host body. Ectoparasites have a variety of direct and indirect effect on their host. Direct injury may be caused due to blood loss (anaemia and debilitation) by sucking blood while indirect effects may be skin inflammation, pruritus and alopecia by mange mite, toxic and allergic responses by ticks. Ectoparasite either may act as a mechanical or biological vector (Wall and Shearer 2001).

Higher number of dogs (81.81%) and cats (75%) were infected with ectoparasites in present study which showed the similar result found by Kumsa and Mekonnen (2011). It is due to the presence of favourable climatic conditions important for survival, reproduction and development of various stages of ectoparasites of dogs and cats in the study area (Kumsa and Mekonnen 2011).In current study, dogs were found to be infested with more ectoparasite species whereas cat were infested with less ectoparasite species which resembles with the findings of Xhaxhiu et al. (2009). From these findings, it is clear that dogs were preferred hosts for fleas, ticks and lice where as in cats, due to their strong grooming behaviour lower numbers of ectoparasites were found (Eckstein and Hart 2000). Moreover, dogs have thicker, longer and denser fur that provides a suitable environment with temperature and humidity conditions that allow the survival and development of different stages of ectoparasites, making them preferred hosts over cats (Canon-Franco and Perez-Bedoya 2010).

The prevalence of *Rhipicephalus sanguineus* in dogs was the highest than other ectoparasites which matches with the findings of several studies (Dantas-Torres 2009, Szabo et al. 2001).The highest abundance of *Rh. sanguineus* than all the other ectoparasites species on dogs was due to the variation in the biology and biotic potential of different spices (Dantas-Torres 2008). Dogs were the preferred hosts for *Rh. sanguineus* (Wall and Shearer, 1997). In present study, the prevalence of *Linogthaus setosus* in dogs was least which contrasts to the different study in Ethiopia, Sweden, Norway where *L. setosus* was

the most common louse found on dogs (Tadesse et al. 2019; Christensson et al. 1998; Bredal et al. 1994).

This study revealed the finding of less number of *Rhipicephalus sanguineus* in cats which is supported by the study carried out in Australia, Central United States (Greay et al 2016, Akucewich et al.2002, Burroughs et al. 2016). *R. sanguineus* is known to infest premises and the free-roaming cat which may account for the decrease in prevalence. *Rhipicephalus* spp. have shortened mouthparts, which may allow cats to more successfully remove them by grooming (Thomas et al. 2016).

The most common flea in dog was *Ctenocephalides felis* followed by the *Ctenocephalides canis* which is supported by the several studies (Durden et al. 2005, Bellato et al. 2003). Both species of *Ctenocephalides* often coexist in the same geographical region and sometimes even on the same host individual (Durden et al. 2005). Present study revealed that *Ctenocephalides felis* as the dominant flea on both cat and dog which matches with other reports (Akucewich et al., 2002, Tavassoli et al., 2010). *C. felis* is generally regarded as the predominant flea species found on dogs and cats, replacing *C. canis* on domestic dogs in many countries which is due to the greater adaptation to wider range of environmental factors in *C. felis* than the other flea species (Gracia et al. 2008, Slapeta et al., 2011).

Recent study revealed that rabbits were infested by *Ctenocephalides felis* and *Ctenocephalides canis* which contrasts with the study carried out by Pinter (2008) which revealed *Spilopsyllus cuniculi* as ectoparasite causing infestation in rabbit. Due to the closeness with cat and dog in same environment rabbit may acquaire the infestation from *Ctenocephalides felis* and *Ctenocephalides canis*. Single infestation in dog was higher than the double and triple infestation which matches with the study of South-west of Iran and North and Center of Iran (Mosallanejad et al. 2012, Ebrahimzade et al. 2016). The percentage of female in the present study was higher (62%) than the percentage of male (38%) which is similar to the various study (Ramon et al., 2010; Carvelli et al, 2016; Gates et al., 2019). In this study, hand washing after having direct contact with the pet was less practiced which contrast to the study carried by Kiflu et al. (2016) where 78.8% of the pet owner washed their hand after direct contact with pet. This study showed only few respondents knew about parasitic disease besides rabies while majority of them knew only rabies. In line with this finding, a study in Hawassa (G/selasie et al., 2013) showed that

85.7% of respondents had awareness about zoonotic canine diseases. But their awareness was mainly restricted to rabies which accounted for 97% and only few of them had awareness about canine zoonotic parasites (3%). In another study in Ambo, only 44.3% of the owners had awareness about the role of dogs in transmitting diseases to human which was also restricted to rabies and none of them had awareness of other canine zoonotic diseases (Zewdu et al., 2010).

In current study, all the respondents had received information about pet-associated diseases. 69% of respondents received the information from their friends or relatives, 22% and 9% of them had received information from veterinarians and media/internet respectively. This study contrasts from the reports of Bingham et al. (2010) in USA and Palmer et al. (2010) in Australia where veterinarians and internet were reported as the two most frequent sources of information. Similarly, another contrasting study in New York (Gursimrat and Devinder, 2014) reported that 40% of participants reported veterinarian as their primary source of information, while 20% and 5% of the participants reported internet and media as their source of information respectively. The finding from present study showed that more than half of the respondents gave their pet a bath once a month where as 27% of the respondents gave their pet a bath every two weeks. This study matches with the study carried out by Abdulkareem et al. (2018) in Nigeria where 67.4% and 10% of the respondents gave their pet a bath every month and every two weeks respectively.

This study found out that maximum respondents take their pet to veterinary at least once a year which is similar to the study by Tensay (2017) who reported 61% of the respondents took their pet to veterinary at once a year. 56% respondents stated that pet slept in pet house which differed markly from the study of Kebede (2019) who found out that minimum no. of pet owner confined their dog to the dog house on compound. According to pet owner, pet roaming within the compound was maximum which contrasts with the study of Ojo et al. (2019). Only 47% of pet owner used shampoo to control ectoparasite which contrasts with the study of Johansson (2015) where 85% of the pet owner used shampoo.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The present study was conducted on prevalence of ectoparasite on pet animals in 6 wards of Tansen Municipality, Palpa. Out of 134 pet animals examined, 69% were found to be infested with ectoparasites where 30.59% were infested with *Rhipicephalus sanguineus*, 20.89% with *Ctenocephalides canis*, 45.52% with *Ctenocephalides felis* and 2.24% with *Linognathus setosus*. The comparision of overall ectoparasite infestation among pet animals indicates that dogs were more susceptible to ectoparasites in comparision to cat and rabbit. This is due to the least grooming behaviour of dog as compared to cat and rabbit. The concurrency of parasitic infestation in dog, cat and rabbit revealed that single infestation was found prevalent over double and triple infestation. A semi structured questionnaires were conducted among 68 pet owners to know their knowledge, attitude and practice about ectoparasite infestation on pet animals. The study mentioned that most of the pet owners were not aware of parasitic disease. This lack of awareness is due to the absence of knowledge about the role of ectoparasites as the vector of various diseases. Considering the level of awareness, pet related zoonotic diseases are the major threat of public health in the present study area. Hence, there is the need for public health intervention program in the area.

6.2 Recommendation

Based on the above conclusion the following recommendations are forwarded:

- Extensive public education about pet related zoonoses is needed to create awareness on the public and minimize the risk disease.
- Veterinary extension program is needed to encourage the people to bring pet to veterinary for treatment and other medical service.
- Both medical and veterinary profession should collaborate to design effective zoonotic disease prevention and control program.
- Regular vaccination program and sanitation of pets is needed to minimize the risk.

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APPENDIX-1

Key to Genera of Siphonaptera

1. Pronotal ctenidium present----------5

   Pronotal ctenidium absent---------- 2

2. Abdominal terga with two rows of setae---------- Rhopalopsyllus

   Abdominal terga with one row of setae----------3

3. The three thoracic terga combined, shorter than the first abdominal tergum.

   Front margin of head angular---------- Echidnophaga

   The three thoracic terga combined, longer than the first abdominal

   tergum. Front margin of head rounded---------- 4

4. Mesopleuron with vertical pleural sclerotization. Ocular bristle inserted

   in front of eye ----------Xenopsylla

   Mesopleuron without vertical pleural sclerotization. Ocular bristle inserted

   below eye----------Pulex

5. Genal ctenidium absent----------6

   Genal ctenidium present----------8

6. Patch of spiniform bristles on inside of metacoxa (located toward distal

   end of anterior margin) ----------Odontopsyllus

   Metacoxa without spiniform bristles---------- 7

7. Fifth tarsal segment of each leg armed with four pairs of lateral plantar

   bristles and basal, ventral, submedian pair ----------Orchopeas

   Fifth tarsal segment of each leg armed with five pairs of lateral plantar

   bristles----------Nosopsyllus

8. First abdominal tergum with ctenidium----------Stenopora

First abdominal tergum without ctenidium----------9

9. Genal ctenidium with two to four teeth----------10

Genal ctenidium with five or more teeth----------13

10. Genal ctenidium with four teeth. Two spiniform bristles along frontal

margin----------Leptopsylla

Genal ctenidium with less than four teeth----------11

11. Genal ctenidium with three teeth ---------- Ctenophthalmus

Genal ctenidium with two teeth----------12

12. Genal teeth separate, not overlapping. Head angulate in front. Anterior margin of clypeus with short spinelets---------- Peromyscopsylla

Genal teeth overlapping. Head not angulate in front. Anterior margin of clypeus without short spinelets ----------Epitedia

18. Genal ctenidium horizontal with curved, sharp teeth---------- *Ctenocephalides*

Genal ctenidium sub-vertical with straight, blunt teeth---------- Cediopsylla

Key to the Known Species of *Ctenocephalides*

Interval between postmedian and apical long bristles of dorsal margin of hind tibia containing two small notches, each with a short, stout bristle (upper one may be reduced in size, seta-like) ----------*C. canis*

Interval between post median and apical long bristles of hind tibia containing two small notches the upper notch without a bristle or with a hair; the lower notch

with a bristle ----------*C. felis*

Key to the order of lice

1. Anterior margin of head acute, rostrum present, mouthparts adapted for piercing and sucking; opposing mandibles absent; tarsal claws single, often large----------Anoplura

Anterior margin of head generally broadly rounded, rostrum absent, mouthparts adapted for chewing; opposing mandibles well developed, on ventral surface; tarsal claws small, either single or paired ----------Mallophaga

Key to the families, genera and species of anoplura

1. Eyes well developed with distinct lens ----------Pediculidae

Eyes vestigial or absent ----------2

2. Paratergal plates of abdominal segments heavily sclerotized forming lateral lobes;

all legs of equal size ----------Haematopinidae

Paratergal plates of abdominal segments absent; if present, greatly reduced and weakly

sclerotized; first pair of legs smaller than second and third pairs ----------Linognathidae

Family Linognathidae

6. Abdominal segments with only one transverse row of setae; abdominal spiracles borne on small tubercles (the capillate cattle louse)----------*Solenopotes capillatus*

Abdominal segments with more than one transverse row of setae; abdominal spiracles not borne on tubercles----------7

7. Postantennal region laterally produced (on sheep and goats)------*Linognathus africanus*

Postantennal region not laterally produced----------8

8. Head twice as long as broad; preantennal region as long as broad ----------9

Head about as long as broad or slightly longer; preantennal region much

broader than long----------10

9. Preantennal region elongate, apically acute; lateral margins of postantennal regions

straight, appearing rectangular (the long-nosed cattle louse)-------*Linognathus vituli*

Preantennal region acute; lateral margins of postantennal regions slightly convex

(the goat sucking louse) ----------*Linognathus stenopsis*

10. Head as long as broad, preantennal region very short, lateral margins of postantennal region slightly convex (the sheep foot louse) ----------*Linognathus pedalis*

Head slightly longer than broad, preantennal region well developed, with lateral margins straight and apex blunt, lateral margins of post antennal region parallel

(the dog sucking louse) ----------*Linognathus setosus*

Key to the family of tick

1. Capitulum visible from above, scutum present---------- Ixodidae

   Capitulum not visible from above, scutum absent ----------Argasidae

Key to the Adult Hard Ticks (Ixodidae)

1. Anal groove extending anteriorly around anus ----------Ixodes

   Anal groove never extending anteriorly around anus ----------2

2. Palpal segment 2 not extending laterally, eyes present ----------3

   Palpal segment 2 extending laterally, eyes absent ----------*Haemaphysalis*

3. Basis capituli hexagonal ----------4

   Basis capituli rectangular

4. Festoons present, palpi as long as or longer than basis capituli scutum without white

   marking; basis capituli produced laterally to form an angle---*Rhipicephalussanguineus*

APPENDIX -2

Questionnaire survey of ectoparasites infestation in pet animals of Tansen Municipality, Palpa

Information about pet and pet owner

1. Name of Pet owner ……..

2. Gender …….....Male/ Female

3. Level of education……Illiterate/literate/Primary/secondary/college

4. Occupation …….

5. How many pet animals do you have?

   a) One b) Two c) Three d) Four

   What are they?

   a) Dog b) Cat c) Rabbit

6. Do you know about Zoonotic disease? Yes/ No

   If yes? What are they?

7. Mention the Source of information about the diseases.

   i. Friends and relatives
   ii. Veterinarian
   iii. Media/ Internet

8. Do you know ectoparasites act as vector of zoonoses? Yes/ No

9. Do you agree that pet's lifestyle plays important for gaining external parasites? Yes/ No

10. Mention the mode of transmission of ectoparasite on pet animals.

    a) Infested animal b) Grass or bush

11. Do you wash your hand after touching your pet? Yes/ No

    If yes how often? a) Always

    b) Sometimes

12. How often do you visit veterinarian? a) Once a year b) Never

13. Where does your pet roam? a) Inside the house

b) Within the compound only

14. Where does your pet sleep? a) In the living room

b) Pet house

c) In the living room and pet house

15. Do you give your pet a bath?

If yes how often? i) Every two weeks

ii) Once a month

iii) Never

16. What do you use for the treatment of ectoparasites in pet?

APPENDIX-3

PHOTOGRAPHS

[Some photo plates of ectoparasites]

Photo plate 1. *Ctenocephalides canis*
(10x X 4x)(3mm)

Photo plate 2. *Ctenocephalides felis*
(10x X 4x) (2.5mm)

Photo plate 3. *Linognathus setosus*
(10x X 4x)(2mm)

Photo plate 4. *Rhipicephalus sanguineus*
(10x X 4x)(4mm)

[Some photo plates of ectoparasite collection from pet animals and questionnaire survey]

Photo plate 5. Collection of ectoparasite from cat

Photo plate 6. Collection of ectoparasite from rabbit

Photo plate 7. Collection of ectoparasite from dog

Photo plate 8. Questionnaire to the pet owner

[Some photo plates of products used for ectoparasite control]

Photo plate 9. Shampoo for bathing pet

Photo plate 10. Soap for bathing pet

Photo plate 11. Titepati (*Artemisia vulgaris*)

Photo plate 12. Neem (*Azadirachta indica*)