

Prevalence and pathology of mite infestation in street dogs at Dinajpur municipality area

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Abstract

This study was designed to investigate the prevalence and pathology of mite infestation in the street dog at Dinajpur municipality area, Dinajpur, Bangladesh, during June to September, 2010 using simultaneous clinical and histopathological examination and identification. A total of 48 street dogs (27 male and 21 female) were examined, among them 30(62.5%) were infested with one or more species of mites. Two species of mites were identified as *Sarcoptes scabiei* var. *canis* and *Demodex canis*. The range of mites burden was 1-5 per square inch of heavily infested area. Mean mites burden was high in case of *Sarcoptes scabiei* var. *canis* (1.5 ± 0.2) followed by *Demodex canis* (0.6 ± 0.1). Prevalence was higher in the dog of 1-2 years of age (68.9%) than in the dog of >2-4 years of age (52.6%). Infestation of mite was significantly ($p < 0.05$) higher in male (66.6%) than female (57.1%) dog. Mite infestation was more prevalent in the poor healthy dog (75.7%) than the normal healthy dog (33.3%). Prevalence of mites infestation was significantly ($p < 0.05$) higher in back region (68.1%) followed by face and neck (66.6%) and abdomen (58.3%) and lowest in thigh and groin (40.0%). Grossly, alopecia, rough, dry leathery and corrugation of skin, erythema, pustules, crusts and pruritus were found. Microscopically, it was characterized by acanthosis, slight hyperkeratosis, formation of hyperplastic rete-pegs, destruction of dermis and epidermis, hyperplastic changes in sweat glands, sebaceous glands and hair follicular cells, pyogranuloma in papillary layer and hair follicles and infiltration of neutrophils, eosinophils, lymphocytes and few macrophages. The results indicate that street dogs of Dinajpur municipality area are very much susceptible to mite infestation. The mite produces clinico- pathological effects on dog, which may be the serious threat to public health.

Keywords: Prevalence, Pathology, Mite infestation, Street dogs

Introduction

Street dog (dog found in public places irrespective of the level of care and level of supervision imposed upon them) is one of the important inhabitants in the environment of Bangladesh. In Dinajpur district, street dogs are scattered everywhere irrespective of urban and rural areas. Its lives are led at outdoor environment. Dogs live in unhygienic condition and readily come into contact with the humans and domesticated animals. Street dogs impose a burden on the community in a number of ways. Street dogs pose serious public health, socio-economic and animal welfare problems in many countries. A diverse range of zoonotic infections, including parasitic diseases are transmitted from the dog and cat to human (Acha and Szyfres, 2003; WHO, FAO and OIE, 2004). Mites are the common and pivotal cause of skin diseases in the dog. They can transmit various diseases and can cause hypersensitivity disorders in animals. They may also cause life threatening anemia in young and/or debilitated animals (Araujo *et al.*, 1998). Mites are microscopic external parasites that cause mild to chronic skin disease known as "Mange" in a wide range of hosts including domestic, farm and wild animals (Pence and Ueckermann, 2002). Mange in dog can be caused by a range of mites including *Demodex canis*, *Sarcoptes scabiei* var. *canis* and *Cheyletiella yasguri*. Demodectic mange caused by the *Demodex* has been identified from Bangladesh (Rahman, 2006). Disease is characterized by hair loss, itching and scabby eruptions in most affected animals. In some cases, humans can also become affected. It is thought that skin disease may be the most common group of diseases to affect dogs (Nuttall, 2004). *Demodex canis* was the main causative agent of canine demodicosis, an inflammatory parasitic skin disease characterized by the presence of large numbers of demodexid mites (Scott *et al.*, 2001). Canine demodicosis can present as a generalised or localised condition. It may be either juvenile or adult in onset. Juvenile onset demodicosis, as in this case, has a better prognosis than adult onset demodicosis, which was often associated with other primary systemic diseases such as hyperadrenocorticism (Henfrey, 1990 and Lemarie, 1996). Localised demodicosis was a mild clinical disease, most cases resolving without treatment. However, the generalised form was a severe disease with a guarded prognosis (Scott, 1979b and Folz, 1984).

Sarcoptic mange is commonly reported in the dogs and foxes and related to the human skin disease called scabies. Dog mange is caused by the canine mange, which frequently attacks man (Soglia *et al.*, 2007). In Bangladesh there is little information on the prevalence of this mite. However, a significant percentage of skin diseases of man and animals might be due to *Sarcoptes scabiei*. Isolated cases of scabies in dog due to *Sarcoptes scabiei* were recognised in the Department of Parasitology, Bangladesh Agricultural University, Mymensingh. Huq *et al.* (1974) reported 60.66% infection with *Sarcoptes scabiei* in Freedom Fighters (Bangladesh Liberation Forces) in and around Bangladesh Agricultural University Campus. Huq *et al.* (1985) also recorded *Sarcoptes scabiei* infection in man and dogs of Dhaka district. Skin scrapings were taken from 105 human beings having skin lesion on different parts of the body and from 95 dogs randomly caught from Narayanganj, Munshigonj, Savar and Jaydevpur. *Sarcoptes scabiei* was found in 31(29.52%) human and 5(5.26%) dog skin scrapings. In view of the above facts, it is assumed that mite infestation is one of the major problem for the street dogs, but no attention has been paid to study the prevalence and its effects on the dog in Dinajpur district. Therefore, the present study was undertaken to determine the prevalence and pathology of mite infestation in street dogs at Dinajpur municipality area of Bangladesh.

Materials and Methods

Study period and area

The investigation was carried out during the period from June to September, 2010. Samples were collected from different areas of Dinajpur municipality at Dinajpur district in Bangladesh. Morphological examination of collected parasites was performed in the Department of Parasitology, Bangladesh Agricultural University, Mymensingh.

Selection and examination of dogs

Forty eight street dogs (27 male and 21 female) were selected randomly irrespective of age, sex and health status of the dogs from the areas as mentioned above. The street dogs were collected from the different region of Dinajpur municipality while they euthanasized by the authority during rabies control program. The age of the dog was determined by examining teeth (De Lahunta and Habel, 1986). According to age, dogs were divided into two groups, namely, young (1-2 years) and adult (>2-4 years). Similarly health status of the dog was determined by eye inspection and body condition (poor or healthy). According to health status, dogs were grouped into poor and normal health. The samples were collected with protective clothing using sterile instrument and transferred to the laboratory for identification of mite and histopathological examination. The selected dogs were thoroughly investigated by close inspection. Age, sex, health status of the dog and other relevant data were collected carefully.

Preservation of samples

Skin scrapings were taken from the suspected area of the street dog using glycerinized scalpel until oozing of blood. The suspected areas of skin were measured by using plastic scale (in inch). Skin scrapings were preserved in 70% alcohol in clear, well-stopped glass vials. Vials were labeled properly.

Identification of mites

Morphological identification was done in the Parasitology laboratory. The scrapings were heated near the boiling point adding 10% potassium hydroxide and then examined with the help of dissecting (4x) and compound (10x) microscope. Final identification was done according to the keys and descriptions described by Soulsby (1982) and Wall and Shearer (1997).

Collection of tissues for histopathological study

Dogs were examined carefully and gross pathological changes were recorded, if any. During necropsy, the skins having gross lesions were collected and fixed in 10% formalin for histopathological studies. Formalin fixed tissue samples were processed and stained as per standard method described by Luna (1968). Buffered neutral formalin fixed tissues were dehydrated in graded alcohol, cleared in chloroform and impregnated and then embedded in paraffin. Tissues were sectioned at five to six micron thickness

and stained with Hematoxylin and Eosin. The stained tissue sections were studied under low (10x) and high power (40x) objectives. Microphotographs of the tissue sections having characteristics pathological changes were taken.

Statistical analyses

Statistical analyses were carried out by using Statistical Package for Social Sciences (SPSS) using F-test. Odds ratio was calculated according to the formula given by Schlesselman (1982).

Results and Discussion

Overall prevalence of mite infestation in the dog

The study indicates that about 62.5% dogs were infested with one or more species of mites (Table1), namely, *Sarcoptes scabiei* var. *canis* (50.0%) (Fig.1) and *Demodex canis*(35.4%) (Fig.2). These results support to the reports of Kalyan *et al.* (2005) in Aizawl who reported 46.6% mite infestation in the dog, of which 64.3% were positive for sarcoptic mange and 35.7% for demodectic mange. Mahato *et al.* (2005) reported 10.5% dogs with generalized demodicosis in India. Solanki and Hasnani (2006) found overall demodicosis (25.4%) prevalence in India. Curtis (2001) confirmed 32.4% sarcoptic mange through skin scrapings examination. Jeong-Hyun *et al.* (2008) reported 45.6% mite infestation in the dog, of which 19.4% were positive for *Sarcoptes scabiei* var. *canis* and 4.9% for *Demodex canis*. Huq *et al.* (1974) reported 60.66% infection with *Sarcoptes scabiei* in Freedom Fighters (Bangladesh Liberation Forces) in and around Bangladesh Agricultural University Campus. Huq *et al.* (1985) also recorded *Sarcoptes scabiei* infection in 31(29.52%) human and 5(5.26%) dog skin scrapings. These differences among the results of present and earlier study could not be easily explained, but might be attributed to epidemiological factors, such as weather, seasonal variations, geographical location, differences in sample collection technique and data collection.

Table 1. Overall prevalence of mite infestation in the dog

Name of the mite	No. of dogs affected N=48	Prevalence (%)	Mite burden (per square inch of heavy infested area)	
			Range	Mean±SE
<i>S. scabiei</i> var. <i>canis</i>	24	50.0	1-5	1.5±0.2
<i>Demodex canis</i>	17	35.4	1-3	0.6±0.1
Total	30^P	62.5	1-5	1.1±0.2

N = Total no. of dogs examined

P = Total no. of dogs affected is less than the summation of individual infestation because same dog was infested by more than one species of mites.

Age related prevalence of mite infestation in the dog

It was revealed that age of the dog had an effect on mite infestation. Among the age groups, young (1-2 year) dogs were more susceptible (68.9%) to mite infestation than adults >2-4 year (52.6%) (Table 2). These results support to the reports of Nayak *et al.* (1997) who found that young dogs up to 1 year were more susceptible (60%) than adults above 2 years of age (17%). Mahato *et al.* (2005) reported demodicosis (66.6%) predominantly in dogs below 2 years old. It was difficult to explain exactly the frequent occurrence of mite infestation in young. Although, it could be due to more sociable with other dogs or exploring the outdoor environment more, meaning they were at a higher risk of being exposed to mite through direct contact or fomites. Younger animals have a less developed immune system compared to older animals. It was shown by Arlian and Morgan (2000) that 58% of dogs have serum containing small amounts of immunoglobulin E (IgE) and IgG to proteins from *S. scabiei* var. *canis* before they have even been exposed to the mite, possibly due to the cross reactivity with dust mite antigenic epitopes.

Table 2. Age related prevalence of mite infestation in the dog

Age of the dog	Name of the mite recovered	No. of dogs affected	Prevalence (%)	Mite burden		Odds ratio
				Range	Mean±SE	
Young (1-2 year) n=29	<i>S. scabiei</i> var. <i>canis</i>	17	58.6	1-5	1.8±0.3	Young vs adult =2
	<i>D. canis</i>	11	37.9	1-3	0.7±0.2	
	Subtotal	20^P	68.9	1-5	1.5±0.2	
Adult (>2-4 year) n=19	<i>S. scabiei</i> var. <i>canis</i>	7	36.8	1-3	1.1±0.3	
	<i>D. canis</i>	6	31.5	1-5	0.4±0.1	
	Subtotal	10^P	52.6	1-5	0.6±0.1	
P value			0.319^{NS}			

n = Total no. of dogs examined

^P = Total no. of dogs affected is less than the summation of individual infestation because same dog was infested by more than one species of mites.

^{NS} = Means not significant

Sex related prevalence of mite infestation in the dog

The prevalence of mite was significantly ($p < 0.05$) higher in male (66.6%) than female (57.1%) dog (Table 3). This result is an agreement with the report of Chakrabarti *et al.* (2002) who reported the highest prevalence of mite in male (67.8%) than female dogs (32.1%). It also supports the report of Nayak *et al.* (1997) who found that the occurrence of demodicosis 51% in male and 49% in female dogs. Mahato *et al.* (2005) reported predominantly demodicosis in male dogs (55.5%) than bitches (44.5%). The exact cause of higher prevalence of mite infestation in male dogs could not be explained but it could be hypothesized that some hormonal influences might be associated with this phenomenon. Although the elevated plasma testosterone (T) levels were generally associated with increased parasitism (Roberts *et al.*, 2004), the causal mechanisms underlying this pattern were not well understood. Two primary, nonexclusive hypotheses proposed to link T levels with parasite load (Klukowski and Nelson, 2001). One possibility was that T increased the probability of encountering parasites by stimulating movement and extending daily activity period. Alternatively, T might increase susceptibility to infestation via suppression of the immune system (Klein, 2004). This mechanism had received considerable attention in light of the immunocompetence handicap hypothesis (Folstad and Karter, 1992).

Table 3. Sex related prevalence of mite infestation in the dog

Sex of the dog	Name of the mite recovered	No. of dogs affected	Prevalence (%)	Mite burden		Odds ratio
				Range	Mean±SE	
Male n=27	<i>S. scabiei</i> var. <i>canis</i>	14	51.8	1-5	1.5±0.2	Male Vs Female =1.5
	<i>D. canis</i>	10	37.0	1-3	0.6±0.2	
	Subtotal	18^P	66.6	1-5	1.4±0.3	
Female n=21	<i>S. scabiei</i> var. <i>canis</i>	10	47.6	1-5	1.7±0.4	
	<i>D. canis</i>	7	33.3	1-3	0.6±0.2	
	Subtotal	12^P	57.1	1-5	0.7±0.1	
P value			0.049*			

n = Total no. of dogs examined

^P = Total no. of dogs affected is less than the summation of individual infestation because same dog was infested by more than one species of mites.

* = Means $p < 0.05$

Health status related prevalence of mite infestation in the dog

It was revealed that nutritional condition of the dog had an effect with mite infestation. Mite infestation was recorded higher in poor body conditioned (75.7%) dogs than normal body conditioned (33.3%) dogs (Table 4). This result supports to the report of Curtis (2001) who reported that infestation of sarcoptic mite were more in poor body conditioned dogs than normal dogs. The present study agreed with the earlier study of Lapage (1962) who found that malnourished animals were more susceptible to any infection as they were immune compromised.

Table 4. Health status related prevalence of mite infestation in the dog

Health status of the dog	Name of the mite recovered	No. of dogs affected	Prevalence (%)	Mite burden		Odds ratio
				Range	Mean±SE	
Poor health n=33	<i>S. scabiei</i> var. <i>canis</i>	20	60.6	1-5	1.9±0.3	Poor health Vs Normal health = 6.2
	<i>D. canis</i>	15	45.4	1-3	0.8±0.1	
	Subtotal	25^P	75.7	1-5	0.7±0.3	
Normal health n=15	<i>S. scabiei</i> var. <i>canis</i>	4	26.6	1-5	1.5±0.2	
	<i>D. canis</i>	2	13.3	1-3	0.3±0.2	
	Subtotal	5^P	33.3	1-5	0.6±0.1	
P value			0.296^{NS}			

n = Total no. of dogs examined

^P = Total no. of dogs affected is less than the summation of individual infestation because same dog was infested by more than one species of mites.

^{NS} = Means not significant

Body region related prevalence of mite infestation in the dog

The prevalence of mite were significantly ($p < 0.05$) higher in back region (68.1%) followed by face and neck (66.6%) and abdomen (58.3%) and lower in thigh and groin (40.0%) (Table 5). This result supports with the reports of some others. Pin *et al.* (2006) reported 10 cases of localised sarcoptic mange in dogs from the precise area of the skin such as the feet (one case), the face and/or the pinnae (six cases), the abdominal skin (one case), the flank (one case) and the lumbar area (one case). Solanki *et al.* (2006) recovered demodectic mite from the skin of the leg, head and trunk. Tamura *et al.* (2000) detected demodectic mite from the skin around the ears, eyes, lips, chin and legs. The exact cause of variation of mite infestation in different body parts of dogs could not be explained. The present study supported with the earlier study of Wall and Shearer (1997) who explained that the host provided a number of important resources for the ectoparasites. Most vitally, the host supplied a source of food, which might be blood, lymph, tears or sweat or the debris of skin, hair or feathers. The hosts body also provided the environment in which many ectoparasites live, generating warmth, moisture and, within the skin or hair, a degree of protection from the external environment. The host might be provided transportation from place to place for the parasites and a site at which to mate; in many cases was the means of transmission from host to host.

Pathological lesions produced by the mite

Grossly, the skin lesions were characterized by dermatitis with rough, dry and leathery condition, alopecia, thickening of skin, in some cases corrugation and presences of dandruff, erythema, pustules, crusts and pruritus (Fig. 3, 4). Pathological changes of mite infestation in dogs were described by some others. Pin *et al.* (2006), found erythema, papules, lichenification, scales, crusts and alopecia in the feet, the face and/or the pinnae, the abdominal skin, the flank and the lumbar area. Solanki and Hasnani (2006) found pruritus, encrustation, complete alopecia and wrinkling of the skin of the leg, head and trunk. Chen (1995) found alopecia and scaling on the ventral aspects of the chest, all four limbs, ventral aspect of the neck and around the eyes. Tamura *et al.* (2000) found scaly dermatitis with patches of pustules around the ears, eyes, lips, chin and legs.

Table 5. Body region related prevalence of mite infestation in the dog

Body regions of the dog	Name of the mite recovered	No. of dogs affected	Prevalence (%)	Mite burden	
				Range	Mean±SE
Face and neck n=9	<i>S. scabiei</i> var. <i>canis</i>	2	22.2	1-5	0.3±0.2
	<i>D. canis</i>	5	55.5	1-3	1.5±0.5
	Subtotal	6^P	66.6	1-5	0.9±0.3^c
Back region n=22	<i>S. scabiei</i> var. <i>canis</i>	14	63.6	1-5	2.0±0.3
	<i>D. canis</i>	8	36.3	1-3	0.4±0.1
	Subtotal	15^P	68.1	1-5	1.2±0.2^a
Abdomen n=12	<i>S. scabiei</i> var. <i>canis</i>	6	50.0	1-5	1.7±0.6
	<i>D. canis</i>	3	25.0	1-3	0.5±0.2
	Subtotal	7^P	58.3	1-5	1.1±0.4^b
Thigh and groin n=5	<i>S. scabiei</i> var. <i>canis</i>	2	40.0	1-5	1.2±0.7
	<i>D. canis</i>	1	20.0	1-3	0.2±0.2
	Subtotal	2^P	40.0	1-5	0.7±0.4^d
P value			0.022*		

n = Total no. of dogs examined

^P = Total no. of dogs affected is less than the summation of individual infestation because same dog was infested by more than one species of mites.

Values in the sixth column having different superscript are statistically significant ($p < 0.05$).

Histopathological lesions were characterized by acanthosis, slight hyperkeratosis, formation of hyperplastic rete-pegs and destruction of dermis and epidermis. Hyperplastic changes in sweat glands, sebaceous glands and hair follicular cells. Pyogranuloma in papillary layer and sometimes in few hair follicles. Pyogranuloma consists of neutrophils, eosinophils, lymphocytes and macrophages (Fig. 5, 6, 7, 8). Histopathological lesions were described by some others. Rojko *et al.* (1978) found ulceration, acanthosis, hyperkeratosis, parakeratosis, intraepidermal pustule formation and epidermal degeneration associated with neutrophilic infiltration. Radbea (2005) observed hyperkeratosis with *Demodex canis* mite in the pilous follicle. Casewell *et al.* (1997) found mural folliculitis in canine demodicosis. Baker (1975) reported hyperpigmentation with melanocyte activity in the epidermis and pustular reaction follows follicular rupture.

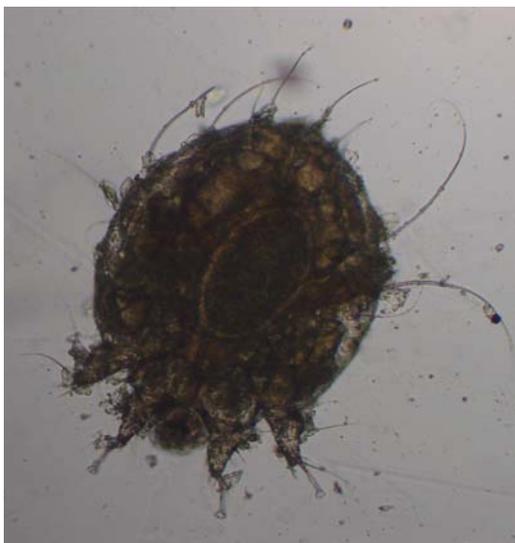


Fig. 1. *Sarcoptes scabiei* var. *canis*



Fig. 2. *Demodex canis*



Fig. 3. Severe infestation with *Sarcoptes scabiei* var. *canis* characterized by alopecia, formation of crust with dried exudates, thickening and corrugation of skin



Fig. 4. Severe infestation with *Demodex canis* characterized by alopecia, erythema, pastules, crusts and pruritus

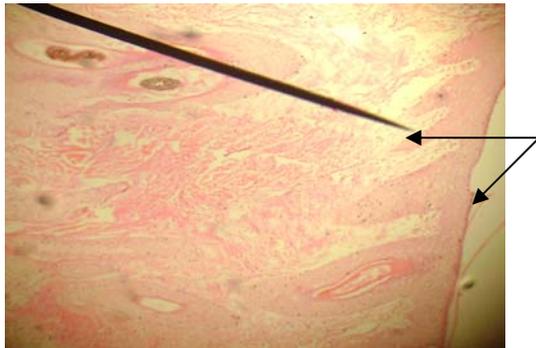


Fig. 5. Acanthosis, slight hyperkeratosis, formation of hyperplastic rete-pegs, destruction of dermis and epidermis in *Sarcoptes scabiei* var. *canis* infestation (330x)

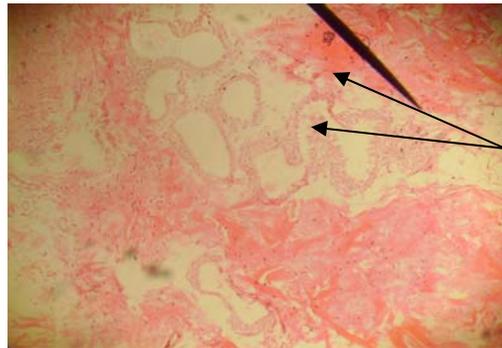


Fig. 6. Hyperplastic changes in sweat glands, sebaceous glands and hair follicular cells in *Demodex canis* infestation (330x)

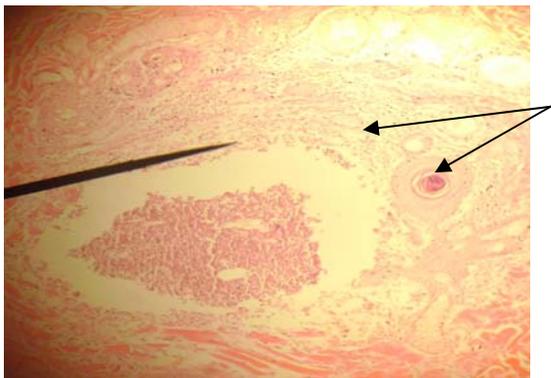


Fig 7. Pyogranuloma in papillary layer and hair follicles (330x)

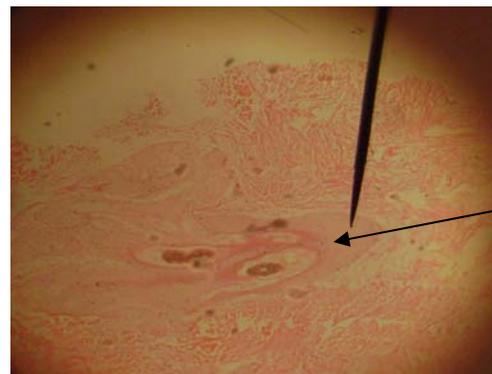


Fig. 8. Hyperplastic changes in the hair follicular cells with infiltration of inflammatory cells (330x)

Conclusion

It is concluded that the mite infestation in the dog is highly prevalent in the study area. So, thorough and extensive works on different aspect of mite in dog including its control measures are necessary.

References

- Acha, P. and Szyfres, B. 2003. Zoonosis and communicable diseases common to man and animals; chlamydioses, rickettsioses and viruses. PAHO, WHO, Washington DC, USA.
- Araujo, F.R., Silva, M.P., Lopes, A.A., Ribeiro, O.C., Pires, P.P., Carvalho, C.M., Balbuena, C.B., Villas, A.A. and Ramos, J.K. 1998. Severe cat flea infestation of dairy calves in Brazil. *Veterinary Parasitology*, 80: 83-86.
- Arlan, L.G. and Morgan, M.S. 2000. Serum antibody to *Sarcoptes scabiei* and house dust mite prior to and during infestation with *S. scabiei*. *Veterinary Parasitology*, 90:315-326
- Baker, K.P. 1975. Hyperpigmentation of the skin in canine demodicosis. *Veterinary Parasitology*, 1(2):193-197.
- Caswell, J.L., Yager, J.A., Parker, W.M. and Moore, P.F. 1997. A prospective study of the immunophenotype and temporal changes in the histologic lesions of canine. *Veterinary Pathology*, 34:279-287.
- Chakrabarti, A. and Navjeevan, C.S. 2002. Canine alopecia an epidemiological study. *Indian Journal of Veterinary Medicine*, 22(1): 57-58.
- Chen, C. 1995. A short-tailed demodectic mite and *Demodex canis* infestation in a Chihuahua dog. *Veterinary Dermatology*, 6(4): 227-229.
- Curtis, C.F. 2001. Evaluation of a commercially available enzyme-linked immunosorbent assay for the diagnosis of canine sarcoptic mange. *The Veterinary Record*, 148: 238-239.
- De Lahunta, A. and Habel, R.E. 1986. *Applied Veterinary Anatomy*, (1st edition), W.B. Saunders Company, Philadelphia, pp: 13-15.
- Folstad, I. and Karter, A.J. 1992. Parasites, bright males and the immunocompetence handicap hypothesis. *American Naturalist*, 139: 603-622.
- Folz, S.D. 1984. Canine scabies (*Sarcoptes scabiei* infestation). *Compendium on Continuing Education for the Practicing Veterinarian*, 6: 176- 180.
- Henfrey, J.I. 1990. Canine demodicosis. *In Practice*, 30:187-192.
- Huq, M.M., Safiruddin, M. and Shaikh, H.U. 1974. Scabies among the members of the "Bangladesh Muktibahini"(Bangladesh Liberation Forces). *Third International Congress of Parasitology Proceed*. Vol. II. pp: 975-976(August 25-31, 1974).
- Huq, M.M., Shaikh, H.U., Karim, M.J. and Khan, M.M.M. 1985. Scabies in man and dogs. *Bangladesh Veterinary Journal*, 19(1-4): 63-65.
- Jeong-Hyun Chee, Jung-Kee Kwon, Ho-Seong Cho, Kyoung-Oh Cho, Yu-Jin Lee, AM Abd El-Aty and Sung-Shik Shin. 2008. A survey of ectoparasite infestations in stray dogs of Gwang-ju City, Republic of Korea. *Korean Journal of Parasitology*, 46(1): 23-27.
- Kalyan, S., Borthakur, S.K. and Girin, K. 2005. Incidence of mange mite infestation in dogs a case report. *Journal of Veterinary Parasitology*, 19(2):71-74.
- Klein, S.L. 2004. Hormonal and immunological mechanisms mediating sex differences in parasite infection. *Parasite Immunology*, 26: 247-264.
- Klukowski, M. and Nelson, C.E. 2001. Ectoparasite loads in free-ranging northern fence lizards, *Sceloporus undulatus hyacinthinus*: effects of testosterone and sex. *Behavioral Ecology and Sociobiology*, 49: 289-295.
- Lapage, G. 1962. *Moning Veterinary Helminthology and Entomology*, 5th edition, Bailliere, Tindal and Cox, London, pp: 566-723.
- Lemarie, S.L. 1996. Canine demodicosis. *Compendium on Continuing Education for the Practicing Veterinarian*, 18: 354-368.
- Luna, L.G. 1968. *Manual of Histologic Staining Methods of the Armed Forces Institute of pathology*, 3rd edition, Mc Graw Hill Book Company, New York, pp: 32-46.
- Mahato, S., Baksi, S. and Chakrabarti, A. 2005. A note on generalized demodicosis in canines. *Indian Veterinary Journal*, 82(7): 794-798.
- Nayak, D.C., Tripathy, S.B., Dey, P.C., Ray, S.K., Mohanty, D.N., Parida, G.S., Biswal, S. and Das, M. 1997. Prevalence of canine demodicosis in Orissa (India). *Veterinary Parasitology*, 73(3-4):347-352.
- Nuttall, T. 2004. *Introduction*. In, *Veterinary advice on skin disorders in dogs*. 1st edition, Ringpress, Dorking, pp. 4-6.
- Pence, D.B. and Ueckermann, E. 2002. Sarcoptic mange in wildlife. *Revue Scientifique et Technique -Office International Epizoot*, 21:385-398.
- Pin, D., Bensignor, E., Carlotti, D.N. and Cadiergues, M.C. 2006. Localised sarcoptic mange in dogs: a retrospective study of 10 cases. *The Journal of Small Animal Practice*, 47(10): 611-614.

- Radbea, N. 2005. Histopathological aspects in canine pyodermatitis. *Revista Romana de Medicina Veterinara*, 15(2): 43-50
- Rahman, S.M. 2006. *Canine and Feline Medicine*, Vol.-I (1st edition), Published by Prithul and Piya publication, Mymensingh, pp: 145-147.
- Roberts, M.L., Buchanan, K.L. and Evans, M.R. 2004. Testing the immunocompetence handicap hypothesis: a review of the evidence. *Animal Behaviour*, 68: 227–239.
- Rojko, J.L., Hoover, E.A. and Martin, S.L. 1978. Histologic interpretation of cutaneous biopsies from dogs with dermatologic disorders. *Veterinary Pathology*, 15:579-589.
- Schlesselman, J.J. 1982. *Case Control Studies*, 1st edition, Oxford University Press, New York, pp: 174-177.
- Scott, D.W. 1979b. Canine demodicosis. *Veterinary Clinics of North America: The journal of Small Animal Practice*, 9: 79-92.
- Scott, D.W., Miller, W.M. and Griffin, C.E. 2001. Parasitic skin diseases. In: Muller and Kirk (edit.), *Small Animal Dermatology*, 6th edition, W.B. Saunders Company, Philadelphia, pp: 423–516.
- Soglia, D., Rasero, R., Rossi, L., Sartore, S., Sacchi, P. and Maione, S. 2007. Microsatellites as markers for comparison among different populations of *Sarcoptes scabiei*. *Italian Journal of Animal Science*, 6(1): 214-216.
- Solanki, J.B. and Hasnani, J.J. 2006. Clinico-prevalence of canine demodicosis in Gujarat. *Indian Journal of Field Veterinarians*, 1(3): 11-13
- Soulsby, E.J.L. 1982. *Helminths, Arthropod and Protozoa of Domesticated Animals*, 7th edition, Bailliere Tindal, London, pp: 476-486.
- Tamura, Y., Moriyasu, I., Kawamura, Y., Inoue, I. and Ishino, S. 2000. A case of canine demodicosis complicated by *Demodex canis* and a short-bodied (unidentified) demodex mite. *Journal of the Japan Veterinary Medical Association*, 53(10): 676-678
- Wall, R. and Shearer, D. 1997. *Veterinary Entomology*, 1st edition, Published by Chapman and Hall, 2-6 Boundary Row, London, pp: 3-4, 43-135.
- WHO, FAO and OIE 2004. Report of the WHO/FAO/OIE joint consultation on emerging zoonotic diseases, technical report WHO/CDS/CPE/ZFK/2004. World Health Organization, Food and Agriculture Organization of the United Nations and Office International des Epizooties.