Impact of epidemiological factors on the prevalence, intensity and distribution of ectoparasites in pigeons

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Abstract This study was carried out on domestic pigeons (*Columba livia domestica*) from September (2014) to June (2015) to determine the prevalence, intensity and species of ectoparasites in Sargodha region, east of Pakistan. A total of 200 domestic pigeons were inspected from the study area. Parasites were collected by forceps and stored in 70% ethanol. The epidemiological information e.g. health condition, color of plumage, mode of living, breed, intensity etc. were recorded in the form of questionnaire. The overall prevalence of ectoparasites in pigeon was 90.5% (181/200). Of the total of 200 (83 males and 117 females) domestic pigeons inspected, 73 (87.95%) and 108 (92.30%) were

infected, respectively. The ectoparasites spp. were identified as *Cumbicola columbae* (Linnaeus, 1758) and *Colpocephalum turbinatum* (Denny, 1842). The Qasid breed showed highest infestation rate (91.25%) as compared to other two observed breeds. Pigeon of white color were more infested (91%) as compared to other colors. Thus color and breed factors showing the random differences. In medicated birds the rate of infestation of ectoparasites was 87% reflecting that drugs are unable to control or might be due to resistance. There was significant difference between the number of parasites on tail, neck, chest and wings within different breeds, as well as in the months. The mean intensity of parasites was in urban areas (28.5), rural areas (14.98), and sub-rural areas (23.55). In conclusion the prevalence of ectoparasites in pigeons is very high in north-east region of Pakistan.

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Introduction

Pigeons (*Columba livia domestica*) are present almost all over the world except the poles. Pigeons have been used for a long time as cultural and religious symbols as well as reared as pets (Cooper 1984; Harlin 1994). The population of pigeons are increasing worldwide especially in larger cities because of abundant food supply via natural, seasonal food, food spillage and disposal of food by humans (Simms 1979; Haag-wackernagel 1995). The increase in population of feral pigeons causes problems for humans especially their droppings. Droppings of feral pigeons contain bacteria, fungi and some parasites which are hazardous for

humans (Weber 1979). In urban areas these droppings may accumulate on buildings, sideways, vehicles and various other constructions (Haag-Wackernagel 2000). Therefore human food, health and buildings are directly affected by pigeons (Haag 1988; Harris 1996; Buijs and Wijnen 2001).

Pakistan is a country which have very suitable climate for the various parasites and diseases to grow (Shahiduzzaman et al. 1999). Several health problems can affect pigeon, but parasite infections play a major role (Rodrigues and Matta 2001). Passerine birds can carry fleas, ticks, mites and other parasites (Deviche et al. 2001). These ectoparasites effects the health and productivity as they suck blood, along with this they cause irritation to the host bird, which starts preening except other essential life activities (Adang et al. 2008).

Parasites like lice deteriorate the quality of plumage by making small holes in the plumage as well as may cause feather breakage so may diminish the thermoregulatory capacity of feathers (Booth et al. 1993; Kose and Møller 1999; Vas et al. 2008). Intense lice infestation can potentially produce direct (e.g. hyperkeratosis and feather damage) and indirect (e.g. negative sexual selection) pathological effects to hosts (Lopez et al. 2008; Liebana et al. 2011; Moreno-Rueda and Hoi 2012). The present study was designed to determine the prevalence and intensity of ectoparasites infestation of pigeons and also impact of epidemiological factors on the prevalence.

Materials and methods

Study area

This study was carried out in Sargodha region in the east of Pakistan (Fig. 1). Pigeon is a common pet bird found in the areas of district Sargodha. Pigeons were observed under different captive conditions. The sampling was carried out from the urban, suburban and rural areas of study area. Sampling was done at i) Urban areas containing suburbs of Sargodha city and ii) Rural area of Sargodha. iii) Sub-urban area of tehsil Shahpur, including a village Kandan.

Study duration

The survey was carried out from September (2014) to June (2015) on monthly basis from each study area. The epidemiological information's was recorded in the form of questionnaire in different seasons from the study area.

Collection of samples

The plumage of each bird was thoroughly brushed onto a white tray for the collection of ectoparasites. The feathers

of head, neck, under the wings, body, legs and cloaca were raised and thoroughly examined with hand lens for ectoparasites. Attached ectoparasites such as louse and ticks, which could not be removed by brushing, were gently dislodged with a pair of thumb forceps and their sites noted. The ectoparasites were prepared for identification by relaxing and dehydrating them in 70% alcohol (Beck and Davies 1981) and later mounting them on a microscopy slide under a dissecting microscope, and a light microscope. After mounted, the ectoparasites were counted and preserved in labeled vials containing 70% alcohol (methanol) and a drop of glycerine. The ectoparasites were identified using standard texts by Soulsby (1982).

Epidemiological factors

Before collecting data, to make survey more useful and easy, a sheet was prepared having different factors effecting prevalence and persistence of ectoparasites. These factors were area (rural or urban), sex, age (A-Nestlings-(<3 months); adults-B (3 months to 1.5 year), C (3–4.5 years), D (4.5–5 years), E (5–6.5 years), F (6.5–8 years), breed (Aseel, Latha, Qasid), flock, color (white, grey, brown, black headed white), month, feed, intensity of parasites per pigeon.

Identification of ectoparasites

These ectoparasites were identified using standard references (Soulsby 1982; Naz et al. 2012; Dik and Halajian 2012).

Statistical evaluations

Prevalence of individual parasite species was calculated as a percentage of the host population that was infested with a specific parasite (Thrusfield 1995). Intensity was calculated as the number of parasites per infected birds. Chi square analysis was done by using SPSS® computer software.

Results

In the present study a total of 3 localities, 10 flocks with 200 birds were carefully inspected to determine the prevalence and intensity of ectoparasites in pigeons. The overall prevalence was 90.5% (181/200). The prevalence of ectoparasites was in urban area (95%), sub-rural area (93%) and rural area (81%), respectively. The results showed that there is a wide variation in the prevalence of ectoparasites in different regions of study area ($P < 0.05$). The prevalence rate was 91.25% in Aseel, 96.66% in

Fig. 1 The map of study area

Qasid, while it was 83.33% in Latha breed. The results showed that birds of Qasid breed were significantly more infested as compared to other breeds ($P < 0.05$). Pigeons are categorized into eight groups on the basis of their colors. Out of total 181 infested birds, white headed black and grey brown color pigeon were more infested (100%) followed by brown color pigeons (93.33%), white color pigeons (91.66%), white-black color (90.90%), Grey color (88.88%), Black-white color (87.5%), respectively (Table 1).

In the present study two main species of ectoparasites were identified as *Columbicola columbae* (Linnaeus, 1758) and *Colpocephalum turbinatum* (Denny, 1842) (Fig. 2).

Majority of the infested birds belongs to the weak health status as compared to non infested birds having healthy status. These weak pigeons have relatively more susceptible to the parasitic infection than those which are healthy as these weak pigeons mostly do not show efficient preening behavior than those of weaker ones. Similarly most of the studied birds are kept in cages while only 9% are studied in the wild. Mostly studied wild birds are nestling. These wild birds have comparatively less number of parasites. The prevalence was in captive versus wild pigeons were determined in the present study. These findings show that captive birds were more infested (91.75%) than wild birds (77.77%). The female were more infested (92.30%) than

Table 1 Impact of different epidemiological factors on the prevalence of ectoparasites in pigeons

No.	Factors	Co-factors	Examined (n)	Infested (n)	Prevalence (%)	Statistical analysis (Chi-square)
1	Area	Rural	60	49	81	$\chi^2 = 7.8899$, $df = 2$, $P = 0.01935$
		Sub-rural	60	56	93	
		Urban	80	76	95	
2	Breeds	Aseel	80	73	91.25	$\chi^2 = 6.2906$, $df = 2$, $P = 0.04305$
		Latha	60	50	83.33	
		Qasid	60	58	96.66	
3	Color	Black headed white	35	31	88.57	$\chi^2 = 1.0177$, $df = 7$, $P = 0.9945$
		Brown	15	14	93.33	
		More black and less white	16	14	87.5	
		Grey	36	32	88.88	
		Grey brown	1	1	100	
		White	84	77	91.66	
		More white and less black	11	10	90.90	
4	Physical status	White headed black	2	2	100	$\chi^2 = 1.3416$, $df = 1$, $P = 0.2467$
		Healthy	165	147	89.09	
		Weak	35	34	97.14	
5	Management	Captive	182	167	91.75	$\chi^2 = 2.2752$, $df = 1$, $P = 0.1315$
		Wild	18	14	77.77	
6	Sex	Male	83	73	87.95	$\chi^2 = 0.6248$, $df = 1$, $P = 0.4293$
		Female	117	108	92.30	
7	Medication	KMnO ₄	86	76	88.37	$\chi^2 = 0.41972$, $df = 1$, $P = 0.5171$
		No treatment	114	105	92.10	

Fig. 2 The month wise prevalence of ectoparasites in pigeons

Table 2 Prevalence and intensity of ectoparasites in pigeons

Study area	No. of examined birds	No of infested birds	Prevalence (%)	Total number of parasites	Mean	Median	Min–maximum	Confidence intervals (CI)
Rural	60	49	81	899	14.98	7.5	0–73	±4.54
Sub-rural	60	56	93	1413	23.55	15	0–131	±6.68
Urban	80	76	95	1710	28.5	21	0–129	±5.42

Table 3 Month wise prevalence of ectoparasites in pigeons

No.	Months	Total (n)	Infested (n)	Prevalence (%)	Statistical analysis (Chi-square analysis)
1	September	20	20	100	$\chi^2 = 16.807$, $df = 9$, $P = 0.05182$
2	October	20	19	95	
3	November	20	19	95	
4	December	20	20	100	
5	January	20	20	100	
6	February	20	15	75	
7	March	20	17	85	
8	April	20	18	90	
9	May	20	17	85	
10	June	20	16	80	
	Total	200	181	90.5	

male (87.95%) but statistically non-significant difference was observed between them. Similarly, the bird's plumages were treated with KMnO_4 have a little impact on the prevalence of parasites in pigeon (Table 1).

There were a significant difference was observed between the intensity of parasites collected from the urban areas to the rural areas of Sargodha. The total numbers of parasites collected from urban, rural and suburban areas were 1710, 899, 1413, respectively. Mean number of parasites in each bird were 24.74 in urban areas, 17.94 in rural areas, and 26.41 in sub-rural areas (Table 2).

Month based prevalence of ectoparasites was also determined in the present study. Every month 20 individual pigeons from 3 different localities were observed. In September, December and January all (100%) the pigeons were infested as compared to other months. The minimum prevalence rate was observed during the month of February (Table 3; Fig. 2).

Wings wise

The difference in the number of parasites on wings on comparison between different months was also observed. Highest number of parasites collected was 61 while lowest number for most of the months was zero. This comparison shows that most of the months do not show any difference on comparison. The comparison of different breeds for the parasites on the wings which shows that there is no

difference between Latha and Qasid breeds while Aseel breed shows highly different number relative to the other two. It indicates the significances of different trait variances of parasites on the wings of the pigeons which show that statistically there is significant difference between the number of parasites on wing within different breeds, captivity as well as in the months. But color and gender do not show any significance (Table 4).

Neck wise

The results showed that there was no significant difference in the intensity of parasites in neck region between Latha and Qasid breeds while Aseel breed shows highly different number relative to the other two. The statistical analysis showed the significances of different trait variances of parasites on the neck of the pigeons which shows that statistically there is significant difference between the number of parasites on neck within different breeds as well as in the months (Table 4).

Chest wise

Highest number of parasites collected from chest region was 8 while lowest number for most of the months was zero. This comparison shows that most of the months do not show any difference on comparison. The results showed that there is a statistically significant difference

Table 4 Statistical analysis showing the impact of month, breeds, color, captive/wild in different body parts of pigeon

No.	Parameter	Traits	d.f	Sum of square	Mean square	F value	Pr (>F)	Significance
1	Tail	Month	9	2468	274.2	3.99	0.00	***
		Breed	2	3768	1883.8	27.40	4.14e ⁻¹¹	***
		Color	7	678	96.9	1.41	0.20	
		Captive/wild	1	307	306.8	4.46	0.03	*
		Gender	1	19	18.7	0.272	0.60	
2	Chest	Month	9	50.40	5.60	3.34	0.00	***
		Breed	2	46.22	23.11	13.78	2.71	***
		Color	7	9.40	1.34	0.80	0.58	
		Captive/wild	1	5.88	5.88	3.50	0.06	—
		Gender	1	8.06	8.06	4.80	0.02	*
3	Neck	Month	9	83.4	9.27	2.48	0.01	*
		Breed	2	79.1	39.54	10.59	4.5e ⁻⁰⁵	***
		Color	7	34.2	4.88	1.30	0.24	
		Captive/wild	1	13.72	13.72	3.67	0.05	—
		Gender	1	1.56	1.56	0.41	0.51	
4	Wings	Month	9	2038	226	2.10	0.03	*
		Breed	2	10,926	5463	50.76	2e ⁻¹⁶	***
		Color	7	1356	194	1.79	0.08	—
		Captive/wild	1	1856	1856	17.25	5.07e ⁻⁰⁵	***
		Gender	1	9	9	0.081	0.776	

*** Most highly significant; ** highly significant; * significant

observed between the number of parasites on neck within different breeds, gender as well as in the months. But color and captivity do not show any significance (Table 4).

Tail wise

The results based on the parasitic infestation in the tail of pigeon showed non-significant association between Latha and Qasid breeds as compared to Aseel breed. The F value shows the significances of different trait variances of parasites on the tail of the pigeons which shows that there is significant difference between the number of parasites on tail within different breeds, captivity as well as in the months (Table 4).

Discussion

The overall prevalence rate of parasites in domestic pigeons was considerably high, which indicates that parasitic infection is a common problem in this area. According to Harlin (1994), *Columbicola columbae* is the most common malophagian parasite of pigeons while Musa et al. (2011) reported the *Colpocephalum turbinatum* (Denny, 1842) and *Columbicola columbae* (Linnaeus, 1758) are the most important ones. The results showed that *Colpocephalum turbinatum* (Denny, 1842) and *Columbicola*

columba (Linnaeus, 1758) are common ectoparasites of pigeons. Similar observations were reported by Ullah et al. (2005), who reported *Columbicola columbae* from Lahore (Pakistan). These two species chewing lice were reported in pigeons of Iran (Dik and Halajian 2012). The rate of infestation with *Columbicola columbae* in this study was in agreement with Harlin (1994).

In the present study the pigeons were infested with only two species of ectoparasites. Our results are in accordance with the neighboring country Bangladesh where domestic pigeons were infested with *Columbicola columbae* (Linnaeus, 1758) and *Campanulatus compar* (Begum and Sehrin 2011). Similar observations were reported in Iran where domestic pigeons could be less susceptible to mixed infections in comparison with free-range birds (Radfar et al. 2012).

The overall prevalence of ectoparasites in pigeon was 90.5% (181/200). Similarly the prevalence was 84.78% (Radfar et al. 2012) and 78% (Bahrami et al. 2011) in domestic pigeons of Iran while it was 90.33% different localities of Lahore, Pakistan (Ullah et al. 2005). Similar observations were reported from different geographic regions (Hashmi 1971; Gammaz 1990; Dranzoa et al. 1999). In contrary to our results there is a considerable variation in prevalence rate (29–61%) on blue rock pigeons of different species of Phthiraptera on Indian common pigeon (Khan et al. 2009; Singh et al. 1998).

The month wise variation in the intensity of ectoparasites in pigeon might be due to the climate factors that affects the intensity and distribution of parasites in pigeon in a specific area.

The higher intensity of parasites was observed in urban, rural areas followed by suburban areas. It might be due to the management practices, Hygienic conditions, Personal care of birds, Population variability, Feeding variation, Sanitary conditions, Climatic conditions and other physical factors.

Female birds were more infested as compared to male pigeon. Similar findings were reported in Bangladesh where females (30.11%) birds were more infested as compared to males (29.04%). The male and female birds had 10 ectoparasite species each and result shows insignificant difference in the intensity of infestation between male and female birds and these results are also in accordance with the Adang et al. (2008) and Senlik et al. (2005). These parasites were examined from different body parts as well. Which shows on comparison that at tail and wings of pigeons has abundant number of parasites are present while on the head and chest region very small number of ectoparasites is present in the pigeons. The difference in the number of parasites within these four body parts are most probably due to the larger surface area which is further increased by the large feathers in these areas of body. Whiteman and Parker (2004) found a negative relationship between host body condition and the abundance of parasite (e.g. *C. turbinatum*). Thus, the abundance of the *C. turbinatum* had a strong correlation with body condition (Whiteman and Parker 2004). The findings showed that area and breeds are the significant epidemiological factors, while color, physical status, type, and medication have no impact on the prevalence of ectoparasites in pigeons.

The present study shows that pigeons have high prevalence of ectoparasites infestation and has a wide variation in across the world. These differences were probably linked to geographical variations. Parasitic infestation in almost all cases is harmful to their host. The pigeon infested with parasites are more weak and lower productive potential.

Conclusions

In conclusion the prevalence of ectoparasites in pigeons is very high in north-east region of Pakistan. The study highlighted the potential public health importance of meat of pigeon as source of infection for humans. If a bird weak having more chances to get infected with other pathogens that might be zoonotic. There should be some eradication strategies and management practices should

be implemented to reduce the prevalence rate in other agro- ecological zones of Pakistan.

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Compliance with ethical standards

Conflict of interest The authors fully declare any financial or other potential conflict of interest.

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