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Common Shrew (*Suncus murinus*): A Potential Reservoir of Pathogenic Bacteria at Poultry Farms, Rawalpindi, Pakistan

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Abstract.- The prevalence of pathogenic bacteria in fecal matter, urine and blood of common shrew (*Suncus murinus*) inhabiting poultry farms was studied. Thirteen shrews were captured and checked for the presence of pathogenic bacteria. Prevalence of *Escherichia coli* and *Proteus* spp. was 61.5% and 15.38% in fecal matter, respectively. Prevalence of *Salmonella* spp. was 69.2% in fecal matter and urine. It is concluded that common shrews serve as reservoir of pathogenic bacteria that can be prevented by adopting suitable strategies to eliminate the shrew populations from the poultry farms.

Keywords: Bacteria, poultry farms, Salmonella, shrew.

Common shrew (*Suncus murinus*), a rodent, is commonly found as pest at poultry farms and causes damage to the food, food products, buildings and stored products. In Pakistan, no information is available on common shrew as the potential reservoir of bacteria dangerous to human and animal health. *Escherichia coli*, *Proteus* spp. and *Salmonella* spp. are important human pathogens worldwide associated with rodents at poultry farms (Doyle *et al.*, 1990; Mehmood *et al.*, 2011). Rodents transmit these bacteria through feces, urine and hair remnants (Padula *et al.*, 2000). Shrews residing at poultry farms can be a potential risk of bacterial infection for the poultry products and birds. Therefore, it is required to screen shrew populations for *E. coli*, *Proteus* spp. and *Salmonella* spp. inhabiting poultry farms. The present preliminary study was conducted to assess the prevalence of pathogenic bacteria in fecal matter, urine and blood of shrew residing at poultry farms.

Materials and methods

Thirteen shrews were live trapped from poultry farms located in Sehala area of Rawalpindi/Islamabad, Pakistan and immediately transported to laboratory for fecal matter, urine and blood sample collection. They were euthanized with chloroform and dissected. All samples were taken individually avoiding contamination from external sources (Pocock *et al.*, 2001).

Culture media was prepared by adding 50 g of MacConkey agar to 1 liter of distilled water. Culture media was subjected to heat to dissolve the entire agar. The culture media was autoclaved, cooled down and poured to petri dishes. The petri dishes were allowed to solidify and refrigerated for further use. Enrichment media (Selenite broth) was prepared by the same method as given above and stored in sterilized conical flasks.

Samples were inoculated into enrichment media and incubated at 37°C overnight. The inoculated tubes were then checked for turbidity as an indicator of bacterial growth. To obtain the pure isolates, samples were allowed to grow on the MacConkey agar plates at 37°C for 12-24 hours. After incubation period colonies were selected on the basis of their morphological characteristics and again cultured. Isolated bacteria were identified by gram-staining and biochemical tests.

Results and discussion

This study was designed to check the prevalence of pathogenic bacteria in fecal matter, urine and blood samples of shrew residing at poultry farms. The data on the prevalence of *E. coli*, *Proteus* spp. and *Salmonella* spp. in fecal matter, urine and blood of shrew is given Table I. Prevalence of *E. coli* and *Proteus* spp. was 61.5% and 15.38% in

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fecal matter respectively. Prevalence of *Salmonella* spp. was 69.2% in fecal matter and urine.

Table I.- Occurrence of pathogenic bacteria in fecal matter, urine and blood of shrew residing at poultry farms.

Bacterial species	Occurrence (%)		
	Fecal matter	Urine	Blood
Escherichia coli	61.5 (8/13)	0	0
Proteus spp.	15.38 (2/13)	0	0
Salmonella spp.	69.2 (9/13)	69.2 (9/13)	0

It is well recognized that small mammals are the reservoir of pathogenic bacteria at poultry farms (Meerburg *et al.*, 2006) and have definite association with the occurrence of pathogenic bacteria in poultry meat (Arsenault *et al*., 2007) and eggs (Humphrey, 1989) and are potential hazards for human health. This is the first report that shrew, a rodent, resident of poultry farms is also serving as reservoir of bacterial infection through fecal matter and urine. Shrews feed on poultry feed, products and birds, and make them a reservoir of different bacteria through direct transmission of bacteria from the environment of poultry farms. It is pertinent to mention that horizontal transmission of pathogenic bacteria in small mammals is common and rapid (Welch *et al.*, 1941). The population of shrews in a poultry facility might have high risk of the bacterial infection in poultry products. Risks of bacterial infection from shrews to the poultry birds and products can be reduced by eliminating the shrew populations from the poultry farms by extensive live trapping and making the structures rodent proof.

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Sero-prevalence of *Mycoplasma capricolum* subspecies *capripneumoniae* in Beetal and Beetal Teddy Cross Goat Breeds by Latex Agglutination Test in Different Districts of Punjab

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Abstract.-A study was conducted to determine the prevalence of *Mycoplasma capricolum* subspecies *capripneumoniae* (Mccp) antibodies in beetal and beetal teddy cross breeds of goats in Okara, Sahiwal and Faisalabad districts by using field diagnostic Latex Agglutination Test (LAT) kit "CapriLAT" during September, 2010 to February, 2011. Out of 750 serum samples, 343 samples (45.70 %) were positive for Mccp antibodies. Prevalence of Mccp antibodies attributed to goat breeds significantly differs in Okara and Sahiwal districts as well as in the aggregate of three districts altogether.

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Key words: Contagious caprine pleuro pneumonia, antibodies, *Mycoplasma mycoides* cluster, CapriLAT.

In Pakistan, livestock contributed approximately 55.1% of the agriculture value added and 11.5% to national GDP during 2010-2011 (Anonymous, 2011). The role of livestock in the economy of the country can be gauged from the fact that 30–35 million rural population is engaged in livestock raising, as every family has 2-3 cattle/ buffaloes and 5-6 sheep/goats, thus leading to 30-40% of their income from these animals (Anonymous, 2011). Goat rearing carries tremendous importance in rural economy particularly for the non-agriculturalists (Rahman *et al*., 2006). The population of goats has been estimated as 61.5 million (M) in Pakistan and it yielded 0.759 M tons of milk for human consumption, 0.616 M tons of mutton and 23.685 M skins during 2010-2011 (Anonymous, 2011).

This species of animal in the country is facing diversified problems including poor managemental practices, underfeeding and diseases including infectious and non-infectious one. Among the infectious diseases, contagious caprine pleuropneumonia poses a significant threat to production capacities of this animal (Rahman *et al.,* 2006).

Many mycoplasma species are important pathogens for caprine; these include *Mycoplasma mycoides* subsp. *mycoides* small colony (MmmSC), *Mycoplasma capricolum* subsp. *capripneumoniae* (Mccp), *Mycoplasma mycoides* subsp. *capri* (Mmc), *Mycoplasma mycoides* subsp. *mycoides* Large Colony (MmmLC), *Mycoplasma capricolum* subsp. *capricolum* (Mcc) and *Mycoplasma bovine* group 7 (MBG7). All of these belong to a group of very closely related mycoplasmas known as the "*Mycoplasma mycoides* (Mm) cluster" (Manso-Silvan *et al.,* 2007).

Mycoplasma capricolum subsp. *capripneumoniae* (Mccp), the sole cause of Contagious Caprine Pleuropneumonia (CCPP) has recently been isolated in goats and confirmed through molecular tools in Pishin district which is adjacent to Afghan border (Awan *et al*., 2009). Thus it is important to investigate the prevalence of Mccp in goats in central part of the country especially in Punjab province which contribute 37% of the total goat population (Livestock Censes, 2006). This is also necessary because there is free movement of goats through out the year from this province to other provinces which have borders with Afghanistan, Iran and India. For this purpose initial screening in goat populated districts for the detection of Mccp antibodies will give a preliminary picture about the species as well as its prevalence in goats in this area.

Materials and methods

During a period of six months (September, 2010 to February, 2011), three districts including Okara, Sahiwal and Faisalabad (heavily goat populated) were selected for screening antibodies against *Mycoplasma capricolum* subspecies *capripneumoniae* (Mccp) in Beetal and Beetal Teddy Cross goat breeds by Latex Agglutination Test Kit "Capri LAT". Using random sampling technique, a total of 750 serum samples, 250 from each district, were collected from clinically affected goats of different breeds, age groups and either sex showing symptoms of nasal discharge, pneumonia, coughing and high temperature etc. All samples were obtained prospectively for the purpose of study from different goat flocks (from 7 to 200 goats in each flock) in each district, which were mainly kept on traditional grazing of weeds, trees and seasonal green fodder. The affected animals were identified through clinical signs and symptoms of the disease, post-mortem lesions of affected died goats and also by taking the history of the affected animals from the owners at the time of

sampling. The detail of number of samples collected in each district, breed and sex is given in Table I. None of the animals were known to have been vaccinated against *Mycoplasma capricolum* subsp. *capripneumoniae* before, or at the time of sampling. A pre-designed questionnaire was recorded regarding the species, breed, age, vaccination schedule, clinical signs observed, morbidity, mortality due to respiratory disease, purchased or sold animals and history of previous medication etc. Thirty healthy goats with no history of respiratory tract infections or CCPP were maintained at Livestock Production Research Institute Bahadurnagar, Okara and were used as known control negative group.

Five ml blood was collected from the jugular vein in a 10 ml clean sterile vacutainer (BD Franklin Lakes, NJ, USA) without having any additive. The blood was left to clot overnight at 4°C. Serum was decanted into sterile tubes and brought to lab on ice packs within 24 h of collection. In the lab the sera samples were tested immediately or stored at –20°C until tested.

Serum samples were subjected to latex agglutination test by using a commercially available kit "CapriLAT" (donated by Dr. Robin Nicholas, Veterinary Laboratory Agency, UK) according to the protocol as described by kit manufactures. Briefly 20 µl serum samples were admixed at room temperature (37°C) with one drop of antigen supplied on a specially prepared black paper card and mixed thoroughly by rocking the reaction side from left to right for upto three minutes and recorded agglutinations if any. Positive and negative controls reactions were also performed in parallel after every 22 samples to check the specificity of the CapriLAT kit.

Results

Out of 750 serum samples from three districts, 343 samples (45.70%) showed strong or clear clumping of latex beads. Agglutination was found within three minutes indicating that samples were sero-positive with latex beads which were coated with a capsular polysaccharide (CPS) purified from Mccp cells. To investigate the influence of breed and sex on antibody prevalence in goats, data from the three districts were analyzed, the details of which is given in Table I. Prevalence of Mccp antibodies in the observed serum samples of goats is homogeneously proportional between districts, showing (χ^2) statistic with p-value (0.0696).

Prevalence of Mccp antibodies in goats in each district respectively as well as in the aggregate of three districts altogether attributed to goat gender is also homogeneously proportional, with p-values as (Okara = 0.3734, Sahiwal = 0.6357, Faisalabad = 0.2961 and district aggregates = 0.1808)

Prevalence of Mccp antibodies attributed to goat breeds significantly differs in Okara & Sahiwal districts respectively (p-values: 0.0088***** and 0.0000*****) as well as in the aggregate of three districts altogether (p-value = 0.0000*****), but it is homogeneously proportional in district Faisalabad (p-value = 0.2930). This may be due to only random variation in samples by chance.

In case of Okara district as well as in aggregate of three districts altogether, prevalence of Mccp antibodies in goats attributed to goat breeds is statistically independent of goat gender; with p-values respectively (0.1794 and 0.7367). However in districts of Sahiwal and Faisalabad, prevalence of Mccp antibodies attributed to goat breeds is significantly associated with goat gender with p-values, respectively (0.0041***** and 0.0006*****).

Discussion

Different researchers selected the above mentioned areas to study on various aspects of goat mycoplasmosis during different time

Table I.- District wise Prevalence of *Mycoplasma capricolumn* subspecies *capripneumoniae* antibodies in different breeds of goats and sex by using Latex Agglutination Test Kit "CapriLAT" .

District	Goat breeds	Total No. of samples collected			No. of samples observed					
					N_i (+ve)		Prevalence (P_i%)		Total & (P_i%)	
		Male	Female	by breed	Male	Female	Male	Female	by breed	(%)
Okara	Beetal	30	127	157	17	54	56.7%	42.5%	71	45.2%
	BTC$^+$	17	76	93	10	48	58.8%	63.2%	58	62.4%
	Total	47	203	**250**	27	102	57.4%	50.2%	**129**	51.6%
Sahiwal	Beetal	10	147	157	4	39	40.0%	26.5%	43	27.4%
	BTC	26	67	93	13	53	50.0%	79.1%	66	71.0%
	Total	36	214	**250**	17	92	47.2%	43.0%	**109**	43.6%
Faisalabad	Beetal	37	70	107	13	36	35.1%	51.4%	49	45.8%
	BTC	26	117	143	17	39	65.4%	33.3%	56	39.2%
	Total	63	187	**250**	30	75	47.6%	40.1%	**105**	42.0%
	Grand total	146	604	**750**	74	269	50.7%	44.5%	**343**	45.7%

BTC$^+$, Beetal teddy cross.

spans. Hayat and Siddique (1997) and Rahman *et al*. (2006) surveyed district Faisalabad for isolation and sero-prevalence of *Mycoplasma mycoides* subsp. *capri* respectively. Shahzad *et al.* (2011) has confirmed, 6.6% prevalence of *Mycoplasma mycoides* subspecies *capri* in goats through polymerase chain reaction in district Faisalabad.

The latex agglutination test (LAT) kit "CapriLAT" is particularly useful in identifying animals suffering from CCPP and combines sensitivity and low cost with ease of application in the field, without the need for any specialist training or equipment. The specificity of this test in Mauritius has been confirmed by immunoblotting by using antiserum raised in goats experimentally infected with F38 strain of Mccp (Srivastava *et al*.. 2010). The findings of this study correlate to the results of Awan *et al.* (2009) who also reported the molecular prevalence (17.65%) of Mccp in goats in Pishin district of Balochistan, Pakistan in 2008. The higher sero-prevalence (45.7%) of Mccp in the central districts of Punjab is justified as there is a difference of almost three years between these two studies, further there is free movements of goats/goat traders/goat breeders among all four provinces which have borders to different countries like India, Iran and Afghanistan. Furthermore this higher sero-prevalence (45.7%) pertains to only clinically affected goat herds as the samples of this study were obtained from clinically affected goats and this higher sero-prevalence rate is certainly not the overall sero-prevalence rate in these districts which is otherwise lower. Beside higher prevalence of Mccp antibodies in goats, low or no mortality has been observed/reported in goats, the reasons being spot slaughtering of the affected animals for mutton purpose and absence of disease reporting system and improved disease diagnostic facilities like PCR, LAT with Mccp

antigen etc. This higher prevalence (45.7%) of Mccp antibodies in different goat breeds is alarming and urge the need for development and implementation of CCPP vaccine containing Mccp antigen for the better control of caprine mycoplasmosis in Pakistan.

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Effect of Tillage Practice on the Seasonal Dynamics of Ground Spiders

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Abstract.- Present study was conducted to evaluate the effects of tillage activity on the abundance of ground spiders in rice ecosystem. Overall, there was no difference in the number of species or families of spiders captured from the tilled and untilled fields. However, abundance of spiders was significantly lower in the tilled field compared to the untilled field. Results of the study suggests that tilled fields support less spiders, thus reducing the impact of biological control of this important predatory group in the fields.

Keywords: Tillage, spiders, biological control.

Among generalist predators, spiders constitute a major and ecologically important group in many cropping systems. They consume a wide range of prey species (Motobayashi *et al.*, 2006) and prevent economically important outbreaks (Symondson *et al.*, 2002). Most of the generalist predators are sensitive to ecological disturbances including field management practices such as tillage, ploughing, herbicide and insecticides treatment. It has also been observed that changes in the crop management practices affect crop environment and agronomic sustainability (Shrestha and Parajulee, 2009). According to previous studies generalist predators, including spiders, occur in higher numbers in untilled or reduced-tillage fields than in conventionally tilled fields (House and All, 1981; House and Parmelee, 1985; Robertson *et al.*,

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1994; Tahir and Butt, 2009). Reduce tillage results in, more weeds; more plants residues, less disturbance, higher soil surface moisture (Wardle, 1995) and proliferation of detrivores (Robertson *et al.*, 1994). Assemblage of spiders that is enhanced by no-tillage management may play an important role in reducing pest populations or plant damage in up-land crop fields (Brust *et al.*, 1985; Clark, 1994). Reduce tillage is preferred due to yield advantages and substantial resource savings (Shrestha and Parajulee, 2010). In the present study, we investigated the effect of tillage practice on the population dynamic of ground spiders in rice ecosystem.

Materials and methods

The study was carried out in district Lahore Punjab, Pakistan from August through October of 2007 and 2008. Two fields of approximately 300 m^2 were selected in village Kirka located about 35 kilometers south east from University of the Punjab, Lahore across BRB canal. Each of the two fields was surrounded by other rice fields from all sides. The distance between two fields was about 500 meter. Both fields were irrigated in early June and 35 days old rice seedlings of super basmati were transplanted to the fields in mid-June at the rate of 16 hills m^2. Both experimental fields were subjected to different management practices *i.e.*, tillage activity was performed in one field but not in other. In tilled field, tillage activity was performed on third week of August and last week of October each year. During the course of the study, the temperature fell to approximately 28±5°C at night, and rose to about 35±6°C during the day. The relative humidity was highly variable (65-86 %).

From August to October each year, abundance of spiders and other arthropods in each plot were recorded by using pitfall traps. Each pitfall trap consisted of glass jars (6cm diameter x 12cm deep) set in 3 x 3 m grid pattern at twelve localities (4 girds in each plot). Two hundred and fifty ml of 70% alcohol and two drops of 5% liquid detergent were added to each trap. Pitfall traps were operated consecutively for 72 hours (= trapping session) after every fifteen days. Captured spider specimens were transferred to glass tubes containing a mixture of 70% ethanol and 30% glycerol. Specimens were identified only up to species level with the help of keys and catalogues available. All spider specimens were submitted at the Biological Pest Control Laboratory, Department of Zoology, University of the Punjab, Lahore, Pakistan. SPSS 10 was consulted for the data analyses and $P<0.05$ was considered as significant level.

Table I.- Number of spider families, genera, species and specimens collected during the sampling period of two years.

Treatments	No. of spider families	No. of genera	No. of species	No. of specimens
Tilled field				
2007	7	16	32	0989
2008	8	17	29	1088
Untilled field				
2007	8	17	32	1436
2008	9	19	34	1502
Total				**5015**

Results

In total, 5015 spider specimens, representing 37 species, 19 genera and 9 families were captured during the two sampling years. Out of the total spiders captured, 2938 spiders representing 34 species, 18 genera and 9 families were collected from the untilled field. However, 2077 spider specimens (representing 32 species, 16 genera and 8 families) were sampled from tilled field. Table I is showing the comparison of data of spiders collected from tilled and untilled fields during the study period of two years. Rank order of families (on the basis of their abundance) recorded from the tilled and untilled fields is given in the Table II. Rank order of dominant species (represented at least 1% of the total abundance) in the tilled and untilled fields is given in the Table III. Among the eight families Lycosidae was the most abundant family while *Lycosa terrestris* was the most abundant species both in tilled and untilled fields. Two years combined data analysis showed that species composition among different trapping sessions was statistically different between tilled and untilled fields ($t= 2.65$; $P= 0.03$). The abundance of ground spider in tilled field was significantly lower than untilled field ($t = 3.8$; $P = 0.007$, Fig. 1).

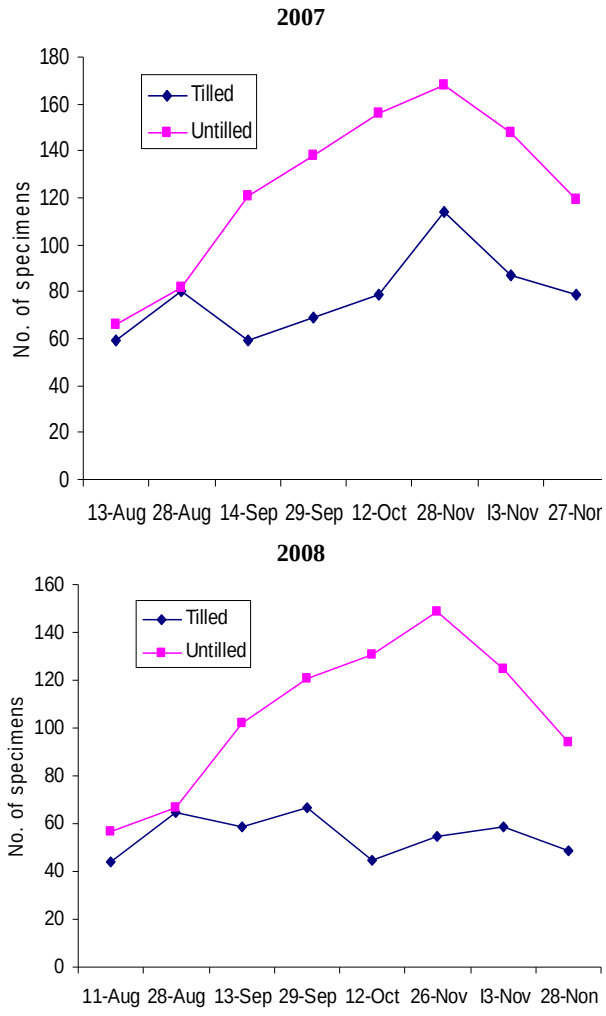

Fig. 1. Seasonal dynamics of ground spiders in tilled and untilled field.

Table II.- Rank order of spider families collected from the tilled and untilled fields (combined for two years).

Families of spiders	Untilled field	Tilled field
Araneidae	8	8
Clubionidae	6	6
Gnaphosidae	4	3
Lycosidae	1	1
Linyphiidae	7	7
Oxyopidae	5	5
Salticidae	2	2
Thomisidae	3	4
Tetragnathidae	9	-

Note: Ranking of spider families is done on the basis of their abundance.

Table III.- List of dominant spider species (which contributed at least 1% of the total abundance) with their respective families and rank order.

No	Species name	Family name	Untilled field	Tilled field
1	*Bianor albobimaculatus*	Salticidae	3	4
2	*Hasarius adansoni*	Salticidae	4	3
3	*Lycosa nigricans*	Lycosidae	6	6
4	*Lycosa terrestris*	Lycosidae	1	1
5	*Oxyopes javanus*	Oxyopidae	7	7
6	*Pardosa birmanica*	Lycosidae	2	2
7	*Runcinia affinis*	Thomisidae	5	5
8	*Thomisus elongatus*	Thomisidae	8	8
9	*Thyene imperialis*	Salticidae	9	9

Discussion

Crop management practices influence soil properties and microclimate, which consequently affect the dynamics of crop pests and their natural enemies. Tillage practice had no effect on the family and species composition but affected the abundance of the spiders. Reduce tillage practice enhance the spider abundance in the fields. This finding is in conformity with the results of Hidaka (1993, 1997) and Motobayashi *et al.* (2006). Reduce tillage practice help to conserve soil moisture, reduce nitrogen leaching, enhance soil organic matter, and reduce soil erosion (Lascano, 2000; Bronson *et al.*, 2001). Reduce tillage practice support more spiders in agricultural fields because of richer habitat structure, lower disturbance and proliferation of detritivores (Wardle, 1995; Sunderland and Samu, 2000). In the present study, higher spider abundance in the untilled field might be related to the high soil moisture and high weed density which supports more food for spiders (herbivores) compared to the tilled fields. Menalled *et al.* (2007) and Hatten *et al.* (2007) also reported higher predators diversity in reduce tillage and organic systems compared with that observed in conventional systems. Frequent disturbances in the agricultural fields also affect the habitat and development of the spiders (because of

change in the number available prey). It is concluded that tillage practice has negative effect on the abundance of spiders in rice ecosystem which in turn may reduces the biological control impact of this important predatory group. For the better understanding of the effect of different management practices on the ecology and behavior of ground spiders, further studies are in demand.

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Morphometric Analysis For Population Samples of Imago Caste of *Odontotermes feae* (Wasmann) (Isoptera: Termitidae: Macrotermitinae)

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Abstract.- Morphometric variations in imago caste of *Odontotermes feae* (Wasmann) were studied for the first time from the India and Bangladesh. Samples from six different nests have been statistically analyzed. Further comparison was made by considering all parameters for Manhattan distance re-arranged by similarity. Cluster analysis revealed that sample from locality B (India: Mysore) and C (India: Calcutta) were more closely related. Morphometric analysis presented in this research for *O. feae* (Wasmann) will serve as standard comparison for future specimens of this species.

Key Words: Imago, morphometric variability, *Odontotermes feae*.

O*dontotermes feae* (Wasmann) is widely distributed in India, Ceylon, Burma, Thailand, Bangladesh and Malaysia (Chhotani, 1997). It is a common, earth dwelling termite which usually attacks dead wood as well in house hold furniture. For foraging, it makes covered tunnels, earth plasters and sheets over surface of trees etc., beneath which workers and soldiers move. In Bangladesh, it has been observed living in close association with two species *viz., Macrotermes serrulatus, Hypotermes xenotermitis* and *Microtermes pakistanicus* nesting in its mound (Akhtar, 1975).

Morphometry is an important tool in taxonomic work and analysis of head capsule in

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case of soldier caste of termites helps in recognizing species differences. Furthermore, this study is now-a-days coupled with DNA gene sequence character analysis and accurate species identification underlies all termite field studies and population genetics research. Only a few studies on morphometric variations in termites have been carried out until now (Ahmad, 1949; Akhtar and Ahmad, 1991; Akhtar and Anwar, 1991; Chhotani, 1997; Chhotani and Das, 1979; Coronel and Porcel, 2002; Roonwal, 1970), so the present study would contribute to a better taxonomic knowledge of this species by means of the study of the intracolonial and intercolonial variations in the imago caste.

Materials and methods

The present study is based on preserved specimens available in collection of Prof. Dr. Muzaffar Ahmad, Department of Zoology, University of the Punjab, Lahore. Individual specimens from whole sample were picked up at random and measured under stereoscope (with built in magnification changer). Measurements were taken by calibrated ocular micrometer. Taxonomic terminology and measurements by Akhtar (1975) has been used. For estimating the Manhattan Distance, ranges were coded as three characters; Character range of the maximum number of individuals was coded as 1, less than this as 0 and higher to it as 2. Some of the absolute differences between character state of each character for every possible pair of population samples collected from different localities were also worked out.

For each individual imago, the following parameters were measured: i) length of head to tip of labrum ii) length of head to side base of mandibles iii) maximum width of head iv) length of postclypeus v) width of postclypeus vi) length of pronotum vii) width of pronotum viii) long diameter of ocellus ix) short diameter of ocellus x) long diameter of eye xi) short diameter of eye xii) distance of ocellus from eye. Photographs of specimens were also captured for exact morphological appearance of various taxonomic characters.

Material examined

Termites were collected from Bangladesh and India. The details of samples collected from Bangladesh is as follows**:** (i).Cox's Bazar, leg. and det. M.S. Akhtar, imagoes collected from a nest in a soil, 29.iv.1970; (ii) Adampur, leg. N. K. Malik, det. M. S. Akhtar, imagoes collected from a mound, 17.xi.1968, whereas from India the details are as follows, (i) Mysore: Sidapur, leg. Fletcher, det. N. Holmgren, imagoes, 15.02.1914; (ii) Calcutta, Indian Museum compound, leg. Graveley, det. M. Ahmad, imagoes, 10.1.1915; (iii) S. India: Coimbatore, leg. T.B. Fletcher, det. (iv) Dehra Dun, New forests, leg. and det. M. Feroz, imagoes, 14.9.1933.

Results and discussion

The imago of *O. feae* (Wasmann) is characterized by subcircular head capsule, much wider than long; fontanelle small, minute, slightly raised from head surface. Eyes subcircular, moderately large. Ocelli oval, moderately large; from eyes situated at about their short diameter. Pronotum trapezoidal, narrower than head; anterior margin slightly raised and with a weak, median notch; posterior margin also weakly incurved medially. Table I reveals the results of statistical analysis for Mean, Standard deviation, standard error, coefficient of variability, confidence interval (95%) for all the parameters discussed in materials and methods. From the Table I, it is evident that the highest value of coefficient of variability (C.V = 13.6) was recorded for distance of ocellus from eye. Short diameter of eye is less variable character (C.V = 4.23) for the imago caste (Table I). Smallest sample belonged to locality E (Bangladesh: Adampur).

Cluster analysis

Further comparison was made by considering all parameters for Manhattan distance re-arranged by similarity. Sample from locality B (India: Mysore) and C (India: Calcutta) form the primary cluster at value of 6. Sample from locality A (Bangladesh: Cox's Bazar) joins the cluster BC to form secondary cluster at value of 7.5 (Fig. 1). Sample from locality D, E and F were not included in cluster analysis.

Table I.- Statistics for various parameters for *O. feae* (Wasmann), collected from all localities.

Parameters	N	O.R.	$\overline{X}$	S.D.	S.E.	C.I. (95%)	C.V.
Length of head to tip of labrum	19	2.38-3.17	2.80	0.23	0.05	2.68-2.91	8.55
Length of head to side base of mandibles	19	1.48-2.10	1.84	0.18	0.04	1.75-1.93	9.97
Maximum width of head	19	2.47-3.09	2.68	0.13	0.03	2.61-2.75	5.20
Length of postclypeus	19	0.45-0.64	0.53	0.05	0.01	0.50-0.56	10.0
Width of postclypeus	19	1.09-1.28	1.18	0.08	0.01	1.14-1.22	6.75
Length of pronotum	19	1.09-1.63	1.26	0.09	0.02	1.21-1.30	7.49
Width of pronotum	19	2.02-2.73	2.45	0.17	0.03	2.37-2.53	6.95
Long diameter of eye	19	0.64-0.81	0.70	0.03	0.008	0.68-0.71	5.55
Short diameter of eye	19	0.57-0.67	0.62	0.02	0.006	0.61-0.63	4.23
Long diameter of ocellus	19	0.32-0.41	0.34	0.03	0.007	0.33-0.36	9.87
Short diameter of ocellus	19	0.16-0.25	0.20	0.02	0.006	0.18-0.21	13.3
Distance of Ocellus from eye	19	0.16-0.22	0.18	0.02	0.005	0.16-0.19	13.6

N, Number of samples; O.R., Observed range; X, Mean; S.D., Standard Deviation; S.E., Standard Error; C.I., Confidence Interval; C.V., Coefficient of variance.

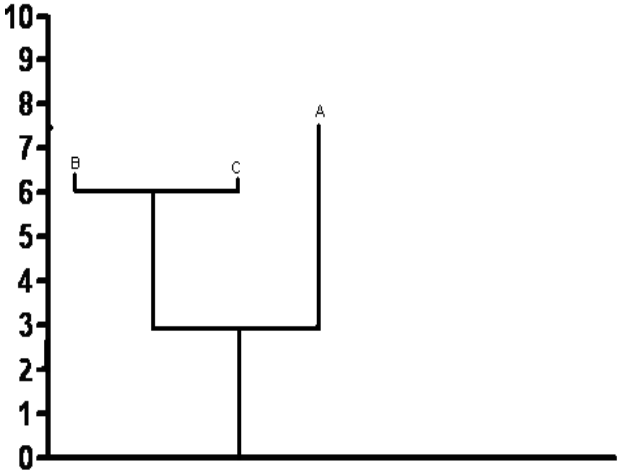

Fig. 1. Dendrogram: Based on Manhattan distance, specimens from locality B (Mysore) and C (Calcutta) form primary cluster at value of 6. Specimens form locality A (Cox's Bazar) joins B and C to form secondary cluster at value of 7.5.

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Distribution and Relative Abundance of Freshwater Turtles in Korang River Islamabad- Rawalpindi, Pakistan

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Abstract.- Two families, six genera and eight species of fresh water turtles are reported from Pakistan, distributed throughout the Indus river system. The current study investigated the distribution and abundance of fresh water turtle species inhabiting Korang River, Islamabad-

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Rawalpindi. Three species were recorded in the study area; Indus mud turtle (*Lissemys punctata*) was found to be the most abundant species contributing up to 56 %, the Indian soft shelled turtle (*Aspideretes gangeticus*) 30%, and the brown river turtle (*Kachuga smithii*) constituted 8% of total number of turtles recorded (6% turtles unidentified).

Key words: Fresh water turtles, distribution, abundance, Korang river Islamabad.

Fresh water turtles, "Testudines" occur in six genera and eight species in Pakistan. Family Emididae consists of four species of hard shelled turtles; spotted pond turtle (*Geoclemys hamiltoni*), crowned river turtle (*Hardella thurjii),* brown river turtle (*Kachuga smithii)* and Indian roofed turtle (*Kachuga tecta tecta).* These are distributed in Pakistan, India, Bangladesh, Nepal, Burma, Thailand, Vietnam, Malaysia and Sumatra (Moll, 1987). The other family Trionychidae comprises of soft shelled turtles, also represented by four species; Indian narrow-headed soft shell turtle (*Chitra indica),* Indian soft shell turtle (*Aspideretes gangeticus),* Indian peacock soft shell turtle (*Aspideretes hurum)* and Indus mud turtle *(Lissemys punctata).* These are larger in size as compared to hard shelled turtles and occur in temperate eastern North America, tropical south and Southeast Asia, in the countries of the Mediterranean region, and Africa (Khan, 1999; 2004; 2006). Both of these families of freshwater turtles have been recorded from the rivers of the Punjab province, Pakistan.

Fresh water turtles play important role in the health of aquatic ecosystem, since they are scavengers, herbivores, and carnivores, provide dispersal mechanism for plants (Brooks *et al*., 1988; Lovich, 1994), clean up water resources by scavenging on dead organic matter and help to maintain healthy populations of fish (Lovich, 1994). Soft shelled turtles are source of Traditional Chinese Medicine (TCM), and their shells are highly effective for purifying blood and cure many diseases (Zuberi, 2007), also these are most palatable non-marine Chelonians in Southeast Asia (Jenkins, 1995).

Indian soft-shelled turtle (*Aspideretes gangeticus)* is listed in Appendix-I of CITES while Indus mud turtle (*Lissemys punctata*) along with the Brown river turtle (*Kachuga smithii),* are listed in Appendix-II. The current study investigated the distribution and abundance of these freshwater turtles inhabiting Korang river Islamabad-Rawalpindi, Pakistan.

Methodology

The current study was conducted at Korang river, Islamabad / Rawalpindi. The river originates from Rawal Lake (33° 41'.27" N and 73° 07'.54" E) Islamabad and after covering a distance of approximately 20 kilometers (km) in a zigzag fashion, finally falls into Sowan river (33° 33'.17" N and 73° 06'.29" E). The study river was divided into six different transects (Table I) on the basis of availability of sufficient water as potential site for turtles, each transect having a length of 1km with an average width of 250m. Transects were visited twice a month for data collection from January 2010 to subsequent June. "Visual observations" were recorded with the help of a binocular (Olympus 10X x 50X) by walking along each transect on foot following Akbar *et al*. (2006) while "Cast net method" (Azam *et al*., 2005) was used to capture turtles to identify species following Khan (2006). The following parameters were measured;

1. Population density (D); = n / A

where, n is mean number of turtles of a particular species observed and A is area of the transect.

2. Estimated total population (TP);

TP= Density of turtles/km^2 x total area of the Korang river

3. Relative abundance (RA)

RA= Number of individuals of a turtle species/number of individuals of all turtle species X 100

Results and discussion

Distribution

Three species of freshwater turtles were recorded from various transects of the river; Indus mud turtle (*Lissemys punctata*), the Indian soft shell

turtle (*Aspideretes gangeticus*) and the brown river turtle (*Kachuga smithii*).

Table I.- Details of the selected transects in the Korang river Islamabad during the current study period.

Transects	Geographical Coordinates	Description
I- Rawal Dam spillway	33° 41'.27" N 73 °07'.54" E	Starts from Rawal Dam spillway across Park road bridge, The sewage of the employees colony falls in this part of river near the bridge.
II- Margalla Town	33 ° 39'.94" N, 73 ° 06'.52" E	Large water body having sandy area near Margalla Town, sewage of Margalla Town takes its way to this part of the river
III- Zia Masjid	33 ° 38'.31" N 73 ° 06'.94" E	Located around "Zia Masjid" near Islamabad Highway and was highly contaminated due to the sewage of all the adjoining populated areas that falls in this part of the river.
IV- Burma bridge	33 ° 38'.04" N 73 ° 07'.83" E	Near Burma bridge at Lehtrar road, Islamabad, it was highly polluted area since sewage of surrounding residential areas takes its way to this part of river. It was also the least disturbed part of study area.
V- Loi Bher Wildlife park	33 °35'.17" N 73 08'.20" E	Water body in Loi Bher Wildlife Park, Rawalpindi, a wild area of Korang river, very important as it was located within the boundary of Loi Bher Wildlife Park.
VI- Junction of Sowan and Korang rivers	33 °33'.17" N 73 ° 06'.29" E	Consisted of area located just before the junction of Korang and Sowan rivers near "Sowan bridge", close to Grand Trunk (G. T.) road towards Jhelum, sewage and debris from these nearby areas added to the pollution of water.

Area of each transect: A=L x W; 0.25 $km^{2.}$ Total Area of six transects= 1.5 km^2

Maximum freshwater turtles during the study period were recorded from transect-V (approximately 24%) and it seems to be the best habitat for the turtles. This transect was located in the Loi Bher Wildlife Park, where the hunting pressure is minimum as well as more vegetation, fish, frog and other small animals were available to these turtles as food and shelter. The Indus mud turtle (*Lissemys punctata)* was dominant in four (transect-II, III, IV and VI) out of six transects of the study area whereas the Indian soft shelled turtle was dominant in transect-I and V (67.47%). On the other hand, the least preferred habitat of turtles in the study area appeared to be transect-I where only 12.17% of the total population was recorded. The probable reason could be scarcity of food and shelter as well as periodic shortage of water in this transect. Moreover, this transect was found to be highly disturbed area by human activities. A considerable hunting pressure was also noticeable in this particular transect, where some Chinese were found frequently catching turtles by using fishing hooks.

Azam *et al.* (2005) conducted surveys on freshwater turtles of the river Indus and recorded 6 species including *Kachuga tecta, Kachuga smithii, Hardella thurjii, Chitra indica, Aspideretes gangeticus* and *Lissemys punctata*. Likewise, Akbar *et al.* (2006), estimated 3528 freshwater turtles belonging to 8 different species from different barrages of the Punjab, Pakistan; *Kachuga tecta, Kachuga smithii, Hardella thurjii, Chitra indica, Aspideretes gangeticus, Lissemys punctata, Geoclemys hamiltonii* and *Aspideretes hurum;* the Indus mud turtle (*Lissemys punctata)* being least in number in their study area. However, in the current study, this species was the most abundant, probably because it loves shallow streams, stagnant waters of rivers, marshes, ponds, lakes and often extends in sewage system of metropolitan cities. Minton (1966) also reported the same behavior of the Indus mud turtle. The brown river turtle is generally found in standing and slow moving water bodies (Minton, 1966), the similar case being in the current study area. The Indian soft-shelled turtle also inhabits rivers, lakes, and permanent ponds where it remains buried in the bottom gravel (Das, 1991).

Population density (D)

A total of 345 individuals of three different turtle species were recorded in six transects of the Korang river with a mean of 57.5 turtles per transect. The average population density of turtle species was estimated to be 38.33 individuals/km^2 (Table II). For Indus mud turtle, maximum density was recorded during June 2010 (35/km^2) while least in January 2010. For Indian soft shell turtle, the lowest population was found in January 2010 (2/km^2) while highest in June 2010 (24/km^2). The brown river turtle was also found least in January and March 2010 (0.6/km^2) and maximum in June 2010 (8.6/km^2).

Table II.- Density (D) and total estimated population of three turtle species recorded in the study area from January 2010 to June 2010.

Months	*Lissemys punctata*			*Aspideretes gangeticus*			*Kachuga smithi*			Unidentified	Grand total (n)	Avg. population/ Km^2
	*n	*D	*TP	*n	*D	*TP	*n	*D	*TP			
Jan.10	6	4	20	3	2	10	1	0.6	3	3	2	
Feb.10	9	6	30	5	3.3	16.5	2	1.3	6.5	6.5	2	
Mar,10	29	19.4	97	6	4	20	1	0.6	3	3	4	
Apr.10	45	30	150	25	16.6	83	5	3.3	16.5	16.5	5	
May,10	48	32	160	30	20	100	6	4	20	20	5	
Jun.10	53	35	176	36	24	120	13	8.6	43	43	4	
Total	**190**	**126.4**	**633**	**105**	**69.9**	**350**	**28**	**18.4**	**92**	**22**	**345**	
Mean	**31.6**	**21.0**	**105.5**	**17.5**	**11.6**	**58.3**	**4.6**	**3.1**	**15.3**	**3.7**	**57.5**	38.33

*n, numbers of turtles observed in six selected transects; D, density/K**m**^{2} **,** *TP, total estimated population in the Korang river.
* Area, A=L x W; L, length of each transect = 1km, W, width of each transect= 250m

Estimated total population (TP)

Density estimates of each turtle species were extrapolated to the total area of the Korang river to estimate the total population of each turtle species in the study area; Indus mud turtle showed the highest total estimated population with 633 individuals, the Indian soft-shell turtle 350 individuals whereas the brown river turtle 92 individuals across the whole river (Table II).

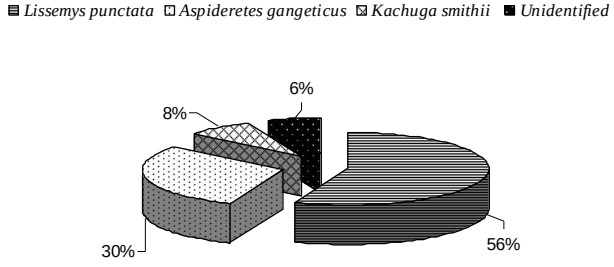

Fig. 1 Relative abundance of the three turtle species which were recorded from six selected transects of the Korang river Islamabad during the study period.

Relative abundance (RA)

In the current study, the Indus mud turtle (*Lissemys punctata*) was the most abundant species contributing up to 56% of the total numbers of turtles recorded. The Indian soft shell turtle (*Aspideretes gangeticus*) contributed 30% while the brown river turtle was least abundant (8%) during the study period (Fig. 1). Approximately 6% turtle species could not be identified due to various reasons. Earlier on, Akbar *et al*. (2006) studied the distribution of freshwater turtles in Punjab province and showed that the most abundant species was *Kachuga smithi* (43.62%) followed by *Kachuga tecta* (42.06%). The Indus mud turtle was (1.50%) was most frequent while the Indian soft shell turtle (*Aspederates gangeticus*) was common (6.55%). However, in the current study, *Kachuga smithi* was least abundant.

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Butterfly Fauna of the Province of Hatay, Turkey and Major Taxonomic Characters of *Polyommatus bollandi* Dumont, 1998 (Lycaenidae)

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Abstract.- During the studies conducted on site and in laboratory in Hatay in 2009 and 2010, 57 species of butter flies from 6 families (Papilionidae, Pieridae, Argynnidae (Nymphalidae), Satyridae, Lycaenidae and Hesperiidae) were identified. According to these studies, *Polyommatus bollandi*, *Hipparchia semele*, *Melanargia grumi*, *Melanargia syriaca* are endemic for Hatay. Moreover, *Polyommatus iphigenia*, *Polyommatus bellagrus*, *Melanargia grumi*, *Hipparchia semele*, *Coenonympha pamphilus*, *Melitaea interrupta*, *Charaxes jasius* are newly recorded species for the Hatay fauna. The number of butter fly species has now risen from 131 to 138 including the species mentioned above.

Key words. *Polyommatus bollandi*, butterfly, Lycaenidae, Hatay, Turkey

Studies aimed at identifying the lepidopteran fauna in Turkey were started by Zeller in 1845. He reported two major families namely Noctuidae and Geometridae (Okyar and Aktaç, 1997). European Entomologists (Betti, 1989; De Latin, 1950; Fountaine, 1904; Graves, 1911; Higgins, 1966; Mann, 1862), besides, studies and later Turkish entomologists (Avcı and Özbek, 1996; Güneyi and Uyar, 1972; Kansu, 1961, 1962, 1963a; Koçak, 1989; Öktem, 1962; Şengün and Güneyi, 1968; Kovancı *et al*., 2007), Rhopalocera fauna described in Turkey.

As far as diversity is concerned, lepidoptera order is the second after coleoptera order in hexapoda class (Avcı, 1994). Today, butterfly (Rhopalocera) makes up approximately 15,000 of 200,000 lepidopteran species (Avcı, 1994; Kansu, 1963b). Koçak and Kemal (2006, 2007, 2009) reported 405 species of butter flies in Turkey from 9 families. Ozden *et al*. (2008) reported 349, 139, 232, 58 and 129 butterflies from Turkey, Lebanon, Greece, Egypt and Israel, respectively, thus emphasizing the rich diversity of the butterfly fauna in Turkey. The number of butterfly species in Europe is 360 (Bee, 2002).

While Karaçetin *et al*. (2011) reported 387 butterfly species in Turkey 9.79% of which are endangered. Lycaenidae family tops the list with its 23 species under threat. According to Koçak and Kemal (2009), the province of Hatay has 131 species, constituting 32% of the butterfly fauna in Turkey.

With its 88 species, *Polyommatus* makes up the widest genus of the Lycaenidae family in Turkey (Koçak and Kemal, 2009). *Polyommatus bollandi* Dumont, 1998 and *P. icarus* (Rottemburg, 1775) are two species which are rather hard to distinguish from one another *P. bollandi* was detected for the first time by Dominique DUMONT in Kızıldağ Mountain, Hatay on 28-29 May 1998. *P. bollandi*, an endemic species in Hatay region (Karaçetin *et al*., 2011; Karaçetin and Welch, 2011) is one of the three butterfly species designated as critical (CR) position in the Red List Status.

The present paper describes the easy distinction between the two the species, *P. bollandi* and *P. icarus*, based on fore and hindwing venation (wing veins), male genital organs and antennae.

Materials and methods

Butterflies were collected from the Amanos Mountains within the province of Hatay in Eastern Mediterranean Region in 2009-2010 with insect net from different elevations with various vegetation, placed in killing jars. Afterwards, wings of

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butterflies were stretched wide open on collection boards for identification. Then *Polyommatus bollandi* and *P. icarus* were dissected to prepare slides of male genital organ, fore and hind wings and antennae knobbed slides according to Atay (2006) were described. Finally, butterfly specimens have been stored in the Biology Department of Mustafa Kemal University. For species identification, we made use of works by Borror *et al*. (1989), Baytaş and Karaçetin (2008), Demirsoy (2003), Ecevit (2000), Karaçetin and Welch (2011), Koçak and Kemal (2009).

P. bollandi was caught on a half open wooden areas in Kızıldağ region, 1550 meter in height, in the coordinates of $N36^0\ 18^{'}\ 13^{''}$ – $E36^0\ 01^{'}\ 54^{''}$ about the afternoon on 09.06.2011.

Results

In this report 57 species belonging to from the families Papilionidae, Pieridae, Argynnidae (Nymphalidae), Satyridae, Lycaenidae and Hesperiidae have been reported from Hatay. Of these seven are new records, increasing the number of species present in Hatay from 131 to 138. According to these data, the Hatay butterfly fauna makes up 35% of the fauna in Turkey. The list of species found out in this study is as follows:

Family: Papilionidae

01. *Archon apollinus* (Herbst, 1798) (False Apollo) (LC)
02. *Iphiclides podalirius* (Linnaeus, 1758) (Scarce Swallowtail) (LC)
03. *Papilio machaon* Linnaeus, 1758 (Swallowtail) (LC)
04. *Zerynthia cerisyi* (Godart, 1822) (Eastern Festoon) (LC)
05. *Zerynthia deyrollei* (Oberthür, 1869) (Eastern Steppe Festoon) (LC)

Family: Pieridae

06. *Anthocharis cardamines* (Linnaeus, 1758) (Orange Tip) (LC)
07. *Anthocharis damone* Boisduval, 1836 (Eastern Orange Tip) (LC)
08. *Aporia crataegi* (Linnaeus, 1758) (Black-veined White) (LC)
09. *Colias crocea* (Fourcroy, 1785) (Dark Clouded Yellow) (LC)
10. *Euchloe belemia* (Esper, 1800) (Green-striped White) (NA)
11. *Gonepteryx rhamni* (Linnaeus, 1758) (Brimstone) (LC)
12. *Leptidea sinapis* (Linnaeus, 1758) (Wood White) (LC)
13. *Pieris brassicae* (Linnaeus, 1758) (Large White) (LC)
14. *Pieris rapae* (Linnaeus, 1758) (Small White) (LC)
15. *Pontia edusa* (Fabricius, 1777) (New Bath White) (LC)

Family: Argynnidae (Nymphalidae)

16. *Argynnis pandora* (Denis & Schiffermüller, 1775) (Cardinal) (LC)
17. *Charaxes jasius* (Linnaeus, 1758) (Two-tailed Pasha) (LC) (New for Hatay)
18. *Limenitis reducta* Staudinger, 1901 (Southern White Admiral) (LC)
19. *Melitaea cinxia* (Linnaeus, 1758) (Glanville Fritillary) (LC)
20. *Melitaea didyma* (Esper, 1779) (Spotted Fritillary) (LC)
21. *Melitaea interrupta* Kolenati, 1846 (Caucasian Spotted Fritillary) (LC) (New for Hatay)
22. *Melitaea punica* (Goeze, 1779) (Algerian Fritillary) (LC)
23. *Melitaea trivia* (Denis & Schiffermüller, 1775) (Lasser Spotted Fritillary) (LC)
24. *Vanessa atalanta* (Linnaeus, 1758) (Red Admiral) (LC)
25. *Vanessa cardui* (Linnaeus, 1758) (Painted Lady) (LC)

Family: Satyridae

26. *Brintesia circe* (Fabricius, 1775) (Great Banded Grayling) (LC)
27. *Chazara briseis* (Linnaeus, 1764) (The Hermit) (LC)
28. *Coenonympha pamphilus* (Linnaeus, 1758) (Small Heath) (LC) (New for Hatay)

29. *Hipparchia fatua* (Freyer, 1844) (Freyer's Grayling) (LC)
30. *Hipparchia semele* Linnaeus, 1758 (Grayling) (Endemic) (New for Hatay)
31. *Hipparchia syriaca* (Staudinger, 1871) (Syrian Rock Grayling) (LC)
32. *Lasiommata maera* (Linnaeus, 1758) (Large Wall Brown) (LC)
33. *Lasiommata megera* (Linnaeus, 1767) (Wall Butterfly) (LC)
34. *Melanargia grumi* Standfuss, 1892 (Grum's Marbled White) (Endemic) (New for Hatay)
35. *Melanargia syriaca* (Oberthür, 1894) (Syrian Marbled White) (Endemic)
36. *Maniola jurtina* (Linnaeus, 1758) (Meadow Brown) (LC)
37. *Maniola telmessia* (Zeller, 1847) (Eastern Meadow Brown) (LC)
38. *Pararge aegeria* (Linnaeus, 1758) (Speckled Wood) (LC)
39. *Ypthima asterope* (Klug, 1832) ((African Ringlet) (LC)

Family: Lycaenidae

40. *Celastrina argiolus* (Linnaeus, 1758) (Holly Blue) (LC)
41. *Glaucopsyche alexis* (Poda, 1761) (Green-underside Blue) (LC)
42. *Lampides boeticus* (Linnaeus, 1767) (Long-tailed Blue) (LC)
43. *Leptotes pirithous* (Linnaeus, 1767) (Lang's Short-tailed Blue) (LC)
44. *Lycaena phlaeas* (Linnaeus, 1761) (Small Copper) (LC)
45. *Polyommatus agestis* (Denis & Schiffermüller, 1775) (Brown Argus) (LC)
46. *Polyommatus bollandi* Dumont, 1998 (Bolland's Blue) (CR) (Endemic)
47. *Polyommatus bellargus* (Rottemburg, 1775) (Adonis Blue) (LC) (New for Hatay)
48. *Polyommatus icarus* (Rottemburg, 1775) (Common Blue) (LC)
49. *Polyommatus iphigenia* (Herrich-Schaffer, 1847) (Iphigenia Blue) (LC) (New for Hatay)
50. *Satyrium ilicis* (Esper, 1779) (Ilex Hairstreak) (LC)

Family: Hesperiidae

51. *Carcharodus alceae* (Esper, 1780) (Mallow Skipper) (LC)
52. *Erynnis tages* (Linnaeus, 1758) (Dingy Skipper) (LC)
53. *Gegenes pumilio* (Hoffmannsegg, 1804) (Pygmy Skipper) (LC)
54. *Ochlodes venatus* (Bremer & Grey, 1852) (Large Skipper) (LC)
55. *Pelopidas thrax* (Hübner, 1821) (Millet Skipper) (LC)
56. *Pyrgus melotis* (Duphonchel, 1834) (Aegean Skipper) (LC)
57. *Thymelicus lineolus* (Ochsenheimer, 1808) (Essex Skipper) (LC)

Polyommatus bollandi Dumont, 1998

Material

Kızıldağ-Hatay (1550 m), 09.vi.2011, 2 ♂

Measurements

Length 14 mm; wingspan 33 mm; antennae clubbed (knobbed) length 5.25 times longer than width; forewing length 1.64 times longer than width; hindwing length 1.36 times longer than width.

Discussion

P. bollandi inhabits only in the vicinity of Kızıldağ, Hatay, in the southwestern end of the Amanos Mountains (Dumont, 1998a). Karaçetin *et al*. (2011) reported environmental degradation in the region including intensive mining and waste disposal. Furthermore, it is reported in the report that there exists limited information on the biology, ecology, distribution and the behaviour of this species. The authors classified the species as critical due to such factors. Dumont (1998a, 2000) pointed out that there are many streams, grasslands and in-forest open lands at the elevation of 1500 meter in the Kızıldağ region, which is the only point where *P. bollandi* inhabits. Dumont (1998b, 2000) reported that *P. bollandi* resembles *P. icarus* a lot; wheras, it flies much faster.

Dumont (1998a, 2000) mentions among other threats to *P. bollandi* as the development of

settlement, extensive garbage disposal into the forest, uncontrolled collection of rare plants, deviating the water resources, road construction, forest fires and digging out the mountain for the purpose of extracting stone from quarries in addition to mining operations.

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A Preliminary Report on the Diversity of Spiders (Arachnida: Araneae) in the Cholistan Desert, Pakistan

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Abstract.– Spiders (Arachnida.: Araneae) were collected by hand picking and shaking plants methods from different habitats of the Cholistan Desert. These samples contained 10 families, 32 genera and 62 species. The Philodromidae was found to have greatest diversity of species (30%) followed by Lycosidae (26%) and Gnaphosidae (18%) respectively. Studies on species sex ratios studies indicated that generally female spiders were more abundant than males and immature spiders during the entire study. The present study provides preliminary data on the diversity of spiders which can be useful for the researchers working on diversity, taxonomy and conservation of spiders. It was concluded that the Arachnida is a diverse class of Arthopoda in the Cholistan Desert. However, it is suggested that more intensive studies are needed to fully document the arachnid diversity in this region.

Key words: Araneae, Cholistan Desert, sex ratio.

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The Cholistan Desert comprises of a large area of 26000 km^2 in the South Eastern portion of Punjab Province. It is located between latitude 27°42́ and 29° 45́ north and longitude 69° 52́ and 72° 24́ east (FAO, 1993; Akbar *et al.,* 1996). This desert is characterized by extremely hot summers (±51°C) and cold winters (±0°C). The relative humidity is low in summer but high during winter (Fig.1). The flora of the desert mostly consists of drought resistant plants. The most common grasses such as *Cenchrus, Lasiurus, Cymbopogon* and *Penicum* and shrub and tree species (*Calligonum, Haloxylon, Prosapis, Zizyphus and Acacia*) have profound effects on habitat structure and fauna (Arshad and Rao, 1994). A number of researchers have been exploring the ecology and taxonomy of desert spiders all over the world (Ward and Lubin, 1993; Hanschel, 1994; Lubin and Hanschel, 1996; Brandit, 1998), and India (Tikader, 1974, 1980, 1982; Tikader and Biswas, 1981). Information on the desert spiders of Pakistan is very scarce. Ghafoor and Beg (2002) and Mukhtar (2004) have provided important taxonomic information on species from various non – desert locations in Punjab Province, Pakistan. Considering the small amount of data available on the taxonomy of Pakistan desert spiders, this study was initiated to provide bench mark data on the diversity of desert spiders of the Cholistan Desert which can be utilized by future researchers working on the taxonomy, distribution and conservation of desert spiders.

Materials and methods

Specimens were collected from January 2001 to December 2003. The samples were collected from various localities around Bahawalpur, its out skirts and the desert area of Bughdad–ul–jadeed Campus, The Islamia University of Bahawalpur.

Arachnids were collected using hand picking and shaking plants methods. Collected samples were stored in separate vials containing preservative solution (50 ml 70% ethanol, 1 ml glycerin, and 5ml glacial aectic acid). Samples were stored at a cool place in the laboratory until studied. Specimens were identified to the species level with the aid of various standard taxonomic keys provided by Pocock, (1900), Tikadar (1980) and Tikadar and Biswas (1981). The specimens collected were enumerated and sexed. Some specimens could not be identified to the species level because of unresoleved taxonomic problems. Immature spiders are generally considered difficult to the species level. Some specimen may represent new species.

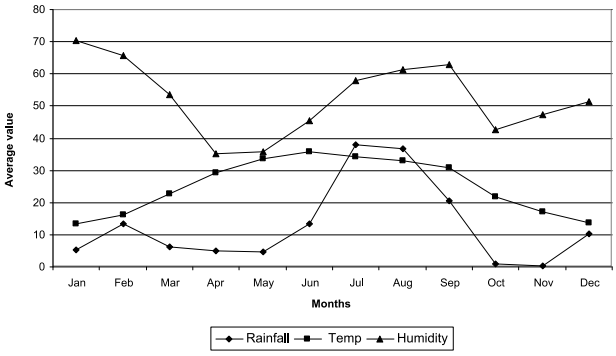

Fig. 1. Monthly average meteorological data for five years (2001 – 2005) including the study years (2001 – 2003) from Cholistan Desert. Source: Regional Meteorological Station Bahawalpur.

Results

A total of 10 families, 32 genera and 62 spider species were recoded from the specimens collected during this study. The Philodromidae had the highest diversity (19 species) while Theridiidae, Zodaridae and Tetragnathidae each had but one species. The Lycosidae, Graphosidae, Araneidae, Thomisidae and Erasidae were represented 16, 11, 4, 4 and 2 species, respectively (Table I).

The relative diversity (%) among families is given in Figure 2. The Philodromidae has the

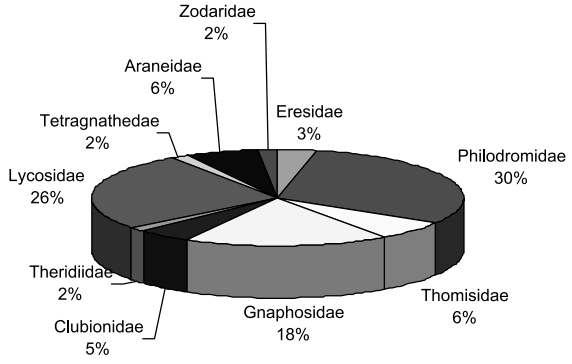

Fig. 2. Relative diversity of spider families recorded during in three study years.

Table I. – Number and abundance of arachnid species recorded from different habitats during the study period (January 2001 – December 2003).

Families	Species	Year 2001	Year 2002	Year 2003	Total specimens	
		F – M – Imt	F – M – Imt	F – M – Imt	No.	%
Lycosidae	*Evippa shivajii* (Tikader & Malhotra, 1980)		56 – 14 – 0	0 – 0 – 0	70	2.33
	Flanona puellula (Simon 1898)	0 – 0 – 0	42 – 14 – 0	0 – 0 – 0	56	1.86
	Evippa sohani (Dyal 1935)	28 – 0 – 0	28 – 0 – 0	0 – 0 – 0	56	1.86
	Aractosa mulani (Dyal 1935)	0 – 0 – 0	28 – 0 – 0	0 – 0 – 0	28	0.93
	Hippasa madrasptana (Gravely 1924)	0 – 0 – 0	14 – 0 – 0	0 – 0 – 0	14	0.47
	Hippasa partita (G. P. Cambridge 1876)	0 – 0 – 28	42 – 0 – 0	0 – 0 – 0	70	2.33
	Ocyale atlanta (Sudouin 1826)	0 – 0 – 0	28 – 0 – 0	0 – 0 – 0	28	0.93
	Lycosa poonaensis (G. P. Cambridge 1876)	0 – 0 – 0	14 – 0 – 0	0 – 0 – 0	14	0.47
	Evippa Rajasthanicus (Tikader & Malhotra, 1980)	14 – 0 – 0	0 – 0 – 0	0 – 0 – 0	14	0.47
	Evippa praelongipes (O. P. – Cambridge, 1870)	154 – 0 – 14	210 – 0 – 14	420 – 0 – 28	840	27.93
	Evippa rubiginosa (Simon, 1885)	546 – 0 – 0	0 – 0 – 252	0 – 14 – 0	812	27.00
	Evippa Sp.1	0 – 0 – 1	9 – 0 – 8	1 – 0 – 1	20	0.67
	Evippa Sp.2	0 – 0 – 0	1 – 1 – 0	0 – 0 – 0	2	0.06
	Evippa Sp.3	0 – 0 – 3	0 – 0 – 1	1 – 0 – 0	5	0.17
	Hippasa Sp.	0 – 0 – 0	0 – 0 – 0	1 – 0 – 0	1	0.03
	Evippa Sp.4	0 – 0 – 0	0 – 0 – 0	1 – 0 – 0	1	0.03
Araneidae	*Cyrtophora feae* (Threll 1887)	42 – 0 – 0	0 – 0 – 0	0 – 0 – 0	42	1.40
	Araneus bitubercula (Walckenaer 1802)	28 – 0 – 0	28 – 0 – 0	0 – 0 – 0	56	1.86
	Neoscona theis (Walckenaer 1841)		28 – 14 – 0	0 – 0 – 0	42	1.40
	Neoscona Sp.	1 – 0 – 0	0 – 0 – 0	0 – 0 – 0	1	0.03
Tetragnathidae	*Leucauge* Sp.	1 – 0 – 1	0 – 0 – 0	0 – 0 – 0	2	0.06
Eresidae	*Stegodyphus* Sp.	0 – 0 – 0	1 – 0 – 0	1 – 0 – 0	2	0.06
Theridiidae	*Latrodectus* Sp.	0 – 0 – 0	0 – 0 – 0	2 – 0 – 0	2	0.06
Zodaridae	*Asceua* Sp.	0 – 0 – 0	1 – 1 – 0	0 – 1 – 0	3	0.10
Clubionidae	*Clubiona pashabhai* (Litsinger 1992)	0 – 0 – 0	42 – 0 – 14	0 – 0 – 0	56	1.86
	Clubiona filicata (O. P. – Cambridge, 1874)	42 – 0 – 0	0 – 0 – 0	0 – 0 – 0	42	1.40
	Castianeir tinae (Patel & Patel 1974)	0 – 0 – 0	28 – 0 – 0	0 – 0 – 0	28	0.93
Gnaphosidae	*Gnaphosa poonaensis* (Tikader 1973)	56 – 0 – 112	0 – 0 – 0		168	5.59
	Cllilepis rajasthanicus (Tikader & Gaybe 1977)	42 – 0 – 14	0 – 0 – 14	70 – 0 – 14	154	5.12
	Scotophinus maind (Simon 1905)	0 – 14 – 0	0 – 0 – 0	28 – 0 – 0	42	1.40
	Sosticus sundar (Chamvberlin 1922)	14 – 0 – 0	0 – 0 – 0	0 – 0 – 0	14	0.47
	Eilica platnigki (Tikader & Gaybe 1976)	14 – 0 – 0	0 – 0 – 0	0 – 0 – 0	14	0.47
	Scotophinus Sp.1	1 – 0 – 1	0 – 0 – 0	0 – 0 – 0	2	0.06
	Poecilochroa Sp.	3 – 0 – 1	0 – 0 – 0	0 – 0 – 0	4	0.13
	Callilepis Sp.1	1 – 0 – 1	0 – 0 – 0	0 – 0 – 0	2	0.06
	Callilepis Sp.2	1 – 0 – 1	0 – 0 – 0	0 – 0 – 0	1	0.03
	Callilepis Sp.3	2 – 0 – 2	2 – 0 – 2	2 – 0 – 2	12	0.40
	Callilepis Sp.4	0 – 0 – 0	0 – 0 – 0	1 – 0 – 0	1	0.03
	Drassylus Sp.1	0 – 0 – 1	0 – 0 – 0	1 – 0 – 0	2	0.06
	Drassodes Sp.2	0 – 0 – 0	0 – 0 – 0	1 – 0 – 0	1	0.03
	Gnaphosa Sp.	1 – 1 – 0	0 – 0 – 0	0 – 1 – 0	3	0.10
	Scotophaeus Sp.2	0 – 0 – 0	0 – 0 – 0	0 – 1 – 0	1	0.03
Thomisidae	*Oxyptila reenae* (Basu 1964)	14 – 0 – 0	0 – 0 – 0	0 – 0 – 0	14	0.47
	Dieae kapuri (Thorell 1869	0 – 0 – 0	14 – 0 – 0	0 – 0 – 0	14	0.47
	Xysticus Sp.	3 – 0 – 0	0 – 0 – 0	0 – 0 – 0	3	0.10
	Ebo emo (Tikader 1970)	0 – 1 – 3	1 – 0 – 1	5 – 0 – 1	12	0.40
	Ebo somathaii (Tikader 1965)	1 – 0 – 0	0 – 0 – 0	0 – 0 – 0	1	0.03
Philobromidae	*Tibellus pashanensis* (Tikader 1960)	14 – 0 – 0	14 – 0 – 0	0 – 0 – 0	28	0.93
	Thantus dhakuricus (Tikader 1962)	42 – 0 – 0	0 – 0 – 0	0 – 0 – 0	42	1.40
	Philodromus decoratus (Tikader 1962)	28 – 0 – 0	0 – 0 – 0	0 – 0 – 0	28	0.93

Continued

Families	Species	Year 2001	Year 2002	Year 2003	Total specimens	
		F – M – Imt	F – M – Imt	F – M – Imt	No.	%
	Philodromus Sp.1	9 – 0 – 0	0 – 0 – 0	5 – 0 – 5	19	0.63
	Philodromus Sp.2	0 – 0 – 0	0 – 0 – 0	4 – 0 – 6	10	0.33
	Philodromus Sp.3	5 – 0 – 2	0 – 0 – 0	16 – 0 – 0	23	0.76
	Philodromus Sp.4	1 – 0 – 0	2 – 0 – 0	1 – 0 – 0	4	0.13
	Philodromus Sp.5	0 – 0 – 0	0 – 0 – 1	3 – 0 – 0	4	0.13
	Philodromus Sp.6	17 – 0 – 1	7 – 2 – 4	0 – 0 – 0	31	1.03
	Philodromus Sp.7	2 – 0 – 2	0 – 0 – 4	1 – 2 – 4	15	0.50
	Philodromus Sp.8	0 – 0 – 0	1 – 0 – 1	1 – 0 – 1	4	0.13
	Philodromus Sp.9	0 – 0 – 0	2 – 0 – 1	0 – 0 – 1	4	0.13
	Philodromus Sp.10	0 – 0 – 0	0 – 0 – 0	1 – 0 – 0	1	0.03
	Philodromus Sp.11	0 – 0 – 0	1 – 0 – 0	1 – 0 – 0	2	0.06
	Philodromus Sp.12	1 – 0 – 0	1 – 0 – 0	1 – 1 – 1	5	0.17
	Philodromus Sp.13	0 – 0 – 0	0 – 0 – 0	1 – 0 – 2	3	0.10
	Philodromus Sp.14	1 – 0 – 0	0 – 0 – 0	0 – 0 – 0	1	0.03
	Tibellus Sp.1	1 – 0 – 0	4 – 0 – 1	0 – 0 – 0	6	0.20
	Tibellus Sp.2	0 – 0 – 0	0 – 0 – 0	1 – 0 – 4	5	0.17

F, female; Imt, immature; M, male.

highest diversity (30% of spider species collected), followed by the Lycosidae (26%) and Gnaphosidae (18%), respectively. The Araneidae and Thomisidae had 6% of the total diversity, while the rest of the families had 5% or less.

The sex ratios for the examined spiders (Fig. 3) showed that the maximum percentage of females to males occurred during 2001 and 2003 while the minimum occurred in 2002. The number of male spiders generally remained very low compared to that of female spiders; however, relatively more male spiders were collected during 2002. The lowest number of immature spiders was observed in 2003 and the highest in 2002.

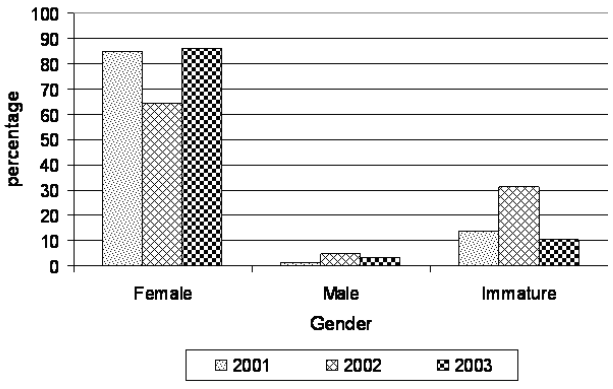

Fig. 3. Sex ratio of spiders collected by hand picking method during study period (2001 – 2003)

Discussion

Little is known about the ecology and diversity of arachnids from Pakistan's desert areas, particularly the Cholistan Desert. Our results show that 10 families with 62 species were encountered. A relatively high diversity of spiders can be expected in the desert areas considering our findings and those of Sivaperuman and Rathore (2004) who observed 13 families and 28 species in the Desert National Park of Rajusthan India. The diversity of spiders in deserts appears to be strongly influenced by habitat conditions and vegetation structure as we collected a higher number of spiders from the bushy habitats than in tree habitats (Bonte and Maelfait, 2001; Sorensen, 2003). These data would thus suggest that only selected taxa are able to adapt successfully to the extreme climatic conditions and limited habitat diversity (Pearce *et al*., 2003). During our study it was also noted that in spite of very harsh environmental conditions in the desert some spider were visible throughout year.

The strong dominance of Philodromideae in this study may be attributed to the vegetation composition (bushy and grassy). Abundance of individual species in different habitats may be affected by the vegetation types (Pearce *et al*., 2003). The hand picking and plant shaking methods are more useful than the pit fall method in the desert areas due to arid conditions causing the preserving solution to evaporate too soon to capture

the specimens.

Females were found more frequently than males which may be attributed to the time of collection during our survey. Most of our collections were limited to early mornings or during the mild and cool seasons of the year. It has been reported that desert insects are more active during the above mentioned times (Pearce *et al*., 2003). During summer most of the spider webs were observed either on the undersurface of the plant leaves or beneath a bush on the ground where shade and moisture was available. Another reason for this sex ratio may be the breeding behavior of the spiders as it has been reported that breeding of spiders under the desert conditions is more common in cooler, milder conditions. The seasonal timing of the surveys may also explain the high number of immature specimens encountered (Foelix, 1982; Walker and Rypstra, 2002).

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