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Zygoptera in Himalayan Foot Hills of Pakistan

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Abstract

In 2014, 56 localities in four provinces of Lesser Himalaya in Pakistan were studied. A total of 28 species have been recorded. A female of the data deficient, threatened species *Coeliccia vacca* was recorded from Charhaan. The record of *Drepanosticta carmichaeli* is a new addition to the list of Odonata of Pakistan, and expand the range of this species further to the west. The taxonomical status of *Ischnura aurora aurora* – considered common in Pakistan, following baseline literature of Fraser (1933) – now turns out to be *Ischnura aurora rubilio*.

Key words: Pakistan, Zygoptera, *Coeliccia vacca*, *Drepanosticta carmichaeli*, *Ischnura aurora rubilio*

Introduction

The Himalayas, Karakorum and the Hindu Kush are world's biggest mountain ranges that serve as major bio-geographic boundaries between tropical and subtropical flora and fauna of the Indian subcontinent and temperate climate Palearctic eco-zone (Rafi et al. 2010; Khan, 2014). Among these, Himalayan range is a series of mountains in South Asia that is bordered by the Tibetan Plateau (north wards), the Indo-Gangetic Plain (south wards), the Karakoram & Hindu Kush ranges (northwest), and by the Indian states of Assam and Arunachal Pradesh (east wards). It is spread in five countries (Fig. 1) i.e. China (Tibet), Nepal, Bhutan, India and Pakistan (Khan, 2014).

Pakistan occupies an important geographic position by possessing four important mountain ranges i.e. the Himalaya, the Karakoram, the Hindukush and the Suleiman range (Fig 2). The former three mighty mountains are northern in location and meet in Pakistan in Juglot city of Gilgit-Blatistan (Fig. 3). While the fourth one is south western and is characteristically different from Northern Mountains by having very less precipitation and medium elevations. The highest peak in northern series which is also second highest mountain of the world is K-2 (8611m / 28,251 ft) while the highest peak in south western Suleiman range is Takht-i-Suleiman in Baluchistan province (3,487m / 11,440ft). Highest peak in Karakorum Range of Pakistan is Tirich Mir

(7706m / 25,289 ft) while in Himalayan range highest peak is Nanga Parbat (8126m / 26,660 ft) as documented by Khan (2014).

Because of the versatility, discrete habitat types and ecological zones, Himalayan hill range inhabits complex of insect fauna that needs to be explored thoroughly. Insect distribution is affected by lot of physical barriers. Among these, altitudinal gradients are very important as they affect both physical and biotic environments. Odonata biology and population also has a direct relation to the altitudinal clines as they are affected both directly as well as indirectly by the physical or ecological factors like temperature, humidity, sunlight etc. The higher hill ranges remained a popular subject for exploring insect species throughout the world. However the foothills are often overlooked and neglected. Yet it is very important to study foothills in lieu of the rapid changes in climate.



Fig. 1: Himalayan Range spread to five countries (Khan, 2014)

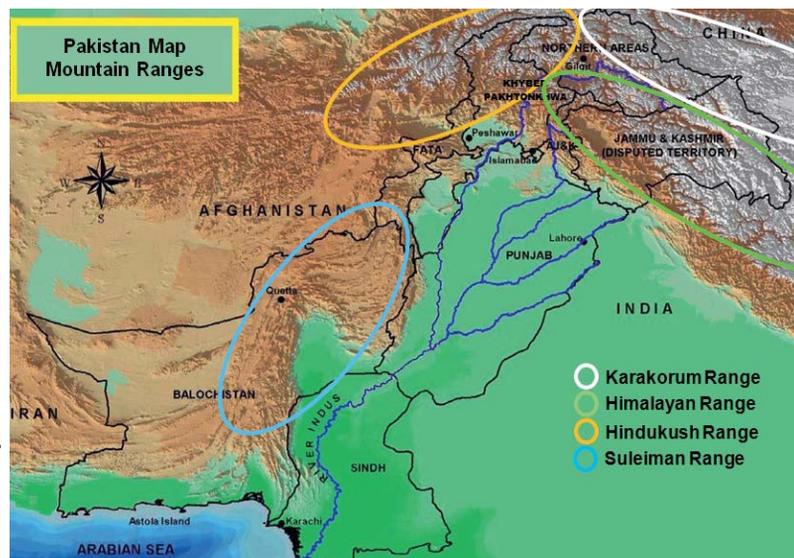


Fig. 2: Map showing four Mountain Ranges of Pakistan (Khan, 2014)



Fig. 3: Junction of Karakorum, Himalaya and Hindukush in Northern Pakistan (Anonymous, 2015)

In Pakistan, insect fauna under Western Himalayas, Hindu Kush, Karakorum and Sulaiman Range shows Palearctic representation while that of eastern Himalaya is Oriental (Zia et al. 2011b). According to Rafi et al. (2010) insect fauna supports transitional of Pakistan position between Oriental and Palearctic regions. In the present study, selected foot hills of Himalaya falling under boundaries of Pakistan are studied to provide an overall picture for inhabiting Zygoptera species. Although many faunistic studies have been conducted in past but the Sub-Himalayan hill range is very poorly explored and remained badly neglected in all previous studies recording Odonata fauna of Pakistan. The foot hills of Himalaya, present as a continuous hill series under administrative boundaries of three districts (Islamabad, Rawalpindi & Attock) of Punjab province, two districts (Haripur & Abbotabad) of Khyber Pakhtunkhwa province and one district (Mir Pur) of Azad Jammu & Kashmir (AJ&K) are visited during present study. Yet the foothills extended to Kotli and Bhimber districts of AJ&K and those that are present in the shape of sliced part (separated about >100km from continuous series) in Chakwal district of Punjab province are not explored in this study as these present a much different and drier climate than continuous series. The explored area of Lesser Himalaya is under thick forest cover of coniferous trees with lot of aquatic spots in the form of springs, lakes, seasonal streams, rivers and lakes. It has diverse ecology with hot summers and peaks receiving snow fall in winter. Although many of the areas are facing threats from deforestation and increased urbanization but still a major part of it represents undisturbed ecology. This hill range represents records of many important Zygoptera species. From the limited

information available, here are records of few threatened (*Lestes umbrinus*, *Protosticta hearseyi*) and poorly known species (*Coeliccia vacca*) that were lastly seen during 2005-2007 (Zia, 2010). Following a massive earth quake of May, 2005 many natural springs of the area went out of scene periodically; making niche of many inhabiting species dried and vanished. Rehabilitation activities in the area also gave rise to rapid deforestation and increased urbanization that also adversely affected inhabiting invertebrate species. Knowing the importance of species and so of the area, it was thought imperative to thoroughly explore foot hills of this Himalaya in Pakistan to get updated information for inhabiting Zygoptera fauna.

Materials and Methods

Collection surveys were conducted during April to November, 2014 to explore Zygoptera species inhabiting Sub Himalaya in Pakistan (Fig. 4). Adults were collected from 56 localities (Table 1) using aerial nets. Collected specimens were killed using ethyl acetate while mated pairs were kept separately in paper envelopes. Collected

Table 1: Collection sites visited for recording Zygoptera complex in Lesser Himalaya.

Name of Province	District	Localities
Punjab	Rawalpindi	Angoory Forest Stream-I, Angoory Forest Stream-II, Angoory Bridge Spot, Charhaan, Lehtarar - 12 Number Jungle, Perchan, Perhanna - Harwanni, Seir Giraan, Phawandi, Rata Kas, Jandala, Jandy, Saloni, Kahuta Bridge Spot, Neela Sandh, Thanda Pani, Kallhya, Batala, Pinjar, Wah Garden, Kheriot, Pihhaar, Simbala, Jandy, Manga, Lakot, Gokina, Bostal - Qaseri Spot
	Islamabad	Chapar pul, Simly Dam Stream, Karor, Laacha, Kurri, Malot, Bobry, Kathar, Nilore Bridge (Ara Spot), Rumli, Shodara, Ghariala, Talhar, Ghagri
	Attock	Shahpur Dam (Fateh Jang)
Khyber Pakhtun Khwa	Haripur	Kala Bagh, Thandi kassi (Thanda Choa Spot), Bakot Sharif, Aliyot, Qalandar Kassi, Qumul, Barkot, Garam Thon, Khanpur dam, Bhamala
	Abottabad	Harnoi
Azad Jammu & Kashmir	Mirpur	Mangla Dam, Mangla dam stream, Jaatla (Ali Beg railway track stream)

specimens were brought to laboratory for pinning, stretching, identification and labeling. Specimens were identified following Laidlaw (1932), Fraser (1933-34), Khaliq (1990), Papazian et al. (2007), Mitra & Babu (2010) and Zia (2010). However help was also taken from housed collection of Zygoptera in National Insect Museum (NIM) of Pakistan. Photography of important specimens was also carried out in field, when a live so as to record their original body coloration that obviously helps in identification. For the specimens that were first time recorded for the country, few live specimens were brought to laboratory in small field cages. These were killed in the laboratory and their digestive tracts were cleared so as to preserve their coloration permanently and for future reference studies. For each visited locality data regarding locality name along with its coordinates, elevation (in ft), dry temperature (°C), prevailing weather condition (see. Table 2 in appendix) and habitat details were recorded to enhance knowledge on the recorded species. The information generated can surely help in designing future strategies for survival and protection of endangered, threatened and poorly known species of these foothills.



Fig. 4: GIS map showing visited sites in Lesser Himalaya (Pakistan) for recorded Zygoptera

Results

During this series of surveys expanded over a period of eight months (April to November, 2014), a total of 28 damselfly species were recorded under three super families, nine families, ten subfamilies and 18 genera. Sampling details for each locality are provided at Appendix-I while distributional details for each species are provided in detail as below.

Loc. 1: Simly Dam Out flow Stream (N: 33°43', E: 73°14', Alt.: 2010ft), 16.iv.2014: *Pseudagrion rubriceps*, *P. spencei*, *Ceriagrion coromandelianum*, *Ischnura forcipata*, *I. aurora rubilio*; 10.vi.2014: *I. forcipata*, *Enallagma parvum*, *Rhinocypha quadrimaculata*, *C. coromandelianum*, *Ellatoneura campioni*, *I. aurora rubilio*, 05.viii.2014: *I. forcipata*, *Rhinocypha quadrimaculata*, *C. coromandelianum*, *E. campioni*; 16.ix.2014: *E. campioni*, *P. rubriceps*, 22.x.2014: *I. forcipata*, *C. coromandelianum*, *Copera marginipes*, *Agriocnemis pygmaea*, *E. campioni*, *P. rubriceps*.

Habitat: It was an outflow stream of Simly dam, a big water reservoir of Islamabad district. It is located within high mountains having diversified flora and fauna. Dense wild vegetation (dwarf trees to hanging and submerged grasses) was found all along the stream. Big stones that can be easily called small rocks were present in and along its way where specimens of *Rhinocypha* tend to sit and perch. At few places water was stagnant, at some places it splashes by striking rock stones however even at some places it move very silently, slowly and smoothly. At a long distance from spill ways, the water was stagnant in the form of a big pond; extra water comes out of it by flowing very smoothly and passing within the grasses. So over all, this spot was a mix up of many type of water bodies (Fig. 5 & 6), yet the source was same i.e. Dam water, that receive water of perennial springs and rain throughout the year and melted snow water from Murree hills in summers as well.



Fig. 5: Simly dam stream showing slow and silent water.



Fig. 6: Fast flowing and splashing water in Simly dam stream.

Note: *Libellago lineata lineata* was first time recorded from Pakistan by the author during three consecutive years (2005-2007). However during the present study not even a single specimen of this species was found here. It is important to document that during course of time (2007 to 2014), many folds increased urbanization resulting in heavy deforestation has been observed in close proximity to this spot. *L. l. lineata* is an Oriental species having very narrow distribution range. It is known only from North India, Vietnam and Pakistan (Zia, et al., 2011b). Although a few specimens of it were recorded from Locality No. 13 which is far away (about 100km) from this spot, unavailability of this species from Simly dam raised serious questions on its current status in Pakistan. Zia et al., (2011a) have already pointed out a decrease in Odonata species in Pakistan as a result of increased urbanization and habitat destruction. Shifting of this species from this spot to a faraway area indicates its probable search for a suitable niche as the original niche (observed during 2005-2007) was getting disturbed and destroyed at a rapid rate. It is thus recommended to conduct further field surveys in this hill range and surrounding mountains to get more information for current status of this species in Pakistan.

Loc. 2: Karor (N: 33°42', E: 73°19'; Alt. 2380ft), 16.iv.2014: *Megalestes major*, 10.vi. & 05.viii.2014: no Zygoptera found; 13.xi.2014: *Lestes viridulus*.

Habitat: It was a big rock spot with spring water coming from top of it in the form of slow and narrow channel (Fig. 7). The rock was having lot of bare water pockets having no vegetation grown at their banks. Yet lot of *Dedonea* and wild plants were grown in large numbers all around. A road was splitting this spot into two parts. One side was having rock (at eastwards) while the other side (westwards) had a slow depression from which this spring water passes in the form of an irregular channel and falls into Simly dam outflow stream. Dense high grasses were present all along this down road channel until it falls in the stream.



Fig. 7: Water pockets in rocks at Karor, Islamabad
The inset shows a habitat of Anisoptera larvae.

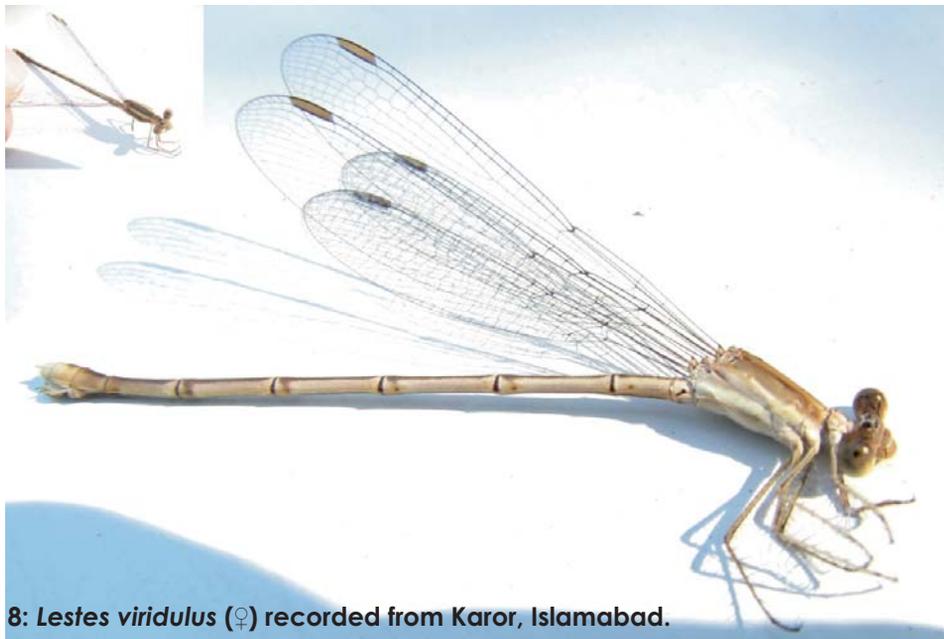


Fig. 8: *Lestes viridulus* (♀) recorded from Karor, Islamabad.

Note: The locality was an ideal spot for many mountain and sub mountain Odonate species, but in contrast only a single teneral and two adults of *Megalestes major* and adults of *L. viridulus* were seen in April and November respectively. It is interesting that at very short distance of <5km (to southwards) more than 10 zygopterous species were recorded from Simly dam stream (at approx. 400ft less elevation) on same dates. However, neither those species were found here nor *M. major* nor *L. viridulus* were seen there. It shows differences in habitat preference of recorded species of both localities. Reduced number (only three specimens) of *M. major* recorded in April however indicates its initial seasonal activities. Yet, its absence during all next trips remained un-understandable. Few larvae of Anisoptera were also recorded from within rock pockets (as shown in inset of Figure 7).

Loc. 3: Laacha: (N: 33°42', E: 73°20', Alt.: 2181ft), 16.iv.2014: *Ischnura aurora rubilio*, *Ceriagrion coromandelianum*.

Habitat: The spot was a village pond made for grazing animal's drinking purpose (at distance of about 4km west to Simly dam) having lot of grasses grown along its margins. Specimens of *I. a. rubilio* and *C. coromandelianum* were observed here in large numbers. As fast wind was blowing, these species were trying to get shelter in long grasses grown at about 2-5 meters away from pond.

Loc. 4: Kurri (N: 33°41' E: 73°10'; Alt. 1821ft), 10.vi.2014: *Ischnura aurora rubilio*, *Ceriagrion coromandelianum*, *Pseudagrion rubriceps*.

Habitat: It was a road side, big, rain water pond having lot of algae grown over it. Water was thus stagnant and unclear. In close proximity lot of wild grasses and dwarf plants were available and specimens of both species were found flying within such vegetation feeding on minute insects. At a short distance to it (about 50ft away) a seasonal narrow water channel was also flowing. Here, *Typha* plants and wild *Acacia* were grown in large numbers.

Loc. 5: Malot (N: 33°43', E: 73°14'; Alt. 1758ft), 16.iv.2014: *Ellatoneura campioni*, *Pseudagrion rubriceps*, *Ischnura forcipata*, *Agriocnemis pygmaea*.

Habitat: It was a perennial stream that gets water from various springs and melted snow of Murree. The water of this locality is constantly getting polluted because of spills of recently launched small cement block factories at its banks. Water here is thus constantly becoming dirty and unlivable for aquatic fauna especially for Odonata larvae. The spot was having wild grassy vegetation grown all around in which damselflies were taking shelter in quite large numbers because of fast blowing wind.

Loc. 6: Angoory Forest Stream-I (N: 33°46', E: 73°16'; 2394ft), 16.iv.2014: *Ceriagrion coromandelianum*, *Ischnura forcipata*; 07.v.2014: *I. forcipata*, *I. senegalensis*; 10.vi.2014: *C. coromandelianum*, *I. forcipata*.



Fig. 9: Angoory forest stream-I having fast flowing water.

Habitat: It was a road side perennial stream (Fig. 9) that gets water of natural springs and melted snow of Murree hills throughout the year. The spot was having thin grassy and other wild vegetation at its bank, while large numbers of pine trees were also grown in the whole area.

Loc. 7: Angoory Forest Stream-II (N: 33°48', E: 73°21'; 3746ft), 16.iv.2014: *Ceriagrion coromandelianum*, *Ischnura forcipata*, *Agriocnemis pygmaea*, *Copera marginipes*,



Fig. 10: West side view of Angoory Forest Stream-II.



Fig. 11: East side view of Angoory Forest Stream-II.

Elatoneura campioni, *I. aurora rubilio*; 10.vi.2014: *Copera marginipes*, *E. campioni*, *Pseudagrion rubriceps*; 25.ix.2014: *C. coromandelianum*, *I. forcipata*, *Megalestes major*.

Habitat: It was a mountainous spot. Spring water was coming from uphill in irregular paths. The spot was surrounded by high mountains very densely covered by pine trees so that sunlight could reach ground hardly for 2 hour in a day. *Dedonea* plants and wild grasses were also available but in limited numbers. A metalled road passes here dividing this spot in two parts (Fig. 10 & 11). At east end were high mountains from where water was coming but at west end this water flows down smoothly along the road and reaches up to a depression of 100ft approximately. Here water passes through small pockets and then make its way in the form of a stream.

Remarks: Because of reduced sunlight almost all the day and throughout the year, resulting in lower temperature, much reduced Zygoptera activity was observed here.



Fig. 12: Angoory bridge spot (West view).

Loc. 8: Angoory Bridge Spot (N: 33°49', E: 73°21'; Alt. 3983ft), 16.iv.2014: *Rhinocypha quadrimaculata*, *Ceriagrion coromandelianum*; 10.vi. & 25.ix.2014: *R. quadrimaculata*.

Habitat: It was a big mountainous spot getting waters of seasonal streams and perennial springs of the area (Fig. 12-14). Very high mountains and pine trees were surrounding it at all of its sides. Big rock stones were present in it and it serves as a popular recreational spot for local village people during every summer evening and especially at weekends, thus get much human disturbance almost daily. Water of this stream keeps flowing almost throughout the year.



Fig. 13: Angoory bridge spot close up view (East).



Fig. 14: Angoory bridge spot (East view).



Fig. 15: A picture of *Coeliccia renifera* (♂) taken at Charhaan, Rawalpindi.

Loc. 9: Charhaan (N: 33°52', E: 73°26'; Alt. 4863ft), 05.viii.2014: *Megalestes major*, *Coeliccia renifera*, *Bayadera indica*, *C. vacca*, *Ischnura senegalensis*; 10.vi.2014: *Rhinocypha unimaculata*.

Habitat: It was a very damp and moist mountainous spot with lot of lush green vegetation all around (Fig. 15-17). Whole spot had a very thick pine cover and temperature here never goes above 30-32 °C throughout the year.

Note: Among recorded species *C. vacca* is a threatened and data deficient species (Dow & Sharma, 2010). Only two female specimens are recorded for this species that are identified through Laidlaw (1932) and Fraser (1933).

Loc. 10: Bobry (N: 33°46', E: 73°16'; Alt. 2183ft), 07.v.2014: *Ischnura forcipata*, *Ceragrion coromandelianum*, *Agriocnemis pygmaea*, *Copera marginipes*, *Elatoneura campioni*; 10.vi.2014: *Ischnura forcipata*, *I. aurora rubilio*, *C. marginipes*, *E. campioni*, *Pseudagrion rubriceps*, *Rhinocypha quadrimaculata*; 25.ix.2014: *I. forcipata*, *Ceragrion coromandelianum*, *C. marginipes*, *P. rubriceps*.

Habitat: It was a road side aquatic spot (Fig. 18). Water flows here very slowly but almost throughout the year because of a natural spring. However during monsoon season it flows very swift because of its central position in the mountains. At after short distances water get stagnant and takes the shape of small ponds with lot of *Typha*, *Dedonea*, *Eucalyptus* and wild grasses grown in and around.

Loc. 11: Kathar (N: 33°46', E: 73°16'; 2706ft). 16.iv.2014: *Ischnura forcipata*, *Agriocnemis pygmaea*, *Ceragrion coromandelianum*; 07.v.2014: *I. forcipata*, *C. coroman-*



Fig. 16: Rainwater bringing eroded soil from upper reaches of mountain at Charhaan.

Fig. 17: Perennial spring at Charhaan, Rawalpindi.



Fig. 18: Boby stream in Bharakahu village, Islamabad.

delianum, *Lestes thoracicus*, *A. pygmaea*; 10.vi.2014: *I. forcipata*, *C. coromandelianum*, *A. pygmaea*.

Habitat: It was an irregular spring water stream that gets stopped each year if summer gets hotter and drier. However it flows during rainy monsoon season every year. At collection spot (Fig. 19), water was stagnant in the form of short muddy and shady pond in which lot of *Typha* plants were grown. In close proximity were present trees of Olive, *Olea*, *Dalbergia* and *Dedonea*. Specimens of *Lestes thoracicus* were observed to sit and perch on the spiky branches of *Olea* trees and even many times hiding within *Typha* plants. Mating of *L. thoracicus* was observed in higher incidence.

Remarks: It is interesting to document that *L. thoracicus* specimens were found only during the visit of May, 2014. Although lot of mating was observed in visit of May but surprisingly no adult or teneral was seen here after May, 2014.

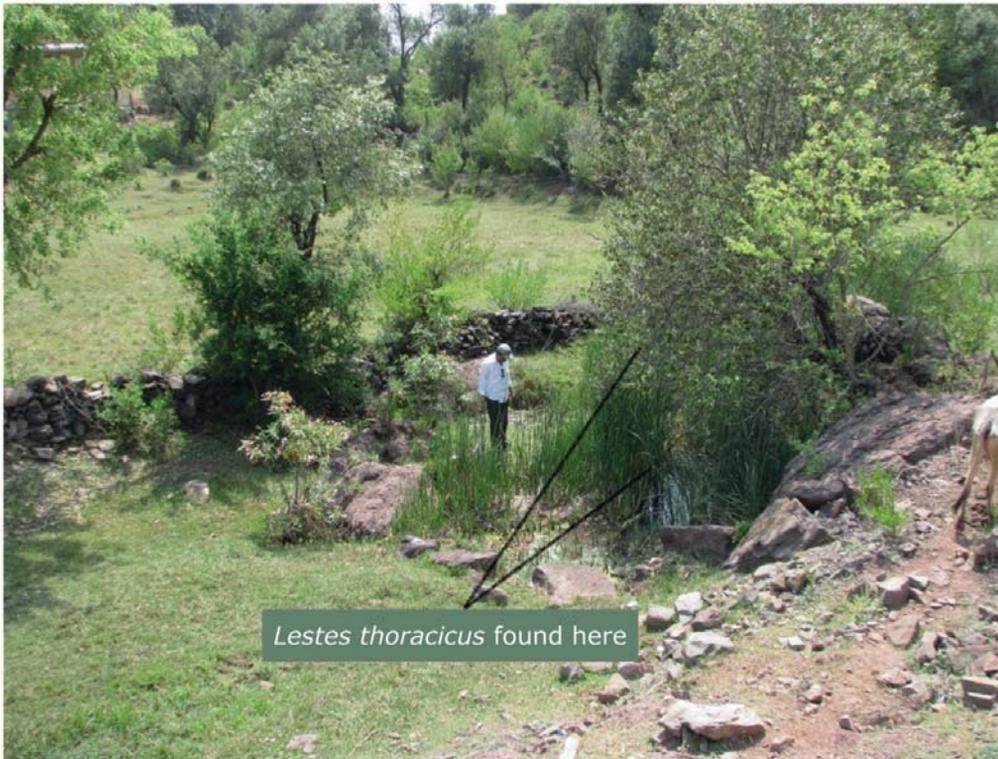


Fig.19: Kathar spot near Bharakahu village, Islamabad.

Loc. 12: Shahpur Dam (N: 33°35', E: 72°41'; Alt. 3150ft). 11.ix.2014: *Pseudagrion rubriceps*.

Habitat: The dam is located on Nandana river of Punjab province in district Attock. Collection was done from many small fish ponds made in line along the dam. Thin grasses were present on banks of all ponds. Low population of *P. rubriceps* was seen here.

Loc. 13: Wah Garden (N: 33°48', E: 72°41'; Alt. 3279ft). 11.ix.2014: *Neurobasis chinensis*, *Libellago lineata lineata*, *Copera marginipes*, *Ellatoneura campioni*.

Habitat: It was a big recreational park (Fig. 20) of Mughal times (dated back to 1542-1605). It has unlimited water in the form of natural springs. Here were present lot of cemented canals, ponds, waterfalls and out of it is the main stream that gets surplus spring water of the park. This stream is densely covered by many types of vegetation including *Dalbergia*, *Ficus*, *Broussonetia*, *Cactus* and wild long grasses from which *Neurobasis chinensis* was observed in large numbers. Mating incidence of *N. chinensis* frequent and lots of larvae of this species and Gomphidae (Anisoptera) were found here. The stream had lot of pebbles and small stones in it. Temperature was not so high but humidity level of this spot was very high because of recently prevailed monsoon/rainfalls.



Fig.20: Spring water stream flowing along boundary of Wah garden, Rawalpindi.

Loc. 14: Harnoi (N: 34°09', E: 73°18'; Alt. 3436ft), 11.ix.2014: no records.

Habitat: It was a hill side spot with lot of grasses and lush green vegetation. Very cold spring water was passing in the form of fast stream making small water falls at few places. In close proximity was passing a heavy traffic road.

Remarks: Nothing was found here as temperature was very down because of approaching evening and prevailing cloudy weather as well at our visit. The spot should reflect a higher population of *Megalestes major* and *Calicnemia*

eximia but surprisingly nothing was found. Earlier from this spot Zia (2010) collected lot of *Calicnemia eximia* specimens during same month but at a bit higher temperature (25oC).

Loc. 15: Kala Bagh (N: 34°04', E: 73°20'; Alt. 7800ft), 12.ix.2014: *Neurobasis chinensis*.

Habitat: It was a hill side spot with lush green, dense vegetation all around (Fig. 21). The spot was having very big bare rock stones with lot of algae grown over them. Spring water here was very fast and cold and this spot receives heavy rainfall every winter. Although lot of *Coeliccia renifera* and *Megalestes major* were expected, yet only *N. chinensis* specimens were seen.



Fig. 21: A shady spring water spot at Kala Bagh, Haripur.



Fig. 22: Thandi Kassi at Thanda Choa Spot, Haripur.

Loc. 16: Thandi Kassi (Thanda Choa Spot, N: 34°04', E: 78°23'; Alt. 7703ft), 12.ix.2014: no Zygoptera found.

Habitat: It was a cool and moist spot (Fig. 22). A spring was coming up from a very high mountain splashing through a very rough and stony bed fringed by vegetation. Also dense *Pinus* tree cover was present over surrounding mountains.

Remarks: No Zygoptera were found here probably because of lower temperature and cold weather but in April to June a good population of *Megalestes* and *Bayadera* can be expected from here. Yet, three Anisoptera (*Macromidae* and *Gomphidae*) specimens were seen. The spot is in a far away and hard to reach area and has never been surveyed for Odonata. It may come up with many important records (especially of *Euphaeidae*, *Synlestidae*, *Corduliidae*, *Gomphidae* and *Cordulegastridae*) if deeply surveyed during active season.

Loc. 17: Bakot Sharif (N: 34°07', E: 73°29'; Alt. 2338ft), 12.ix.2014: *Calicnemia eximia*.

Habitat: It was a road side spring with lush green vegetation all around (Fig. 23). At few kilometer earlier were the high mountains of Nathia Galli (Thandi Kassi, Namli Meera, Kala Bagh etc as discussed above) and a few kilometer ahead were the forest and high hills of Azad Kashmir (Kohala, Muzaffarabad etc). Whole of the stream was open sunlit throughout. Although a good collection of



Fig. 23: Bakot Sharif, district Haripur - KPK.

Pseudagrion, *Ischnura* and few other Zygoptera were expected but interestingly only a single platycnemid was found.

Loc. 18: Bostal - Qaseri (N: 33°49', E: 73°20'; Alt. 2740ft), 16.ix.2014: *Megalestes major*.

Habitat: It was a natural spring water spot at Murree Express way near Muzaffarabad (AJ&K). The spot was very cold, shady and moist with lot of algae grown over stones (Fig. 24). Water sprinkles at many places making whole spot very slippery and thus difficult to reach.

Loc. 19: Aliyot (N: 33°57', E: 73°28'; Alt. 5002ft), 16.ix.2014: only larvae of Calopterygidae found.



Fig. 24: Qaseri spot in Bostal. Fig. 25: A beautiful spring water stream in Aliyot, Haripur.

Habitat: It was a big water stream (Fig. 25) that flows almost throughout the year because of many uphill springs. It serves as a big source for drinking water of local people. Here were grown lots of trees of *Pinus*, *Populus* wild dwarf trees, along with bushes and wild roses.

Remarks: Although species of *Rhinocypha* and *Macromia* were expected, no specimens were traced probably because of lower temperature. However lots of larvae of Calopterygidae were recorded from small water pockets present at borders. In early summer this spot must be having a rich complex of Anisoptera and Zygoptera species.

Loc. 20: Qalandar Kassi (N: 33°59', E: 73°29'; Alt. 3996ft), 16.ix.2014: *Megalestes major*, *Rhinocypha quadrimaculata*, *R. unimaculata*.

Habitat: The spot was a difficult to climb. Steep Mountain surrounded by high hills all around. Water was flowing at its both sides (i) in great depression at its back side (as shown in inset picture) that was very hard to reach and (ii) at front side as shown in main picture (Fig. 26). The front side receives regular sunlight and human disturbances, being a road side spot. However the rear side in great depression having steep slope was almost impossible to reach and was thus very silent, moist and present undisturbed ecology. Whole of the area was surrounded by dense pine trees and wild vegetation. While viewing from the mountain top, *Rhinocypha* species were looking like jewels sparkling over the water.

Remarks: From the spring water that was passing in front side of mountain no Zygoptera was found. However from the spring water in great depression (see inset picture) lot of *Rhinocypha* specimens were caught.

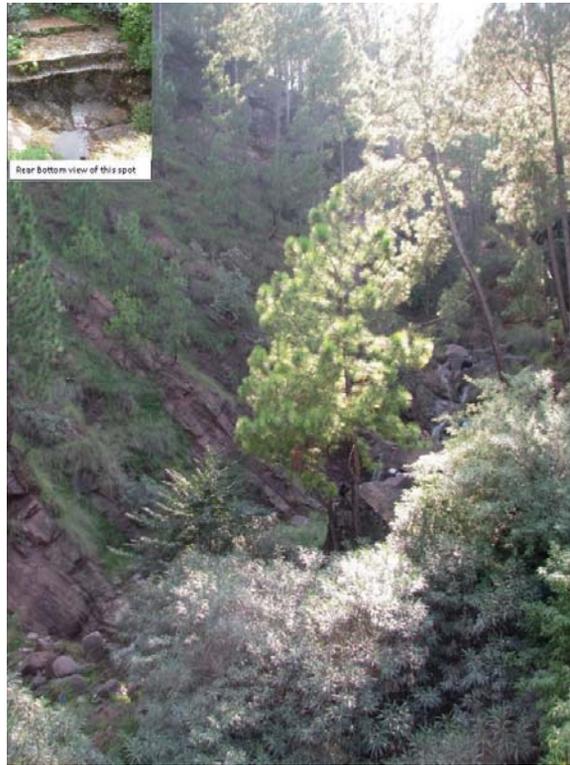


Fig. 26: Qalander Kassi Spot in Haripur.

Fig. 27: Nilore, Ara Stop, Islamabad.



Loc. 21: Nilore, Aara Stop (N: 33°39', E: 73°20'; Alt. 2110ft), 22.ix.2014: *Calicnemia eximia*; 30.x.2014: *Lestes viridulus*, *Rhinocypha quadrimaculata*.

Habitat: The spot was a twisted seasonal stream that gets waters of rain and few seasonal springs (Fig. 27). It was surrounded by lush green high mountains having lot of Paper mulberry, *Dedonea*, *Acacia*, *Zizyphus*, *Mirabilis*, wild grasses, olive trees and wild pome granates. The stream was having very rough soil and small pebbles at its bottom.

Note: During the visit of September, only *Calicnemis eximia* and species belonging to *Anax*, *Orthetrum* and *Trithemis* were observed. However on visiting same spot in October *Lestes viridulus* was recorded in quite reasonable numbers.

Loc. 22: Lehterar - 12 Number Jungle (N: 33°43', E: 73°27'; Alt. 3052ft), 22.ix.2014: *Megalestes major*, *Coeliccia renifera*, *Rhinocypha quadrimaculata*, *R. unimaculata*, *R. bifasciata*.



Fig. 28: A shady stream in 12 No. Jungle of Lehterar, Rawalpindi.

Habitat: It was a highly dense Pine forest with a beautiful, narrow and slow moving spring water stream passing within (Fig. 28). The stream was having small stones in it and wild grasses all around. In addition to *Pinus*, trees of *Dalbergia* and wild fig were growing here. This stream remains shady almost throughout the day because of dense pine cover.

Loc. 23: Perchan (N: 33°49', E: 73°29'; Alt. 3183ft), 22. ix. 2014: no Zygoptera found.

Habitat: It was again a mountainous spot with lot of pine cover (Fig. 29). Source of water was spring coming from a very high mountain in the form of a very slow channel within rocks having thick grass cover. Here, no Zygoptera were found but the locality must be having good Odonata population in early summers. Only a single libellulid dragonfly (*Cratilla metallica*) was however seen here.

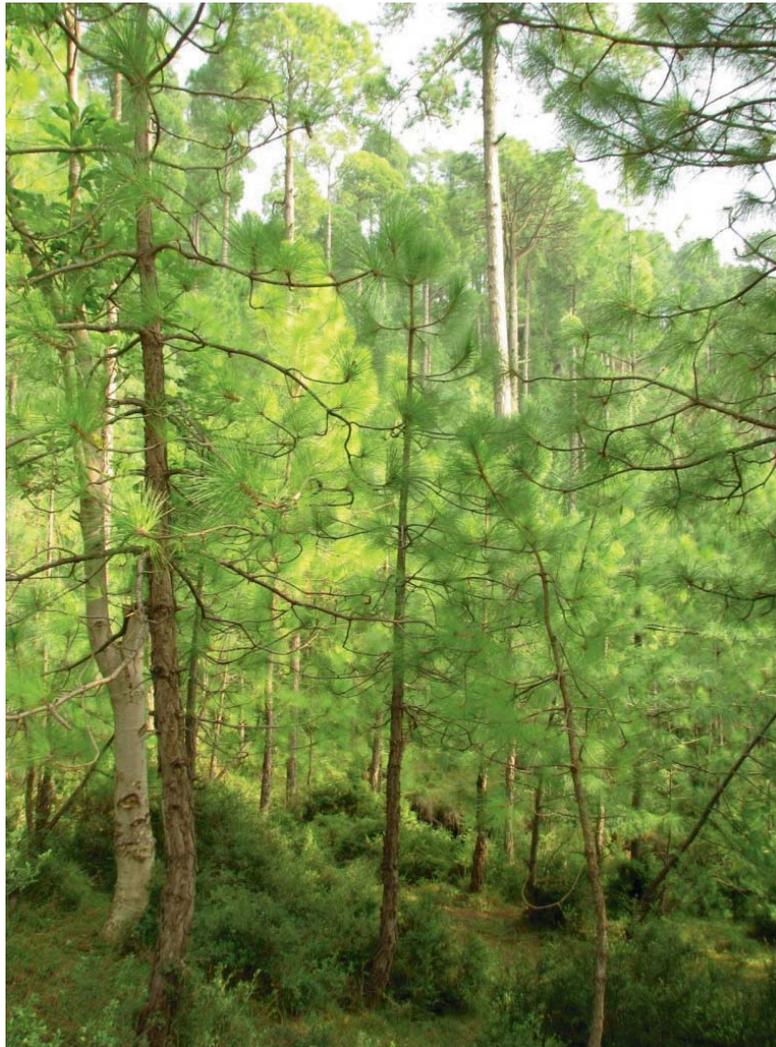


Fig. 29: Lush green pine forest in Perchan, Rawalpindi.



Fig. 30: Cool shady spring water spot in Perhanna-Harwanni, Rawalpindi.

Loc. 24: Perhanna-Harwanni (N: 33°51', E: 73°28'; Alt. 5379ft), 28.viii.2014: *Rhinocypha trifasciata*, *Megalestes major*.

Habitat: It was a very high mountainous spring water spot carrying very dense population of *Pinus*, *Diospyros*, *Populus*, Apple and wild fig trees. Lush green grasses and other wild vegetation were grown everywhere. Stream water was very cold and whole spot was very damp and slippery (Fig. 30).

Loc. 25: Seir Giraan (N: 33°52', E: 73°27'; Alt. 3929ft), 28.viii.2014: *Coeliccia renifera*, *Megalestes major*, *Calicnemia eximia*, *Rhinocypha trifasciata*

Habitat: The spot was an uphill aquatic spot with lot of *Rhinocypha* collection (Fig. 31-33). It was a roadside natural spring with water coming fast within very dense grasses making small water falls at short distances. Whole area was having a dense cover of *Pinus* trees, *Dalbergia*, wild roses and other wild spiny plants. An active population of *Orthetrum* was also observed in addition to the Zygoptera recorded.

Loc. 26: Phawandi (Near Chachal) (N: 33°49', E: 73°29'; Alt. 5954ft), 28.viii.2014 & 02.vi.2014: *Megalestes major*.



Fig. 31: A beautiful aquatic spot in Seir Giran, Rawalpindi.



Fig. 32: *Rhinocypha trifasciata* (♂).



Fig. 33: A *Rhinocypha trifasciata* (♂) shining in sunlight

Habitat: It was a spring water spot within a small village colony. The spot was having trees of pine, walnut, apple, fig and pear in large numbers. In close proximity were grown maize, wheat and garlic at a very short scale. Water was coming from two different streams. One was having pure spring water and other was getting sewerage of nearby houses mixed into spring stream. At a long distance, both of these waters were getting mixed making a single stream. Specimens of *M. major* were found in large numbers from long hanging grasses on the mountain, a bit distant to water stream.

Loc. 27: Rata Kas (N: 33°43', E: 73°27'; Alt. 2750ft), 28.viii.2014: *Rhinocypha bifasciata*, *R. trifasciata*, *R. quadrimaculata*, *Coeliccia renifera*; 02.vi.2014: *R. quadrimaculata*, *Ischnura forcipata*, *Calicnemia eximia*, *Agriocnemis pygmaea*, *Elatoneura campioni*, *Lestes thoracicus*; 30.x.2014: *R. unimaculata*, *R. trifasciata*, *Ceragrion coromandelianum*.

Habitat: It was an interesting spot. A metalled road was splitting it into two parts i.e. uphill and downhill (Fig. 34). Lot of *Dalbergia*, wild Pomegranate and *Pinus* trees were available. Spring water was coming at a good speed and collection was done from both parts. At uphill area, a cement block factory was operating very near to, making lot of air and noise pollution. But downhill spot was in great depression showing no signs of human disturbance. From the uphill spot within grasses grown along the bank of stream were found good population of *Rhinocypha* only. However from downhill collection, lot of specimens of *Ischnura*, *Lestes* and *Calicnemia*, and *Orthetrum* and *Trithemis* were recorded.



Fig. 34: Uphill (background) and downhill (foreground) view of Rata Kas spot.

Loc. 28: Chapar pul (N: 33°38', E: 73°18'; Alt. 1897ft), 02.vi.2014: *Ischnura forcipata*, *Enallagma parvum*, *Pseudagrion rubriceps*.

Habitat: It was a very big and open aquatic spot (Fig. 35). Water of many natural springs as well as of rainfall received at nearby mountains flows in it. Here were present many big rock stones and banks of it were having very limited and thin grasses that were submerged in the flowing water of this big stream. A good population of Libellulidae and Gomphidae was observed in addition to Zygoptera collected.



Fig. 35: A view of Chapar Pul spot in Islamabad.



Fig. 36: An afternoon view of Neela Sandh, Islamabad.

Loc. 29: Neela Sandh (N: 33°39', E: 73°23'; Alt. 2282ft), 02.vi.2014: *Ischnura forcipata*, *Rhinocypha quadrimaculata*, *Enallagma parvum*, *Elatoneura campioni*, *Pseudagrion rubriceps*; 30.x.2014: *I. forcipata*, *I. senegalensis*.

Habitat: It was a beautiful spot having lush green grasses and pine trees all around (Fig. 36).

Loc. 30: Jandala (N: 33°42', E: 73°25'; Alt. 2665ft), 02.vi.2014: *Rhinocypha quadrimaculata*, *Enallagma parvum*, *Elatoneura campioni*, *Pseudagrion spencei*, *P. rubriceps*.

Habitat: The spot was a perennial flow getting water of springs, rainfall and even sewerage of surrounding village. It was having very big rock stones resembling small rocks and water passing over these rocks build up waterfalls.

Loc. 31: Saloni (N: 33°43', E: 73°26'; Alt. 2750ft), 02.vi.2014: *Ischnura forcipata*, *I. senegalensis*, *Bayadera indica*, *Rhinocypha quadrimaculata*.

Habitat: It was also a natural uphill stream; water was coming from very high elevation thus making waterfalls at many places (Fig. 37). Water of the stream was cold (24oC). Whole spot was having dense tree cover and high grasses all around.



Fig. 37: Saloni collection Spot, Islamabad.

Loc. 32: Ghagri (N: 33°33', E 73°12'; Alt. 2020ft), 29.x.2014: no Zygoptera found.

Habitat: A narrow, rain water stream was flowing smoothly because of plain topography of the area (Fig. 38). As rain had received the whole night, lot of water was flowing in it. Long wild grasses, *Typha* and *Dedonea* plants and trees of *Dalbergia* were present.



Fig. 38: Rainwater stream in Gagri, Islamabad.

Fig. 39: Kheriot water stream, Rawalpindi.



Remarks: Surprisingly no Zygoptera were found. Although from such spots, *Ceragrion coromandelianum* and *Ischnura aurora* are commonly found, here only anisopterous species (*Orthetrum*, *Crocothemis* and *Trithemis*) were seen.

Loc. 33: Kheriot (N: 33°37', E: 73°24'; Alt. 2113), 29.x.2014: *Ischnura forcipata*, *Ceragrion coromandelianum*, *Pseudagrion spencei*, *Copera marginipes*.

Habitat: It was a broad stream in an open area (Fig. 39, 40). High lush green mountains were present at its northern end. Source of stream were natural springs and water here was thus very clear with plenty of small fishes. A poultry farm was present in close proximity and the whole area had very scarce trees. However dwarf vegetation cover including plants of *Dedonea*, *Cassia*, *Mirabilis* and, wild bushes was dominant.



Fig. 40: North view of Kheriot spot, Rawalpindi.

Loc. 34: Pihaaar-Paraat (N: 33°38', E: 73°23'; Alt. 2566); 29.x.2014: no Zygoptera found.

Habitat: It was a high mountainous spot. Spring water was coming very slowly with in very big rocks (Fig. 41). A road was separating it into two parts. One side was having rock stones with scarce vegetation but on the other side of hill (Fig 42) were present lot of *Pinus* trees, *Dedonea* and *Cassia*.

Remarks: It was an ideal spot for mountain Zygoptera species like *Bayadera* and *Megalestes* but surprisingly no damselfly was found. In contrast, *Anax*, *Gomphidia*, *Orthetrum* and *Trithemis* dragonflies were seen in few numbers.

Loc. 35: Simbala (N: 33°40', E: 73°24'; Alt. 2877ft), 29.iv.2014: *Ischnura senegalensis*, *Lestes thoracicus*; 29.x.2014: *Megalestes major*, *Rhinocypha quadrimaculata*, *Copera marginipes*, *I. aurora rubilio*, *I. forcipata*, *I. senegalensis*, *Agriocnemis pygmaea*, *Lestes viridulus*.

Fig. 41: Uphill view of Pihaar, Rawalpindi.

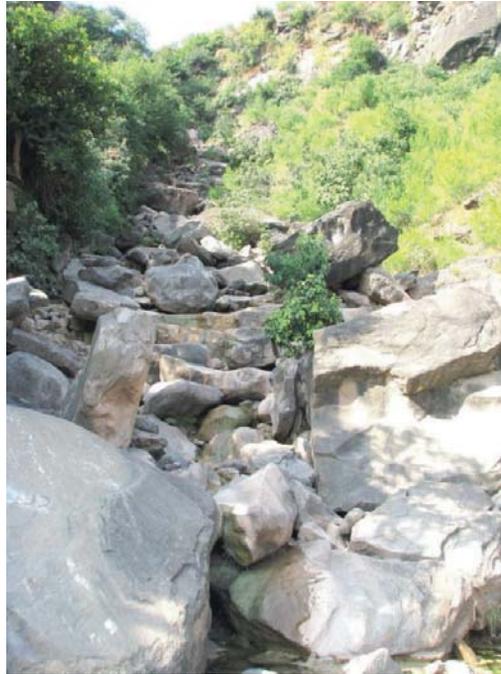


Fig. 42: Downhill view of Pihaar, Rawalpindi.

Habitat: It was a shady water stream with long dry hanging grasses present over the mountain surrounding it along with dense pine forest that was making hard for sunlight to reach ground (Fig. 43& 44).

Loc. 36: Kahuta Bridge Spot (Alt. 2225ft), 21.x.2014: *Ceragrion coromandelianum*, *Ischnura forcipata*, *I. aurora rubilio*, *Pseudagrion rubriceps*.

Habitat: It was a natural spring water stream passing underside a bridge with lot of lush green wild vegetation all around and thick cover of dwarf trees as well.

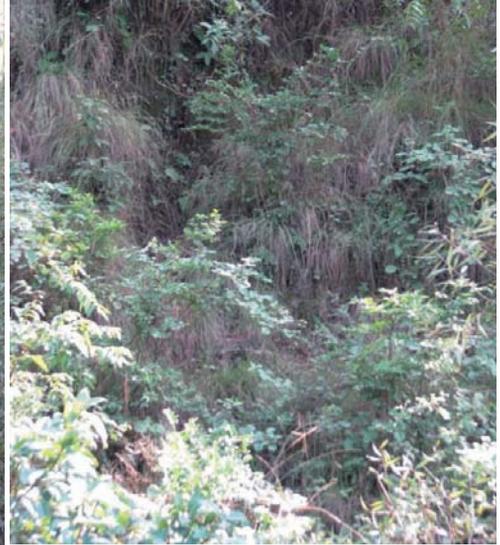


Fig. 43: Shady spring water stream in Simbala, Rawalpindi.

Fig. 44: Log dry grasses mimicking *Les-tes viridulus* Simbala stream.

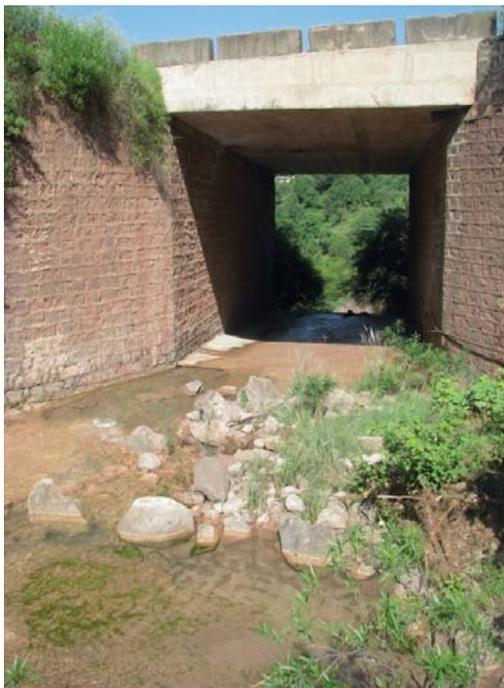


Fig. 45: Thanda Pani spot, Rawalpindi.

Loc. 37: Thanda Pani (Alt. 2255ft), 21.x.2014: *Ischnura forcipata*, *Ceragrion coromandelianum*, *Rhinocypha quadrimaculata*, *Copera marginipes*.

Habitat: The spot was a slow moving water channel passing under a bridge with lot of mixing of sewerage of nearby houses (Fig. 45).

Loc. 38: Jandy (N: 33°35', E: 73°27'; Alt. 2256ft), 21.x.2014: *Rhynocypha quadrimaculata*, *Agriocnemis pygmaea*, *Lestes viridulus*; 23.x.2014: *L.viridulus*, *C. coromandelianum*, *Copera marginipes*.

Habitat: It was a very narrow stream passing within high grasses grown all along the stream. Lot of trees of *Eucalyptus*, *Dalbergia*, *Acacia* and plants of *Dedonea* were present. Most of the grasses were almost dried because of approaching autumn and specimens were always seen about 5ft - 10ft away from water sitting on tender grasses surrounded by dry fallen *Eucalyptus* leaves strongly mimicking it.

Loc. 39: Kallhya (N: 33°33', E: 73°32'; Alt. 1900ft), 21.x.2014: *Neurobasis chinensis*, *Ceriagrion coromandelianum*, *Ischnura forcipata*, *I. aurora rubilio*, *I. senegalensis*, *Agriocnemis pygmaea*, *Rhynocypha quadrimaculata*, *Copera marginipes*, *Aciagrion hisopa*, *Pseudagrion hypermelas*, *P. rubriceps*.

Habitat: The spot was a very big but slow moving stream with lot of stones in it (Fig. 46). A crush plant was also working near to it.



Fig. 46: Kallhya collection spot, Rawalpindi.

Loc. 40: Batala (N: 33°34', E: 73°24'; Alt. 1825ft), 23. x. 2014: *Ischnura forcipata*, *Rhynocypha quadrimaculata*, *Ceriagrion coromandelianum*, *Agriocnemis pygmaea*, *Copera marginipes*.

Habitat: It was a very unique, cool and humid spot. It was surrounded completely by high mountains. The spot was in a circular position (with a diameter of about 100ft) and with a single opening for entrance make it somewhat dark. The water was very cold and falling from two sides of mountain. This water fell, splashes and flows over very big rock stones making each and every stone covered with algae and mosses. It was hard to even move a few feet as whole spot was very slippery. Trees of *Dalbergia*, *Accacia* and *Adhatoda vasica* were grown at encircling mountains.

Remarks: The circled spot should be having a good collection of *Coeliccia renifera* and *Megalestes major*. But surprisingly not even a single Zygoptera or Anisoptera was found. However in a very narrow stream (only 2 to 2.5ft wide) outside this spot were found few specimens of above species. This stream was actually outflow of this spot.

Loc. 41: Pinjar (N: 33°38', E: 73°3'; Alt. 2129ft), 23.x.2014: *Rhinocypha quadrimaculata*, *Ischnura forcipata*, *Ceriagrion coromandelianum*, *Copera marginipes*.

Habitat: It was a seasonal stream that only flows after rainfall. The whole area was having dense pine trees and stream was having lot of *Dedonea* and dry grasses within and along its margins (Fig. 47).



Fig. 47: Seasonal stream of Pinjar, Rawalpindi.

Loc. 42: Lakot (N: 33°53', E: 73°23'; Alt. 4111ft), 05.viii.2014: *Ischnura forcipata*, *Drepanosticta carmichaeli*, *Bayadera indica*; 16.ix.2014: *Ischnura forcipata*, *Megalestes major*, *Calicnemia eximia*, *Agriocnemis pygmaea*, *Bayadera indica*, *Copera marginipes*.

Habitat: It was a road side mountainous spot having lot of fallen rock stones (Fig. 48,49). Water was coming fast from uphill springs. Whole spot was having



Fig. 48: Lakot spot with spring water and rock stones; habitat of *Drepanosticta carmichaeli*. **Fig. 49:** Close up view of habitat of *D. carmichaeli*.

very dense and high grassy vegetation. At one side was passing an express way while the other side was very silent and undisturbed.

Remarks: Single specimen of *D. carmichaeli* was found accidentally when author was taking shelter of a tree because of startup of fast and sudden rainfall. *D. carmichaeli* was seen trying to hide in high grasses present near this tree and along with a big rock stone. Rain fall occurred just for few minutes and even after it stopped and sun shined brightly no more specimens were found. The collection spot shown in picture is at up reach of mountain. This locality was again visited many times in August and September but no specimen of it was found again. However more specimens of this species were found during same month from a similar locality (Manga) which was a few kilometer ahead.

Loc. 43: Manga (N: 33°50', E: 73°20'; 7000ft), 11.viii.2014: *Drepanosticta carmichaeli*, *Megalestes major*, *Coeliccia renifera*, *Bayadera indica*, *Rhinocypha quadrimaculata*, *Rhinocypha unimaculata*.

Habitat: It was a mountainous spring water spot (Fig. 53). Because of prevailing rainy season much rainfall had received few days ago. Here were big rock stones and no vegetation was present within the stream. However dense wild flora was present all around. Whole area had a thick cover of Pine trees (Fig. 54). Specimens of Corduliidae and few larvae of Macromiidae were also found in addition to Zygoptera recorded.

Remarks: *Drepanosticta carmichaeli* (Fig. 55 & 56) is a new record for Pakistan.



Fig. 53: Manga spot on Murree Express way, Rawalpindi.

Fig. 56: Close up view of *Drepanosticta carmichaeli*.

Fig. 54: Manga spot under dense Pine cover; habitat of *D. carmichaeli* at the end of the street (stream running from the left slope).

Loc. 44: Talhar (N:33°46'; E:73°02'; Alt. 3000ft approx.), 30.iv.2014: *Ischnura forcipata*, *Ellatoneura campioni*, *Rhinocypha quadrimaculata*, *Pseudagrion spencei*; 29.vi.2014: *E. campioni*, *Aciagrion hisopa*, *I. forcipata*, *Neurobasis chinensis*, *Copera marginipes*.

Habitat: It was a fast moving and big water stream. At few places small water pockets were present at a distance from the main stream. The stream was having a thick bed of small pebbles and stones. Thin grasses were grown at few spots but the majority of the stream had no vegetation at its margins or within it. However lot of wild vegetation was present on the surrounding mountains.

Loc. 45: Gokina (N: 33°47', E: 73°05'; Alt. 3259ft), 30.iv.2014: *Ischnura forcipata*, *Rhinocypha quadrimaculata*; 19.vi.2014: *Calicnemia eximia*, *I. forcipata*, *Copera marginipes*, *Ellatoneura campioni*; 27.viii.2014: *I. forcipata*, *Coeliccia renifera*, *R. quadrimaculata*, *C. eximia*.

Habitat: It was a beautiful stream that at few places runs along road level very silently and smoothly but after a short distance goes deep into the mountains (Fig. 55-57). It includes variable habitats favoring a broad spectrum of species. At few places it was an open sunlit stream. However at some of its routes, it passes through some very shady and covered spots where no sunlight reaches and lot of springs were sprouting. Even at few spots, it makes small water falls. Water at few places also gets stagnant making small pockets with wild acacia, roses and grasses grown all around. Lot of libellulids and few *Macromia* and *Anax*



Fig. 55: Open sunlit stream at Gokina.



Fig. 56: Small waterfalls adding spring water to Gokina stream.

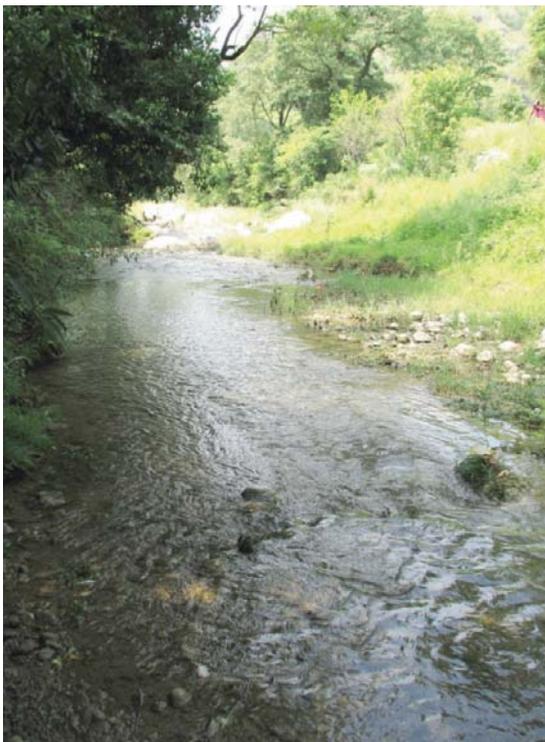


Fig. 57: Shady stream at Gokina.

dragonflies were recorded from this spot in addition to Zygoptera captured. A higher incidence of mating of *Coeliccia renifera* was observed (Fig. 58).

Loc. 46: Qumul (N: 33°50', E: 73°08'; Alt. 3820ft), 27.viii.2014: *Megalestes major*, *Coeliccia renifera*, *Rhinocypha quadrimaculata*, *R. unimaculata*, *Bayadera indica*.

Habitat: It was a fast stream with lot of grassy vegetation nearby. Most of the spot was under dense shade of many small trees. Water here was falling making about 2 to 3 short waterfalls at short distances (Fig. 59, 60). The spot was very damp with lot of algae grown at stones present in it. Fast wind was blowing but as it was covered at one side from high road and on two sides by mountain so the waterfall point was very cool and humid in contrast to open sunlit area of the stream/spot facing fast blowing wind.

Loc. 47: Barkot (N: 33°52', E: 73°10'; Alt. 3346ft), 27.viii.2014: *Rhinocypha quadrimaculata*, *R. unimaculata*, *Ischnura forcipata*, *Pseudagrion spencei*, *Bayadera indica*.

Habitat: It was a narrow twisted stream with lot of rock stones and grasses (Fig. 61). The stream passes flatly under a bridge and whole spot was having thin grasses all around. Water was flowing with some speed and high mountains were present all around. Lot of *Ischnura* and *Ceriagrion* collection was expected but only *Bayadera* adults were seen here.

Loc. 48: Ghariala (N: 33°43', E: 72°54'; Alt. 2165ft), 24.iv.2014: *Copera marginipes*, *Ischnura senegalensis*, *Ischnura forcipata*; 28.x.2014: *Agriocnemis pygmaea*.

Habitat: It was a very cold spring coming in the form of a very narrow and slow channel from the base of a very big hill (Fig. 62). Different types of vegetation were grown all around. At short distance (about 50ft away) water was stored in a small man made pond made for drinking purpose.

Loc. 49: Garam Thon (N: 33°45', E: 72°55'; Alt. 2385), 24.iv.2014: *Agriocnemis pygmaea*, *Ischnura forcipata*, *I. aurora rubilio*, *I. senegalensis*, *Pseudagrion rubriceps*, *P. spencei*; 29.v.2014: *Copera marginipes*, *Elatoneura campioni*, *P. hypermelas*, *P. rubriceps*, *Enallagma parvum*; 28.x.2014: *I. forcipata*, *A. pygmaea*, *E. parvum*.

Habitat: It was a big stream passing from an open area (Fig. 63, 64). Dense dwarf vegetation was scattered all around. But at the immediate stream bank very light grasses were present



Fig. 58: A mating pair of *Coeliccia renifera* at Gokina stream.

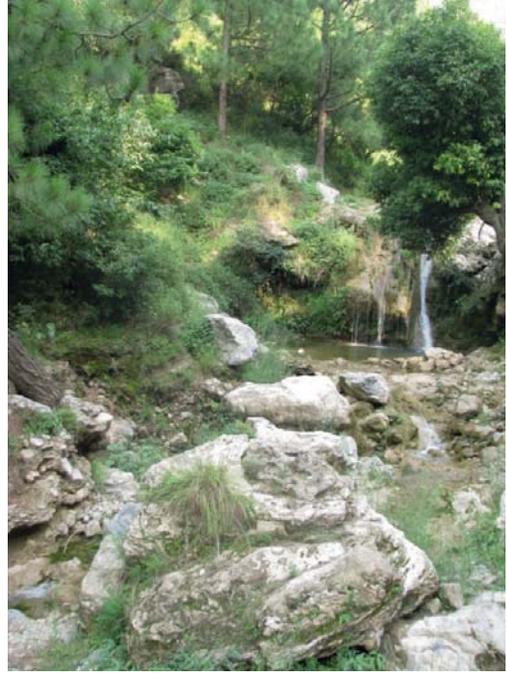


Fig. 59: Dense shady water fall at Qumul Spot. Fig. 60: Sunlit water fall at Qumul spot.

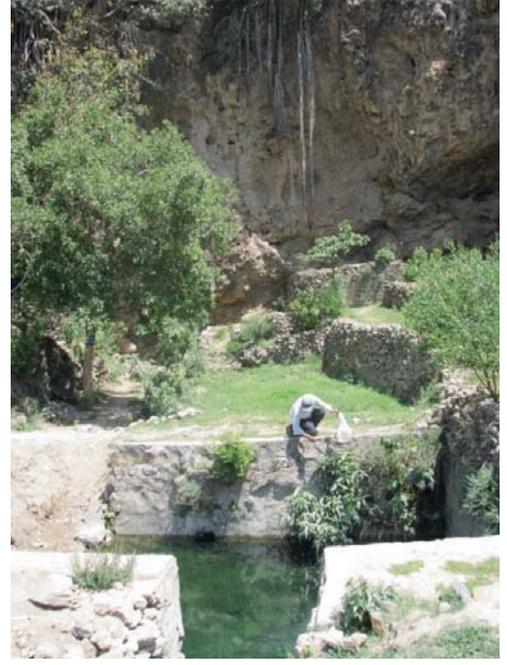


Fig. 61: A twisted stream with dense vegetation at Barkot. Fig. 62: A cold spring spot at Ghariala.

Loc. 50: Khanpur dam (N: 33°49', E: 72°55'; Alt. 2002ft), 24.iv.2014: *Ischnura forcipata*, *Pseudagrion rubriceps*; 29.viii.2014: *I. forcipata*; 28.x.2014: *Neurobasis chinensis*, *P. rubriceps*.



Fig. 63: Dense vegetation cover at Garam Thon spot.



Fig. 64: A view of Garam Thon Stream.

Habitat: The collection was done from three different banks of big water reservoir (Fig. 65-67). High grasses and small wheat fields were also grown nearby. Because of open location, fast wind was blowing and specimens were thus trying to keep them restricted to these vegetation thereby taking shelter.

Loc. 51: Bhamala (N: 33°50', E: 72°58'; Alt. 2031), 28.x., 29.viii. and 24.iv.2014: no Odonata found.

Habitat: It was a very unique spot present at the rear side of Khanpur dam (Fig. 68-71). The spot was having a very big water stream that feeds the dam as its main source. Water was very clear and it was surrounded by very high mountains at its all sides.



Fig. 65: Small wheat fields grown near bank of Khanpur Dam.



Fig. 66: Spiky bushes near bank of Khanpur Dam.



Fig. 67: Beautiful Mountains surrounding Khanpur dam.



Fig. 68: Rear side view of Khanpur dam at Bhamala.

Fig. 69: Scenic view of Bhamala, KPK.

Fig. 70: Close up view of main stream feeding Khanpur dam.

Fig. 71: Main stream view feeding Khanpur dam.



Note: Although these water side mountains were having lot of wild flora and vegetation but surprisingly no Odonata (Zygoptera, Anisoptera or their larvae) activity was seen in any of the visits conducted. The spot was visited on three different months and at three different times of the day. During visits of April and October, temperature was in the optimum for many of the Odonata species and in August, temperature as well as humidity was very high but even at these conditions few species under genus *Ischnura*, *Pseudagrion* and *Ceriagrion* are seen normally. Getting no Odonata from this spot during all the three visits make this spot very mysterious for the author as only a few kilometer back (even on same road), from the banks of same dam were recorded lot of *Ischnura*, *Pseudagrion* and libellulids in every visit.

Loc. 52: Rumli (N: 33°46', E: 73°8'; Alt. 2421ft), 07.v.2014: *Ischnura forcipata*.

Habitat: It was a natural, spring water spot. Water was coming by taking a long

route from surrounding mountains in the form of a rough and stony slow stream. Lot of wild vegetation was present all around.

Loc. 53: Shadara (N: 33°40', E: 73°02'; Alt. 2400ft), 07.v.2014: *Rhinocypha quadrimaculata*, *Ischnura forcipata*, *Pseudagrion rubriceps*.

Habitat: It was a very big water stream in a lush green valley (Fig. 72). Water was flowing very fast. At few places it splashes by striking big rock stones in it. Almost no vegetation was present within stream but at banks wild flora was present at few places. At a long distance wild *Acacia* and *Zizyphus mauritiana* trees were grown in large numbers at nearby hills.



Fig 72: Scenic view of Shadara valley.



Fig. 73: Right edge of Mangla dam, AJ&K. **Fig. 74:** Mangla dam out flow stream (Left view).

Loc. 54: Mangla Dam (N: 33°07', E: 73°48'; Alt. 1200ft), 11.xi.2014: no Zygoptera found.

Habitat: It was a big hydropower dam in Azad Jammu & Kashmir (Fig. 73, 74).

A small service road was made to the boating spot. At one side of this service road was present dam while on the other side of this road was stagnant water in the form of big pocket having lot of algae grown at its bank (Fig. 75). It was actually made up by the rise in underground water table because of nearness to dam. *Acacia* plants were grown in close proximity. Although cool breeze was blowing at dam side but the water pocket side was very humid as it was in great depression. Lot of Libellulidae were present but surprisingly no Zygoptera were found.

Fig. 75: Stagnant water pocket at other side of Mangla dam.

Fig. 76: Mangla dam out flow stream (Right view).

Fig. 77: A link canal of Mangla dam out flow stream in Ali Beig (Jaatla).



Loc. 55: Mangla dam out flow stream (N: 33°00', E: 74°06'; Alt. 1538ft), 11.xi.2014: *Enallagma parvum*, *Pseudagrion rubriceps*, *P. spencei*, *Copera marginipes*, *Aciagrion hisopa*, *Ischnura aurora rubilio*, *I. forcipata*, *I. senegalensis*.

Habitat: It was an out flow stream of Mangla dam (Fig. 76, 77). Water was flowing swiftly and wind was also blowing very fast. Specimens of all recorded Zygoptera were seen trying to fly close along banks taking shelter against blowing wind.

Loc. 56: Ali beig- Jaatla Railway track stream (N: 33°01', 73°51'; Alt. 785ft), 11.xi. 2014: *Ischnura forcipata*, *I. aurora rubilio*, *Agriocnemis pygmaea*, *Rhodischnura nursei*, *Ceragrion cerinorubellum*, *C. coromandelianum*.

Habitat: It was a very narrow stream passing along a railway track. Lot of *Typha* and dwarf wild grasses were grown all along its way and especially wherever water get stagnant. This stream was itself derived from a link canal of Mangla dam for irrigating agricultural fields of the area (Fig. 77).

Note: It is important to document that *Ceriagrion cerinorubellum* was recorded first time in Pakistan by Khaliq (1990) from the mountains of Kallar Kahar (About 120 kilometer away from this spot). However the author during his country wide surveys (2005-2007) found it nowhere else but exactly from this spot. Although at IUCN website it is placed under "Least Concern" category, its distribution in Pakistan seems very restricted.

Discussion

In the current study designed to explore Zygoptera complex inhabiting Sub Himalayan hill tracts of Pakistan, a total of 28 species have been recorded. The Zygoptera fauna of Pakistan has been explored in past by various workers. Previous studies carried out reporting damselfly fauna (larvae and adults) of Pakistan includes work of Kirby (1886), Morton (1907), Fraser (1919), Laidlaw (1920), Fraser (1922, 1923, 1933-36), Chishti (1979), Niazi (1984), Kanth (1985), Hussain (1988), Yousuf and Chishti (1986), Khaliq (1990), Khaliq et al. (1990), Khaliq et al. (1992), Khaliq & Yousuf (1992a,b,c), Khaliq et al. (1993), Khaliq & Yousuf (1993a,b,c), Khaliq & Yousuf (1994), Khaliq et al. (1994), Khaliq & Siddique (1995), Khaliq et al., (1995, 1996), Luqman (1995), Yousuf et al. (1995a,b), Yousuf et al., (1996), Anjum (1997), Jahangir (1997), Khaliq & Maula (1999), Yousuf et al. (2000a,b), Hussain (2006), Zia et al. (2008, 2009, 2011a,b), Mitra & Babu (2009), Rafi et al. (2009), Zia (2010, 2015), Din (2012), Din et al. (2013), Bhatti et al., (2014), Dow et al. (2014). These studies together brought forward a record of only 53 species as known Zygoptera fauna of Pakistan. However during present study (based on only one year data), restricted strictly to selected Himalayan foothills a total of 28 species have been recorded. It highlights the importance of these hills as almost 50% of the country's Zygoptera fauna is reflected by these mountains (Fig. 78). Also it indicates a need and potential of exploring Zygoptera from the country in detail as lot of species are restricted to plains and deserts as well.

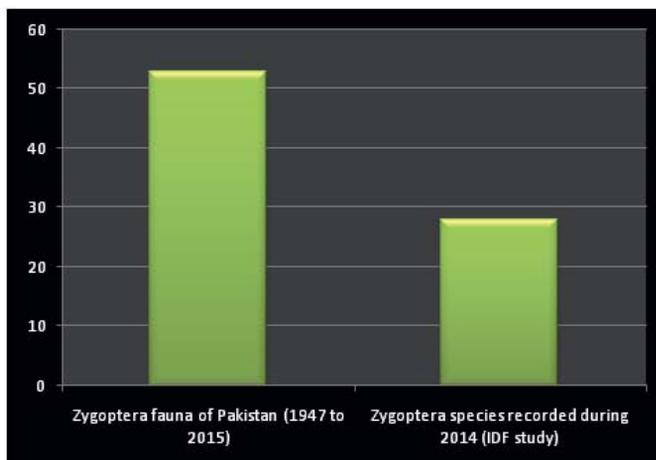


Fig. 78: Zygoptera fauna of Himalayan foothills Vs Country's known fauna

Pakistan is blessed with a very high biodiversity and plenty of different habitat types. Also it occupies an important biogeographic position by representing Palearctic, Oriental and Afro-tropical fauna. The known Zygoptera fauna of neighboring countries carrying similar ecological and topographic conditions is far higher than Pakistan. Among these India is representing 195 species (Subramanian, 2009) and Sri Lanka has a reported record of 58 zygopteran species (Bedjanic et al., 2014).

During the present study efforts were focused strictly on the foothills as during all previous studies (discussed above) Lesser Himalaya is badly neglected and ignored. The sub-Himalayan tracts inhabit many important species that are poorly known, threatened / nearly threatened or even unexplored. Among these *Coeliccia vacca* is a poorly known, data deficient, threatened species (IUCN Red List Status) with no information available for its habitat and ecology (Dow & Sharma 2010). It is reported during the present study by accidentally recording one adult female from Charhaan spot (Fig. 79). It is important to document that earlier Zia (2010) recorded specimens (during 2006, 2007) from three different spots in Himalayan foothills but all of these springs and spots went out of sight following a massive earth quake in Pakistan during the year 2005. Since then no specimen of *C. vacca* has been seen in Pakistan. Finding more specimens of this species thrusts for conducting more collection surveys in whole Lesser Himalaya of Pakistan so as to get detailed information on its biology, ecology and habitat that can be used for its protection and in designing effective conservation plans.

Another important species recorded is *Drepanosticta carmichaeli*. It is one of the new records explored for Pakistan from two localities (Fig. 80). It is known to be native of Bhutan, India and Nepal. It has a wide reported range of distribution in Himalayan belt starting from Uttarakhand (Prasad 1974, Prasad & Singh 1976) in Western Himalayas to Bhutan (Mitra 2008) in the Eastern Himalayas (Mitra, 2010). Although it is a common species of Himalayan range but finding it in Pakistan for the first time stresses that damselfly fauna of Pakistan is poorly known.

In addition to new records, efforts were made to remove existing confusions in identification and status of *Ischnura aurora* species in Pakistan. *Ischnura aurora aurora* is known as a commonly known species of Pakistan, yet all previous workers identified it following baseline literature of Fraser (1933). Specimens of *I. aurora* recorded during current study from ten different localities were compared with the published description of Papazian et al. (2007) and were found to be *Ischnura aurora rubilio*. It is thus recommended that specimens of *I. aurora* housed in various insect repositories of Pakistan should also be re-examined to know about exact taxonomic status of previously known *Ischnura* from various parts of the country.

It is a known fact that Odonata distribution is affected by physical barriers and these physical barriers have a strong relation with the altitudinal clines. In the current study all the 56 surveyed localities were divided into four major groups according to their elevations (Fig. 81). It can be very easily concluded that altitudinal clines affect distribution of Zygoptera species as with increase in altitude, species count became less. Fig. 81 also brings forward the reason for low number of species reported from Pakistan. If we have a look on the faunistic studies carried out earlier on Odonata

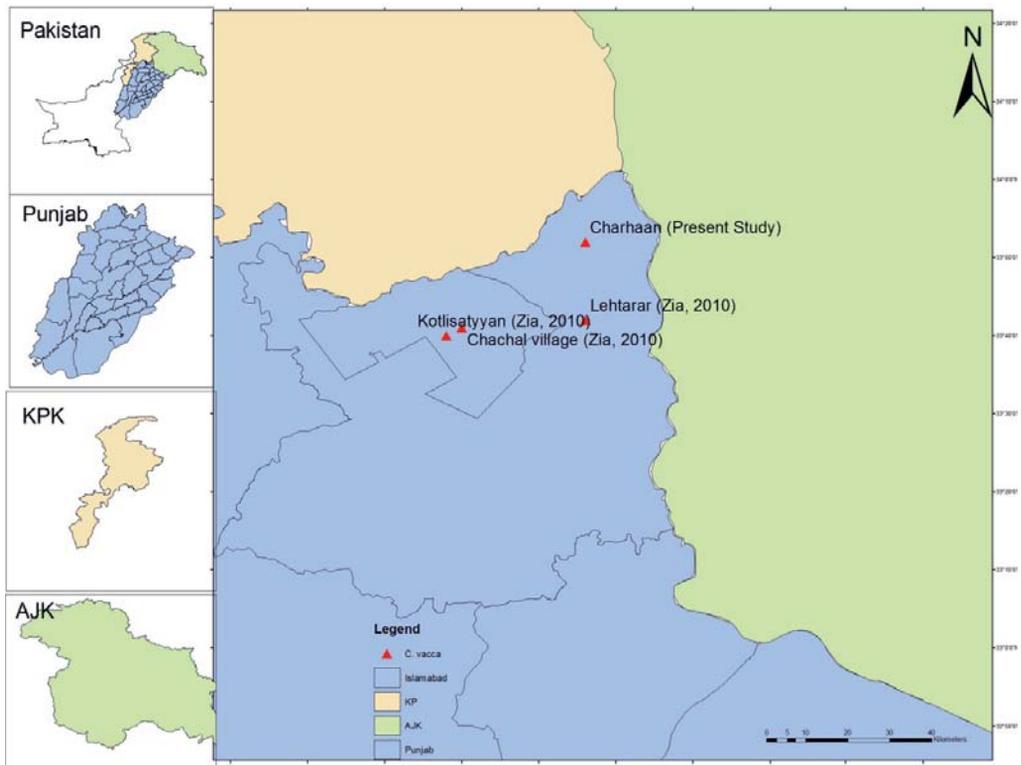


Fig. 79: Distribution of *Coeliccia vacca* in Lesser Himalaya of Pakistan.

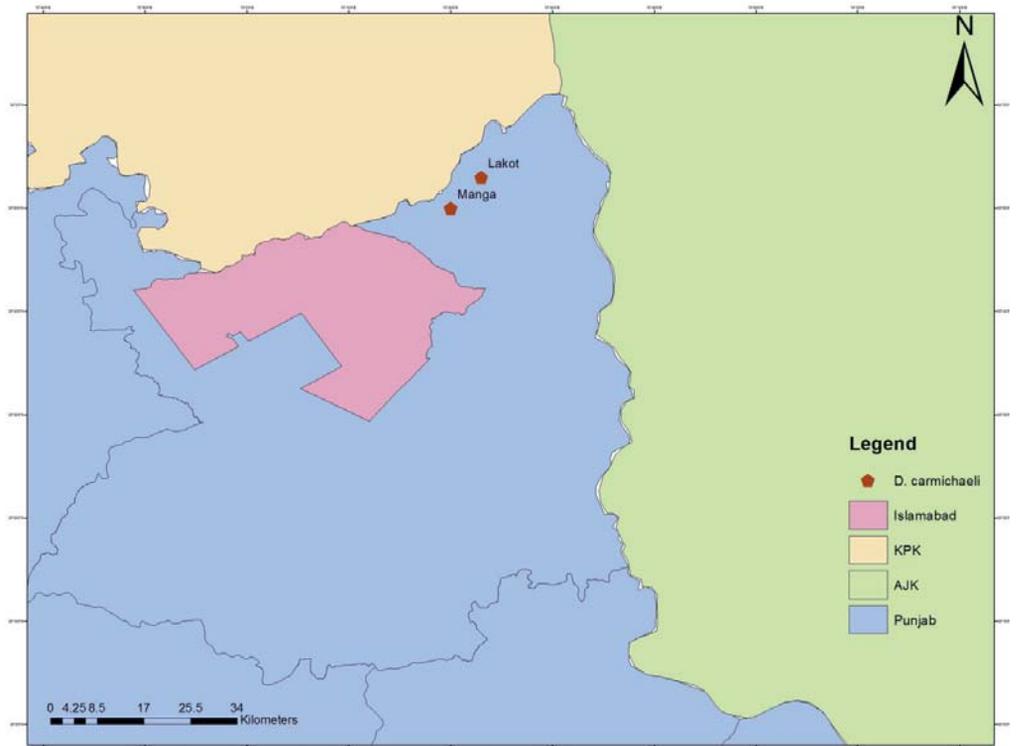


Fig. 80: Distribution of *Drepanosticta carmichaeli* in Lesser Himalaya of Pakistan.

fauna of Pakistan, it will show that mostly surveys are done in hill ranges and in all of these studies the higher elevations are surveyed more deeply than lower ones with even foothills mostly neglected. It is also in compliance to the introductory statement that “The higher hill ranges remained a popular subject for exploring insect species throughout the world. However the foothills are often over looked and neglected”.

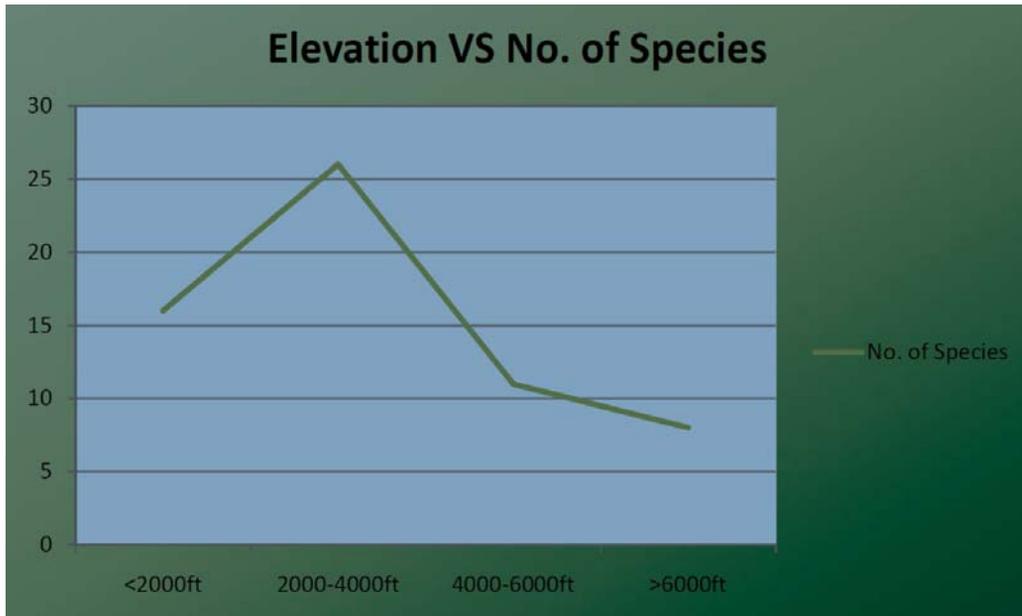


Fig. 81: Chart showing Zygoptera recorded in relation to altitudinal clines.

Summing up all it can be easily concluded that there is a dire need to explore Zygoptera fauna of Pakistan more thoroughly. The upper reaches as well as lower elevations and foothills should be visited in detail so as to bring forward new records of Odonata from these hill ranges. Pakistan is blessed to have four mountain ranges, glaciers, ocean, deserts as well as plains. If searched in depth, it will surely come up with new information for the whole world of Science. As in a recent work (Dow et al., 2014), documented a new to science species (*Calicnemia fortis*) from the mountains of Noseri village of Azad Jammu & Kashmir in Pakistan and Zia (2010) explored nine new records for the country during 2004-2009.

Checklist of damselflies (Zygoptera: Odonata) recorded from Himalayan foothills of Pakistan

Super-family Calopterygoidea

Family Calopterygidae Selys, 1850

Subfamily Calopteryginae

Genus *Neurobasis* Selys, 1853

- *Neurobasis chinensis* Linnaeus, 1758

Family Chlorocyphidae Cowley, 1937

Genus *Libellago* Selys, 1840

- *Libellago lineata lineata* Burmeister, 1839

Genus *Rhinocypha* Rambur, 1842

- *Rhinocypha unimaculata* Selys, 1853
- *Rhinocypha bifasciata*
- *Rhinocypha trifasciata* Selys, 1853
- *Rhinocypha quadrimaculata* Selys, 1853

Family Euphaeidae Selys, 1853

Genus *Bayadera* Selys 1853

- *Bayadera indica* Selys, 1853

Super-family Coenagrionoidea

Family Coenagrionidae Kirby, 1890

Subfamily Agriocnemidinae

Genus *Agriocnemis* Selys, 1877

- *Agriocnemis pygmaea* Rambur, 1842

Subfamily Pseudagrioninae

Genus *Ceriagrion* Selys, 1876

- *Ceriagrion cerinorubellum* Brauer, 1865
- *Ceriagrion coromandelianum* Fabricius, 1798

Genus *Pseudagrion* Selys, 1876

- *Pseudagrion hypermelas* Selys, 1876
- *Pseudagrion rubriceps* Selys, 1876
- *Pseudagrion spencei* Fraser, 1922

Subfamily Ischnurinae

Genus *Aciagrion* Selys 1891

- *Aciagrion hisopa* Selys, 1876

Genus *Enallagma* Charpentier, 1840

- *Enallagma parvum* Selys, 1876

Genus *Ischnura* Charpentier, 1840

- *Ischnura aurora rubilio* Selys, 1876
- *Ischnura elegans* Vander Linden, 1820
- *Ischnura forcipata* Morton, 1907

Genus *Rhodischnura* Laidlaw, 1919

- *Rhodischnura nursei* Morton, 1907

Family Platycnemididae Tillyard, 1917

Subfamily Calicnemidinae

Genus *Calicnemis* Strand, 1928

- *Calicnemis eximia* Selys, 1863

Genus *Coeliccia* Kirby, 1890

- *Coeliccia renifera* Selys, 1886
- *Coeliccia vacca* Laidlaw, 1932

Subfamily Platycnemidinae

Genus *Copera* Kirby, 1890

- *Copera marginipes* Rambur, 1842

Family Platystictidae Laidlaw, 1924

Subfamily Platystictinae

Genus *Drepanosticta* Laidlaw, 1917

- *Drepanosticta carmichaeli* Laidlaw, 1917

Family Protoneuridae Tillyard, 1917

Subfamily Disparoneurinae

Genus *Elatoneura* Cowley, 1935

- *Elatoneura campioni* Fraser, 1922

Super-family Lestoidea

Family Lestidae Calvert, 1901

Subfamily Lestinae

Genus Lestes Leach, 1815

- *Lestes thoracicus* Laidlaw, 1920
- *Lestes viridulus* Rambur, 1845

Family Chlorolestidae

Subfamily Megalestinae

Genus Megalestes Selys, 1862

- *Megalestes major* Selys, 1962

List of Abbreviations Used

Loc.	Locality
°C	Degree Centigrade
♂	Male
♀	Female
&	And
km	Kilometers
Fig.	Figure
Approx.	Approximately
Temp. (°C)	Temperature in Degree Centigrade
Alt.	Altitude
E	East
N	North
TOC	Time of Collection

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Appendix I

Locality	Date	Weather TOC	Time	Temp. (°C)
1	16.iv.2014	Mild Cloudy	12:39	30
1	10.vi.2014	Sunny	11:15	38
1	05.viii.2014	Sunny	11:00	31
1	16.ix.2014	Sunny & Humid	10:45	38
1	22.x.2014	Sunny	11:30	29
2	16.iv.2014	Sunny	13:45	29
2	10.vi.2014	Sunny	11:15	38
2	05.viii.2014	Sunny	11:00	31
2	13.xi.2014	Sunny	11:30	26
3	16.iv.2014	Sunny & Windy	14:30	30
4	10.vi.2014	Sunny	09:45	32
5	16.iv.2014	Mild Cloudy & Windy	11:20	30
6	16.iv.2014	Sunny	16:31	30
6	07.v.2014	Sunny	15:45	30
6	10.vi.2014	Sunny	16:00	32
7	16.iv.2014	Sunny	17:28	30
7	10.vi.2015	Sunny	15:00	31
7	25.ix.2014	Sunny	13:40	28
8	16.iv.2014	Sunny	17:28	30
8	10.vi.2014	Mild cloudy	17:00	32
8	25.ix.2014	Cloudy	13:40	28
9	05.viii.2014	Clear	3:42	30
9	10.vi.2014	Clear	4:54	28
10	07.v.2014	Sunny	12:31	32
10	10.vi.2014	Sunny	13 45	38
10	25.ix.2014	Mild cloudy	11:00	28
11	16.iv.2014	Sunny	12:00	30
11	07.v.2014	Sunny	13:30	34
11	10.vi.2014	Sunny	14:25	38
12	11.ix.2014	Sunny	10: 00	29.5
13	11.ix.2014	Sunny	11:30	23
14	11.ix.2014	Cold and Cloudy	17:45	22

Zygoptera in Himalayan foot hills of Pakistan

Locality	Date	Weather TOC	Time	Temp. (°C)
15	12.ix.2014	Sunny	11:45	21
16	12.ix.2014	Sunny but very cold	12:45	20
17	12.ix.2014	Sunny	16:21	28
18	16.ix.2014	Sunny	10:15	27
19	16.ix.2014	Mild cloudy	13:00	20
20	16.ix.2014	Sunny	15:00	28
21	22.ix.2014	Sunny	10:00	29
21	30.x.2014	Sunny	11:00	24
22	22.ix.2014	Sunny	11:30	30
23	22.ix.2014	Sunny	15:30	27
24	28.viii.2014	Fogy	16:45	25
25	28.viii.2014	Mild cloudy	12:40	25
26	28.viii.2014	Sunny	15:45	24.5
26	02.vi.2014	Sunny	17:45	23
27	28.viii.2014	Sunny	18:40	26
27	02.vi.2014	Sunny	16:00	33
27	30.x.2014	Sunny	13:05	27
28	02.vi.2014	Sunny	11:45	35
29	02.vi.2014	Sunny	13:00	34
29	30.x.2014	Sunny	11:30	27
30	02.vi.2014	Sunny	13:45	33
31	02.vi.2014	Sunny	15:40	33
32	29.x.2014	Sunny	11:00	27
33	29.x.2014	Sunny	13:00	29
34	29.x.2014	Sunny	14:00	28
35	29.iv.2014	Cloudy	11:00	33
35	29.x.2014	Sunny	14:35	23
36	21.x.2014	Sunny	10:30	27
37	21.x.2014	Sunny	11:00	30
38	21.x.2014	Sunny	11:50	27
38	23.x.2014	Sunny	10:00	26
38	23.x.2014	Sunny	17:00	26
39	21.x.2014	Sunny	14:00	30
40	23. x. 2014	Sunny	1100	27

Locality	Date	Weather TOC	Time	Temp. (°C)
41	23.x.2014	Sunny	15:34	26
42	05.viii.2014	Rainy	13:15	28
42	16.ix.2014	Sunny	09:30	30
43	11.viii.2014	Sunny	15:00	32
44	30.iv.2014	Sunny	11:00	31
44	29.vi.2014	Sunny	11:30	32
45	30.iv.2014	Sunny	13:29	32
45	19.vi.2014	Sunny	1200	34
45	27.viii.2014	Cloudy	1100	28
46	27.viii.2014	Sunny	14:30	30
47	27.viii.2014	Sunny	15:15	30
48	24.iv.2014	Hot	11:28	32
48	28.x.2014	Mild Cloudy	10:15	23
49	24.iv.2014	Sunny	14:12	33
49	29.v.2014	Sunny	11:00	35
49	28.x.2014	Mild Cloudy	11:00	26
50	24.iv.2014	Sunny	16:00	33
50	29.viii.2014	Sunny	17:30	42
50	28.x.2014	Sunny	12:30	26
51	28.x.2014	Sunny	14:30	26
51	29.viii.2014	Sunny	16:00	45
51	24.iv.2014	Sunny	12:00	30
52	07.v.2014	Clear	09:15	31
53	07.v.2014	Sunny	11:30	32
54	11.xi.2014	Sunny	10:30	30
55	11.xi.2014	Sunny	13:41	31
56	11.xi. 2014	Sunny	16:03	30

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Reference cited in the text should read as follows: Tillyard (1924), (Tillyard 1924), Swezey & Williams (1942).

The reference list should be prepared according to the following standard:

Swezey, O. & F. Williams, 1942. Dragonflies of Guam. Bernice P. Bishop Museum Bulletin 172: 3-6.

Tillyard, R., 1924. The dragonflies (Order Odonata) of Fiji, with special reference to a collection made by Mr. H.W. Simmonds, F.E.S., on the Island of Viti Levu. Transactions of the Entomological Society London 1923 III-IV: 305-346.

Citations of internet sources should include the date of access.

The manuscript should end with a list of captions to the figures and tables. The latter should be submitted separately from the text preferably as graphics made using one of the Microsoft Office products or as a high resolution picture saved as a .jpg .tif or .ps file. Pictures should be at least 11 cm wide and with a minimum 300 dpi resolution, better 360 dpi. Line drawings and graphics could have 1200 dpi for better details. If you compose many pictures to one figure, please submit the original files as well. Please leave some space in the upper left corner of each picture, to insert a letter (a, b, c...) later. Hand-made drawings should be scanned and submitted electronically. Printed figures sent by the post could be damaged, in which case authors will be asked to resubmit them.

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the 1990s, the incidence of *S. pneumoniae* meningitis in children has increased in the United Kingdom [10].

The epidemiology of meningitis in children is complex, with a number of different organisms causing disease. The epidemiology of meningitis in children is different from that in adults, with meningitis in children being more common in the winter months and more common in children aged 5 years and under [11].

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