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Research Article

**DIVERSITY OF CARPENTER BEE FAUNA (XYLOCOPA SPP.) IN DIR LOWER, KHYBER PAKHTUNKHWA, PAKISTAN**Akbar Hussain<sup>1</sup>, Mohammad Attaullah<sup>2</sup>, Muhammad Ather Rafi<sup>3</sup>, Hamad Khan<sup>1</sup>,  
Abdul Waris<sup>4</sup>, Anwar Zeb<sup>5</sup>, Abdul Baset<sup>6</sup><sup>1</sup>Department of Zoology, Shaheed Benazir Bhutto University, Sheringal, Dir Upper, Khyber Pakhtunkhwa, Pakistan<sup>2</sup>Department of Zoology, Faculty of Biological Science, University of Malakand, Pakistan<sup>3</sup>Department of Zoology, Women University Swabi, Pakistan, Director National Insect Museum, Islamabad, Pakistan<sup>4</sup>Department of Biotechnology, Quaid-e-Azam University Islamabad, Pakistan<sup>5</sup>Department of Zoology, Faculty of Science, Hazara University, Mansehra, Pakistan<sup>6</sup>Department of Zoology, Bacha Khan University, Charsadda, Pakistan\*Corresponding author: [drabdulbaset@bkuc.edu.pk](mailto:drabdulbaset@bkuc.edu.pk)**Abstract:**

*This study was conducted at District Dir Lower, in north western Pakistan for the evaluation of diversity of Xylocopa spp. during March to September 2015. The study area was divided in 7 different localities namely Chakdara, Talash, Timergara, Jandol, Khal, Dermal and Lal Qilla. Higher Simpson's index (1/D) values were calculated for Talash (0.7464) followed by Khal (0.7392), Chakdara and Jandol (same value 0.7366), Dermal (0.7268), Lal Qilla (0.7244) and lowest value was calculated for Timergara (0.716). Divider and Scale method was used for the morphometric measurement of carpenter bees. Out of the total 321 specimens collected, four species namely, Xylocopa collaris, Xylocopa acutipennis, Xylocopa dissimilis and Xylocopa pubescens were identified. X. dissimilis was the abundant species recorded which represented 29.60 % of the total collection, while X. pubescens, X. collaris and X. acutipennis represented 27.60 %, 23.1 % and 19.62 % of the total collection respectively.*

**Keywords:** Xylocopa, Carpenter bees, Diversity, Simpson's Index, Shannon's Index, Dir Lower.

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## 1. INTRODUCTION:

*Xylocopa spp.* belong to Order Hymenoptera, Super family Apoidea, family Apidae and sub family Xylocopinae. They are commonly known as carpenter bees due to making holes in wooden goods. They are cosmopolitan in distribution (Hurd *et al.*, 1963; Thakur 2012). The largest diversity of are found part of its species occurs in the tropics or subtropics regions. Fewer extend into the temperate zones, reaching as far North as the prairielands of Russia (Malyshev, 1931). They forage on a wide range of food plants and can tolerance high temperatures (Thakur 2012), while their large body size makes them recognized as good pollinators (Gerling *et al.*, 1989). These characters make them attractive candidates for agricultural pollination in hot climates, particularly in greenhouses, and of night-blooming crops. Carpenter bees are sometime confused with bumblebees because of their morphological appearance and body size. The largest bee is 3 cm in length (Malyshev, 1931) with distinctly hairy thorax and legs, other than a hairless abdomen. The abdomen is metallic or glittering, and may reflect blue, black, bronze, purple, green or buff, depending upon the species (Beyond Pesticides/NCAMP, 2016). Female of the most species are noticeable and they are black or blue in color, which may be varied with lighter color pubescences. Male either resemble female or may be completely covered with a light brown, light green or yellowish green pubescence (Malyshev, 1931). All *Xylocopa* species are believed to be polylectic and are commonly associated with large and showy flowers with abundant pollen and nectar (Hurd 1956).

All *Xylocopa* are attractive to showy flowers rich , and mostly visit tubular or non-tubular flowers of medium to large size which offer nectar and pollen to satisfy their nourishment needs (Cruden, 1977; Aluri, 2012) and are said to be polylectic in nature (Hurd, 1956)and choose colorful(In reward they fertilized plant species. However, their importance in the sexual reproduction of different wild or cultivated plant species is well known (Aluri, 2012) and are considered to be significant pollinators for agricultural crops (Keasar, 2010), such as Peach (Abrol and Bhat, 1990), Mango (Rehman *et al.*, 1990), Sunflower (Talpur, 1995), Almond (Abrol and Bath, 1998), Apricot (Mariyam, 2012),Passionflower, Blueberries, Greenhouse Tomatoes and Greenhouse Melons (Thakur, 2012), *Passiflora* and *Luffa* species and other cultivated fruits, vegetables (Gerling., *et al.*, 1989) and pomes fruits at different altitude (Gerling., *et al.*, 1989) (Hussain *et al.*, 2012).

They are wood nesting generalist pollinators (Thakur, 2012), and appear solitary in nature (Aluri, 2012). They are diurnal in foraging behavior and visit a wide variety of flowers during the day or

occasionally even under low light (Zafar *et al.*, 2005; Thakur, 2012).The carpenter bees are important pollinators, despite this beneficial aspect, carpenter bees are infamous for damaging man-made wooden structures, lead cables, fiberglass insulation, and polystyrene foams regardless of their large size, widespread distribution, and use of timber as substrate, they do not frequently cause severe economic damage because they tunnel very slowly and their damage is very restricted (Gerling *et al.*,1989).

Carpenter bees do not create threat to humans, males cannot sting, though their interactions are noisy and may seem threatening as they guard and confront each other over their territories. However, females focus on provisioning their nests and are most repeatedly seen entering and emerging from large entrance holes in wood or in flowers searching for pollen. Although they can sting or bite if roughly handled (Beyond Pesticides/NCAMP, 2016).The carpenter bees are characterized by building tunnels for nesting in solid wood, dead branches of trees, in hollow stems and soft plant material (Hurd *et al.*, 1963; Gerling *et al.*, 1989; Aluri, 2012) while bamboo culms are commonly used for nesting associated with plants like *Syzygiumcumini* and *Cassia siamea*. Females are involved in nest construction, digging tunnels or holes in the selected wood with their strong and well developed mouthparts (Zafar *et al.*, 2005). The nest constructed usually varies from species to species (Steen and Schwarz, 2000). During brood cycle the female lays one or a few eggs along a tunnel, provisions them, and makes partitions of chewed wood to separate the offspring from one another. Motherly care in carpenter bees also involves protecting of the immature offspring and feeding of the newly developed by trophallaxis (Gerling *et al.*, 1981; Steen, 2001) in brooding pattern varying from two to four generations per year spread over February–November or even restricted to March–April and August–September, suggesting a complementarity between forage and nesting (Zafar *et al.*, 2005). The activity season of carpenter bees spans 8-12 months, depending on species (Mordechai *et al.*, 1978; Camillo, 1982). However, in temperate areas they hibernate during the cold season (Sugiura, 1995; Steen, 2000), but emerge to forage on warm winter days (Mordechai *et al.*, 1978). The work on genus *Xylocopa* is not enough in District Dir Lower and its vicinities. As these are significantly important pollinators so the current study was conducted in District Dir lower with the following aims and objectives. (1) To report carpenter bee's fauna of genus *Xylocopa* from Distract Dir Lower. (2) To investigate distribution in District Dir Lower.

## 2. MATERIALS AND METHODS:

### 2.1 Study Area

The present research work was carried out at District Dir Lower, Khyber Pakhtunkhwa, Pakistan. It is located at 35°-10' to 35°-16' N and longitude 71°-50' to 71°-83' E in the range of Hindu-Kush mountains (Ali *et al.*, 2008). District Dir Lower is a small and princely state, located in Malakand Division and lies in the Valley of River Panjkora which merges with the River Swat near Chakdara (Word Food Program, 2011).

Total area of Dir lower is 1583 km<sup>2</sup> which is bounded by District Swat to the East, Dir Upper to the North while Bajawar Agency to the West. Dir lower is divided in to seven Tehsils namely Timergarah, Balambat, LalQilla, Adenzai, Munda, Khall and Samarbagh (Rahat Ullah *et al.*, 2012). The valley is about 1200 m above sea level in the Southern parts and the level increases towards the Northern parts.

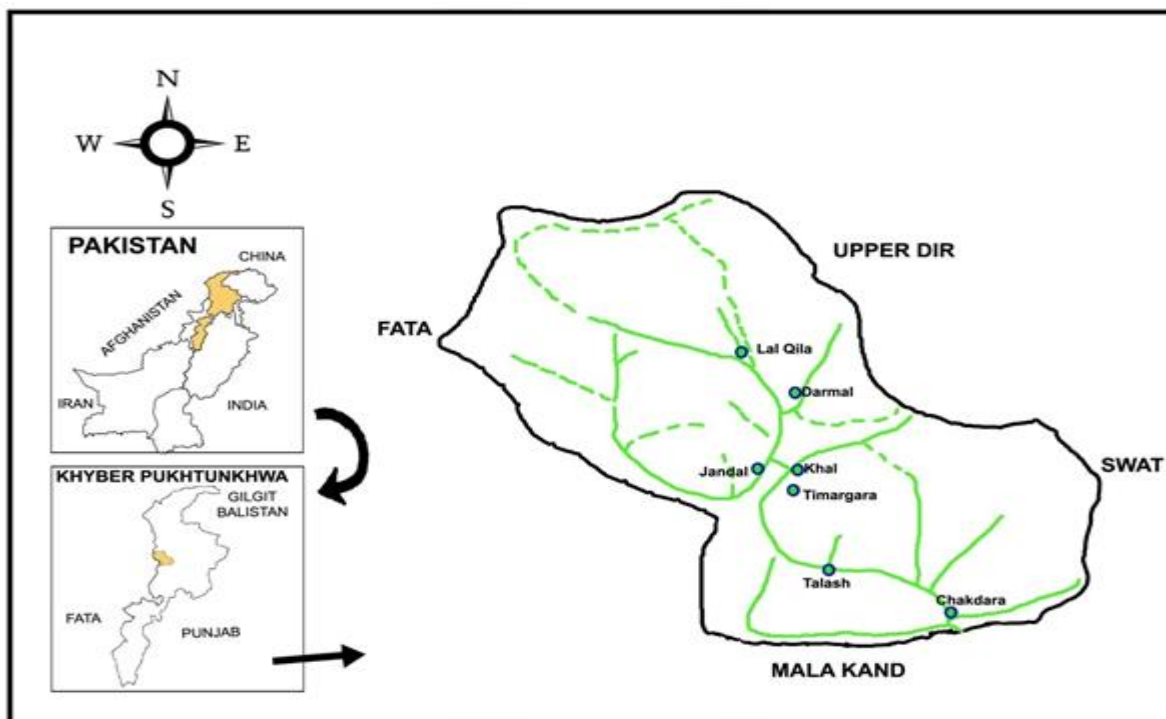


Figure 1. Map of District Dir Lower showing selected localities.

## 2.2 Collection Sites

Carpenter bees specimens were collected from seven localities of District Dir lower namely Chakdara, Talash, Timergara, Jandol, Khal, Darmal and LalQilla (Figure 1)

## 2.3 Collection and Preservation

The collection of Carpenter bees specimens were done during the day hours' time in sunny days from April 2015 to September 2015 after 30 days interval from different habitats such as gardens, fruits orchards, vegetables fields, grasses and other plants from 9: 00 AM to 5: 00 PM. The bees were collected from each locality with the help of aerial net having about one meter long handle (Gullan and Cranston, 2005). Specimens were collected from pitches, woods timber and mostly from flowers, gardens and other vegetable. Collected specimens of carpenter bees were then captured in glass jars with the help of cotton soaked in Ethyl Acetate. Specimens were Stretched with the help of insect pins and labeled on thermo-pore sheets. Label reflects details of date of collection, name of collector and locality.

After drying, labeled specimens were transferred into wooden boxes. Naphthalene balls were placed to protect the dry specimens from ants attack.

## 2.4 Identification

Carpenter bees were identified under compound microscope up to species level using keys of *Xylocopa* species (Bingham, 1897; Wililams, 1991; and Mischner, 2007). The comparison of all the species from the study area was done with previously reported species collected from other various localities of Pakistan for reconfirmation which were housed in National Insect Museum at National Agricultural Research Center, Islamabad.

## 2.5 Diversity Indices

Prepared from each locality the diversity indices estimated the maximum abundance with the help "PAST" software and used data (Table 4.3) from the selected localities also used several indices such as (Shannon's, 1963), (Margalef, 1969) and the Simpson's index (1-D) is commonly used to

calculate the maximum abundant species in the specimen however for measuring species abundance it is less sensitive (Simpson, 1949). The index depend upon size and its values decrease with the increase in size of sample and the value mostly ranges from 0 to 1 while higher diversity is considered in preferred areas if the values tend towards zero.

Higher Simpson's index (1/D) values was observed at Talash 0.7464 followed by Khal 0.7392, Chakdara and Jandol same value 0.7366, Darmal 0.7268, Lal Qila 0.7244, and lowest was observed from 0.716. To measure the richness and abundance of the calculated species. Shannon (H) index was used.

### 2.6 Measurement

"Divider and scale method" (Zia 2010) was used for the measurement of carpenter bees. Body length of specimens was measured by scale from post clypeus area up to last abdominal segment.

Photographs of the identified species were taken with the help of Canon s5 IS digital camera.

### 3. RESULTS AND DISCUSSION:

During present study monthly field surveys were conducted spanning detail from March 2015 to September 2015 in seven pre-determined seven determined localities of District Dir (Table 2). During the field surveys a total of 321 carpenter bee specimens were collected from seven localities including Chakdara, Talash, Timergra, Jandol, Khal, Darmal and Lal Qilla, of District Lower Dir. In 321 specimens four species belong to *Xylocopa* genus were explored. Among 321 specimens 95 individuals were *Xylocopa dissimiliss* whereas 89 individuals belong to *Xylocopa pubesens* followed by *Xylocopa collaris* representing 74 specimens and 63 specimens were belong to *Xylocopa acutipennis*.

Taxonomic sources were provided for the identified carpenter bees species and validation of the species of specimen were made with their synonyms, diagnostic characters i.e. body length, hairs, legs, colors, mouth parts antennae and wings characters etc. The relative percentage abundance of all the collected species from each localities of District Dir Lower is shown in Table 3.

#### 3.1 *Xylocopa collaris* Lepeletier, 1841

Synonym: *Xylocopa collaris* Lepeletier, 1841; *Xylocopa dejeanii* Lepeletier, 1841; *Xylocopa defeanii* Hurdand Moure 1963.

Diagnostic characters: Body length 17-21mm. clypeus, face yellow with thin yellowish brown hairs or pubescences on vertex, thorax and on 1-2

segments of abdomen with dull white hairs while rest of segments are with black hairs.



**Figure 2.** *Xylocopa collaris* Lepeletier, 1841

Remarks: This is the first record of this species from Dir Lower. A total of 74 specimens were collected from seven localities during this study. Previously, it was reported from Peshawar (Bibi, 1984). Rahoo *et al.*, (1985) recorded it from sun flower in Sind. It was also recorded from Sindh TandoJamon cotton (Dhuyo, 1986) and Gilgit Baltistan (Maryam, 2012). Distribution: From India, Malaya (Bingham, 1897), from Pakistan, (Bibi, 1984; Dhuyo, 1986; Rahoo *et al.*, 1985) Mariyam (2012) reported it from Gilgit-Baltistan. From Sri Lanka, (wijesekara, 2001).

#### 3.2 *Xylocopa acutipennis* Smith, 1854

Synonym: *Xylocopa acutipennis* Smith, 1854; *Xylocopa splendidipennis* Ritsema, 1876.

Diagnostic character: Body length 28 mm; head thinly punctured; thorax flat in middle through spread breaks on side; in the middle of the base of antennae a higher carina existing; black hair on whole body with black brown hair on sides of thorax, margins and abdomen; wings fuscous through rich coppery bronze effulgence.



**Figure 3.** *Xylocopa acutipennis* Smith, 1854

Remarks: Currently reported from Dir Lower. Mariyam (2012) reported from Gilgit-Baltistan, Pakistan.

Distribution: India, Pakistan, Myanmar and Nepal (Bingham, 1897; Gupta, 2010).

#### 3.3 *Xylocopa dissimilis* Lepeletire, 1841

Synonym: *Xylocopa violacea* Linnaeus, 1800; *Xylocopa nasalis* Westwood, 1838; *Xylocopana salisnasalis* Westwood, 1838; *Xylocopa dissimilis* Lepeletire, 1841; *Xylocopa lunulata*; Lepeletier, 1841; *Xylocopa dissimilis* Lepeletire, 1854; *Xylocopa auripennis* Lepeletier, 1874; *Xylocopa amethystina* Fabricius, 1878; *Xylocopa cyanoptera* Taschenberg, 1879; *Xylocopa lunulataminensis* Cockerell, 1909.



Diagnostic character: Body length: 24-27 millimeter; in head region coarsa punctured, slightly punctures on thorax and black hairs abdomen through compact hairs on mesonotum; wings purple on base besides through reddish coppery effulgence spinning to silver green at top.



**Figure 4.** *Xylocopa dissimilis* Lepelletire, 1841

Remarks: This species is reported first time from District Dir lower. Ninety-five specimens were collected from different localities. Previously this species described by Hussain *et al.*, (2010) from Skardu. Mariyam (2012) reported from Gilgit-Baltistan.

Distribution: From Sri Lanka (wijesekara, 2001), India, China, Philippine (Gupta, 2010), from Pakistan (Hussain *et al.*, 2010; Mariyam, 2012).

### 3.4 *Xylocopa pubescens* Spinola, 1838

Synonym: *Xylocopa aestuans* Gribodo, 1884.

Diagnostic Character: Body length: 27mm; Head larger than elongated length, clypeus evenly heavily punctate lacking indication of middle impunctate mark. The segment of flagella in antennae short, third segment almost similar- sided, from 2.2 - 2.4 times as elongated as its thickness at top and only a little elongated.

Remarks: New record for Dir Lower. During present study 89 specimens of this species were collected from all selected localities. Perversely reported from Punjab: Khewra, Faisalabaid, ChoaSadian Shah, Lahore, Rawalpindi, Shahappura, Wazirabad. **Sindh:** Karachi, Dadu, SkarduTandojam. Khyber Pakhtunkhwa: Peshawar and Tank while from Baluchistan: Makran and Pasni (Irshad, *et al.* 2014).



**Figure 5.** *Xylocopa pubescens* Spinola, 1838

Distribution: It is commonly distributed species in India, Iran, Nepal, Burma, West Bengal, Afghanistan, Israel, Syria, Algeria, Egypt, Ethiopia, Turkey, Senegal, Sudan, Kenya, Morocco, Mozambique, and Tanzania (Warncke, 1982; Ascher and Pickering, 2012).

Calculation was done for the relative percentage abundance of reported species in the current study. The highest calculated relative percentage abundance (29.60 %) was observed for *Xylocopa dissimilis* followed by *Xylocopa pubescens* (27.72%) and *Xylocopa collaris* (23.1%). The lowest calculated relative percentage abundance 19.62% was observed for *Xylocopa acutipennis*. In current survey *X. dissimilis* was the most abundant species in all localities whereas *X. acutipennis* species was in lowest percentage.

**Table 1. Latitude and longitude of selected localities of Dir Lower**

Locality	Latitude 'N'	Longitude 'E'	Altitude (from sea) 'M'
Chakdara (L1)	34.65°	72.03°	710
Talash (L2)	34.73°	71.90°	851
Timergara (L3)	34.82°	71.84°	823
Jandol (L4)	34.48°	71.46°	1057
Khal (L5)	34.53	71.58	869
Darmal (L6)	34.54	71.51	1010
Lal Qilla (L7)	34.57	72.48	1083

**Table 2. Month wise survey detail from March to September 2015 for seven selected localities.**

Locality	March	April	June	July	August	September
Chakdara	19-03-2015	19-04-2015	19-06-2015	19-07-2015	19-08-2015	19-09-2015
Talash	18-03-2015	18-04-2015	18-06-2015	18-07-2015	18-08-2015	18-09-2015
Timergara	17-03-2015	17-04-2015	17-06-2015	17-07-2015	17-08-2015	17-09-2015
Jandol	03-03-2015	03-04-2015	03-06-2015	03-07-2015	03-08-2015	03-09-2015
Khal	05-03-2015	05-04-2015	05-06-2015	05-07-2015	05-08-2015	05-09-2015
Darmal	15-03-2015	15-04-2015	15-06-2015	15-07-2015	15-08-2015	15-09-2015
LalQilla	21-03-2015	21-04-2015	21-06-2015	21-07-2015	21-08-2015	21-09-2015

Other 2 species were also collected from all seven localities. Maximum percentage of 18.1% was observed at Jandol, followed by Timergara with a percentage of 15.57, Talash, have a percentage of 15.27, Darmal with a percentage of 14.33, Chakdara with a percentage of 13.70, while Lalqilla, 11.83%, and Khal has the lowest percentage of 11.21. shown in, (Table 3).

Collection of 321 specimens of Carpenter bees was done during March 2015 to September 2015 which was from family Apidae order Hymenoptera and genus *Xylocopa*. The identification up to species level was done yielding four species explored for the first time from Districts Dir Lower.

The comparison of all the species from the study area was done with previously reported species collected from other various localities of Pakistan for reconfirmation which were housed in National Insect Museum at National Agricultural Research Center, Islamabad. In order Hymenoptera, family Apidae, genus *Xylocopa* was represented by four species from Dir Lower area i.e. *X. collaris*, *X. acutipennis*, *X. dissimilis*, and *X. pubescens*. Huda (1975) first time reported seven species of genus *Xylocopa* from different areas of Pakistan. The species *X. collaris* was first time reported from Pakistan Huda (1975) while Mariyam (2012) reported from

Gilgit-Baltistan. During current study this species was reported from all seven localities of District Dir Lower. The species of *X. acutipennis*, was also collected from all selected localities of Dir Lower.

This species was also reported by (Mariyam (2012) Hunza-Nagar Chalt. The species of *X. dissimilis*, was first time recorded from District Skardu by, Hussain *et al.* (2012), and Mariyam (2012) reported from Gilgit-Baltistan. During the current study this species was collected from all seven localities namely Chakdara, Talash, Timergara, Khal, Jandol, Darmal Lower, and Medain Lalqilla. The species of *Xylocopa pubescens* spinola was first time reported from Pakistan (Dhuyo *et al.*, 1986), while Ali and Ali (1989) reported *Xylocopa pubescens* from Karachi and Rehman *et al.* (1990) reported the *Xylocopa pubescens*. The graphical demonstration of species which has been collected during the present study from selected localities of Dir Lower. The four species which has been collected from Chakdara (L1), Talash (L2), Timergara (L3), Khal (L4), Jandol (L5), Darmal Lower (L6), and Lalqilla (L7), Dir Lower. Among all recorded species *Xylocopa collaris*, which has been recorded from 7 localities of Dir Lower, However the percentage *Xylocopa collaris*, from L1, 14.87%, L2, 13.52%, L3, 21.62%, L4, 17.57%, L5, 12.17%, L6, 10.82%, and L7, 9.46% (Table 3).

**Table 3. Distributions of the *Xylocopa* species in different localities of District Dir Lower**

Species	Chakdara	Talash	Timergara	Jandol	Khal	Darmal	Lalqilla	Total	Relative%
<i>X. collaris</i>	11	10	16	13	9	8	7	74	23.1
<i>X. acutipennis</i>	8	12	7	10	11	9	6	63	19.62
<i>X. dissimilis</i>	10	13	18	19	6	17	12	95	29.60
<i>X. pubescens</i>	15	14	9	16	10	12	13	89	27.72
Total	44	49	50	58	36	46	38	321	100
Relative%	13.70	15.26	15.57	18.1	11.21	14.33	11.83	100	

All recorded species *Xylocopa acutipennis*, which has been recorded from 7 localities of Dir Lower, However the percentage *Xylocopa acutipennis*, from L1, 12.70%, L2, 19.04%, L3, 11.11%, L4, 15.88%, L5, 17.47%, L6, 14.28%, and L7, 9.52% as shown in Table 3. The percentage *Xylocopa dissimilis*, from L1, 10.52%, L2, 13.68%, L3, 18.94%, L4, 20%, L5, 6.31%, L6, 17.90%, and L7, 12.63% as shown in Table 3. The percentage *Xylocopa*

*pubescens*, from L1, 16.85%, L2, 15.73%, L3, 10.11%, L4, 17.98%, L5, 11.23%, L6, 13.48%, and L7, 14.6% as shown in Table 3

**Table 4. Estimated values species diversity index, richness and evenness of *xylocopa* species from different localities of District Dir Lower.**

Localities	Chakdara	Talash	Timergara	Khal	Darmal	Lalqilla	Jandol
Taxa_S	4	4	4	4	4	4	4
Individuals	44	49	50	36	46	38	58
Dominance_D	0.2634	0.2536	0.284	0.2608	0.2732	0.2756	0.2634
Simpson_1-D	0.7366	0.7464	0.716	0.7392	0.7268	0.7244	0.7366
Shannon_H	1.36	1.379	1.316	1.363	1.342	1.334	1.359
Evenness_e^H/S	0.9742	0.9926	0.9324	0.9773	0.9565	0.9491	0.9732
Margalef	0.7928	0.7708	0.7669	0.8372	0.7836	0.8247	0.7388
Equitability_J	0.9811	0.9946	0.9495	0.9834	0.9679	0.9623	0.9804
Chao-1	4	4	4	4	4	4	4

#### 4. CONCLUSION:

List of the identified species may be increased if extensive surveys will be conducted. However, this work provide us species details and somehow their importance in agriculture. It is recommended that further detail studies on ecology which is lacking from Pakistan should be given priorities not only for *xylocopa* but also on other bee pollinators. Such types of studies will be helpful to increase our knowledge and also helpful to enhanced crop production.

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