

Research Article

Preliminary Study on Impact of Altitudinal Clines Over Distribution of Aphidoidea Complex in Kaghan Valley, Khyber Pakhtunkhwa, Pakistan

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Abstract | Diversity of Aphidoidea in Kaghan valley of Khyber Pakhtunkhwa province, Pakistan is studied for the first time since inception of the country in 1947. Aphids were recorded from cultivated as well as wild plants grown at variable altitudes of the valley. A total of 398 individuals were collected from 26 host plants of which, 23 species and 13 genera are reported for the first time for this valley. Within the recorded fauna, *Macrosiphum euphorbiae* was found to be abundant with 103 individuals followed by *Myzus persicae* and *Aphis craccivora*, respectively. Impact of altitudinal variations over the distribution of recorded fauna was also studied and discussed in detail.

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Introduction

Aphids are soft-bodied insects that belong to family Aphididae of order Hemiptera and commonly known as phloem feeders. They normally range in size from 0.7- 7.0 mm and can be green, brown, black, red and yellowish depending upon species as well as host type (Jalalizand, *et al.*, 2012). They are cosmopolitan and are more commonly found in temperate regions (Maryam, *et al.*, 2019). High fecundity rate, smaller

size, recurring parthenogenetic reproduction, short development time, varied host-plant partialities and close by association with host plants makes aphids an economically important pest worldwide (Akyürek *et al.*, 2019). In addition to their notoriety as enemies of plant farmers, they are exceptionally interesting scientifically, especially at the genetic and molecular levels (Loxadle *et al.*, 2020).

Aphids show an inverse relationship with elevation,

in general. The difference in species richness patterns alongside elevation gradient depends on the mountainous region's elevation incline, temperature, vegetation and taxa. Many niches suitable for adaptation of aphids are related to microclimates provided by the altitudinal gradients. Though a lot of work has been done on the diversity and host plant relationship of aphids, yet little work has been reported on their valuation along with height (Amin *et al.*, 2021). The altitudinal variations some time have significant effect over insects' body size as well as distribution. Gaston and Chown (1999) discussed in detail the phenomenon of increased insect population with the increase in altitude, however Mousseau (1997) emphasized decrease in size of insects with increase in altitude. According to Hardy *et al.*, (2001) there is a significant effect of altitude on the richness of species and it declines even with a 100-meter increase in altitude. These works supports the phenomenon that distribution of insect fauna is affected by the altitudinal gradients. This is why, the current study was planned to be conducted in a valley that has never been explored for aphid fauna but reflect altitudinal clines.

Materials and Methods

For collection of aphids, random sampling was done during the months of March to September of the year 2020 (Figure 1). The coordinates and altitudes of each surveyed locality (13 in total) were taken using Garmin GPS (10.0) and the localities were then grouped into six altitudinal zones to compare the taxa' distributional trends.

Both cultivated as well as wild flora were visited to record samples. Sampling was undertaken through hand picking using camel hair brush and beating methods. Collected samples were kept in glass vials containing 70% ethanol. Data for ecology, geography along with the physical factors was recorded for each positive site. Identification of the recorded samples was undertaken at National Insect Museum (NARC) of Pakistan under Labomed CX-R4 Slide Microscope and Olympus SZX7 Stereoscope. Identified specimens were deposited at Hazara University's Zoology department, Mansehra whereas their representatives were kept at National Insect Museum, NIM, Islamabad for addition to national repository for future study and as reference material.

Results and Discussion

Present study was conducted in Kaghan valley of Khyber Pakhtunkhwa province located within 34° 54' 27" North, 73° 38' 56" East and at altitude of 2039 m (Safdar *et al.*, 2014). A wide variety of flora and fauna including trees, perennials, vegetables, shrubs and herbs are grown here. Though, the valley gives a great opportunity to study the biodiversity, yet no work on inhabiting Aphidoidea complex has ever been conducted here since 1947 i.e., the inception of Pakistan. Present study was undertaken to assess the diversity and distribution of aphid fauna along with variable altitudinal gradients as the baseline work in Kaghan valley. During the present work, as a whole 398 individuals of aphids were collected. A total of 23 species under 13 genera were recorded from an elevation of 1310-2509m (Figure 2, Table 1).

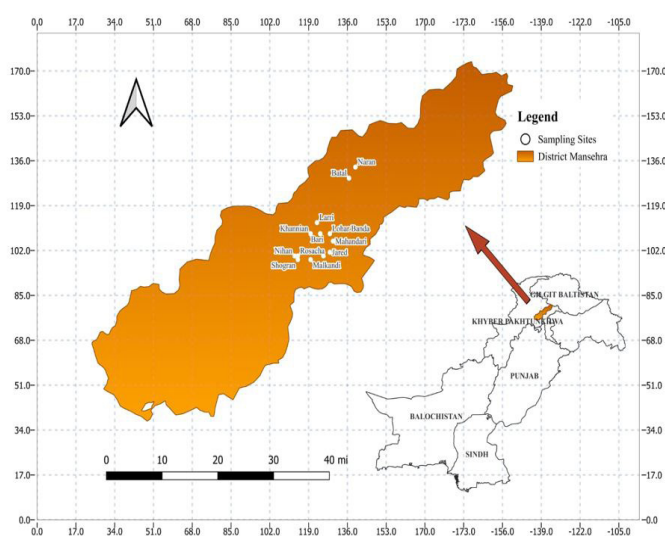


Figure 1: Map of surveyed localities in Kaghan Valley, Pakistan.

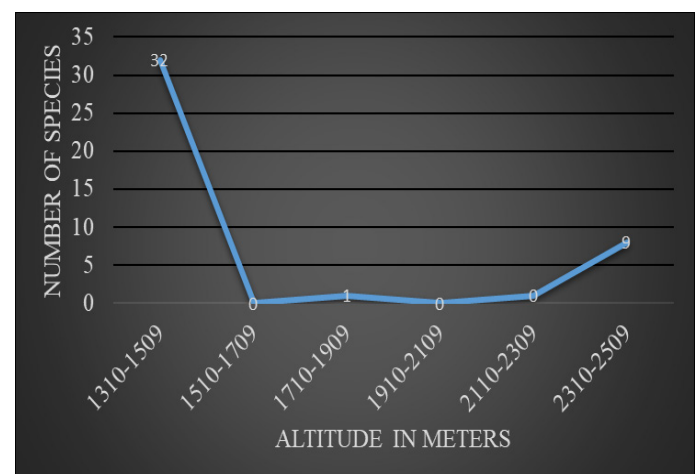


Figure 2: Distributional trend of species along different altitudinal gradients in the study area.

Table 1: Species wise distribution of *Aphidoidea* at different altitudinal zones.

Genera	Altitude (in Meters)					
	Zone-I 1310-1509	Zone-II 1510-1709	Zone-III 1710-1909	Zone-IV 1910-2109	Zone-V 2110-2309	Zone-VI 2310-2509
			Species			
<i>Acyrtosiphum</i>	2	-	1	-	-	-
<i>Aphis</i>	5	-	-	-	-	2
<i>Aulacorthum</i>	1	-	-	-	-	-
<i>Cavariella</i>	2	-	-	-	-	-
<i>Hyadaphis</i>	1	-	-	-	-	-
<i>Hyperomyzus</i>	1	-	-	-	-	-
<i>Lipaphis</i>	1	-	-	-	-	-
<i>Macrosiphum</i>	3	-	-	-	-	1
<i>Melanaphis</i>	1	-	-	-	-	-
<i>Myzus</i>	2	-	-	-	-	1
<i>Megoura</i>	-	-	-	-	-	1
<i>Smynthodes</i>	-	-	-	-	-	1
<i>Uroleucon</i>	2	-	-	-	-	-

Material examined

Aphids (*Aphidoidea*) collected from Kaghan Valley Family: *Aphididae*

Genus Aphis, Linnaeus 1758

***Aphis craccivora* (Koch, 1854):** Rosacha: 1-IV-2020, apterae, Alt 1311, Lat 34°6', Long 73°4'; Nihan: 13-V-2020, apterae, Alt 1273, Lat 34°6', Long 73°4', host plants: *Vicia faba* (Broad beans) and *Solanum betaceum* (Tree Tomato).

***Aphis citricola* (van der Goot, 1912):** Batal: 23-IX-2020, apterae, Alt 2414, Lat 34°8', Long 73°6', host plant: *Chenopodium album* (Wild Spinach).

***Aphis fabae* (Scopoli, 1763):** Nihan: 13-V-2020, apterae, Alt 1273, Lat 34°6', Long 73°4', host plant: *Solanum betaceum* (Tree Tomato).

***Aphis gossypii* (Glover, 1877):** Batal: 23-IX-2020, apterae, Alt 2414, Lat 34°8', Long 73°6'; Rosacha: 10-VII-2020, apterae, Alt 1311, Lat 34°6', Long 73°4'; host plant: *Chenopodium album* (Wild Spinach), *Vigna radiate* (Mung Beans), *Abelmoschus esculentus* (Lady Finger), *Mentha spicata* (Mint).

***Aphis nasturtii* (Kaltenbach, 1843):** Rosacha: 15-III-2020, apterae, Alt 1311, Lat 34°6', Long 73°4', host plant: *Malva neglecta* (Sonchal).

Genus Acyrthosiphon, Mordvilko 1914

***Acyrtosiphon gossypii* (Mordvilko, 1914):** Rosacha: 15-III-2020, apterae, Alt 1311, Lat 34°6', Long 73°4', host plant: *Malva neglecta* (Sonchal).

***Acyrtosiphon bidenticola* (Smith, 1960):** Rosacha: 28-V-2020, apterae, Alt 1311, Lat 34°6', Long 73°4', host plant: *Parthenium hysterophorus* (Whote top Weed).

***Acyrtosiphon rubi* (Narzikulov, 1957):** Khannian: 23-IX-2020, apterae, Alt 1757, Lat 34°7', Long 73°5', host plant: *Rumex nepalensis* (Nepal Dock).

Genus Aulacorthum, Mordvilko 1843

***Aulacorthum solani* (Kaltenbach, 1843):** Rosacha: 14-III-2020, apterae, Alt 1311, Lat 34°6', Long 73°4', host plant: *Conzuya Canadensis* (Horse Weed), *Stellaria media* (Chickweed).

Genus Cavariella, Del Guercio 1911

***Cavariella aegopodii* (Scopoli, 1763):** Malkandi: 23-IV-2020, apterae, Alt 1391, Lat 34°6', Long 73°5'; Rosacha: 14-III-2020, apterae, Alt 1311, Lat 34°6', Long 73°4', host plant: *Anethum graveolens* (Fresh Green Dill), *Foeniculum vulgare* (Fennel).

Genus Hyperomyzus, Börner 1933

***Hyperomyzus lactucae* (Linnaeus, 1758):** Rosacha: 17-III-2020, apterae, Alt 1311, Lat 34°6', Long 73°4'; Nihan: 13-V-2020, apterae, Alt 1273, Lat 34°6', Long

73°4', host plant: *Sonchus asper* (Prickly Sow Thistle).

Genus Hyadaphis Kirkaldy 1904

***Hyadaphis coriandri* (Das, 1918):** Rosacha: 13-III-2020, apterae, Alt 1311, Lat 34°6', Long 73°4', host plant: *Anethum graveolens* (Fresh Green Dill).

Genus Lipaphis, Mordvilko, 1928

***Lipaphis erysimi* (Kaltenbach, 1843):** Rosacha: 1-IV-2020, apterae, Alt 1311, Lat 34°6', Long 73°4'; Batal: 23-IX-2020, apterae, Alt 2414, Lat 34°8', Long 73°6', host plant: *Neslia paniculata* (Ball Mustard), *Brassica rapa* (Turnip).

Genus Macrosiphum, Passerini 1860

***Macrosiphum euphorbiae* (Thomas, 1878):** Rosacha: 13-III-2020, 14-III-2020, 17-III-2020, 1-IV-2020, 28-V-2020, apterae, Alt 1311, Lat 34°6', Long 73°4'; Batal: 23-IX-2020, apterae, Alt 2414, Lat 34°8', Long 73°6', host plant: *Rosa indica* (Rose), *Solanum tuberosum* (Potato), *Parthenium hysterophorus* (White Top Weed), *Stellaria media* (Chickweed), *Rumex acetosa* (Wild Sorrel), *Spinacia oleracea* (Zingi Spinich (Kashmiri Saag), *Conzya bonariensis* (Fleabane).

***Macrosiphum pallidum* (Oestlund, 1887):** Nihan: 13-V-2020, apterae, Alt 1273, Lat 34°6', Long 73°4', host plant: *Rosa indica* (Rose).

***Macrosiphum rosae* (Linnaeus, 1758):** Nihan: 13-V-2020, apterae, Alt 1273, Lat 34°6', Long 73°4', host plant: *Rosa indica* (Rose).

Genus Megoura, Buckton, 1876

***Megoura dooarsis* (Gosh and Raychaudhuri, 1969):** Shogran: 27-VIII-2020, apterae, Alt 1932, Lat 34°6', Long 73°4', host plant: *Indigofera tinctoria* (Indigofera).

Genus Melanaphis, Goot 1917

***Melanaphis sacchari* (Zehntner, 1897):** Rosacha: 23-IX-2020, apterae, Alt 1311, Lat 34°6', Long 73°4', host plant: *Zea mays* (Maize).

Genus Myzus, Passerini 1860

***Myzus persicae* (Sultzer, 1776):** Rosacha: 13-III-2020, 1-IV-2020, 10-VII-2020, apterae, Alt 1311, Lat 34°6', Long 73°4'; Malkandi: 23-IV-2020, apterae, Alt 1391, Lat 34°6', Long 73°5'; Batal: 23-IX-2020, apterae, Alt 2414, Lat 34°8', Long 73°6', host plant: *Anethum graveolens* (Fresh Green Dill), *Capsicum*

anum (Green Chilli), *Brassica oleracea* (Cabbage), *Torilis japonica* (Erect Hedge Parsley).

Genus Smynthuroides, Westwood 1849

***Smynthuroides betae* (Westwood, 1849):** Batal: 23-IX-2020, apterae, Alt 2414, Lat 34°8', Long 73°6', host plant: *Brassica rapa* (Turnip).

Genus Uroleucon, Mordvilko

***Uroleucon ambrosiae* (Thomas, 1878):** Rosacha: 15-III-2020, apterae, Alt 1311, Lat 34°6', Long 73°4', host plant: *Malva neglecta* (Sonchal).

***Uroleucon (Lambersius) erigeronense* (Thomas, 1878):** Rosacha: 14-III-2020, apterae, Alt 1311, Lat 34°6', Long 73°4', host plant: *Conzya Canadensis* (Horseweed).

In the study, it was observed that highest number of species were found at lower altitudes. Among the identified genera, *Aphis* genus was observed dominant representing five species; *Aphis craccivora*, *Aphis citricola*, *Aphis fabae*, *Aphis gossypii* and *Aphis nasturtii*, respectively. It was noticed that altitudes showing more human activity came up with a higher number of species abundance that may be a possible effect of the fact that at these altitudes, in addition to wild flora, many vegetables and fruit orchards were available. It is a known phenomenon that at higher altitudes, low temperature prevails and tall wooden trees are more seen that obviously are harder to attack for aphids. However, no aphids were found at few locations that may be a result of the fact that frequent rainfall followed by hail storms were received here during the survey period.

According to (Amin et al., 2021) at higher elevations due to variable factors lower crops productivity results in decreased abundance and richness of aphids and therefore habitat along different elevational gradients has direct relationships with species diversity. As aphids are poikilothermic creatures, their biology is directly affected by the rise in temperature (Dampc et al., 2021). Temperature prevailing in the study area varies with height where the average mean lowest and extreme temperatures were 22°C and 40°C respectively. Here the coldest and snowfall months are November, December, January and February whereas in other months moderate temperature prevails (Awan et al., 2011).

Conclusions and Recommendations

The results shows rich biodiversity of the study area. Although aphid shows a decrease in number with increase in altitude. However, species richness was profusely evident at high altitude in the present day work. According to the findings, factors such as altitude, climate and floral diversity interact to form aphid diversity as it varies with elevation. The findings would act as a benchmark for future research as no work has yet reported on aphid fauna from the study area.

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Novelty Statement

This study brought forward first record of aphid fauna inhabiting Kaghan valley of Mansehra district, KP, since inception of Pakistan i.e. 1947.

Author's Contribution

Marriyam Batool: Conducted field survey, recorded samples and taxonomic identification of all samples.

Ahmed Zia: Did taxonomic identification and co-supervision of whole study.

Shabir Ahmed: Supervised whole study.

Imran Bodlah: Did confirmation of samples.

Waheed Ali Panhwar and Muhammad Ashfaq: Generated funds.

Falak Naz and Muhammad Muneer: Paper making and proof reading.

Conflict of interest

The authors have declared no conflict of interest.

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