Study of environmental variables in the moist-temperate environs of western Himalayan mountain range, Pakistan.

Chaudhry M. Shafique [1], Sohail Barkati[2] and Anser Rizvi[2]

1. Zoological Survey Department, Government of Pakistan, Islamabad
2. Department of Zoology, University of Karachi

Abstract

In order to study the effect of environmental variables on the distribution of flora and fauna in a moist-temperate mountain environment; the temperature, humidity and rain-fall (precipitation) were recorded from February 1997 to February 2000 at two distinctive places at the height of 2130m and 2500m altitude from the sea level at Ayubia National Park located in the Galliat Forest Division, Abbotabad district, NWFP – Province. The present study is of its own kind which represents variable features of the environmental variables at the same time at two distinct places located distantly (approximately 7 km straight through the hill-ridges). To record the environs data, one of them the higher station (2500m) located north-west at the steep hill-range, whereas the lower one located in the south-east on dilating and gentle slopes in the opposite direction.

Keywords: temperature, humidity, moisture, altitude - 2130m, 2500, Ayubia National Park.

Introduction:

The present study was carried out in a protected area called Ayubia National Park at the turn of the 20th (last) century. The Park is situated in the Galliat Forest Division of Abbotabad district, province NWFP (Northwest Frontier Province), Pakistan between 34°-1′ to 34°-3.8′ N latitude and 73° 22.8′ to 73°-27.1′ E longitude. Originally it spreads over an area of 1684 hectares which was notified under Section-18 of NWFP-Wildlife Act 1975, declared as National Park in 1984. Exercising on the initial area, the Government of NWFP, and the Provincial Departments of Fisheries, Forests and Wildlife agreed to extend the original area to over an area of 3312 hectares in 1998.

The present investigation studied the environmental variables at an altitude of 2130m and 2500m where daily temperature, precipitation (rainfall) humidity during morning (0800 hrs.) and evening (1700 hrs.) were noted; the average daily precipitation was also observed during the study period. The work started in March 1997 and lasted for 3 consecutive years, ending in February 2000.

Materials and Methods:

Precipitation (Rainfall): Any open container that has a consistent cross section through the cane may be used as a rain gauge. Various types of sophisticated rain gauges are used to measure small and large amounts of rain fall - Pakistan Meteorology Department (PMD). A rain gauge having a diameter of about 5 inches at the top was used to collect the dropping rain (locally manufactured in the workshop of Pakistan Meteorology Department (PMD) in the container. Once the drops are caught, a funnel passes the water through a narrow opening into a cylindrical measuring tube that had a cross-sectional diameter one-tenth of the receiver (standard), readings were taken to the nearest 0.1mm as given on the scale of measuring cylinder. The instrument is designed to avoid the effect of evaporation. Precautions were taken to install the instrument at a suitable place in the field to minimize the wind and turbulence effect. For this purpose a wind screen was placed above the instrument so that the rain falls into the gauge and not carried across it, instead of collecting a representative quantity of rain.

Humidity (Moisture): The term is used generally to describe the amount of water vapours in the air. Presently many kinds of devices and methods are used to determine the amount of vapours (humidity) and to quantitatively express humidity which is denoted as absolute humidity, specific humidity and relative humidity (PMD).

In the present study, the moisture content of air i.e. the relative humidity was determined twice a day at 800 and 1700 hrs. The measurements were taken with the help of two identical thermometers fixed in the “Enclosure Screen” which is locally made in the workshop of PMD - Karachi, one was with wet bulb and the other

with a dry bulb. The thermometer with wet bulb, has a thin muslin strip wrapped around the bulb at the base and its other end is dipped into the water (in a fixed water bottle below the wet bulb). A continuous current of air is passed over the strip of cloth, as a result of which water evaporates from the strip and the temperature of the wet bulb lowers the thermometer reading. The amount of cooling is directly proportional to dryness of the air; the drier the air, the more is the cooling. Therefore, the larger the difference between the readings of the two thermometers, the lower is the relative humidity and vice versa. If the moisture increases and the air is saturated, no evaporation will occur. In this case, the two thermometers will have identical readings and the relative humidity in the air will be 100 percent.

Tables (standard) were devised for calculating the relative humidity. Readings of wet and dry bulb thermometers were used to determine the relative humidity with the help of standard table.

Temperature: Both maximum and minimum temperatures were obtained. The thermometers are designated as the maximum and minimum thermometers (Casella, UK). Mercury is used in case of "maximum thermometer". A narrow passage called constriction is present in the bore of the glass tube just above the bulb. As the temperature rises, the mercury expands and forced through the narrow opening whereas when the temperature falls the constriction prevents the return of mercury. As a result, the top of the mercury column remains at the highest point. The instrument is reset by shaking after taking the reading. Once the thermometer is set, it indicates the current air temperature.

Conversely, the thermometer used to record minimum temperature contains a liquid of low density such as alcohol. Temperature measurements were taken accurate to 0.1mm. The accurate determination of air temperature depends not only on the care with which the thermometer is constructed but also on its proper exposure. To obtain a meaningful temperature reading, thermometers must be shaded from direct sunlight and be shielded from radiating surfaces such as buildings and the ground. Radiation should be prevented from reaching the instruments because thermometers are much more efficient absorbers than the air. It is the air temperature that is desired not the temperature of the thermometer after absorbing radiation. In addition, good ventilation is essential. Thermometers sheltered from freely moving air can not indicate the true air temperature. In order to take precise and correct readings free of various environmental factors, thermometers were hanged in the "Enclosure Screen". The Enclosure Screen is a white box having louvered sides permitting the free movement of air through it while shielding the instruments from sunshine and precipitation. The screen was placed over a grassy ground and was mounted on a stand about 2 meters above the ground.

Observations and Discussion:

Since the present study site is located along a main ridge running North-South at an altitude ranging from 1600 – 3000 meters from the sea level, as such it can be placed in moist-temperate climate (Champion and Seth, 1966) which is influenced by heavy monsoon rainfall (Roberts, 1997). The summers of the Park are quite moderate but winters are quite covered with heavy snowfall.

Temperature:

During the study a little variation in temperature was observed at two different study stations located at 2130m and 2500m. The minimum lowest temperature occurred in the months of January and February (Figures 1 and 2) at both the altitudes (stations) where average minimum temperature was below the freezing point and average maximum below 11˚C. While in May, June and July average minimum temperatures calculated above 13 ˚C and average maximum temperature calculated below 27 ˚C devised from the standard tables which contained the daily entries of minimum and maximum temperatures at both the stations at 2130m and 2500m altitude. The graphs (Fig. 1 and 2) plotted are showing values of temperature monthly averaged minimum and maximum of the two dissimilar altitudes abstracted from the daily recorded values. Daily recorded values typically may vary from the monthly calculates averaged.

Variation in average monthly temperatures as shown in the figures 1 and 2 clearly indicates a momentous rise from the month of February to June during all the years and then a gradual fall (return) to the month of January.

Due to differences in the temperature at two different altitudes, the forest habitat also predominantly differed. At 2500m fairly mixed forests of coniferous dominates the Himalayan Silver Fir, *Abies pindrow* Spruce, *Picea smithiana*

Blue Pine, *Pinus wallichiana* yew, *Taxus wallichiana* and broad-leave and evergreen Holly Oak, *Quercus floribunda* Oak, *Quercus glauca* Himalayan Bird Cherry, *Prunus Cornuta*

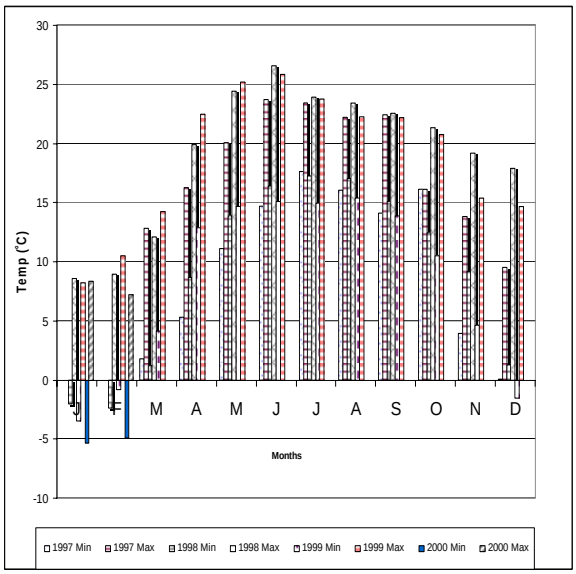

Fig 1: Seasonal variation in values of monthly average temperature (maximum and minimum ˚C) at 2130m altitude (station -1) Ayubia National Park during the study period from 1997-2000.

Himalayan Popler, *Populus cilliata* Large-leaved Elm, *Ulmus wallichiana* Maple, *Acer caesium* and Horse Chestnut *Aesculus indica.* At 2130m altitude where only Blue Pine *Pinus wallichiana* and Deodar *Cedrus deodara* sparcely spread, other species of broad leave also intersperse with bare patches, these include broad-leave as White Oak, *Quercus incana* Walnut, *Juglans regia* and a dominant layer of bushes in this range. This clearly indicates that temperature greatly influenced the wild life inhabitant at the different ranges of the area, and due to concentration of forests at high altitude, the condensation of wild life also occurred.

There is a wide variation in daily or monthly average (minimum and maximum) temperature at a given altitude during the same month. This variation is more marked during colder seasons i.e. from December to March. Variation gradually decreased during spring and warmer months of June, July and August. From September onwards this range of temperature begins dropping (decreasing) till February.

The same pattern of variation in average (minimum and maximum) temperature was also derived from the daily taken readings at higher altitude (2500m). A maximum variation of at least 11˚C represented during the cold months which decreased to 5 - 6 ˚C in warmer seasons.

The maximum difference between temperature of warmest month (e.g. June) and coldest months (e.g. January & February) was more than 20˚C at a given altitude.

It is well known that, animals of one sort or another can thrive high on mountains or at high altitudes and in the heart of equatorial continental deserts. Not only the average temperature but also its variability will be reflected by the particular animal. Those that live in cold places have a favourable range lower than that for animals from warmer zones.

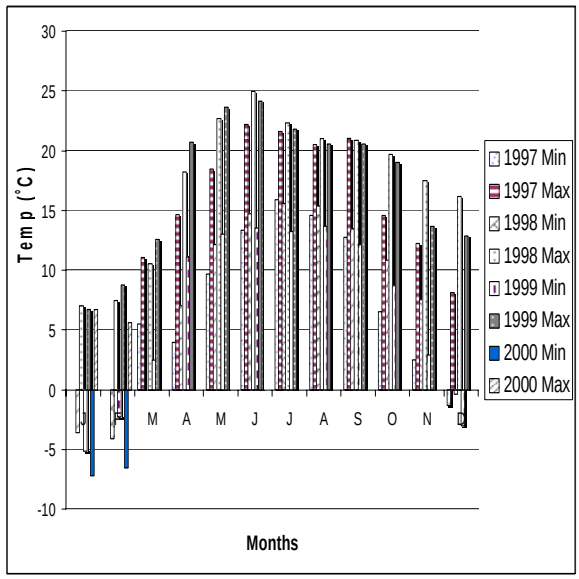

Fig 2: Seasonal variation in values of monthly average temperature (maximum and minimum ˚C) at 2500m altitude (station – 2) at Ayubia National Park during the study period from 1997-2000.

If an animal is introduced (exposed) to a temperature higher or lower than its normal range, it may either could not survive or if continue to live its growth and ability to reproduce will badly suffer.

Moisture (Humidity): The present study may be regarded as the one which has taken observations regarding humidity, temperature, precipitation etc. at Ayubia National Park. Daily

two readings were noted, one in the morning at 0800 hrs. and the other in the evening at 1700 hrs. The observations were made at two different altitudes; at 2130m altitude (Figures 3 and 5) and 2500m altitude (Figures 5 & 6).

The average humidity markedly increased during the heavy rainy seasons (monsoon) at both the altitudes. In general the humidity increased during the evening at both the altitudes while it rarely increased in the morning as compared to the evening. The values of humidity may differ ranging from 6 to 17% the same day in the morning and evening and with the increase or decrease in the altitude. While comparing the humidity in the same month from 1997 to 2000,

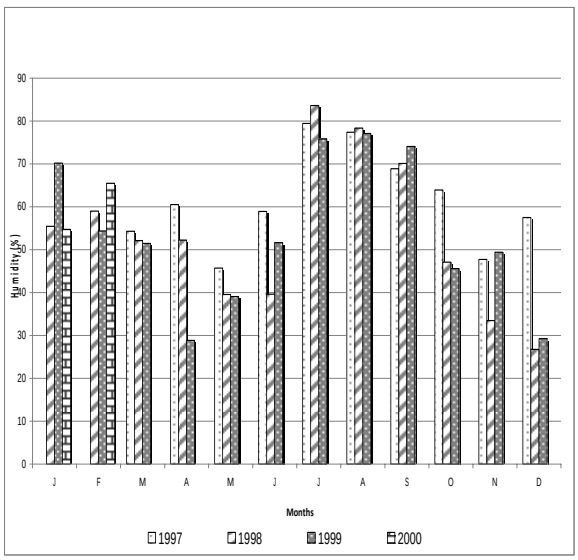

Fig 3: Seasonal changes in values of monthly average humidity (%) (station-1) at 2130m altitude of Auybia National Park during the study period from 1997-2000 based on observations taken daily at 0800 hours.

it was observed that during a given period of the year the relative humidity was almost constant with the exception of a very minor variation which may have a negligible effect as whole. The same observation is made at the higher altitude starting from March to February.

A gradual decrease in values of humidity was recorded from January to June and thence a sharp increase in July occurred reaching to as high as 93.32% in the evening and 88.9% in the morning at 2500m altitude in 1998. This was the maximum average humidity noted during the three years of study. A gradual and continue decline in the values of average humidity was seen commencing from September to December. The minimum average humidity was noted in the month of December when the ground was covering snow everywhere. The only variation in this observation was recorded during the year 1997 when the average humidity recorded 57.52% in the morning at 2130m altitude and 69.52% in the evening as compared to the altitude of 2500m where it was markedly high as 63.68% in the morning and 74.58% in the evening.

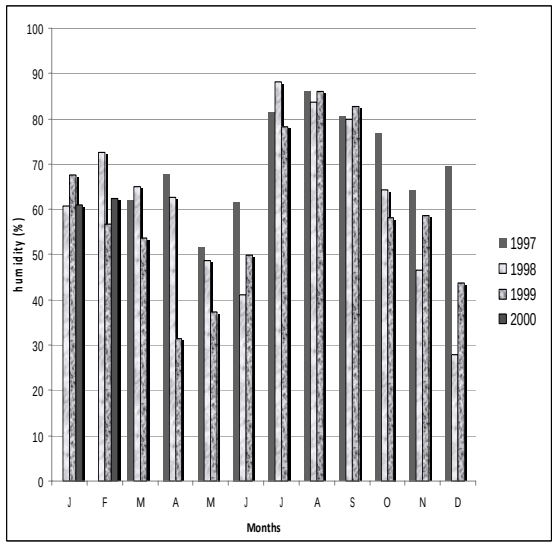

Fig 5: Seasonal changes in values of monthly average humidity (%) (station-1) at 2130m altitude of Auybia National Park during the study period from 1997-2000 based on observations taken daily at 1700 hours.

This was quite a humid atmosphere as compared to the readings noted during the following years in 1998 and 1999 when in the same month the humidity was low as 26.74% and 29.26% in the morning and 28.0% and 43.74% in the evening in respective years at 2130m altitude. At 2500m altitude these values were 32.42% and 34.61% in the morning and 34.13% and 49.48% in the evening respectively. Consequently, it was the lowest noted atmospheric moisture during the study period in these moist-temperate environs of western Himalayan range.

In short, the humidity was noted at its maximum during rainy periods and minimum during snowy seasons. Most animals need to keep the proportion of water in their bodies' within rather narrow limits. The tendency, which can be readily observed in some animals, to move in a definite direction along a gradient of humidity until they come to rest in some particular part if it may some times be recognized as an adaptation which helps the animals to avoid extremes of wetness or dryness and bring it forward the places where

moisture is more favourable. The distribution of many animals is restricted by extensive wetness or excessive dryness.

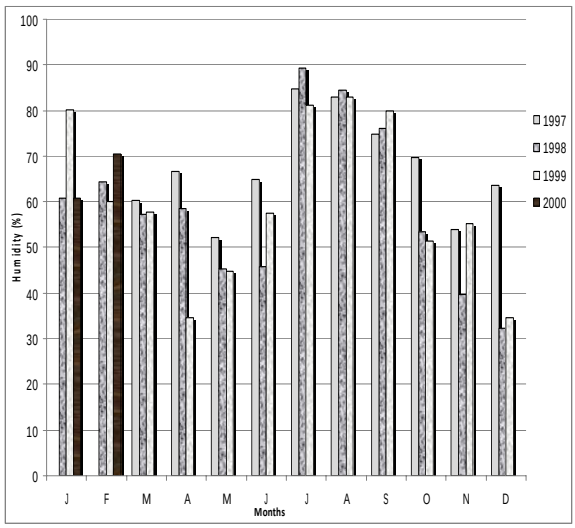

Fig 4: Seasonal changes in values of monthly average humidity (%) (station-2) at 25000m altitude of Auybia National Park during the study period from 1997-2000 based on observations taken daily at 0800 hours.

It was observed that animals may respond to moisture in a way which takes them to places where the moisture gives them a good chance to survive and multiply, for example yellow-throated marten, *Martes flavigula* Murree vole, *Hyperacrius wynnei* Himalayan giant flying squirrel, *Petaurista petaurista albiventer* Kashmir masked palm civet *Paguma larvata grayi* and Koklass Pheasant *Pucrasia macrolopha biddulphi* adapted and preferred high moisture conditions.

Some animals move away from moisture to dry places while others move from dryness to wetter places. But whether they are in dry or wet places, animals are still faced with the necessity for maintaining the water content of their bodies at a relatively constant level. When their water content falls below a certain minimal amount they dies, animals also die when their water content increase above "normal" as it may in very wet places.

Precipitation (Rainfall):

Except for the maximum snowy days which were observed during January and February, the rest of the calendar days were rainy days but there were very low rains in the months of November and December. It was very little (0.46mm) averagely daily in April, 1999 and too heavy (21.83 mm) in August, 1997 but being the porous soils they receive and absorb a good amount of precipitation. As a result many springs flow in the area, which provide another environment for a number of species which do not live far from the water (forktails, redstarts, dippers).

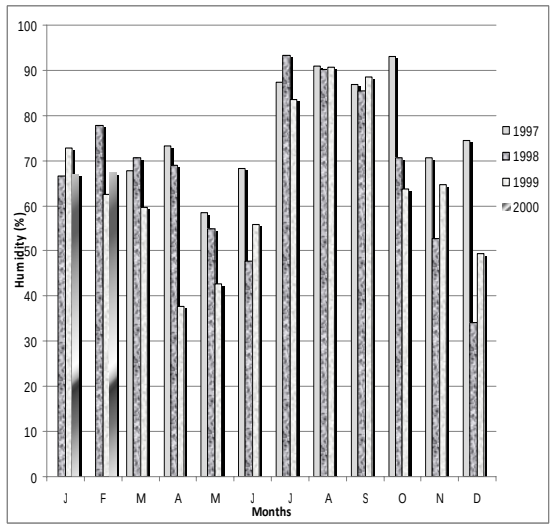

Fig 6: Seasonal changes in values of monthly average humidity (%) (station-2) at 2500m altitude of Auybia National Park during the study period from 1997-2000 based on observations taken daily at 1700 hours.

The area observed the dry season during the months of May and November. In the spring season there were good amounts of rains (February, March and April). After a short break, there was again a burst of heavy showers during the months of June, July and august. This burst was heavier than the episode that occurs in the early months of the year due to monsoonic influence. The same pattern was observed at both the altitudes at 2100m and 2500 m (Figure 7 and 8). The only difference is in the amount, the rains are higher at 2130m and lesser at 2500m altitude because heavier clouds seemed to occupy the lower height than 2500m altitude. Unusual split of rains was experienced in August 1997 when it was calculated as daily average above 20mm.

Light is mainly important in relation to behavior and as a stimulus for those mechanisms which regulate life cycles and keep them in step with seasons. In the present case, generally the weather is cloudy and the forest has a thick canopy which prevents penetration of direct light at the floor. The moist-temperate forest is a

paradise for those species which are low-light loving.

It is a common observation that many species of animals are not equally active throughout the day. Some are primarily nocturnal, others are diurnal and still others are referred to as "crepuscular" which are active mainly at dawn and dusk. A species may confine its activities of feeding, mating , and moving about from one place to another to there particular periods of the 24 hours light in the main environmental components which under go a daily fluctuations besides temperature and moisture.

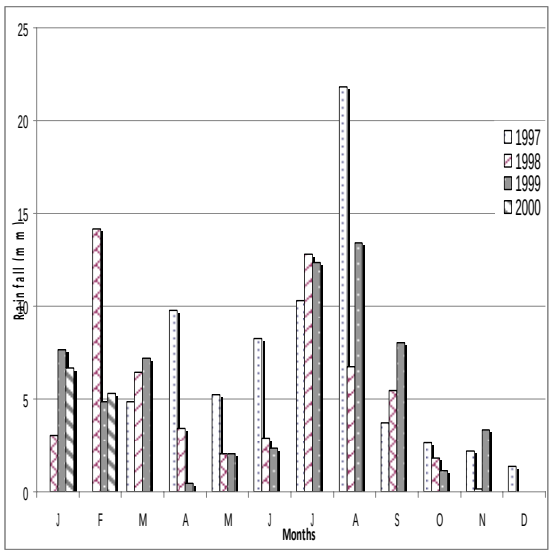

Fig 7: Seasonal variation in values of daily average rainfall (mm) (station - 1) at 2130m altitude of Ayubia National Park during the study period from 1997 – 2000.

Desert climates are characterized by annual rainfall of less than 250mm per annum with total highly unpredictable from year to year, and potential evaporation exceeding rainfall often by a considerable amount (Begon et. al. 1990). For instance Kirthar National Park (KNP) Sindh and Lal Sohanra National Park, Punjab (LNP) where soils are sandy, mostly sand dunes (LNP) gravally–hilly, unconsolidated and skeletal (KNP) and therefore under arid climate conditions with low rates of activity by organisms may have a prominent aspect. Humidity is very low and the winds are dry. The vegetation is likely dominated by open communities of small trees and woody shrubs, most of which are winter deciduous.

Thus in case of Kirthar National Park, mean annual rainfall is 150-200mm falling mostly in July and August. Temperatures are often extreme, exceeding 38 ˚C during most of the summer. Humidity is lowest in summer and highest in winter (Holloway and Khan, 1973). Thus the plants which grow characterized by the species of Saharo-Sindhian biogeographic region (Roberts, 1995) with the distribution of many species and genera stretching from north-eastern Africa though to sindh and the Punjab. Common species of flora in KNP comprise mostly as bushy woods and plants as *Acasia nilotica*, *A. Senegal*, *Euphorbia caducifolia*, *Salvadora oleoides*, *Prosopis cineraria* and *Tamarix spp*. The tropical thorn low mountain range provide the major refuge for a number of rare and endangered mammal species including Sindh ibex (wild goat), urial (wild sheep), chinkara gazelle, striped hyaena, leopard and desert wolf, pangolin and jungle cats (Roberts, 1997).

While the desert sand dune environment of Lal Sohanra national Park, Biogeographical Province – Thar Desert are arid subtropical continental characterized by low sporadic rainfall, hot summer winds low relative humidity, high evaporation rates, and mild winters. Vegetation is dominated by *Acasia nilotica*, *Suaeda-Salsola* scrub and riverine *Tamarix* forest, *salvadora oleoides*, *Prosopis spicigera* and *P. glandulosa*. Important fauna includes; black buck became extinct in the Cholistan desert, reintroduced in the large enclosures together with chinkara, nilgai, hog deer, and Indian rhinoceros (Roberts 1975, Sheikh 1982). Other mammals include wolf, jackal, Bengal fox, ratel, common otter, Indian mongoose, caracal, jungle cat and wild boar (masud 1980).

Alpine environs of Khunjerab National Park – Biogeographical Province Himalayan Highlands are represented by the range from 3200m to over 6000m, half of the park is above 4000m (Wegge 1988), distinguished feature is Khunjerab pass, and the gateway to China Karakoram highway is at 4934m altitude. Climatic conditions vary considerably with altitude. The minimum temperature winter (December and January is -12 ˚C). July and August are the hottest months with a mean temperature of 14 ˚C. Most precipitation falls during the winter in the form of snow. Vegetation is sparse as *Salix spp*., *Potentilla desertorum*, *Mertensia tibetica* and a few grasses and sedges dominated by *Saxifraga sibirica*, *Primula macrophylla*, *Sedum spp.* and *Polygonum spp*.

Only fifteen species of mammals are recoded inhabiting in Khunjerab national Park, others are likely to be present (Wegge, 1988). Most important mammals adapted in this harsh environment comprised of Marcopolo sheep, blue sheep, snow leopard and Himalayan marmot (Schaller, 1974), and birds include Himalayan snow cock and chukar are common (Rasool, 1981).

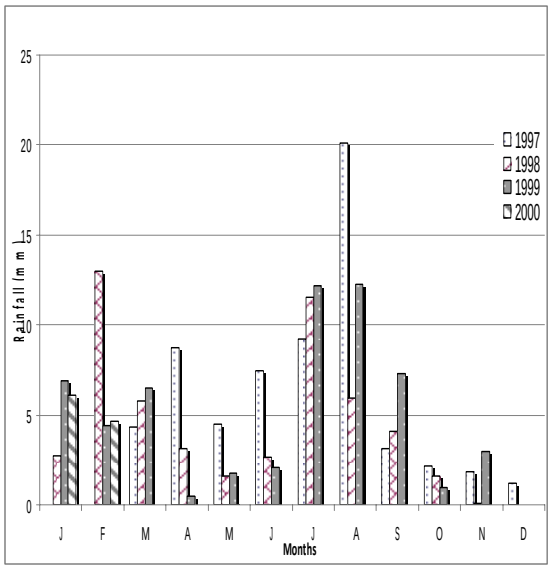

Fig 8: Seasonal variation in values of daily average rainfall (mm) (station - 2) at 2500m altitude of Ayubia National Park during the study period from 1997 – 2000.

Himalayan habitat in the alpine belt is characterized by glaciers and glacial deposits such as moraines, outwash etc. the vegetation is influenced by climatic factors such as rainfall, humidity, temperature and winter precipitation apart from topographical considerations like direction and precipitousness of slope. Exposed steep slopes in many situations don't permit the formation of matured soil as the mineral soil is easily washed down with the humus layer.

Rainfall in the alpine environment may be as low as 100 – 120mm while in the winter precipitation is heavy in the form of snow. At 4500m., it may exceed 10 meters. As regards temperature, it falls with the increasing altitude at the rate of 1 ˚C, for each 180 meter rise, daily fluctuation is possible (Meher and Puri, 1989)

In the present case, soils are porous, deep and fertile on the steep slopes, they have strong capacity of water holding and absorbing which in turn they grow a rich variety of plant life (421 species of flora), and support a large diversified fauna (22 mammal species, 154 species of birds and 8 species of herps). Rainfalls and atmospheric moisture content is high.

Thus the characteristics of the different environments are unique. Champion and Seth (1966) classified alpine vegetation as alpine forest and alpine scrub which grow above 3600 meters, and the temperate forests below 3600 meters and above 1700 meters altitude. Below this (1700 meters altitude), the range is occupied by the tropical and sub-tropical forests. It is for this reason that in each case the environment is greatly differentiated with the adaptation of fauna and flora. Life therefore is an active equilibrium between the living organisms and its surrounding, an equilibrium which can be maintained only if the environment suits the particular animal or plant which is then said to be adapted to that environment (Shafique, 2003).

References:

Begon, M., Harper, J. L. and Townsend, C. R. (1990) Ecology: Individuals, populations and communities. Blackwell, Oxford.

Champion, Sir H. T., Seth, S. K. and Khattak, G. M. (1966). 'Forest Types of Pakistan', *The Pakistan Forest Institute*, Peshawar.

Holloway, C. W. and Khan, M. K. (1985). Protected areas and local population in kirthar national park, Pakistan. In: Mcneely, J.A., thorsell, J. W. and Chalise, S. R. (Eds), People and Protected areas in the Hindu Kush-Himalaya. King Mahendra Trust for Nature conservation and International Centre for Integrated mountain Development, Kathmandu. pp. 59-61.

Masud, R. M. (1980). Master Plan for Lal Sohanra National Park, Bahawalpur – Pakistan 1980-1985. National Council for Conservation of wildlife (NCCW), in Pakistan, Islamabad. 55pp.

Meher, V. M. and Puri, G. S. (1989). Forest Ecology. Oxford and IBH Publishing Co. Pvt. Ltd. New delhi, Bombay, Calcutta. 304pp.

Rasool, G., (1990). Population status of wildlife in Khunjerab National Park (Pakistan). Tiger Paper, 17 (4): 25 – 28.

Roberts, T. J. (1975). Blackbucks return to Pakistan. In: Sitwell, N. (eds) The World Conservation Year Book. The Danbury Press, UK. pp 50-55.

Roberts, T. J. The Mammals of Pakistan. (1977). London: Ernest Benn, 1977. 525pp.

Roberts, T. J., nasir, Y. J. and rafique, R. A. (eds) (1995). Wildflowers of Pakistan. Oxford University press Karachi.

Schaller, G. B. (1974). The Marcopolo Sheep in Pakistan. New York Zoological Society, New York.

Schaller, G. B. (1976B). Mountain Mammals in Pakistan, Oryx. Journal of the Fauna Preservation Society. Vol. 13 (4), pp. 351-356.

Shafique, C. M. (2003). Some Aspects of Bio-Ecology of Ayubia National Park, District Abbotabad, NWFP. Ph.D. Thesis, 438pp.

Sheikh, M. H. (1982). Lal Sohanra National Park, Bahawalpur. World wildlife Fund – Pakistan. Newsletter 4-6: 4-8.

Wegge, P. (1988). Assessment of Khunjerab National Park and Environs, Pakistan. Unpublished report, IUCN, Gland, Switzerland. 25 pp.