

UNDERSTANDING THE ECOLOGICAL LINKAGES OF *ECOSYSTEMS* TO CONSERVE WILDLIFE

Z. B. Mirza

Islamabad, Pakistan

Corresponding Author email: zbmirza1936@gmail.com

ABSTRACT

The dynamic process of life involves interaction between the abiotic and biotic components and amongst the biotic components. It is called an ecosystems, in which biomass is produced and energy flows. The ecosystems run on the basis of interdependence. The interdependence is a complex phenomenon involving several biotic and abiotic components and the processes. More simply, the species are linked with each other, among each other and with their habitats.

INTRODUCTION

Wildlife is generally considered as those species which are of some interest to man by way of hunting or their beauty. Fishes are kept separate. But Butterflies, outdoor reptiles and amphibian are included. Conservation involves good understanding of their ecological linkages. Some of the ecological linkages of some species as observed by the author are discussed through 'Multimedia Show':

- The amount of insect larvae consumed by Cinnamon Tree Sparrow nestlings in a day, in a Moist Temperate Forest of Lower Kaghan valley was measured and average daily consumption per nest in 1st brood was estimated. The daily amount of green leaf consumed by one butterfly larva in a day was studied. Similarly food of some other Grainivorous and insectivorous birds was studied in available nesting cavities on snags in Malkandi Forest were studied.
- These nesting cavities were mainly excavated by two species of Himalayan woodpeckers.
- The other cavity users were Large Red Flying Squirrel, Small Grey Flying Squirrel, Yellow-throated Marten, Palm Civet, Grey Long-eared Bat and Himalayan Pipistrelle.
- Common epiphyte of Blue pines 'Ivy' were probed for bird nests. At least 21% of these in a sample had bird nest in May in Malkandi forest of Kaghan.
- Himalayan Snowcock and Snow Partridge were observed digging and feeding in Aeolian areas in barren highlands. The soil deposit was minutely observed with hand lens. The place was full of mites, spider and minute diptera insects. These attracted snow partridges and snowcock. If the deposited debris is deep, high altitude grasses grow in them. High altitude ungulates like Himalayan Ibex graze there.
- Food of alpine choughs soaring, diving and maneuvering in the air around the snowy peaks was studied.
- Their guts were chocked with tiny spiders and tiny *Diptera*.
- In lower ecozones tiny spider hatchlings crawl up the tips of leaves, position themselves abdomen up and a tiny silky strand is released from the spinning gland. Enormous number of these is lifted up by the thermal currents.
- Alpine Swifts had the same food in its gut.
- Temperature of rising thermal air current was measured at upper tree limit elevation of a forested mountain and another nearby slope without forest, having the same aspect, at the same time on two consecutive days. The forested slope temperature was 5⁰C lower than the bare slope. Cooler rising air current allows slow melting of snow above, ensuring continued flow of water through the summer.
- A Tibetan fox's fecal matter samples from different localities at alpine zone contained incisors of 3-7 'High Mountain Vole'. It weighs 35-40gm. A captured fox ate little more than one kilogram of meat daily.
- Himalayan Brown Bear's largest population in Pakistan is in Deosai plateau, which is around 40 individuals. Its dispersal is limited by unsuitable conditions of lower altitude habitats surrounding its pocket of occurrence. Although its genetic drift was not confirmed in the laboratory, but definite drift from Eurasian population was noted in its food preference and breeding frequency.
- At all the barrages depressions created due to the excavation of earth to build marginal bunds and the spurs have become permanent pond habitats due to seepage water or inundation due to floods.

- At Balloki Head Works up to 3 km upstream Typha was growing in estimated area of 500 acres between the marginal bunds.
- Cattle Egrets were observed feeding in association with livestock herds. This bird weighed 440 gm on the average and it consumed on the average 135 gm of grasshoppers per day.
- Estimated 1100 Bank Mynas were feeding with the herds its average own weight is 73.3 gm and consumes around 23 grams of insects in a day.
- Over 60,000 Wagtails, Pipits, Bluethroats and Rubythroats roosted for the night in 10 ha. Area of Typha.
- Average weight of a wagtail is 18 gm. Their daily insect consumption was found to be three fourth of their own weight.
- Over 6,000 Black Starlings roosted for the night in another patch of Typha at Balloki. While over 100,000 Black Starlings roosted for the night in Fragmitis at the margin of Kallar Kahar lake in autumn migration. These birds control insects in rangelands, where livestock grazing is free.
- 200 families living in the vicinity of Balloki Head Works depend on Typha for their livelihood and they harvest 70% of total typha by birds autumn migration season.
- Hog deer has vanished from most of its range due to typha and tamarisk Commercial exploitation.
- Wildlife conservation needs ecological approach that requires field research based management.

Pakistan has highest mountains of the world. Most peaks and the ranges are permanently covered with snow. The snow line on the southern slopes of the Karakoram is 5650 m and Western Himalaya 5180 m. A large number of glaciers of all sizes including the longest in the world after the polar region are present in these mountains. Distance wise these glaciers are not far from hot valleys down below. The desert around the Indus River is only 25 km. from the glaciers of Nanga Parbat. The altitudinal differences have created vertical spectrum of temperature and precipitation. These different sets of abiotic conditions have formed striking ecozones of the biotic components. These are from cold barren highlands of permanent snow to the sea, including the shelf and the deep sea. In each ecozone ecosystems run on the basis of interdependence of several biotic and abiotic components and the processes. The Interdependence is not only within the ecosystems but also there is interdependence of the ecosystems. This was understood by studying some ecotlinkages of the following ecozones:

Barren highlands or permanent snow zone and the Ecosystem: The permanent snow zone in the north western mountains at 5,000 m. height coincides with 4-5 °C isotherms during May to September period. At 6,000 m. elevation it remains below 0 °C throughout the year.

Yet there is life in the 'Aelion zone', extends as far up as 6,700m along the vertical mountain slopes and the energy flows through food-chain, though during the short summer. This comprises of debris of pollen, plant fragments, and tiny dead insects blown up to these heights and deposited in the cracks, crevices and on the short depressions on the upper surface of the rocks by the rising thermal winds. In summer these places are full of mites, spiders and minute insects. These attract snow partridges and Snow cocks. If the deposited debris is deep, high altitude grasses grow in them. High altitude ungulates like Himalayan Ibex graze on these green patches.

Flocks of Alpine Choughs can be seen flying, soaring, diving and maneuvering in the air around the snowy peaks of northern mountains from late in the morning or afternoon to about sunset. Several times almost the whole flock suddenly sits on the rocks and after a while all birds become air borne again all together.

The barren cold rocks of these high mountains offer nothing to feed on. Yet there can be flocks of even more than sixty choughs for several days in one area. Specimens shot at different times of the day were found to have their gut chocked with tiny spiders. These tiny spiders were caught on wings from the thermal air, rising up the mountain slope from lower elevations.

Huge numbers (observed in spring and early summer) of spider hatchlings are produced in lower ecozones, mainly in grassy areas. These crawl up the leaf blades and position on tips with abdomen up and head downwards. A tiny silky strand is released from the spinning, which oscillates in the air.

At the lower heights as the air temperature increases with the rising Sun. Warm breeze or thermal air currents or 'thermals' start rising, taking along huge number of ballooning young spiders. When the thermals shift due to cross winds the food supply is disrupted, so the birds wait on the cliffs until the thermals take the normal course again.

On cloudy days the thermals slow down or do not rise. So the food supply to the alpine choughs. These then shift to new suitable areas.

Alpine Swifts also nest in the cliffs, in the 'Permanent Snow Zone' and the 'Alpine Zone'. This bird also finds food in thermals in the same way as that of the choughs (guts studied for food material).

Alpine Ecological Zone and its ecosystem: Gentle slopes and plateaus at around 3500m to 4,600m in Pakistan's northern mountains remain covered with snow until the end of May or early June, depending on the aspect of the slope. The sunny spring season, after a prolonged winter, brings greenery and flowers. Lush green pastures provide forage to the livestock of the nomads, wild ungulates and rodents. Brown Bear, Marmot, Pikas, High Altitude Vole also get plenty of soft

green food. This nutritious food results in good success in breeding. Domestic goats produce healthy kids and mostly twins. These pastures are of high socioeconomic and ecological value. Erupting populations of rodents are controlled by their natural predators. A fox may eat one kg of rodents in a day (experimented).

Colourful sheets of flowers attract insect swarms. These help in pollination, but their larvae eat voraciously the green leaves. Birds control their damage to green pastures by consuming these in large quantities. Birds feed their nestlings on the high protein diet of insect larvae. Falcons also appear to feed on birds, pikas, voles and Agama lizards. Falcons have declined as these are under pressure of falcon catchers (legal or illegal).

Snows of this zone are a sustainable source of fresh water for the lower altitude ecosystems. Avalanches or snow-slides on the steep mountains bring top soil at the base of the mountain in the valley. It is mixture of loose stones and soil. It commonly spreads in a fan shape, if the valley is open or wide. These are called alluvial fans.

Tree seeds germinate during the summer if the alluvial soil has moisture in it. The alluvial fans at the base of snowy mountains keep getting water supply from the melting snow above. The seedlings root and grow in such moist soils. The alluvial fans in Northern Areas have luxuriant growth of forests. However, such forests are now rare, as these have been converted into agricultural or urbanized areas.

Dry Temperate Coniferous Forests Ecozone: The Himalayan ranges intercept summer monsoons. So the mountainous region north of Himalaya does not get the summer precipitation. Rain and snow falls in winters. The talus created by the snow-slide or avalanche remains dry in summer if it is not at the base of a snow-clad mountain. Such soils remain without forest. Snow covered mountains are the source of water for the forests in Dry Temperate Ecozone. Air currents if rising through a forest become relatively cooler due to evaporation from stomata of the leaves. In a scientific investigation by the author, at two close by mountain slopes of the same aspect, air temperatures were taken in the late afternoon at the upper tree line. One slope was covered with a forest while the second was mostly denuded. The forested slope had 5 °C lower temperatures than the slope where forest was almost cut. Cool air reaching the snow of the uppermost ecozone does not cause quick melting away of the snow. So there is sustainable supply of water to the forested alluvial fans in dry summers from the snow above. On the contrary if the forest is removed the rising air instead of becoming cool becomes relatively warm by the heat released by solar radiation on the bare land surface. Such conditions cause quick receding of the snow on the mountain top. Quick melting of snow first causes floods and then drying of many streams from such

areas, thus disrupting one of the natural water cycle systems of northern mountains.

Forests of the alluvial fans are now rare in Northern Areas. These have been cut and the soil is now under agriculture.

The Moist Temperate Coniferous Forests Ecozone prevails mainly on southern and middle Himalayan ranges, as these ranges intercept moist monsoon winds in summer in addition to winter precipitation. The forests form thick canopy and the forest floor remains moist. There is deep humus on the forest floor that retains water. Micorhyza, a fungus acts like a sponge and swells with moisture in the roots of huge trees. This moisture is also available to the trees when the soil becomes dry.

The winter snow on the forested slopes melts slower than that on the bare slopes. More water goes subsoil than surface run off. Thus the supply of water is ensured throughout the dry summer season. Rising air currents from forested slopes are cooler and cause condensation of moisture when clouds arrive. This starts the phenomenon of rain fall.

The forest debris on the floor has rich soil biodiversity. These recycle the dead organic matter and convert it into nutrients for the trees. Sometimes if the soil biodiversity has plant parasitic nematodes these are consumed by certain soil fungi. The hyphae of fungi form several loops in the soil. As the soft bodied nematode tries to pass through the loops these constrict. These fungi have no cellulose covering. So the juices from the fungi start digesting the body of the nematode. Thus reducing the number of soil parasites of the forest plants.

The forest debris also serves as insulating layer against extremes of temperature. It makes suitable seed bank. Soil fungi form white foams around the fallen leaves. These foams are moist as these trap moisture. Previous year's seeds fallen in the autumn start germination in the moist soil in next summer.

With the mobility of the soil creatures the top soil gets aerated and its water absorption capacity increases many folds as compared to the bare soil, where water runoff is fast and water absorption is very poor. Forest soils absorb huge quantities of rain water and snow water. Not only several small aquifers slowly get replenished with water but also it travels and seeps out in the form of springs, at several places in the valley. These springs give rise to streams.

Interruptions caused by man in the fantastic systems of interdependence in nature are resulting in shorter water supply to the lower ecozones and short food production in the plains.

Species play role in the water cycle: During the month of March the lower heights have spring season at around 1,500m elevation. Higher than this elevation, winter still prevails. There is ice on the forest floor and the branches of the deciduous plants are still without leaves or flowers.

There are no insects or their larvae and hence no food for birds.

In the belt of spring around 1,500m, as the temperature starts increasing the non-conifer plants come in full blossom and get covered with fresh soft foliage. Nectar sucking and foliage eating insects start appearing and increase day by day. Variety of butterflies in the day and the moths at night time give rise to huge number of caterpillars. These start crawling on branches and the soft leaves are eaten quickly.

In the plains the month of March is sufficiently warm. The winter visiting birds from northern mountains start their migration back. Upon reach the spring belt at the lower heights of the mountains these birds get plenty of food. Abundance of insects and their larvae, soft buds and soft fruits, prepare them for breeding soon. Courtship rituals and singing of hundreds of altitudinal migrants accumulated in a narrow belt of spring are seen restless to ascend to the nesting areas at various heights above.

As the spring ascends with receding winter conditions the food availability increases for more flocks of birds. They had already eaten huge quantities of insects and provided relief to the host vegetation of the forest at lower heights.

The epiphytes twine round the tree trunks to reach the heights where they get more light from the Sun. On one hand they are burden on the tree, on the other hand they form thickets of branches and leaves where birds can make their nests, and play their role of controlling the forest insects.

In the Himalayan moist temperate forests the fir trees usually are the tallest. During the thunderstorms, often the lightning kills one or several of such tall trees. The dead trees or snags also play their role to protect forests. The old snags have many holes made usually by woodpeckers in search of borer insects.

These woodpeckers play important role in controlling wood-borers. Snags are also ecologically important. Several cavity-nesting birds are dependent on the woodpecker cavities for breeding. Most cavity nesting birds are insectivorous. Even the grainivorous birds, such as cinnamon tree sparrow, feed their nestlings on insect larvae, as these are rich in proteins. A sparrow nestling weighing 16 grams may daily consume 12 grams of insect larvae fed by parent birds. Sparrows have four nestlings in a brood. Most sparrows usually have more than one brood, even up to three broods. So the breeding birds play positive role in controlling the forest insects.

A snag may have even twenty cavities or more made by woodpeckers. These are available to the cavity nesters and other creatures like bats. A bat is estimated to consume night flying insects almost more than half of its own weight during one night.

Some species widen and deepen the woodpecker cavities to suite their size. There are two species of flying squirrels in temperate forests, small grey or Kashmir

flying squirrel and the large red flying squirrel. Both are cavity dwellers. However, the small grey flying squirrel also makes nests in thick branches of trees, particularly in Northern Areas, where cavities are not easily available. This flying squirrel has its role in the dispersal of seeds. It is active at night and is often preyed upon by owls, palm civet and yellow throated martens find it in its cavity during the day.

The Large Red Flying Squirrel is more dependent on Woodpecker cavities than the Grey Flying Squirrel. Flying squirrels are also important components of the food chain in the forest ecosystem. These also play a role in the seed dispersal. These reach the wild fruit bunches of on the tip of the branches and gnaw the fruits. Some of the fruits and seeds full or half eaten fall to the ground. In the morning the fallen seeds or the fruits are then eaten by ground feeding birds such as Koklas pheasant.

This pheasant roosts for the night on trees and spends the whole day on ground in bushes and feeding on tubers and roots of grass, seeds, insects, etc. by scratching the soil with its strong claws. It is important component of food chain in the forest. Other than that it is a good size game bird. It is legally protected, yet it faces hunting pressure where ever the protection is weak.

Subtropical Cheer Pine Forests Ecozone: It ranges roughly from 1,000m to 2,000m elevation. The pine trees shed their needles at a relatively faster rate, resulting in dry needles layer on the forest floor. These needles are very slow biodegradable. The needles accumulate to form a thick insulating layer on the forest floor, thus saving the soil from dehydration in hot and dry season.

The pine needles layer on the forest floor is highly inflammable. These are sometimes allowed to be collected for use as fuel to avoid the risk of forest fires. The south facing slopes are subject to more solar heat in summer. In the bare top soil the capillary action becomes more efficient. Soon it becomes bone dry. The ascent of sap to the top branches of pine trees stops. The top branches of the trees then start drying. Such trees are often subject to the attack of ecto-parasites.

During the dry summer season forest fires are frequent in the subtropical cheer pine forest Ecozone. These have some ecological disadvantages to the pine tree community. Although older pine trees are not killed because of the thick bark but the undergrowth is burnt. When forest fire is in early summer, several bird species still having their second or third brood in bushes get burnt. Arboreal reptiles and mammals are also harmed. Pine forests growing on northern slopes have more biodiversity than the south facing slopes, as these aspects of the mountains are cooler and have more undergrowth providing shelter and breeding places to biodiversity of the area.

In nature the cheer pine tends to grow scattered. The seeds that fall closer to the parent plants have less chance of germination, because most seedlings fail to penetrate their primary root through the thick layer of needles. With the burning of this layer these stand chances of growing closer. Other underbrush and grasses also stand the same chance of germination. The ash left on forest ground makes the soil nutrition enriched.

Some Wetlands Ecosystems: Indus and its tributary rivers have world's most extensive canal system. The barrages and canal head works include marginal earthen protective bunds (embankments) and pond areas created due to excavation of earth to make these bunds.

At Rasool Head Works at river Jhelum on 15th August' 2007 at 5:45 pm over 100,000 low flying Crag martins were estimated in a sample of 2.5 hectares, feeding on mosquitoes and other flying insects of the pond area. Some specimens were shot to measure insect consumption. Each bird had at least 2 grams of insects in its gut. Ducks, which are filter feeders, consume huge quantities of mosquito larvae. Fish plankton also consumes considerable number of zooplanktons which include mosquito larvae. Fish yield in pond areas of barrages is of considerable economic importance. A contract of fish netting at Chashma Barrage at Indus was of 60 million rupees for three years and that of Mangla at Jhelum river it was 40 million rupees for the same period in 2007.

Up to late 1950s River Ravi from Lahore to Balloki Head Works, roughly 70 km stretch of water yielded annually 50,000 Kg of local (un-introduced) fish, including the most relished "Kagga" *Catla catla*. As its water pollution increased due to industrial and urban sewage water, its fish became totally eliminated.

At Balloki Head works this poison is although diluted by the non polluted water from Marala – Ravi Link Canal and Qadirabad – Balloki Link Canal. Toxic water of river Ravi is diluted by the canals that bring water from river Chenab. Fish is then produced in this water. Heavy metals like chromium, copper, zinc, nickel, lead, etc. are toxic to fish and other aquatic life. These bring reduced reproduction, growth and change in population structure of fish. These heavy metals accumulate in fish meat. Fish from this area is marketed mainly in Lahore. Heavy metals enter the human metabolism through fish food of polluted waters, causing serious health hazards. But ignorance on this prevails among Pakistani common man.

This polluted water then flows to Sulemanki Barrage at Sutlej River, through Balloki-Sulemanki link canal. Downstream, this toxic waste and bad smelling water is used for irrigation of agricultural crops, fruit orchards and riverain rangeland, at least in three agricultural divisions of Pakistan. This poison also seeps to ground water, which is causing mainly abdominal

ailments to the communities who directly drink this water.

On the pastures in Ravi river bed, in a sample up to three kilometers upstream of Balloki Barrage there were more than 31,000 cattle and buffaloes grazing in roughly 25000 acres of dry river bed grown with grasses and yielding around 15,000 liters of milk daily. This milk is transported to Lahore after some of it used by the local communities. Toxins drained in this river are transported to the soil of the river bed and then to the forage plants, livestock, milk and ultimately to humans who use this milk and its products. 2500 goats and sheep also grazed in the area. Their meat is also marketed in Lahore.

My study of Balloki Head Works Wetlands ecosystem revealed interesting eco-linkages. The palatable grasses growing on deposited sand and silt in the river bed had large number of grasshoppers and other insects. My experiments revealed that a grasshopper eats green grass leaves almost equivalent to its own weight in a day. A butterfly larva consumed two grams of leaf blades in a day. In addition to the direct consumption both by grasshoppers and butterfly larvae these insects' damage and waste several grasses leaf blades.

There were at least 500 cattle egrets feeding on insects close to the grazing livestock and there were estimated 1100 bank myna and several black drongo during a day in late September, in a sample pasture area of estimated nine square kilometers upstream of Balloki barrage. These birds were estimated to consume insects, almost one third of their own weight. A cattle Egret weighed around 600 grams and consumed almost 200g of grasshoppers in a day. Estimated 1100 Bank Myna were feeding with the livestock herds. Its average weight was 73.3 gm and consumed around 23 grams of insects in a day.

Typha growth in the pond areas of barrages is important roosting habitat for transit migratory birds, shelter for wild boars, hog deer, fishing cat, jungle cat and breeding habitat of many birds. It is source of raw material for mat cottage industry for local riverside human communities. There were more than two hundred families of local communities dependent on Typha mat cottage industry at Balloki alone. So it is regularly auctioned for cutting for the mat cottage industry regardless of the needs of the ecosystem and no regard to over 60,000 wagtails, rubythroats, bluethroats, pipits, sand martins which were estimated to roost in a 2.5 ha sample of Typha area.

Similarly, over 100,000 Sand Martins roosted in a similar sample of Typha at Rasool Barrage pond areas. Over 6,000 Black starlings roosted again in a similar sample of Typha at Kallar Kahar Lake. All these are insect consuming birds, mainly at rangelands, except the Sand martin which consumes mosquitoes and other small flying birds over the wetlands. During their roosting for the night in typha large quantities of their droppings

enrich pond water with nutrients that result in high production of phytoplankton, zooplankton and help in getting high yield of fish.

Mangrove Forests Ecozone: According to the marine fisheries experts, 70% of the Arabian Sea fish and crustacean species breed in Indus delta Mangrove Forests Ecozone. The mixture of sweet water with the saline water of the sea provides ecotones which are suitable for the breeding of fish, lobsters and shrimps. Estimated 8,000 fishermen families depend for their livelihood on the resources of this ecosystem.

Reduced supply of water from Indus has already harmed this ecosystem considerably. Further reduction will further harm this ecosystem. Degradation of the forests in this zone is already causing soil erosion and the sea advance. District Thatta and Badin are getting these negative impacts.

Sandy Deserts Ecozones ----life without water: Desert rodents like Jerboas live without water yet these urinate. Adaptations to no water conditions have enabled them to use metabolic water for physiological needs of their bodies. Not only has that but the whole food chain in such deserts run with water chain through plants and animals.

A common desert creeper "Tumma" or bitter melon *Citrulus colocynthis* is a dune stabilizer. Adapted to extreme arid conditions Tumma opens for dispersal of huge number of seeds. These seeds are eaten by insects, birds and rodents. The animals of prey eat these for food and water.

The issues are uprooting of the anchor plants resulting the sand dunes to become shifting sands.

Tropical Thorn Forests Ecozone of Thar Desert is already badly degraded and patchy. Trees are chopped to feed to goats or are cut for 'charcoal' cottage industry.

The rivers of western Baluchistan have closed basins. These end up as large size shallow lakes. The rivers have fish. But the lakes have no fish as these are saline. Fairy shrimp or Brine shrimp adapted to high concentration salt waters is found in abundance. Gulls, some terns, and flamingos feed on these. Phytoplankton and zooplankton like daphnia are also abundant. These are the food of filter feeders like flamingo and ducks.

During the dry season the lakes dry up. The brine shrimps lay cysted eggs, which can hatch even after remaining dormant in dust for over five years.

Baluchistan Mazri Palm (*Nannorrhops ritchienanain*) which grows on stream edges or on beds has long been commercially over-exploited. It has greatly reduced or vanished from several old habitats.

The following species have declined because these are ignorantly considered dangerous enemy species by almost all Pakistanis: Pangolin *Manis crassicaudata* for its odd shape; Brown Bear *Ursus arctos* for it kills livestock; Black Bear *Ursus thibetanus* for it destroys

maize crops; Wolf *Canis lupus* for it kills livestock and may attack humans; Honey Badger *Mellivora capensis* for it might also eat freshly buried human body; Himalayan Lynx *Felis lynx* for it kills livestock; Caracal *Felis caracal* for it kills livestock; Snow Leopard *Panthera uncia* for it kills livestock; Common Leopard *Panthera pardus* for it kills livestock and may attack humans.



Z.B Mirza (left) with T.J Roberts

Zahid Baig Mirza has achieved worldwide recognition for his publications of field research into the ornithology and mammalogy of Pakistan. In 1982 he received the President of World Wide Fund for Nature (WWF) International Award for Conservation Merit for his work in promoting awareness of wildlife conservation among the people of Pakistan.

As a member of the International Union for Conservation of Nature (IUCN) Environment Education Commission he made important contributions to increase understanding of environmental issues both locally and internationally. Mr. Mirza is a senior member of the Board of the WWF Pakistan and of its Scientific Committee. He served WWF-P as administrator for six years in the 1970s. He is a life Fellow of the Zoological Society of Pakistan, President of the Centre of the Environmental Research and Conservation and one of the founders of the World Pheasant Association Pakistan.

Mr. Mirza developed the Zoological Museums of Punjab University, Basra University and Tripoli University. Subsequently as the first Director of the Pakistan Museum of Natural History, Islamabad, he was in charge of its establishment and of the training of technicians.

His knowledge of the natural history of Pakistan is based on 35 years experience and study, both in the field and through the collection and preservation of specimens. To this end he has travelled the length and breadth of the country.

Professor Z B Mirza, is also renowned biologist and author of several books on wildlife such as 'Mammals of West Pakistan', and 'Illustrated Handbook of Animal Biodiversity of Pakistan.

Courtesy: http://wildlifeofpakistan.com/people_conservation.htm