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Computer Composing Plus Technical Pasting by Mr. Iqbal Khan Pathan

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S U R J

Antibacterial activity of ethanolic and aqueous crude extracts of *Lippia nodiflora* of Khairpur Mirus, Sindh, Pakistan

SURJ

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(Received 22nd January 2006: Revised 23h April 2006)

Abstract

The ethanolic and aqueous extracts prepared from fruit, leaves and stem of *Lippia nodiflora* were examined against Gram positive and Gram negative bacteria; *Staphylococcus aureus, Bacillus subtilis,* Staphylacaccus saprophytious, Staphlococcus epidelmidis, Streptococcus faccolis, Streptococcus pyrgenes *Micrococcus luteus, Eschericihia coli and Bordetella pertussis.*

The ethanolic extracts of all parts stem, fruit and leaves were found active against test organisms, but fruit extract showed more activity than leaf and stem extract. The aqueous extract did not show significant activity.

Keyword: Antibacterial activity, *Lippia nodiflora*,t.

1. Introduction

The *Lippia nodiflora* is a perenial cruper of the family verbenaceae (Tyler *et al.*, 1988). It has world wide distribution, including Indo-Pakistan sub continent. It mainly occurs in wet places,specially along the banks of canals and rivers (Saeed 1970). Locally in Sindh it is available in Larkana, Thatta, Mirpurkhas, Hyderabad and Karachi. It has different names in different languages as in (English) Matlippia, (Gujrati) Ratoliya, (Punjabi) Bakan (Sanskrit) Agrijuala, Bakan and in (Sindhi) called Bukan or Waken. It is used as folk medicine. A poultice composed of the fresh plant is a good medicine for boils and cervical glands. sance of leaves and fruit and is eaten and is useful for treating irritation of internal piles. (Kirtikar and Besin 1984). It is also used se for pain of knee and joint (Chopra and Nayar 1986). Its mixed powder with seeds of *Cuminum cyminum* is used in the treatment of gonorrhea (Stanley *et al*, 1969). The stem decoction with *Leucas aspera* and roots of *Ocimum gratissimam* was used for malarial fever (Plus and Atal 1984). The extract of *L. noiflora* leaves, mixed with onion and ginger oil is used for the treatment of Alopecia (Ponnia and Saraja 1989). The ethanol extract is used as antiascariasis against earth worm (Kaleysa, 1975). The petroleum extract of *L. nodiflora* has been reported to lower blood sugar and serum cholesterol level (Ravishankar *et al.*, 1980). The plant infusion in Iran was used for gastric stimulant, diuretic and for healing wounds (Zargaria, 1992). The petroleum extract of whole plant reported to have hypotensive and cardiotonic effects (Farid, 1993). The plant leaves are used as antidote to snake venom and for treatment of snake bite (Nadkarini, 1954). Taking bath with water boiled with leaves gives relief from itching of measles and chicken pox (Manjunath, 1956). It is reported that, it contains sesquiterpens, 4.2%, o-propy l-4-10%, dimethyl bi-saboline 3.6%, candiene 4.2% calamenene 19.9%, Caryophyllene 18.7%, Copaene 8.4% , Monoterpenes 3.2%, Carvacerof 3.2%, 4-iso-propyl-methylcyclohexane 7.8%. Paracymen -8-10.6%, Linolol 13.7%, B-ocimene trace, b-pinene 8.1%.

The bacteria tested for the sensitivity are *Staphylococcus aureus, Bacillus subtilis, Micrococcus luteus, Bordetella pertussis Escherichia coli, Staphylococcus saprophyticus, Staphylococcus epidermidis, Streptococcus faecalis and Streptococcus pyogenes*.

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Geneus *Staphylococcus* cell shape is spherical and arranged in bunches, it is non-sporing, aerobic and facultative anaerobic. It is a common pathogen, produces superlative diseases in human beings like boils, carbuncles, osteomylitis, deeper tissue abscesses, wound infection pneumonia, septicemia, food poisoning and gastroentritis (Vol. *et al.*, 1970) Genus Bacillus belongs to the family bacillaceae, it is spore forming, chemoorganotrophic, aerobic, rod shape gram positive, arranged inhain, motile and found in soil. e. g. *Bacillus subtilis*. It shows pellicle growth on surface of the liquid medium and produce ammonia smell, it is capable of producing bacitracin antibiotic (Robisher *et al.*, 1974).

Escherichia coli is Gram negative, rod shaped, non-spore forming bacteria. It is found in soil, water sewage and responsible of causing 80% urinary tract infection, gastroentritis and miscellaneous infection.

Genus Boretella is Gram negative cocco-bacilli,non sporing, inhabitant of respiratory tract. e. g. *Bordetella* pertussis, causing whooping cough (pertussis). Genus *Micrcoccus* is gram-positive, non motile, arranged in cluster, it is either saprophyte or parasite and broadly used in antibiotic assay e.g. Penicillin (Paul and Sainsbury *et al.*, 1981).

2. Material and Methods

Lippia nodiflora was collected from district Khairpur in the month of June. The leaves, fruit and stem were separated and were placed in the dark room at room temperature for 25 days to dry. The components of *Lippia noiflora* were extracted by crushing them separately into powdered form through hamer mill. Later 50g powder of every part (Fruit, leaf and stem) was put into the conical flask separately and 250 ml. of distilled water was added into each flask. These flask were kept 72h for maceration, finally the extract as filtered by Whattmans no.1 filter paper under vacuum evaporation by rotary evaporator at 40°C.The ethanolic extract was prepared in the same way where 250ml of ethanol absolute was poured instead of distilled water. The residual yield in shown in Table.1.

Table –1. The residual yield of leaf, Stem and Fruit

S. No	Part used	Wt. of dried powder	Solvent	Yield
01	leaf	50g	Ethyl alcohol i.Distilled water	3.3g 2.16g
02	Steam	50g	Ethyl alcohol i.Distilled water	3.0g 2.4g
03	Fruit	50g	Ethyl alcohol Distilled water	3.0g 2.4g

3. Preparation of dilutions

All the apparatus used were sterilized in the oven at 200°C for 30 minutes. A series of four dilutions were prepared for each extract and marked as n_1, n_2, n_3 and n_4. The dilutions were prepared in the following scheme.

a) First dilutions n1.was prepared by dissolving 100mg of extract in 10ml of ethyl alcohol.

b) Second dilution was prepared by taking one ml of dilution n^1.and 1ml of ethyl alcohol.

c) Third dilution n_3.was prepared by taking one ml of dilution n_2 and 1ml of ethyl alcohol.

d) Fourth dilution was prepared by using one ml of n_3 and one ml of ethyl alcohol.

After the preparation of extract and dilutions, the laboratory media e.g. Nutrient agar, Nutrient broth, MacConkeys agar and MacConkeys broth were prepared. The fresh inoclm of all organisms viz *Staphylococcus aures, Bacills subtilis, Micrococcs luteus, Escherichia coli* were prepared by inoculating them in fresh media plate an slants, incubated for 24h at 37°C. *Boretella pertussis* was incubated for 48-72h. Later, the slants were washed with 5ml of normal saline and suspension was prepared by inoculating it in to flask containing 100ml of cooled melted nutrient agar. This medium was poured in sterilized petri plates and was allowed to solidify. These were incubated at 37°C for 24h. After incubation antibacterial activity was

determined following the method of Koneman *et al.*, (1997).

4. Result and discussion

Around three billion people of under developed countries are affilieted by bacterial infections (Walsh and Warren, 1979). As a result it becomes difficult to treat infectious diseases. Therefore, attempt has been made to study the antibacterial activity of *Lippia nodiflora* over the common pathogenic bacteria. The pathogenic bacteria were tested in vitro for their sensitivity to ethanol extract (Table:2).

According to the antibacterial activity exhibited by extract, it was divided in to four categories, A, B, C, D with E, representing control group. The result demonstrate that the extract from all test dilutions sowed maximum antibacterial activity against the organisms tested. It was observed that the fruit extract were more active against the test organisms relative to the extract of other parts. The present research finding provide a firm experimental evidence that the plant is useful in healing infections wounds, ulcers and scars, because it has shown antibacterial activity against, *Staphylococcus areus*, which common cause of skin infection. Our antibacterial results is an agreement with results of Foretier, *et al*, (1988) and Riaz, *et al* (1995). They showed very effective antibacterial activity results against the pathogenic bacteria. Further antibacterial activity needs more quantitative analysis for the identification of antibacterial chemical constituents.

Table-2. Antibacterial activity of stem, fruit and leaves by Ethanolic extract of *Lippia nodiflora* against pathogenic bacteria along with control.

Test microorganism	Average zone of inhibition (mm)				
	Dilution	Fruit	Leaf	Stem	Control
Staphylococcus aureus ATCC No. 6563	n_1	B	B	C	E
	n_2	B	C	C	E
	n_3	C	C	C	E
	n_4	C	D	D	E
Bacillus subtilis ATCC No. 6631	n_1	B	B	B	E
	n_2	B	C	B	E
	n_3	C	C	C	E
	n_4	C	D	C	E
Micrococcus luteus ATCC No. 6461	n_1	B	D	D	E
	n_2	C	D	D	E
	n_3	C	E	E	E
	n_4	C	E	E	E
Bordetella pertussis ATCC No. 4617	n_1	B	D	C	E
	n_2	B	D	C	E
	n_3	C	D	D	E
	n_4	C	D	D	E
Escherichia coli ATCC No. 8739	n_1	C	C	D	E
	n_2	C	D	D	E
	n_3	D	D	D	E
	n_4	D	D	D	E
Staphylococcus saprophyticus ATCC No. 25922	n_1	C	C	D	E
	n_2	C	C	D	E
	n_3	D	C	D	E
	n_4	D	C	D	E
Staphylococcus epidermidis ATTC No.	n_1	A	D	C	E
	n_2	A	C	C	E
	n_3	B	D	D	E
	n_4	B	C	D	E
Streptococcus fawcalis ATTC No. 10449	n_1	A	B	B	E
	n_2	A	B	B	E
	n_3	C	C	D	E
	n_4	B	C	D	E
Streptococcus pyogenes ATTC	n_1	A	C	D	E
	n_2	A	C	D	E
	n_3	A	C	D	E
	n_4	A	C	D	E

Key: A = 2630mm; B = 2225mm; C = 1519mm; D = 9214mm; E = below 99mm

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First rostrum of carnivorous *Vitakridrinda* (Abelisaurid Theropod Dinosaur) found from the latest Cretaceous Dinosaur Beds (Vitakri) Member of PAB formation, Alam Kali Kakor Locality of Vitakri area, Barkhan District, Balochistan, Pakistan

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(Received 28th December 2005 Revised 27th November 2006)

Abstract

The finding of rostrum of ***Vitakridrinda*** theropod dinosaur is the first one from Pakistan. It is found from the the Latest Cretaceous Dinosaur beds/Vitakri member of upper part of Pab Formation in Alam Kali Kakor locality of Vitakri region, Barkhan District, Balochistan, Pakistan. The newly discovered rostrum consists of articulated premaxilla alongwith narial, dorsolateral and lateral processes; external naris; partial nasal, palate and maxilla. The subterminal rostrocaudally subcircular nares, V shape of anterior snout and teeth characters representing pleisiomorphies of theropods. The ornamentation like pits and grooves on the surface of rostrum is the synapomorphy of abelisaurids. Many autopomorphies and other different useful characters of this rostrum are described here. The external nares seem to be bounded by the premaxilla only. The palate is well exposed at cross section. This snout is found in the site of previously reported basioccipital condyle articulated with partial braincase and a pair of proximal femur of *Vitakridrinda.* Although fragmentary these three masses associate and belong to one animal. This specimen will facilitate comparisons with the Gondwanan as well as Laurischian forms.

It has bite mark, puncture, teeth impression and the embedded teeth revealing confrontation between *Vitakridrinda* and its combatant belonging to same or different species. The skull parts of this theropod are found with the partial skull of adult/subadult titanosaurs. Its occurrences with adult/subadult titanosaur suggest that the theropod came to the titanosaur animnal for feed subsequent fighting with other theropod cauld cause its death. The discovery of *Vitakridrinda a*belisaurids, alongwith saltasaurids, and baurusuchid from Pakistan broadens the distribution and indicates a close affinity with South America, Madagascar and India of Gondwanaland. These assemblages underscore many taxonomical features useful for paleobiology, paleobiogeography, phylogeny, behaviour like fighting, scavenging, predatory and, interaction among other species.

Keywords: Rostrum of ***Vitakridrinda*** theropod dinosaur beds (Vitakri) Member of PAB formation.

1. Introduction

Carnosaurian dinosaurs were the largest carnivorous animals to inhabit the land (Molnar, *et al.*, 1990). Theropoda are carnivorous dinosaurs. It is the most differentiated group of saurischian dinosaurs, consisting of a sister group to the Sauropodomorpha. Theropoda was originally erected by Marsh (1881) to include all the known Triassic dinosaurs, and the Jurassic and Cretaceous carnivorous dinosaurs. Huene (1914) divided the theropods into carnosaurs and coelurosaurs on the basis of size. The large were called carnosaurs and

the small ones coelurosaurs. Bonaparte *et al*, (1990) placed *Abelisaurus*, *Carnotaurus* and *Indosuchas* in the same family, Abelisauridae.

Later on, Huene (1914) proposed an alternative classification of the saurischia and distinguished the coelurosauria. Subsequently Huene (1920) erected carnosauria for large carnivores and coelurosauria for small carnivores. Romer (1956) used the terms as large theropods and small theropods. Gauthier (1986) included the "birds and all saurischians that are closer to the birds than they are to sauropodomrphs" within the Theropoda.

Theropoda is divided into primitive Theropoda and Neotheropoda. Neotheropoda is divided into coelophysoidea, ceratosauria and tetanurae. Abelisauroidea is the major clade of Ceratosauria, further subdivided into Noasauridae and Abelisauridae (Sereno, *et al.*, in review). Tetanurae is divided into carnosauria and coelurosauria. Carnosauria ended in to strart of early Late Cretaceous. Coelurosauria consists of tyranosaurids. Tyranosaurids are additionally characterized by incisor like nipping teeth in the premaxilla, by extremely powerfull jaws and lateral teeth (which unlike those of typical theropods, are relatively thick side to side), and extremely reduced forelimb with only two claws. Large size of tyranosaurids is due to ending of carnosauria and diet problem (bone and flesh)(Tom R., Holtz, Jr. 2000).

The Theropoda shares with the Sauropodomorpha several derived characters (Gauthier 1986): the reduced maxillary process of the premaxilla, invasion of the temporal musculature onto the caudodorsal surface of the frontal, the neck forming at least 33 percent the length of the presacral vertebral column, placement of the postzygapophyses more laterally than the prezygapophyses, accessory hyposphene-hypantrum articulations between the trunk vertebrae, the manus 40 percent or more of the combined length of the humerus and radius, and the pollerx more robust than other manual digits, the former bearing a large ungula. The Theropoda is a monophyletic group characterized by members having an antorbital fossa, fusion of the vomers rostrally, an expanded and ventrally concave ectopterygoid. The presacral verrterbrae are pleurocoelous, and the sacrum includes at least five vertebrae. The manus has a reduced or absent metacarpal and digit V and/ or IV. The penultimate manual phalanges are elongate; the unguals are enlarged, curved, and transversely compressed. The illium has somewhat elongate preacetabular process and pronounced brevis fossa (Osmolska, 1990).

Well preserved skulls are known for *Allosaurus fragilis, Nanotyrannus lencensis, Alberytosaurus libratus, Daspletosaurus torosus, Tarbosaurus bataar, and Tyranosaurus rex* (Osborn 1912, Madsen 1976, Gilmore 1946, Lambe, 1917, Russell 1970, Maleev 1974). Other taxa are represented by less complete skulls *(Alectrosaurus olseni and Alioramus remotus*; Perle 1977; Kurzanov 1976). Most cranial elements are known from isolated and articulated bones. The palate has been described and illustrated for *Tyranosaurus rex*, *Daspletrosaurus torosus* and *Allosaurus fragilis* (Osborn, 1912, Russel, 1970; Madsen 1976). Braincases are not well known but have been described for *Acrocanthosaurus atokensis, Allosaurus fragilis, Carcharodontosaurus saharicus, Chilantaisaurus maortuensis, piantnitzkysaurus floresti,Tarbosaurus bataar, and Tyranosaurus rex* (Stovall and Langston 1950, Madsen 1976, Stromer,193; Hu, 1964, Bonaparte 1985, Maleev,1974, Osborn 1912). More descriptive work is needed for an understanding of both palatal and braincase structure in carnosaurus. Hereby the author

describes the presently discovered rostrum which has well preserved palatal processes.

Theropoda has global occurrences while tyranosaurids have Laurischian affinity and abelisaurids have Gondwanan affinity. Abelisauroid predators have been recorded almost exclusively from South America, India and Madagascar, a distribution thought to document persistent land connections exclusive of Africa. Discovery of horned dinosaur predatory dinosaur *Carnotaurus sastrei* (Bonaparte, 1985; Bonaparte *et al.,* 1990) and close relatives (Bonaparte and Novas, 1985; Bonaparte and Powel, 1980) in rocks of Late Cretaceous (Maastrichtian) age in Argentina brought to light a new group of dinosaurs now recognized as Abelisauroids. Similar–age fossils from India and Madagascar were linked to this group.

Huene and Matley (1933) described 4 families of carnosauria from India. Sereno, *et al.,* (2004) proposed the Pan-Gondwana model (Scotese, 2001) on the basis of finding of Abelisauroids in the Niger, in which three narrow, probably intermittent passages connected major Gondwanan landmasses during the early Cretaceous and disconnected at the end of early Cretaceous while the Africa first model (Sampson *et al.,* 1998; Hay *et al.,* 1999) show separation in early duration of early Cretaceous.

The presence of the eleven named species from the Lameta Formation of India actually represent at least three large bodied theropod *(Rajasaurus, Indosuchas, Indosaurus)* and a fourth, small bodied theropod (*Laevisuchas*) (Wilson, *et al.,* 2003). But recently from Pakistan, Malkani (2004) reported one species *Vitakridrinda* of large bodied theropod. However the finding of rostrum of ***Vitakridrinda*** large bodied abelisaurid theropod dinosaur is the first from Pakistan. However there are some evidences of another species of large bodied abelisaurid theropod from Pakistan based on morphology of vertebrae, one small bodied may be noasaurid theropod and an avian theropod. The discovery of abelisaurids, saltasaurids, and baurusuchid from Pakistan broadens the distribution of saltasaurids, abelisaurid and baurusuchid, indicating close affinity with South America, Madagascar and India of Gondwanaland. This specimen will facilitate comparisons with the Gondwanan as well as Laurischian forms. These assemblages underscore many taxonomical features which may be useful for phylogeny, paleobiogeography, behaviors like fighting, scavenging, predatory and interaction among other species.

The associated biomas community of presently described carnivorous theropod is mentioned as following. After first discovery, uptill now round about three thousand fragmentary bones/pieces of bones/fossils have been collected by author from the terrestrial strata of Latest Cretaceous (Maestrichtian) Dinosaur beds/Vitakri member of uppoer part of Pab Formation from Central Sulaioman foldbelt. Pakistani titanosaurs tails tell five tails. Three genus and species (*Pakisaurus balochistani, Sulaimanisaurus gingerichi and Khetranisaurus barkhani)* of herbivorous Pakisaurid=Titanosaurid, and two genus and species (*Marisaurus jeffi and Balochisaurus malkani)* of herbivorous Saltasaurids titanosaurian sauropod dinosaurs are erected (Malkani, 2004). One genus and species (*Pabwehshi pakistanensis)* of Mesoeucrocodylia was discovered by me and reported by Wilson, Malkani and Gingerich (2001), and Malkani (2004b). In addition to this, a partial skull (Malkani, 2003a) along with nearby findings of some cervicals, dorsals, caudals and appendicular elements (Malkani, in process) of *Marisaurus*, four armor bones (Malkani, 2003b), and one braincase (Wilson, Malkani and Gingerich,2005) of Pakistani titanosaurian sauropod have been reported. Presently new discoveries like a Rostrum of *balochisaurus*, an atlas-axis complex, an overlapping dentary teeth(partial), and many cervical, dorsal and caudal vertebrae, and appendicular elements of Pakistani titanosaurian sauropod saurishian dinosaurs (Malkani, in process) are made. One genus and species (*Brohisaurus kirthari*) of Late Jurassic Titanosauria have been discovered from Kirthar foldbelt, Pakistan (Malkani, 2003c, Malkani, 2004c).

2. History of dinosaur discoveries in Pakistan

The first ever discovery of dinosaurs from Pakistan was made by the author during early (2000) from the Latest Cretaceous Dinosaur beds/Vitakri member of Pab Formation in Vitakri area, Barkhan District, Balochistan. A fossil of

distal femur of titanosaurian sauropod dinosaur was collected but was first reported by Malkani and Anwar (2000). Professor Philip D. Gingerich, University of Michigan visited the location in late 2000 and about 100 bones/pieces of bones of dinosaur Vitakri locality number one were sent to Museum of Paleontology, University of Michigan, USA for sample preparation. The author collected further 1500 bones/pieces of bones from 25 different localities in the Sulaiman foldbelt, administratively located in the areas of Barkhan, Kohlu, Dera Bugti, and Dera Ghazi Khan districts of Balochistan and Punjab provinces during early 2001. Dr Jaffery A Wilson, Museum of Paleontology, University of Michigan, USA visited the GSP museum during March, 2001 and Dr. David A. Krauss of Bostan College, USA visited the GSP museum and Vitakri locality during middle of 2001 for dinosaur project. The second time dinosaur fossils were reported by Malkani, Wilson and Gingerich, in (2001). About 1200 bones/ pieces were collected in the middle of (2001), from Sulaiman foldbelt and 20 pieces of bones of Late Jurassic/Early Cretaceous dinosaur were collected Kirthar foldbelt. Malkani, (2003a,b,c, 2004a) again reported Dinosaurs fossils from the Sulaiman fodbelt areas. Two cranial specimens were collected during early (2005). A good number of bones/fossils have been observed and located in situ at Vitakri and Fort Munro regions of Sulaiman foldbelt during field studies. These are left untouched for detailed field studies, proper excavation, preparation of specimen and laboratory studies to describe this fauna. These localities of archosaurs are easy for excavation due to soft mud/clay host rocks to find the articulated skeleton of these exceptional animals. As a whole the Vitakri and vicinity areas seem to be graveyard of terrestrial ecosystems of Vitakri Late Cretaceous Park and are enriched by bones/fossils.

3. Geological and stratigraphic setting

Newly discovered rostrum of *Vitakridrinda* has been found from Vitakri area, Barkhan District, Balochistan, Pakistan (Figure-1). The study area of Sulaiman fold belt is located in the Central part of Pakistan. The Latest Cretaceous (Maestrichtian) dinosaurs are hosted by the Pab

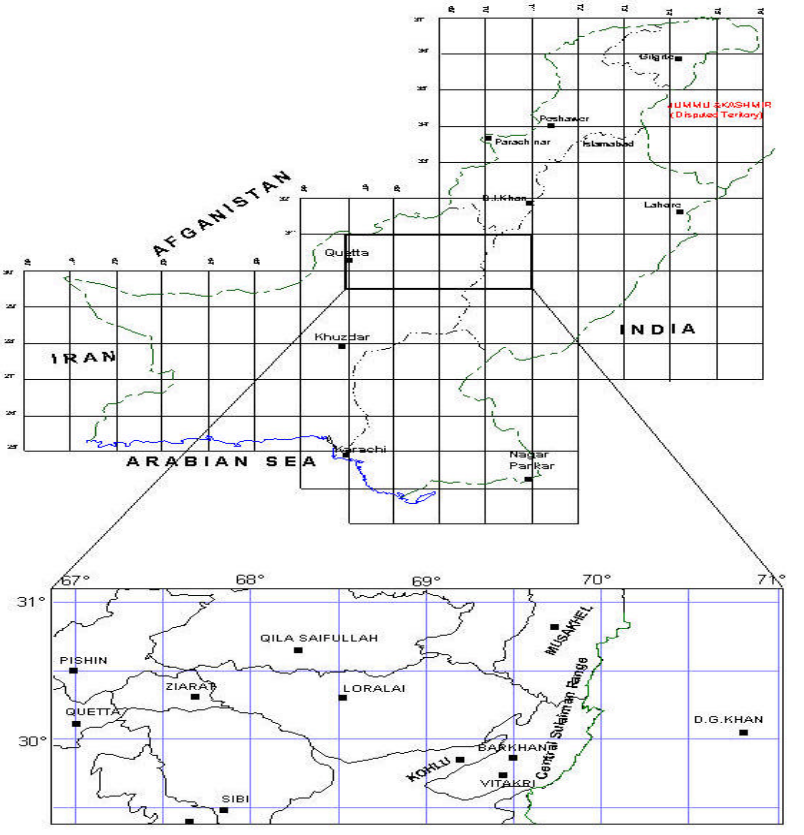

Figure 1. Index map of Pakistan showing the Vitakri locality, which is the host of newly discovered rostrum of *Vitakridrinda sulaimani*, an Abelisaurid theropod

Formation of Sulaiman fold belt. In Vitakri area, the Late Cretaceous Pab Formation has been divided in to three members like Lower Dhaola member, middle Kali member and upper Vitakri member/Dinosaur beds. The Latest Cretaceous sediments in the study area underwent considerable tectonic deformation during the collision of Asian and Indo-Pakistan continental plates that commenced in the Late Cenozoic. As a result dinosaur beds along with other formations have been folded.

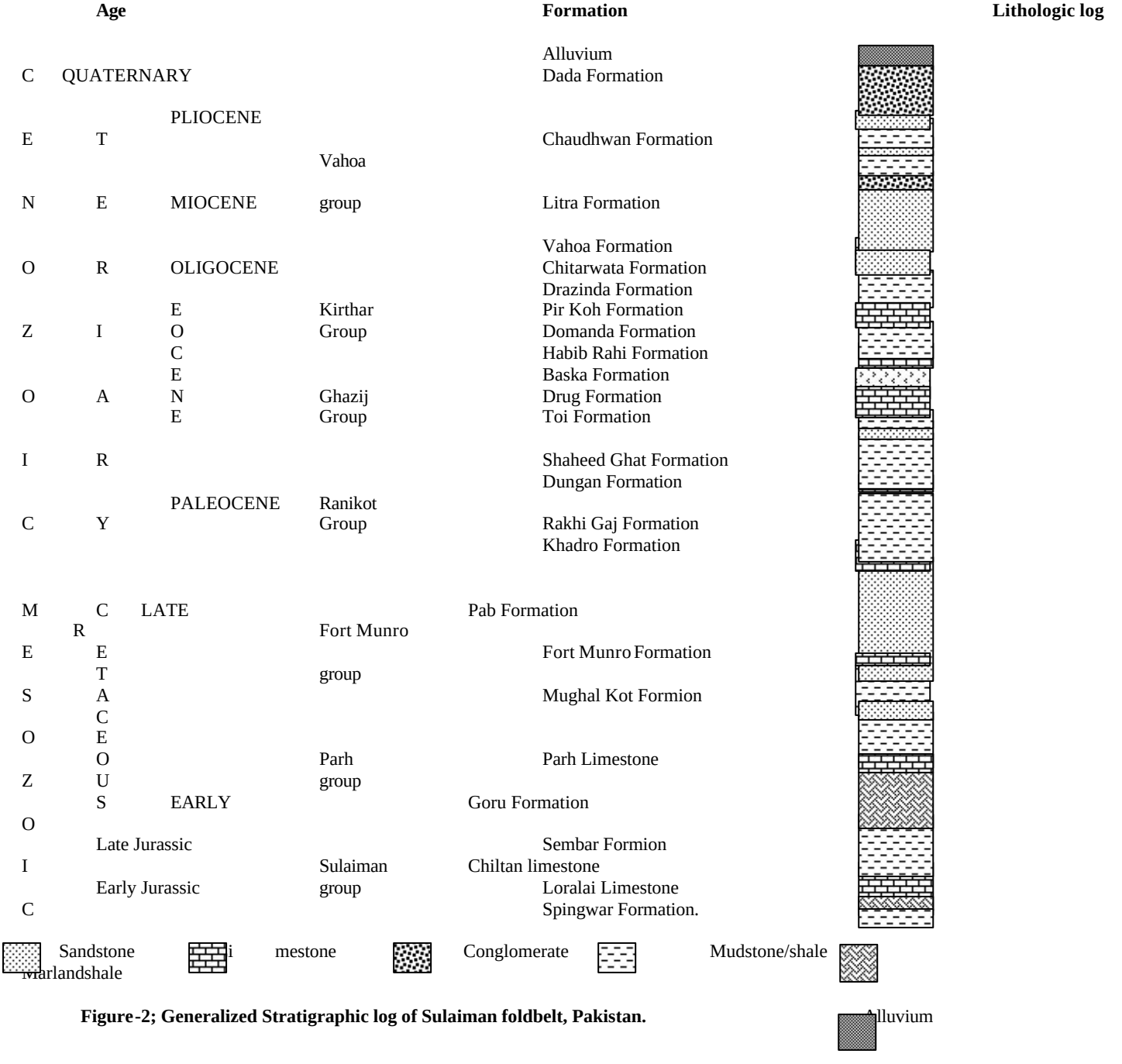

Figure-2; Generalized Stratigraphic log of Sulaiman foldbelt, Pakistan.

The Sulaiman foldbelt consists of sedimentary rocks ranging in age from Jurassic to Recent (Figure-2). The rocks comprising of shale, limestone, sandstone, siltstone, marl and conglomerate in different lithological units in ascending order as; Jurassic Sulaiman group representing Spingwar, Loralai and Chiltan formations, Cretaceous Parh group representing Sember, Goru and Parh formations, newly proposed Fort Munro group representing Mughal Kot, Fort Munro and Pab formations; Paleocene Ranikot Group representing Khadro, Rakhi Gaj and Dungan formations; Eocene Ghazij Group represents Shaheed Ghat, Toi, Drug and Baska formations; (newly proposed) Kirthar group represents Habib Rahi, Domanda, Pir Koh and Drazinda formations, Oligocene-Pliocene Vahoa (newly proposed) group represents Chitarwata, Vahoa, Litra and Chaudhwan formations, Pleistocene Dada Formation, Subrecent and recent fluvial, eolian and colluvial deposits (Malkani, 2004c, Figure-2).

4. Materials and methods

Presently a rostrum of ***Vitakridrinda*** abelisaurid theropod dinosaur (MSM-155-19) have been discovered by the author for the first time in Pakistan and reported here. It is found from the Latest Cretaceous Dinosaur beds/Vitakri member of upper part of Pab Formation in Alam Kali Kakor locality of Vitakri area (Figure-1 and 7), Barkhan District, Balochistan, Pakistan. This snout (Figure 3-6) is found in the site of previously reported (Malkani, 2004a,d) basioccipital condyle articulated with partial braincase and a pair of proximal femur of *Vitakridrinda.* All of these fossils of *Vitakridrinda* are found as fragmentary but field evidence and bone association show residual fragments with no transportation. The host horizon is the red muds/clays rich horizon of Vitakri member/Dinosaur beds (upper member) of Late Cretaceous Pab Formation. Discovered cranial parts are found mainly as two masses on same locality. The first mass consists of a basioccipital condyle articulated with partial braincase consisting of paraoccipital process (Malkani-2004d). The second mass consists of a newly collected rostrum preserving the articulated premaxilla along with narial, dorsolateral and lateral processes; external naris; partial nasal, palate and maxilla, which is described here. Both of these specimens are mostly covered by red, brown and black matrix. The third mass coinsists of a pair of proximal partial femur (left and right). Although fragmentary but all these three masses seems to be associated and belongs to one animal. The reasons is that the locality is same i. e., the basioccipital condyle articulated with braincase is found 50m apart from rostrum and a pair of proximal femur is 100m apart from basioccipital condyle and 150m apart from rostrum. The second reason is that a pair of proximal femur (left and right) show association. The third reason is that relative sizes of bones/fossils are same, representing adult animal. The fourth materials are vertebrae, which belong to other localities but relative size show adult/sub adult animals. The traditional methodology for paleontological investigations applying descriptive, comparative and interpretive aspects.

6. Systematic paleontology

Dinosauria Owen, 1842
Saurischia Seeley,1887
Theropda Marsh, 1881
Ceratosauria Marsh, 1884
Abelisauridae, Bonaparte & Novas, 1985
Vitakridrinda, Malkani, 2004 (a, d)
Vitakridrinda sulaimani, Malkani,2004 (a,d)

Holotype; MSM-59-19,MSM-60-19,MSM-61-19 and MSM-62-19. A pair of left and right proximal femur; Basioccipital condyle along with partial braincase and a tooth (Malkani, 2004d). The holotype specimens are housed in the Museum of the Geological Survey of Pakistan, Quetta. Newly collected rostrum belongs to the above mentioned locality and included as holotype assemblage of *Vitakridrinda* (MSM-155-19; Figure-3,4,5,6).

Referred specimens; MSM-53-2, MSM-54-2, MSM-55-2, MSM-56-1, MSM-57-3, and MSM-58-15; Four fragmentary caudal vertebrae and two possible dorsal vertebrae (Malkani, 2004d).

First Rostrum of Carnivorous Vitakridrin

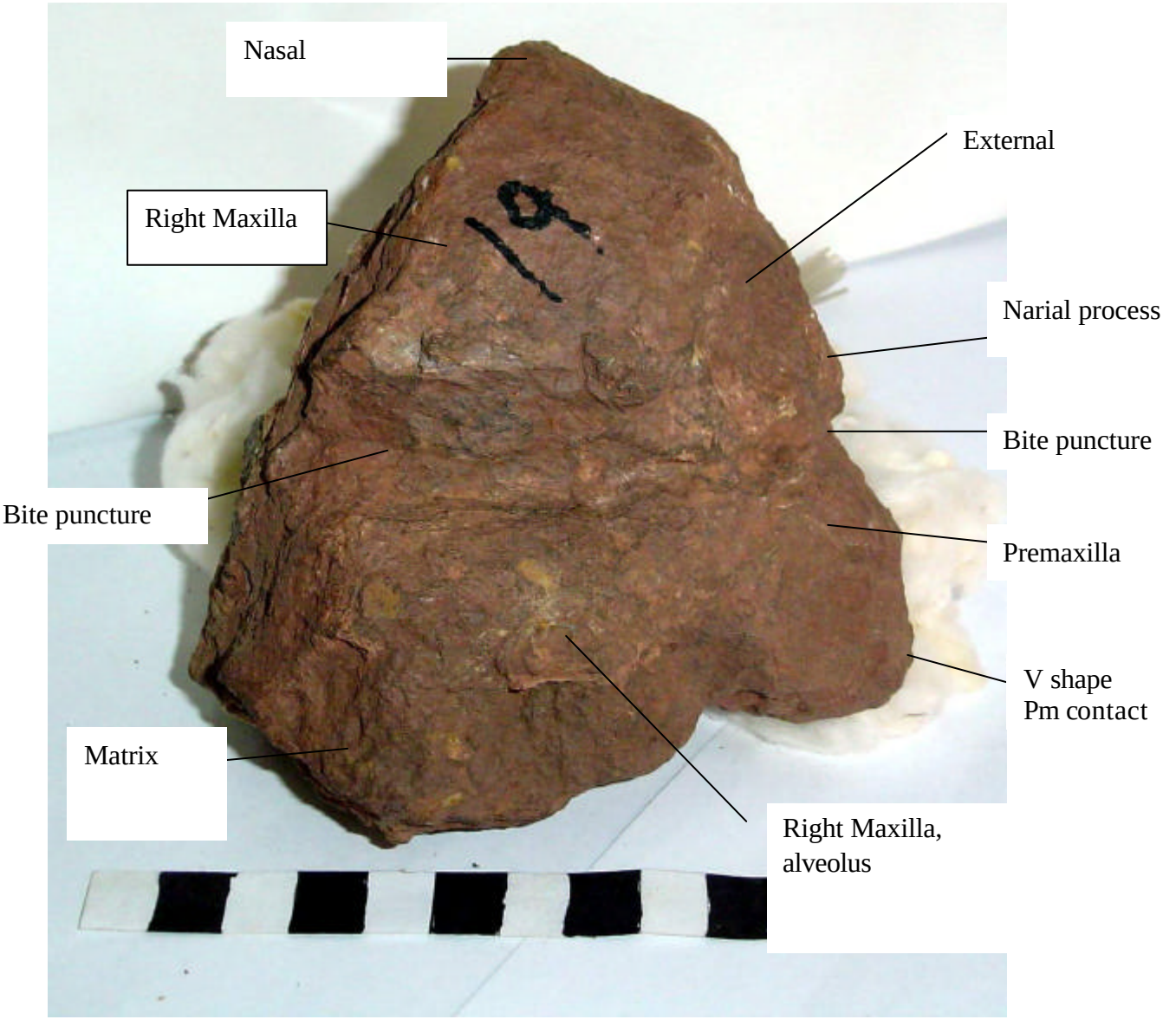

Figure 5.Right lateral View of rostrum of *Vitakridrinda*, a carnivorous abelisaurid theropod dinosaur from Vitakri area, Barkhan District, Balochistan, Pakistan.
Specimen No; MSM-155-19c.
Scale is in centimeter (cm). Every black digit is 1 cm.

These specimens are housed at the Museum of Geological Survey of Pakistan, Quetta.

Horizon and locality; Holotype specimens are collected from Vitakri locality 19 and referred specimens are collected from Vitakri localities 1, 2, 3 and Mari Bohri locality 15. The holotype horizon is the Vitakri member/ Dinosaur beds of upper part of Late Cretaceous Pab Formation and holotype locality is the Alam

Kali Kakor locality (Figure 7) of Vitakri area of Central Sulaiman Range, Barkhan District, Balochistan, Pakistan (Malkani, 2004d).

Age; Vredenburg (1908) reported *Orbitoides (Lepidorbitoides) minor* of early Maestrichtian age from the lower part of the Pab Formation in Rakhi Nala. Williams (1959) recorded a mixed benthonic-pelagic assemblages of foraminifers of Maestrichtian age from the type locality (Pab Range). Hunting Survey Corporation (1961) reported two collections, one of them of "Senonian-Maestrichtian" ages. On the basis of these data, a Maestrichtian age is assigned to the Pab Formation (Fatmi, 1977). Thus age of the dinosaur beds is the Late Cretaceous (Maastrichtian**).**

7. Description of a rostrum of *vitakridrinda* (theropod dinosaur) from pakistan

First rostrum of ***Vitakridrinda*** belongs to large bodied theropod consists of articulated premaxilla along with narial, dorsolateral and lateral processes; external naris; partial nasal, palate and maxilla. The subterminal rostrocaudally subcircular nares, V shape of anterior snout and teeth characters representing pleisomorphies of theropods. The ornamentation like pits and grooves on the surface of rostrum is the synapomorpy of abelisaurids. This rostrum represents many autopomorphies and other different useful characters. The external nares seems to be bounded by the premaxilla only. The short **premaxilla** is subrectangular in lateral view and triangular in anterior view. Its body and dorsal process together form the external naris, and its caudal process contact the nasal and maxilla. On the outer surface it has ornamentation like numerous pits and grooves (Figure3,4). On inner side it is not known and will clear after sample preparation. The anterolateral process is about 4cm long, while the anterior premaxilla along with narial process is 8.5cm long. The separation of posteroventral margins of premaxilla fellows is 4cm. The contact of narial process with the nasal is W shape. The external nares are subcircular having about 2.5cm dia measured on the top where it is filled by matrix (Fig.3). Below the external nares the premaxilla is inset than nasal and maxilla. The midline contact is well exposed in the narial process and feeble on the nasal. Some alveoli without preserved teeth are observed. Minimum anterior width of narial process in the external nare region is 1.2cm. Both the fellows of the premaxilla meet anteriorly with V shape (Figure-3, 4, 5).

The **maxilla** is a large triangular element. The maxilla houses several internal chambers. The major two found in specimen open both rostrally and caudally and may have accommodated olfactory epithelium. The thickness of this chamber varies from 3mm to 7mm and it is 5.5cm long measured on the left maxilla at the posterior broken surface (Figure. 3, 4, 5). Maxilla dorsally is connected with nasal, anteriorly and anterodorsally with premaxilla; and medially with palatal processes. Maxilla have also ornamentation like pitted surface. The preserved lateral process of maxilla is 6cm long and dorsal process is about 9cm long. The rostrum also represents bite mark and puncture (along with combatant teeth and their impression) on the lower side of snout, just below the transversely oriented midline along profile of exposed premaxilla and maxilla. The teeth of combatant are also fixed in the puncture(For detail please see in discussion). One alveolus representing D shape to subcircular asymmetric morphology. Antorbital fenestra is found however it can be clear after sample preparation (Figure-3, 4, 5).

The elongate **nasals** are medially fused. The nasal has feeble rugose mid line contact seems to be tightly fused (Figure-3). The nasal width is about 4cm straight measurements at broken section. Its dorsal circumference is about 4.5cm wide. The thickness of nasal plate is about 7mm to 1cm. The nasal surface represents groove and pitting. The nasal bears two arc shape slight fracture and groove which are parallel to sub parallel. Their arc is convexing backward and forming concave towards anterior. These arcs seem like imbrication.

The **Palate** exposed at about 4cm back of the anterior contact with narial process of premaxilla. It has a long maxillary contact with maxilla representing plate shape contact. Bone texture is spongy and pitted. There are two processess of palate such as dorsal and ventral

First Rostrum of Carnivorous Vitakridrin
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processes (Figure-6). The dorsal process is tetraradiate shape probably projecting medially to contact the vomer and ptyerygoid. The ventral process is also tetraradiate that contact the maxilla and possibly with jugal, by a medially open excavation. The ventral process is more robust than dorsal process. Both processes are also internally excavated and are spongy and have internal chambers. Medially the dorsal and ventral processes of palatal are symmetrically vault shaped on both ventral and dorsal sides. The two major cavities are exposed at the nasal sections which is 4.5cm back of W contact with narial process of premaxilla. There are two major cavities in the palatine. The dorsal cavity is rectangular shape with transverse width 2.3cm and dorsoventral height is 2.7cm. It is symmetrical but due to bite mark it is slightly tilted. On the lower side it seems to be divided medially. The other cavity between the dorsal and ventral processes of palatine is subrectangular and more wide than upper cavity and have wings also. The transverse width is about 4.5cm and dorsoventral height is 2.5cm. It is again symmetrical. It is filled by matrix. The ventral process has a pair of left and right cavities with 1.8 and 1.5cm dia respectively, slightly intruded by thin spike of bone on the dorsal part representing same morphology but also tilted by bite. Medioventral to each cavity another smaller cavity of eye shape found well. Three smaller cavities are well exposed on the dorsal of left side cavity. The section of one fellow of dorsal process is triradiate. All radiation radiate from the point in the mid of upper part of maxilla. The dorsal radiation 1.8cm long running parallel to maxilla meet with joint of maxilla and nasal. It is becoming very thin upward decreasing up to 2mm. The ventral radiation 1.8cm bng also goes parallel to maxilla and meets with the dorsal radiation of ventral process. It is also thinning downward and gradually taper at or near the dorsal end of dorsal radiation of ventral process. The median radiation goes to the median of chamber to meet its with fellow. Its thickness is first decreasing and then increasing to the mid central junction with fellow. The dorsal process is 1cm thick in the middle centre junction while its minimum dorsoventral height is 7mm. It is contacted with maxilla and nasal also. The section of one fellow of ventral process of palatal is also triradiate. All radiation radiate from the point in the mid of lower part of maxilla. The dorsal radiation 2.4cm long running parallel to maxilla meet with the ventral radiation of dorsal process. It is thinning upward to the joint. The thick ventral radiation goes also parallel to maxilla and tapers at 1.8cm. The median radiation goes to the median of chamber to meet with its fellow. Its thickness is decreasing toward the mid central junction with fellow (Fig. 6). The contact of dorsal process on the left side seems to be from the ventral process. It may be due to bite. The ventral process is transversely 6cm and 2.3cm height in the middle and about 4.5cm long contact with maxilla (Fig-3, 4, 5). The lower and upper side of processes form the arc/arcs. On the left side a fossa representing matrix filled may be preantorbital antorbital fossa and fenestra (Fig-4).

Unfortunately the teeth on the premaxilla and maxilla are not preserved. One asymmetrical alveolus in the right maxilla is exposed having antero-posterior length 2cm and maximum width is 1.25cm. matching near about D shape. The two/three possible teeth of combatant are fixed on the line of bite and puncture, having anteroposterior length 2.25cm and transverse width 1cm, while the other is anteroposteriorly length 1.4 m and transverse width 7mm. The third tooth nature is which is found in matrix 1.7cm and width is 7mm. thick in the one side may be posterior side (Fig. 3, 4, 5). The rostrum is also partially weathered. The teeth are eroded away. This rostrum may have anterior dentaries because that portion is mostly covered by matrix. The combatant teeth are also suboval to oval. The large teeth are oval and relatively small show suboval nature (Fig. 4). Isolated teeth D shape and crown length and width ratio is low. Crocodilian teeth are circular to subcircular with striated teeth while the teeth of theropod are oval. The narial fossa is mostly covered by matrix and represent reaching anteriorly inclined downward. Rostrum is compressed and deep. The anterior portions of tooth rows forming V shape joint. Anterior snout V shape, not U shape. One tooth embedded in the matrix along with other bones, found in the same site with the rostrum. This tooth is compressed laterally. Tooth crown is extremely low and the ratio of the crown height to rostro-caudal width is about 1 to 1.5. Tooth anteroposterior breadth is 2.2cm, labial to lingual depth is about 1.3cm. tooth is found embedded in matrix so possible length seems to be low like 2.2 cm as broad, this is interpreted due to seeing the decreasing tooth anteroposterior breadth. The cross sectional shape of tooth is D-shape and slightly asymmetrical (Malkani, 2004d).

There are impressions of **bite** on the snout which are represented by the puncture, groove, gash, on right side and teeth implantation on left side and also there are teeth of another combatant theropod on the snout of this theropod. The puncture is great on right side and also representing teeth impressions. The preserved length and width is about 9cm and 2.5cm respectively, widening on the back and thinning a forward. The puncture is trending anteroposteriorly, located in the lower half and just below the boundary of half.

8. Discussion

Theropod lineage leading to birds (Aves) display some of the features that helped investigators establish the dinosaurian origin of birds-including in the order of their evolution, three functional toes, a three finger hand and a half moon shaped wrist bone. Archaeopteryx (150 million years old) the oldest known birds also show some new traits such as a claw on the back toes that curves toward the claws on the other toes. As later birds evolved, many features underwent change. Notably the fingers fused together, the simple tail became a pygostyle composed of fused vertebrae, and the back toe dropped enabling birds'feet to grasp tree limbs firmly (Kelvin and Chiappe, 2000).

The theropod belongs to bipedal movements while Sauropod belongs to quadrupedal movements. Further among Sauropod it is narrow guage and wide gauge. Abelisaurs are known from Gondwanaland. Two theropod dinosaurs as *Indosuchas* and *Indosaurus* are known from India. The *Indosuchas* has a crest on the fronto parietal region like *tyrannosaurus*. Walker (1964) separated *Indosuchas* from *Indosaurus* at familial level. He stressed that the narrow fronto-parietal crest in *Indosuchas* is like that of *tyrannosaurus*. However *Indosuchas* is less advanced, as the median frontal ridge is not narrow, and the prefrontals are more widely separated. Thus he suggests that Indosuchas is a *Tyranosaurus.* Huene distinguished two types of femur and tibia in the Indian allosaurid collection, one type being stouter and the other more slender. Walker believes that the slenderer variety may belong to *Indosaurus*, the stouter type of *Indosuchas.* Huene hinted that on account of inconsiderable thickness of this maxilla, it could belong to *Indosuchas*. Four premaxillary tooth are characteristics of *Tyranosaurus*, thus established their allocation to *Indosuchas*. Two type of dentaries like shallow curvature (*Indosaurus*) and greater curvature (*Indosuchas*) of the anterior region of dentary or from the jaw ramus to symphysis. Huene found two types of basioccipitals. In one the exoccipital forms the floor of foramin magnum *(Indosaurus)* and in other the exoccipitals are excluded from the floor of the foramin magnum (*Indosuchas).* It thus appears from the above discussions, that there are two carnosaurs present in the Lameta Formaton; one is *Indosasurus matley*, a megalosaur; the other is *Indosuchas raptorius*, a tyranosaur. According to Chatterjee, S. and Rudra, D. K. 1996, *Indosuchas* is referred as abelisaurids. The tooth character of Pakistani theropod tele with the *Indosuchas* and consequently with abelisaurids. Unfortunately the post cranial elements of *Abelisaurus* are unknown. Pakistani form is matching with the Indian theropod on the basis of hollow thin walled stout hindlimb bone resemble with *Carnatosaurus* and *Indosuchas*, Spherical elevated inturned head with a distinct neck, tooth crown extremely low, the ratio of crown height to rostrocaudal width is low 1.5 with *Indosuchas.*

The disjunt distribution of the titanosasurids-abelisaurids assemblage in South America, India and Europe is interesting in the context of drifting continents in Late Cretaceous time. Paleontological evidence suggests that the India and Eurasia collision took place during this time, facilitating the migration of northern fauna to India (Chatterjee, 1992, Jaeger, *et al.*, 1989; Prasad, *et al.*, 1994). Isolation between the northern and southern continents produced dramatically different distributions among dinosaurs. In contrast to northen hemisphere, the dominant herbivore in the late Cretaceous of India and South America were titanosaurids rather than ornithischian, where as the large predators were abelisasurids instead of *Tyranosaurus* (Chatterjee and Rudra, 1996).

Fossil vertebrates of Late Cretaceous age on southern continents are of particular interest because of the dynamic paleography of the period. During the Cretaceous, Gondwana broke apart into separate landmasses, isolating once-contiguous terrestrial faunas. Timing, sequence, and degree of isolation among these landmasses, however remain controversial (Smith, *et al.*, 1994; Hay, *et al.*, 1999; Maisey, 2000; Cracraft, 2001). This uncertainty is compounded by the relative scarcity of diagnostic Cretaceous vertebrate fossiols, whose relationships could offer evidence of prior geographic connections. Among southern landmasses, Cretaceous vertebrates are best documented on South America. This is largely a result of intensive investigations of strata in Argentina over the last 30 years(summarised in Bonaparte, 1978, 1996).

Sulaiman foldbelt of Pakistan is famous for Cenozoic vertebrate (Gingerich *et al.*, 2001) and new dinosaur discoveries from the Latest Cretaceous strata increase the temporal variation of its vertebrate fauna.

There are impressions of bite on the newly collected snout of which are represented by the puncture, groove, gash, on right side and teeth implantation on left side and also there are teeth of another combatant theropod on the snout of this theropod. Here is a brief description about fighting and gregarious behaviour because these features are also found in Pakistani theropod.

Tanke is a leading authority on paleopathology the study of ancient injuries and disease. He has detected a unique pattern of bite marks among theropods, the group of carnivorous dinosaurs that encompasses *T.rex* and other tyrannosaurs. These bite mark consist of gouges and punctures on the sides of the snout, on the sides and bottom of the jaws, and occasionally on the top and back of the skull. Interpreting these wounds, Tanke and Currie reconstructed how these dinosaurs fought. They believe that the animals faced off, but primarily gnawed at one another with one side of their complement of massive teeth rather than snapping from the front. The workers also surmised that the jaw-gripping behavior accounts for peculiar bite marks found on the sides of tyrannosaur teeth. The bite pattern implies that the combatants maintained their heads at the same level throughout a confrontation. Based on magnitude of some of the fossils wounds, *T.rex* clearly showed little reserve, and sometime inflicted severe damage to its conspecific foe. One tyrannosaur studied by Tanke and Currie supports a souvenier tooth, embedded in its own jaw, perhaps left by a fellow combatant. The usual subjects-food, mates, and territory may have prompted the vigorous disagreements among tyrannosaurs. Whatever the motivation behind the fighting, the fossil record demonstrates that the behavior was repeated throughout a tyrannosaur' life. Injuries among younger individuals seem to have been more common, possibly because a juvenile was subject to attack by members of his or her own age group, as well as by large adults. Nevertheless, the fossil records may also be misleading, and simply contains more evidence of injuries in young *T.rex*. Nonlethal injuries to adults would have eventually healed, destroying the evidence. Juvenile were more likely to die from adult-inflicted injuries, and they carried those wounds to the grave. From the fossil records it is not clear that theropod were predator (like Hawk) or scavenger (likeVulture) (Erickson, 2000).

Skeletal assemblages of multiple individuals shine a light on the interaction among many species. Trace fossils reveal activities through physical evidence, such as bite mark in bones and wear patterns in teeth. Also of great value trace fossils are coprolites, fossilized feces. The coprolite "smoking gun" of carnivores contains remains of a herbivore suggesting proof of species interaction. *Tyraranosaurus* are usually depicted as solitary, as was certainly the case in *Jurassic Park*. A discovery was made during the excavation of "Sue" the largest and most complete fossil T. rex ever found. Sue is perhaps as famous for her $ 8.36-million auction price following ownership boggling as for her paleontological status (see "No bones about it," News and Analysis, Scietific American, December, 1997). Remains of second adult, a juvenile, and an infant T. rex were later found in Sue' quarry. Researcher from the American Museum of Natural History in New York City working in Alberta, Canada, found a bone bed- a deposit with fossils of many individuals-holding at least nine of close relatives, albertosaurs. All of these suggest gregarious behavior i. e., it were social and not solo (Erickson, 2000).

The skull parts of *Vitakridrinda sulaimani* are found with the partial skull of adult/subadult titanosaurs (Malkani, 2003a). Its occurrences with adult/subadult titanosaur suggest that the theropod has come to the titanosaur animnal to eat. And subsequent fighting with titanosaur or other theropod may cause his death.

There are two type of head orientation in theropod, one is declined head and other is elevated frontal head. In *Vitakridrinda* elevated inturned frontal head is interpreted. Carnosaur has V shaped extensor groove comparable to depth to the flexor sulcus between the distal condyles of femur.

The present finding of a rostrum in the site of previously collected occipital condyle along with partial braincase (Malkani, 2004d) have strengthen the discovery. The theropopd skull along with braincase is significant. However it's other findings of a pair of proximal femur about 200m apart toward southwest also suggest carrying the skull here by other theropods or the transfer of leg bone by other theropod animals. The size of rostrum matches with the size of found leg bone. Recently one new genus and species of saurischian theropod abelisaurs based on hollow proximal femur (a pair), braincase and vertebrae as *vitakridrinda sulaimani* is erected (Malkani, 2004). The present discovery will be useful for generic-level comparisons and phylogenetic resolution, and Indo-Pakistan will enter in hypothesis of Gondwanan dinosaur biogeography. First and new discoveries by author from Vitakri and its vicinity areas of Pakistan have proved a well developed Vitakri Cretaceous Park for terrestrial ecosystem.

9. Conclusions

The eleven named species from the Lameta Formation of India actually represent at least three large bodied theropod *(Rajasaurus, Indosuchas, Indosaurus*) and a fourth, small bodied theropod (*Laevisuchas).* But recently from Pakistan, (Malkani 2004) reported one genus and species *vitakridrinda sulaimani* of large bodied theropod abelisaur based on hollow proximal femur (a pair, left and right), braincase and vertebrae. However the finding of rostrum of ***Vitakridrinda*** large bodied theropod dinosaur is the first from Pakistan

The first rostrum of *Vitakridrinda* from Pakistan will provide the facility of comparison along with other abelisauid and tyranosaurids from other landmasses.

First rostrum have bite mark, puncture, teeth impression and also embedded teeth can reveal the story of confrontation between *Vitakridrinda* and its combatant.

The present finding of a rostrum of *Vitakridrinda* in the site of previously collected occipital condyle articulated with partial braincase and also nearby finding of a pair (left and right) of proximal femur (Malkani, 2004) have strengthened the discovery and are significant producing useful characters for speciation and correlation. The size of rostrum matches with the size of braincase and proximal femur.

The author discovered a variety of dinosaurs from the Latest Cretaceous Vitakri member/Dinosaur beds of Pab Formation of Pakistan mainly as residual surface finds with some in situ fossils. The Mesozoic archosaur fauna although represented by fragmentary materials, include very large Sauropods, coelurosaurs and carnosaurs theropods, and mesoeucrocodilians. All of these terrestrial ecosystems of Sulaiman Latest Cretaceous Park are found in the red muds/clays rich horizon of Vitakri member/Dinosaur beds (upper member) of Late Cretaceous Pab Formation in the central Sulaiman foldbelt. The environment and vertebrate assemblages of Sulaiman foldbelt Cretaceous Park show a model of medium to large bodied titanosaurids and saltasurids, and theropods habitat along with the possible earlier mammals on the over bank fluvio-lacustrine environments, crocodile habitat in the rivers and lakes, and walking and flying birds on land and air.

The discovery of saltasaurids, abelisaurid and baurusuchid from Pakistan broadens the distribution of saltasaurids, abelisaurid and baurusuchid, and indicate close affinity with South America of Gondwanaland. So far the Late Cretaceous (Maestrichtian) Lameta Formation of India has served as the sole source of information on Cretaceous vertebrates of the Indo-Pakistan

sub-continent and their remains are inadequate for assessing generic-level affinities but the new discoveries from Pakistan have produced a large number of well preserved fossils, and are useful for research like paleobiogeographic reconstruction, phylogeny, tephonomy, depositional environments and KT boundary.

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Hydrochemistry of Snowmelt in Sudhanoti and Poonch Districts of Azad Jammu and Kashmir, Pakistan

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Abstract

A study was conducted to assay the quality of snowmelt in Sudhanoti and Poonch Districts of Kashmir, Pakistan. In this area, primary source of water for drinking and agricultural use is rain, snowfall and snowmelts. Physicochemical parameters; pH, dectrical conductivity (EC), total dissolved solids (TDS), total hardness (TH) HCO_3^-, CO_3^{2-}, Cl^-, SO_4^{2-}, NO_2-N, NO_3-N, Kjeldahl nitrogen (KN), orthophosphate (o-PO4), acid hydrolysable phosphate (t-PO4), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{2+}, Cu^{2+}, Ni^{2+}, Zn^{2+}, Pb^{2+}, Cd^{2+}, and Co^{2+} were determined. Chemical analyses of the snowmelts indicate the presence of major ions as: $Ca^{2+} > Na^+ > Mg^{2+} > K^+ = HCO_3^- > SO_4^{2-} > Cl^- > NO_3^- > CO_3^{2-}$. Ternary plot on elemental composition indicates Ca – Na – Mg – HCO_3^- /CO_3, Ca – Na – SO_4 and Na – Cl as the dominant hydro chemical types; while salinity hazard index sets the criterion for its agricultural utility. Higher concentration of SO_4^{2-} and pH < 7 manifests the effect of industrial pollution as acid rains on hydrological cycle.

Keywords: Snowmelt hydrochemistry, Kashmir, Pakistan

1. Introduction

Pallandri, the sub-division of Sudhanuti District is situated at 1372 m above sea level and is located 97 Km off Rawalpindi, Pakistan. Trarkhal is a small town situated 129 Km from Kohala and 1982 m above sea level. Rawalakot, the district headquarter, is situated in the heart of District Poonch at 1615 m above the sea level. The area of Poonch District is 855 Km^2, population 0.449 million and population density 525 persons /Km^2. The area of Sudhanoti District is 569 Km^2, population 0.242 million and population density 425 persons/Km^2. The average rainfall is 15cm. The quality of water has linear correlation with ecological and anthropogenic factors (Hem, 1985; Hymavathi *et al.*, 1999) while describing the water quality of the stream Mudasarlova, India and Sastre *et al.,* (Sastre *et al.,* 1988) have reported the study of surface run off. Mirza *et al.,* (Mirza *et al.,* 2006) reported physicochemical study of pond and rainwater in Distict Bhimber but the quality of water of Sudhanoti and Poonch Districts is under studied. The present work examines the effect of physicochemical characteristics of snowmelts on the quality of water.

2. Climate of the Area

The state of Azad Jammu and Kashmir stretches between longitude 73º - 75º and latitude 33º - 36º and the altitude rises steeply from 360 meters to 6325 meters above sea level. There are the hot plains of the Bhimber and Mirpur districts and coldest lands of Kel, Taubat, Sharda, Leepa, Forward Kahuta, Rawalakot, Pallandri, Trarkhal, Fatehpur etc. The area has different weather conditions at different places because of the lofty mountains like the Pirpanjal that check the moisture-laden winds from entering the valleys. In summers, the outer plains and hills receive rainfall from monsoon winds while in winters, winds from the Mediterranean cause snowfall and rainfall in the Valleys of Kashmir causing sub zero temperatures [Mirza *et al.*, 2006].

3. Geology of the Area

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The area consists of Siwalik group of rocks in mostly the western part of the Poonch District along with the eastern bank of the Jhelum River. These rocks crop out between Kohala and Azad Pattan. The eastern contact runs in an irregular fashion from Hajeera through Rawalkot to Dhirkot. The rocks consist of granite and crystalline groups. The rocks of the area and mainly composed of chlorite, muscovite schists, mica granite, sand stone, quartzite, calcite, pyrite, etc (Chaudhry and Ashraf, 1984).

4. Sampling

Before sampling a detailed survey of the area was undertaken. Sampling location and in situ testing of physicochemical parameters was carried out in order to plan proper sampling strategy. The objective of the field survey was to locate and select the sampling stations for the study. Pallandri, the district head quarter of Sudhanoti, Trarkhal town and Rawalakot, district head quarter of Poonch were selected as sampling stations.

The sampling was carried out in February-March 2005. Samples were collected in pre-washed high-density polythene containers directly, from selected locations. Field measurements included pH, EC, TDS, and DO, Cl^-, hardness and bicarbonates. For elemental analysis each sample was acidified to pH<2; for organic matter, fixed with $HgCl_2$. Separate samples were taken for specific analysis.

5. Experimental

Dissolved oxygen (DO) in the samples was determined by Wrinkler method (APHA, 1989). Chemical oxygen demand (COD) was estimated by micro-dichromate oxidation method. Hardness, chloride and alkalinity were determined by titration with standard E.D.T.A, silver nitrate and hydrochloric acid. Conductivity, salinity and total dissolved solids (TDS) were evaluated with Orion 115 conductivity meter. The pH was recorded with Orion 420 A pH meter. Kjeldahl nitrogen was determined by using standard procedure (APHA, 1989). Orthophosphate, nitrate and nitrite were determined by spectrophotometery. Orthophosphate was determined by reducing phosphomolybdic acid formed with ascorbic acid to molybdenum blue. Total phosphate was estimated by persulphate acid hydrolysis, followed by determination as for orthophosphate. Nitrate was determined after derivatization with brucine sulphate. Nitrite was estimated using N-naphthyl ethylenediamine as derivatizing reagent as reported (APHA, 1989). Sulphate was determined by turbidimetery as $BaSO_4$ using Hitachi 220 spectrophotometer. The metal ions Na, K, Ca, Mg, Fe, Pb, Cu, Zn, Ni, Cd, and Co were determined with Varian Spectr AA-20 atomic absorption spectrometer with standard burner head and air acetylene flame at the conditions recommended by the manufacturer. The analysis was carried out in triplicate with integration and delay time 3 seconds each. Na, K, Ca and Mg were determined after appropriate dilution. Sample (250ml) containing nitric acid (1ml) was heated gently at 90- 95ºC and was concentrated to about 5-8ml. The solution was transferred to volumetric flask and final volume was adjusted to 10 ml. The solution was analyzed for the contents of Fe, Pb, Cu, Zn, Ni, Cd, and Co by air acetylene flame atomic absorption spectrometer.

6. Results and Discussion

The pH varied between 6.28- 6.5 in one hydrological year with average value 6.36.The pH < 7 may be because of acidic rains due to natural phenomenon (oxidation process during thunder and lightening) and anthropogenic activities but fall within the WHO water quality standards (Table-1). The electrical conductivity (EC) and total dissolved solids (TDS) (Table-1) indicate insignificant inter sample variation. EC and TDS varied within the range 13 - 20µS/cm and 8.32–12.8mg/L. However, EC & TDS values were observed within prescribed limits of WHO [WHO, 1971, 1983].

Table 1. Analysis of physicochemical parameters of snowmelt from three sampling stations of Azad Jammu and Kashmir, Pakistan.

Parameters	Pallandri S_1	Trarkhal S_2	Rawalakot S_3	Mean
PH (25^{0}C)	6.500	6.300	6.280	6.360
EC µS/cm	55.000	50.000	45.000	50.000
TDS mg/L	35.200	32.000	28.800	32.000
HCO_3 mg/L	BDL	BDL	BDL	BDL
TH mg/L	23.000	21.000	20.000	21.333
Cl mg/L	3.200	2.900	2.800	2.967
SO_4 mg/L	12.430	9.110	8.001	9.847
NO_3 mg/L	BDL	BDL	BDL	BDL
o-PO_4 mg/L	BDL	BDL	BDL	BDL
t-PO_4 mg/L	BDL	BDL	BDL	BDL
DO mg/L	8.230	7.880	8.448	8.186
BOD mg/L	BDL	BDL	BDL	BDL
COD mg/L	BDL	BDL	BDL	BDL
Na mg/L	0.19	0.21	0.217	0.206
K mg/L	0.111	0.06	0.037	0.069
Ca mg/L	1.99	1.89	1.671	1.850
Mg mg/L	0.14	0.13	0.105	0.125
Fe mg/L	0.095	0.082	0.072	0.083
Cu mg/L	0.011	0.013	0.017	0.014
Zn mg/L	0.016	0.020	0.010	0.015
Ni mg/L	0.020	0.021	0.019	0.020
Pb mg/L	0.092	0.082	0.093	0.089

Table 2. Statistical description of physicochemical parameters of snowmelt in Azad Kasmir.

Parameters	Min.	Max.	Mean	Range	Count	Median	SD	SV
PH	6.28	6.50	6.36	0.22	3	6.3	0.122	0.015
EC µS/cm	45	55	50	10	3	50	5	25
TDS mg/L	28.8	35.2	32	6.4	3	32	3.2	10.24
HCO_3 mg/L	0.00	0.00	0.00	0.00	3	0.00	0.00	0.00
TH mg/L	20	23	21.33	3	3	21	1.53	2.33
Cl mg/L	2.8	3.2	2.97	0.4	3	2.9	0.21	0.04
SO_4 mg/L	8.001	12.43	9.87	4.429	3	9.11	2.305	5.311
NO_3 mg/L	0.00	0.00	0.00	0.00	3	0.00	0.00	0.00
o-PO_4 mg/L	0.00	0.00	0.00	0.00	3	0.00	0.00	0.00
t-PO_4 mg/L	0.00	0.00	0.00	0.00	3	0.00	0.00	0.00
DO mg/L	7.88	12.24	8.186	0.568	3	8.23	0.286	0.082
BOD mg/L	0.00	0.00	0.00	0.00	3	0.00	0.00	0.00
COD mg/L	0.00	0.00	0.00	0.00	3	0.00	0.00	0.00
Na mg/L	0.19	0.217	0.206	0.027	3	0.21	0.014	0.0002
K mg/L	0.037	0.111	0.069	0.074	3	0.06	0.038	0.001
Ca mg/L	1.671	1.99	1.850	0.319	3	1.89	0.163	0.027
Mg mg/L	0.105	0.14	0.125	0.035	3	0.13	0.018	0.0003
Fe mg/L	0.072	0.095	0.083	0.023	3	0.082	0.012	0.0001
Cu mg/L	0.011	0.017	0.014	0.006	3	0.013	0.003	9.33
Zn mg/L	0.01	0.02	0.015	0.01	3	0.016	0.005	2.53
Ni mg/L	0.019	0.021	0.02	0.002	3	0.02	0.001	1.00
Pb mg/L	0.082	0.093	0.089	0.011	3	0.092	0.006	3.7
Cd mg/L	0.08	0.107	0.092	0.027	3	0.09	0.014	0.0002
Co mg/L	0.052	0.07	0.061	0.018	3	0.06	0.009	3.13

Min = minimum, Max = maximum, SD = standard deviation, SV = sample variance

Kjeldahl nitrogen (K N), nitrite and nitrate are different forms of nitrogen and may be present in the water due to the decomposition of proteinous compounds that enter in wastewater (Voznaya, 1981). Presence of nitrogen of mineral origin is rare in natural waters and presence of nitrogen compounds like Kjeldahl nitrogen, nitrite and nitrate in water indicate pollution by domestic wastewater. Nitrate nitrogen is highest oxidized form of nitrogen in water and WHO standards prescribe 10 mg/L as maximum permissible nitrate concentration of potable water (Fresenius, *et al.,* 1988). Nitrogen is first fixed from the atmosphere and then mineralized by soil bacteria into ammonia. Under aerobic conditions nitrogen is finally converted into nitrate by nitrifying bacteria (Tindall *et al.,* 1995). The consequences of high concentration of nitrogen in drinking water are toxic and cause

blue baby disease, methaemoglobinaemia in children and gastric carcinomas (Comly, 1945; Gilly *et al.,* 1984).

Nitrite and Kjeldahl nitrogen are highly toxic forms of nitrogen. Maximum permissible limit of WHO for both is 1.0 mg/L. Nitrate and Kjeldahl nitrogen were found absent in all the selected samples [Table 1,2]. Nitrite nitrogen indicated values within 0.00 – 0.021mg/L and average value of 0.007 mg/L and was well within the prescribed limits for drinking water.

The DO values range from 7.88 – 8.45 mg/L with an average value of 8.19 mg/L. The BOD and COD were found absent in the samples [Table 1, 2].

The chloride concentration of snowmelt varied between 2.8-3.2mg/L and average value was observed 2.97mg/L. Sulfate concentration range from 8.001 – 12.43mg/L with average value of 9.847 mg/L. No significant inter sample changes were observed in sulfate content [Fig. 1].

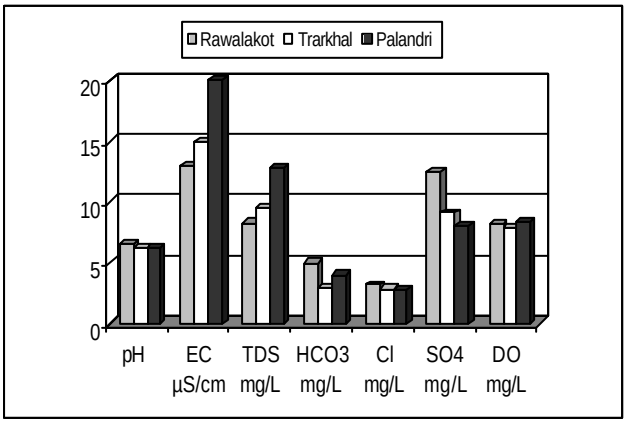

Fig 1: Inter-sample variation in pH, EC, TDS, HCO_3, Cl, and SO_4 DO contents.

All the values of chlorides and sulfates were within WHO (WHO, 1971, 1983) drinking water standards. Orthophosphate and total phosphate were not detected [Table 1].

The concentration of Na^+, K^+, Ca^{2+}, and Mg^{2+} varied moderately within the samples and Ca^{2+} was dominant throughout [Table1, 2] [Fig. 2,4]

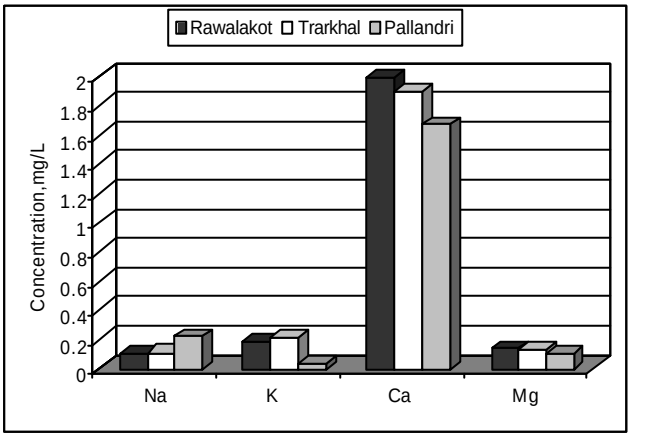

Fig 2: Inter-sample variation in the DO, BOD, COD, Na, K, Ca and Mg contents.

in the following order: $Ca^{2+} > Na^+ > Mg^{2+} > K^+$. The concentration range for the samples investigated varied within Ca^{2+} 1.67 – 1.99 mg/L; Na^+ 0.19 – 0.217 mg/L; Mg^{2+} 0.105 – 0.140 mg/L, and, K^+ 0.0370 – 0.111 mg/L [Table 1].

Minor elements like Cu^{2+}, Ni^{2+}, Zn^{2+}, Fe^{2+}, and Co^{2+} lye within the permissible limits of WHO for metal ions. Lead (0.082-0.093mg/L) and cadmium (0.08-0.107mg/L) exceed the

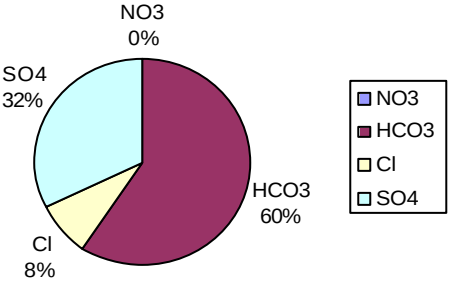

Fig 3: Pie graph showing relative abundance of major anions.

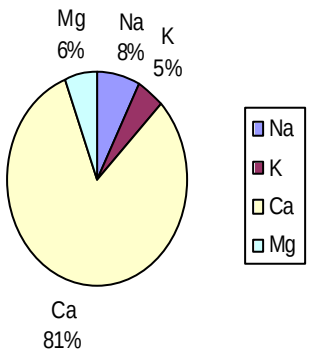

Fig 4: Pie graph showing relative abundance of major cations.

permissible limits (0.01mg/L) and (0.005) mg/L respectively. The metal ions were measured as Fe^{2+} 0.072-0..095mg/L; Cu^{2+} 0.011-0.017mg/L; Zn^{2+} 0.010-0.02mg/L; Ni^{2+} 0.019-0.021mg/L; Co^{2+} 0.052-0.07mg/L; Pb^{2+} 0.082-0.093mg/L and, Cd^{2+} 0.08-0.107 mg/ml in the following order:

Fe > Pb > Cd >Co > Ni > Zn > Cu [Fig. 5 & 6].

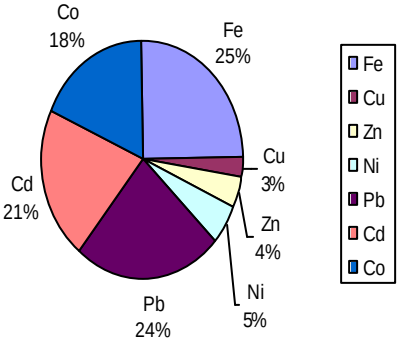

Fig 5: Pie graph showing relative abundance of minor cations.

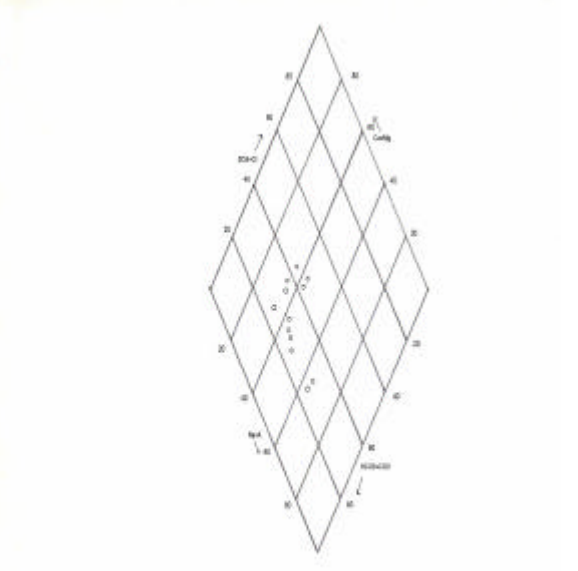

Fig 6: Ternary diagram showing the distribution of major ions.

7. Mass Charge Balance of Major Ions

Mass charge balance of major cations and anions was calculated considering concentrations in meq/L. The sequence of the abundance of major ions was in the following order:

$Ca^{2+} > Na^{+} > Mg^{2+} > K^{+} = HCO_3^{-} > SO_4^{2-} > Cl^{-} > NO_3^{-}$ [Fig. 3, 4].

Major cations and anions indicated concentrations 0.154meq/L and 0.183meq/L respectively. Hence it is suggested that a mass charge balance between major captions and anions is maintained in the snowmelt.

8. Irrigation Water SuitabilityAlkalinity and Salinity Hazards

The snowmelt samples were also tested to ascertain their suitability for irrigation. Two parameters EC and TDS were specifically monitored as these are lineally correlated and are a measure of salinity hazard to crops. Since it reduces osmotic activity of plants and interferes with the absorption

of nutrients [Saleh *et al.*, 1999] sodium adsorption ratio (SAR) was specifically calculated to determine the suitability of snowmelt for irrigation as per the following expression:

$$SAR = \frac{Na^{+}}{(Ca^{2+} + Mg^{2+})^{1/2}/2}$$

(The concentrations are in meq/L.)

The SAR values range from 0.054-0.56 with an average value of 0.055 during one hydrological year (2004-2005). Snowmelt samples fall in the low sodium class. This implies that no alkali hazard is anticipated to the crops. If the SAR value is greater than 6-9, the irrigation will cause permeability problems on shrinking and swelling of clay types (Saleh *et al.*, 1999).

9. Sodium %

The sodium percentage (Na %) is defined by

$$Na\ \% = \frac{(Na^{+} + K^{+})\ 100}{(Ca^{2+} + Mg^{2+} + K^{+} + Na^{+})}$$

where all the concentration are expressed in meq/L.

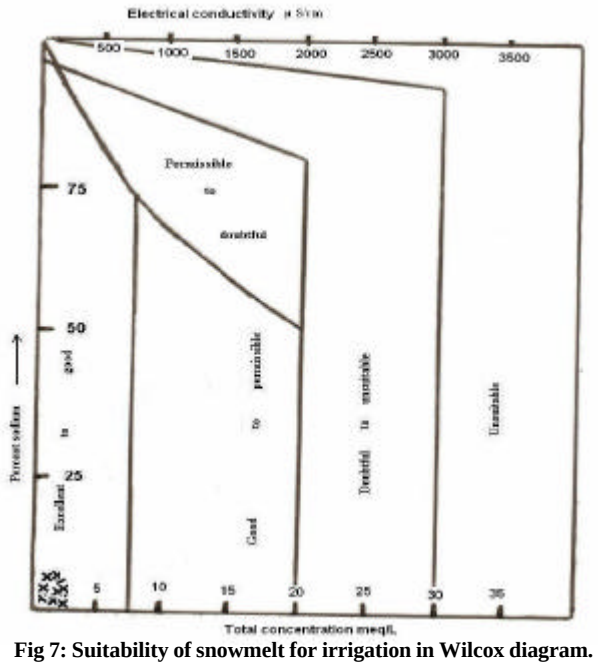

Fig 7: Suitability of snowmelt for irrigation in Wilcox diagram.

The average sodium % of the snowmelt was 9.4 i. e. < 20 indicating that the snowmelt is ideally suitable for irrigation (Ragunath, 1987) [Fig. 7].

10. Conclusion

Hydro chemical analysis of snowmelt during a hydrological year compared to the general quality of drinking and irrigation water as reported earlier (Mirza *et al.*, 2006) indicate a mixed abundance of alkali and alkali earth cations and anions as HCO3 and SO4 in the following order:

$Ca > Na > Mg > K = HCO_3 > SO_4 > Cl > NO_3$. This is attributed mainly to the geochemical interaction of the snow.

Alkali earth ($Ca^{2+} + Mg^{2+}$) = 0.103 meq/L) exceed alkalis ($Na^{+} + K^{+}$) = 0.011 meq/L) and weak acids ($HCO_3^{-} + CO_3^{2-}$) = 0.170 meq/L) exceed strong acids ($Cl^{-} + SO_4^{2-}$) = 0.066 meq/L). Thus the type of snowmelt is $Ca - Mg - HCO_3^{-} / CO_3^{2-}$.

The concentrations of major ions are within the permissible limits of drinking water quality standards, while minor metal ions lead and cadmium exceed threshold values. Kjeldahl nitrogen and nitrite nitrogen concentrations were found below detection limits. Sodium adsorption ratio (SAR) and sodium percent (Na %) make snowmelt suitable for agricultural use.

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SURJ

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Incidence of Infectious Bronchitis Disease in and around Hyderabad

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Abstract

The study was conducted to determine the incidence of infectious bronchitis a viral disease at different broiler farms of Hyderabad district from 1999-2001. The survey was made at regular intervals for the presence of IBV disease and from the official record of the Disease Diagnostic Laboratory of Directorate of Poultry Production Hyderabad, Sindh. Among the 25 surveyed farms a total of 463100 birds examined out of which 982 birds were affected. Whereas the total mortality recorded was 0.16%. The highest mortality rate (0.19%) was recorded from commercial broiler farms of Hala , while lowest mortality rate was from T. Allahyar (0.13 %). Whereas it was observed that highest number of birds infected were in Hala (0.25%) and lowest in Tando Allahyar (0.18%). It was also recorded that the highest percentages of birds survived the infectious bronchitis virus disease were from Tando Allayar (23.95%) whereas lowest were from Tando Muhammad Khan (17.97%).

Keywords: Incidence, infectious bronchitis, broiler farms, Hyderabad

1. Introduction

The Commercial broiler farming is widely practiced in Pakistan and has made the considerable contribution in the economy of country. Until 1964 poultry production was a cottage industry in Pakistan. The management and production on modern scientific lines was not known and disease control measures were also not sufficient. Due to the insufficient marketing system and unhygienic conditions the poultry industry is facing different problems including the incidence of various viral and bacterial diseases.

Infectious bronchitis (IB) is an acute, rapidly spreading, highly contagious respiratory disease caused by infectious bronchitis virus (IBV), which belong to corona virus group is worldwide in distribution and has numerous serotypes. It is an enveloped, single stranded RNA virus. The virus is fairly labile (fragile) being easily destroyed by disinfectants, sunlight, heat and other environmental factors. IB virus is spread by the respiratory discharges and feces. Spread of the disease through a flock is very rapid and transmission from farm to farm is related to the airborne droplets, ingestion of contaminated feed and water, and contaminated equipment and clothing of persons handling birds and movement of vehicles from farm to farm. Following infection, chickens may remain carriers and shed the virus have been found in several countries (Cook *et al.*, 1996). Earlier reports indicated that IB was primarily a disease of young chicks. However, it was later observed to be common in semi-immature and laying flocks (Broadfoot *et al.*, 1956). Many times, the IB virus may spread through the flock without producing obvious clinical signs of disease except a mild cough. However, the disease is characterized by respiratory signs including gasping, coughing, sneezing, tracheal rales, and nasal discharge. In young chickens, severe respiratory distress may occur. In layers, respiratory distress, decrease in egg production, and loss of internal egg quality and eggshell quality are reported. In broiler chickens, IBV infection is a major cause of poor feed conversion, reduced growth rate, and condemnation of meat at processing. Nephropathogenic strains can produce interstitial nephritis with high mortality (up to 60%) in young chickens. In most outbreaks, however, mortality rate is 5%.

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The incidence is not constant through out the year, being reported more often during the cooler months. Vaccines were first used in the 1950s to reduce the losses. Prevention of IB is best achieved through an effective vaccination program modified live vaccines to provide immunity to the flock.

The objective of this work deals with outbreaks of avian IB that occurred among commercial broiler flocks in Sindh during 1999-2001.

2. Materials and methods

1. Experimental material and source of data.

Three years data from 1999-2001 was collected from 25 commercial broiler farms of district Hyderabad. Five farms each were randomly selected from Hyderabad, Hala, Tando Mohammad Khan, Tando Allahyar and Tandojam to record the incidence of infectious bronchitis. The data was collected by regular survey of these farms and from the official record of the Disease Diagnostic Laboratory of Directorate of Poultry Production Hyderabad, Sindh. This data was statistically analyzed to study the year wise occurrence of Infectious bronchitis virus disease in commercial poultry farms for following parameters.

1. Number of birds examined for Infectious bronchitis disease

2· Number of birds affected with Infectious bronchitis diseases

3. Number of birds died due to Infectious bronchitis diseases

4. Number of birds survived from Infectious bronchitis diseases

The following formula for calculating percentage, number of birds affected, died, and survived according to the method suggested by Halpin (1975) to document the incidence of infectious bronchitis among the farms surveyed.

No: of birds affected

1-Percentage of birds affected =---------- X 100

No: of birds Examined

No of birds died

2- Percentage of birds died = ----------X 100

No of birds affected

No of birds survived

3-Percentage of birds survived = --------- X 100

No of birds affected

3. Results and discussion

The Table 1 revealed that during the present investigation a total of 463100 birds were examined for infectious bronchitis virus disease in five different cities of Hyderabad district. According to these results highest mortality rate (0.19%) (Fig-1) was recorded from commercial broiler farms of Hala city, while lowest mortality rate was from Tando Allahyar (0.13 %), (Fig.1) while highest number of birds were infected in Hala city (0.25%) and lowest was recorded in Tando Allahyar city (0.18%), (Fig.1). The highest percentages of birds were survived from infectious bronchitis virus disease from Tando Allayar city (23.95%) while lowest were from T.M Khan (17.97%). (Fig.1). These results are in agreement with the findings of Wang *et al.,* (1996), they isolated seven strains of infectious bronchitis virus from 5 broiler farms in Taiwan during 1992; the signs of disease recorded in broilers were respiratory distress, renal urate deposition and death.

Infectious bronchitis is a highly infectious viral disease characterized by respiratory symptoms increased mortality and decreased egg production (Butcher *et al.,* 1990). This could occur at any stage

of the chicken's life and during any season of the year. However, it was found to be more prevalent (35.7 %) in 7 days to 5 weeks of age with special reference to its higher incidence (66.6%) in the winter.

Name of city/ Town	No. of birds examined	No. of birds affected	(%) of Birds affected	No: of birds died	No. of birds survived	(%) of Birds survived	Mortality (%) on total no: of birds examined
Hyderabad	127100	260	0.20	201	59	22.6	0.15
Hala	66800	167	0.25	128	39	23.35	0.19
T. M. khan	83300	178	0.21	146	32	17.97	0.17
T. Allayar	96200	182	0.18	133	49	26.92	0.13
Tando Jam	89700	195	0.21	148	47	23.95	0.16

Table 1. Number of birds examined, affected, died, survived and over all percentage of mortality

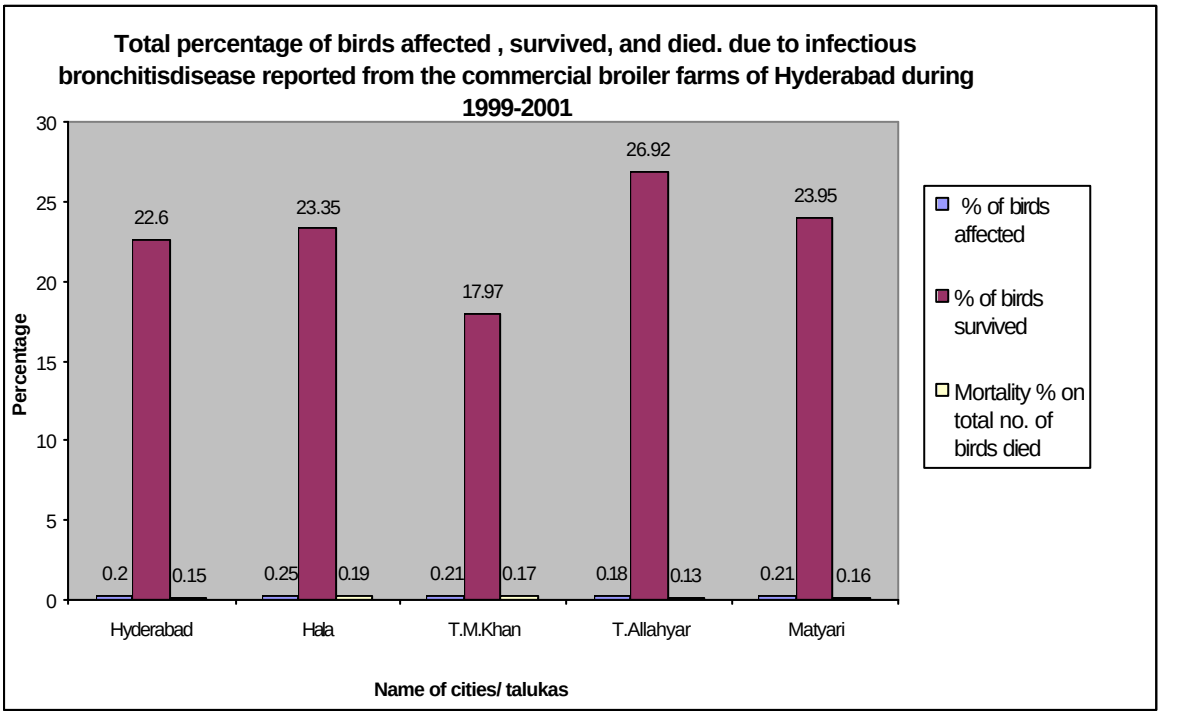

Fig.1. Rate due to infectious bronchitis reported from the commercial broiler Farms of Hyderabad during the 1999 - 2001.

The higher incidence in young chicken was attributed to poor immunity development during the first few weeks of life. Similarly, winter conditions could have also favored the incidence of infectious bronchitis because of stressful conditions; however the maintenance of a healthy environment would further reduce the incidence of the disease. As a second line of defense, chickens in infectious bronchitis problem areas should be

vaccinated with modified live vaccines to provide protection. The multiplicity of serotypes identified in the field presents a challenge in designing an effective vaccination program. To be successful in protecting chickens against challenges it is essential to determine the cross- protective potential of available vaccines.

In Australia, two genotypically distinct groups of strains have been described, some of them exhibiting nephro-pathogenicity (Sapats *et al.*, 1996), in Japan, infectious bronchitis virus strains with additional tropism for tissues other than the respiratory tract have been described (Ostsuki *et al.*, 1990). Several variant serotypes isolated from commercial broilers were described by (Gelb *et al.*, 1991), whereas enterotropic strains of infectious bronchitis virus have also been reported in the U.S. (Karaka *et al.*, 1990; Lucio and Fabricant, 1990), and in England (Ambali and Jones 1990; Ambali, 1992).

However, even when IBV is detected in an IBV-suspected flock, it is important to exclude other possible (infectious and non-infectious) causes of the disease to minimize the risk of confusing a sub-clinical IBV infection or long-term recovery with the real cause of the disease. A permanent monitoring of circulating strains would be advisable in order to adapt the vaccination scheme to the field situation. However, on the basis of past experience and the complexity of the interactions between these predisposing factors, it is virtually impossible to predict the emergence of future infectious diseases. Despite this uncertainty, we do have the current technological capability to rapidly respond to emerging infectious diseases in terms of identification and diagnostic techniques and, to a lesser degree, with vaccines and therapeutic agents.

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S U R J

Pesticide toxicity associated with health conditions of the farmers in Sindh, Pakistan

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Abstract

Pesticide spray by the farmers in agriculture sector is at large scale, which may alter their health. This work was aimed to assess the health conditions among two groups of the farmers; the subject group comprised 'pesticide spray-workers' and the volunteer controls were those away from this occupation. This study indicated the major difference in health status of the subject and control groups hence revealed the pesticide effects on major organ systems of their body. Conclusively the ill health conditaions of the farmers associated with pesticide exposures seem enhanced due to certain allied factors i.e. poor diet, inappropriate protective measures and hot climate. Therefore legislation for Toxic Exposure Surveillance Program (TESP), Crop Management (CM) and Integrated Pest Management (IPM) is suggested for safety of farmers' health.

Keywords: Pesticides, Farmers' health.

1. Introduction

Farmers are reported be involved in pesticide spray over 13.40 million acre cultivated lands in Sindh province of Pakistan hence their health may be affected. They are totally dependent on the success of their crop for their subsistence or livelihood and again depend on good health to produce it. However, a number of the pesticides commonly used are toxic by virtue of their mode of action and so would be expected to negatively affect the health of individuals exposed either directly or indirectly. There are hundreds of chemical compounds marketed as insecticides, fungicides, herbicides, and pesticides causing disorders ranging from topical irritant reactions to complex systemic illness (O'Malley, 1997). One of the crucial problems in developing countries including Pakistan concerns the use of highly toxic pesticides, the use of which very often has been restricted or even banned in the industrialized world (Wesseling, 1997). Beside this the causal factors contributing to acute occupational pesticide poisoning are seen common. This include; sloppy handling during the preparation and spraying of pesticides, using highly toxic pesticide in higher concentrations, direct contact with sprayed crops, going forward against wind during spraying, lack of personal protection and poor personal hygiene (Chen, 1991).

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Farmers are generally unaware of the actual short term or long term exposure hazards associated with many pesticide products. After exposures the immediate impacts on health can appear which include; vomiting, head ache, sweating irritation of skin, eye, and respiratory tract, and fatigue. Acute and chronic types of pesticide poisoning have been distinguished according to the risk of pesticide use. The improper use of pesticides and inappropriate protective measures may engender biological effects beyond those for which they were originally manufactured. Adverse effects of agrochemicals may be caused not only by their active ingredients and the associated impurities, but also by solvents, carriers, emulsifiers, and other constituents of the formulated product (WHO/UNEP 1990 and Al-Saleh, 1994).

Pesticide exposure effects are remarkable and have not been seriously noticed in local farmers, which may lead to negative health impacts and in turn hinder their productivity towards overall diminished crop production. Among those who do

not recognize health Impairment as one of the chronic effects of pesticide exposure will not balance the effectiveness of the pesticides being used on their farm against the risks involved. Therefore the prime objective of this work was aimed around health conditions of the farmers associated with pesticide toxicity, to investigate the extent of the problem and to suggest ways and means for its mitigation.

2. Methodology

Selection of respondents: age matched two groups of farmers were selected separately as respondents; the controls (n=160) were those who in similar environmental and socio-economical conditions were away occupationally from pesticide sprays. the subjects (n=240) with occupational history of at least two years as pesticide spray-workers and three months consistent working in agriculture fields were selected. this was based on their exposure to various pesticides during handling, mixing, loading and spraying over the crops including cotton, vegetable, rice and fruit farms. all male farmers inclusive both groups were interviewed during the selected area visits. The data were collected by author observation and recalling from memory details of their health conditions. They were inquired about dietary habits adapted by them according to their socio-economical conditions. occupational information of the 'subject' respondents was collected about the pesticide products: spray-tools., number of exposures with duration and protective measures taken while spraying their crops; a minimum number of ten farmers in study areas were selected from two distant locations of each district; finally findings reported by the farmers and observed by the author were noted and summarized in the results.

Study Area: Agriculture fields from fourteen districts of Sindh province included in this study i.e. Badin, Dadu, Ghotki, Hyderabad, Jacobabad, Khairpur, Larkana, Mirpurkhas, Nawabshah, Noshehroferoz, Sanghar, Shikarpur, Sukkur and Thatta.

3. Results

Farmer population in this work was between 20 to 60 years of age, initially all the 'subjects' and 'controls' were observed for their diets; they take twice a day in common. The diet include one bread (chapatti) of either wheat or rice with; (i) vegetable, ii) dairy products (milk and lassie) (iii) both vegetable and dairy products and (iv) mixed contents (meat/fish/chicken); thus divided into four 'diet variety groups'. The farmer's percentages of both groups who take various diets are shown in Figure 1.

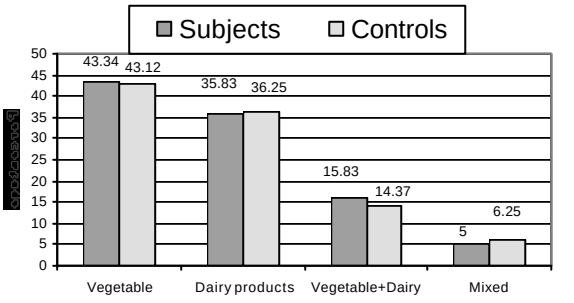

Figure 1. Bar graph shows the diet variety groups and adapting percentage of the Subjects and Controls.

It was noted that the 'backpack spray tanks' as pesticide application tool was used by 95% of 'subjects' in this study. The timings for pesticide spray on crops preferred by them observed over study areas were; morning hours mostly from 6 to 11 A.M. But less than 10% were found engaged at evening time as well. In duration of this work overall 20 pesticide products of organophosphates, pyrethroids, organochlorines, carbamates and miscellaneous groups of agro-chemical compounds were sprayed and/or mixed through water flow in the fields by the subject farmers. Figure 2 shows usage scale in percentage for each pesticide groups.

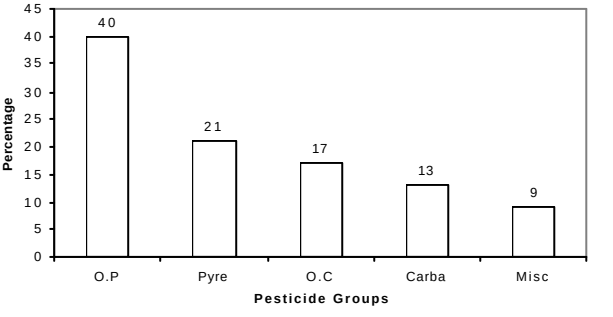

Fig. 2. Bar graph shows the percentage of pesticide groups used bythe subject farmers.

During spray the subjects put on sunglasses and cloth mask (of towel/handkerchief/shawl), either single or both as protective measures only. Among 240 a total of 91 had cloth mask, twenty-two reported with sunglasses and 127 appeared without any production

Table 1. District wise position shows behavior of the farmers (Subjects only) toward protective measures while spraying their cops.

S. No.	Districts surveyed	No. of farmers	Cloth mask	Sunglasses	None-protection	Protective measures %
1	Badin	27	08	-	19	29.62
2	Dadu	16	04	03	09	43.75
3	Ghotki	13	04	01	08	38.46
4	Hyderabad	23	06	02	15	34.78
5	Jacobabad	09	02	03	04	55.55
6	Khairpur	25	08	07	10	60.00
7	Larkana	10	06	-	04	60.00
8	Mirpurkhas	22	04	02	16	27.27
9	Nawabshah	12	07	01	04	66.66
10	Noshehroferoz	13	09	01	03	76.92 **
11	Sanghar	20	11	-	09	55.00
12	Shikarpur	15	03	01	11	26.66 *
13	Sukkur	18	10	01	07	61.11
14	Thatta	17	09	-	08	52.94
	Total	240	91	22	127	47.08

* Minimum and ** Maximum percentage of protective measures taken by the farmers.

A significant number of surveyed subjects reported their health status with more tendency of suffering from acute illness. The comparative data for health conditions reveals percentage differences in organ/systems illness problems between exposed subjects and unexposed controls, which is given below in Table 2.

Organ/Systems	Subjects	Controls
Eyes	(57) 23.75%	(5) 3.12%
Skin	(48) 20.0%	(7) 4.37%
Respiratory tract	(42) 17.50%	(8) 5.0%
Nervous system	(22) 9.16	(4) 2.5%
Gastrointestinal tract	(20) 8.33%	(6) 3.75%
Total	**(189) 78.74%**	**(30) 18.75%**

Table-2. Health problems in percentage as experienced by the number of subjects and controls

The exposure effects and their ratio with illness were detected in the subject farmers. Table 3 unveils the exposures and illness ratio of variances in the subject farmers, hence, alphabetical ranking positions indicate level of population affected at each district.

Table- 3. District wise position of farmers in ranks detected with ratio of variances for exposures and Illness.

District	Ratio of Variances		Area Ranking
	Exposures	Illness	
Badin	1: 1.26	1: 1.71	C
Dadu	1: 1.26	1: 1.78	C
Ghotki	1: 1.68	1: 1.78	CB
Hyderabad	1: 1.90	1: 2.57	B
Jacobabad	1: 2.46	1: 3.07	A
Khairpur	1: 1.54	1: 2.80	B
Larkana	1: 1.20	1: 1.53	C
Mirpurkhas	1: 2.56	1: 2.83	AB
Nawabshah	1: 1.47	1: 2.23	CB
Noshehroferoz	1: 1.38	1: 2.16	CB
Sanghar	1: 1.00	1: 1.35	C
Shikarpur	1: 2.33	1: 3.90	A
Sukkur	1: 1.44	1: 1.85	C
Thatta	1: 1.08	1: 1.66	C
Total	**1: 1.52**	**1: 2.22**	**B**

4. Discussion

Although 'subjects' expressed concern about the health impacts after using pesticides but in general thought the benefits outweighed the risks. Only few had no concern about the impact of pesticide use on their health. Controls' health history was based on their memory, which they expressed if had any illness pertaining to specified organ/system in a similar environment. In this work the subjects had prominently greater incidence of organ/system disease when compared to control group as shown in Table 2. The subjects' exposure and proximity to pesticide groups may be an important matter contributing to these higher rates of health effects.

Present results show the organophosphates as dominating group of pesticides experienced by the subject farmers (Figure 1). Being cholinesterase enzyme inhibitors they produce neurological problems towards significant morbidity and mortality following accidental or suicidal exposures (Singh, 2000). Greater percentage of affected nervous system, respiratory tract and gastrointestinal tract in the subjects seen in this study as indicated in Table 2, were also reported similarly by Kishi, *et al.*, 1995 among the Indonesian farmers. Consistent health conditions at different regions were also recorded by few more authors (Rosenthal, *et al.*, 1991, O'Malley, 1990 and Azaroff *et al.*, 1999). Having this type of toxicity association, other cholinesterase inhibitor group carbamates were also experienced by the subjects in Sindh province, hence their simultaneous toxic role in addition can not be ignored. The pyrethroids are not classified being as hazardous as cholinesterase inhibiting pesticides but reported to cause acute adverse effects among spray workers in

China(Chen *et al.* 1991) and Ecuador (Cole *et al.* 2000). Allergic and other signs/symptoms of neurotoxicity reported by He F 1989 and Dorman *et al.* 1991 for this group pesticides include those which were related with the organ/system seem affected in this work. .

Organochlorines mostly used pesticides noted in present work can not be spared for its widespread health effects. It was reported for significant toxicity in animals and human being and documented reaching at epidemic and catastrophic levels (S.N.1994, Gross *et al.* 1994, Windham B 1999, Colburn T *et al.* 1991 & 1994). Data from animal
studies reveal the organs most likely to be affected include kidneys, liver, blood, and the parathyroid gland (USAT 1990). Certain symptoms of ill health conditions in human beings induced by this group product were already reported by some authors (Corrigan 2000, Reichrtova *et al.* 1999 and Smith 1991). Though, the consistent health conditions of the subject farmers in present work may be due to that reason alone.

Usually farmer belongs to poor communities therefore seem at the greatest risk from pesticide poisoning (Tinoco, 1998). Poor economical conditions of the farmers in Sindh province forced them to survive on insufficient diets, which can be imagined by their dietary habits. Present work reveals that the dietary habits of both control and subject groups are almost same (Figure 1) but the increased rate of systemic illness in the subject farmers indicate the effects of pesticide exposure as shown in Table 2. Population sustaining on nutritionally inadequate diets may be more prone to the toxic effects of pesticides as compared to those having nutritional adequacy (Bulusu, 1988). Therefore, systemic studies pertaining to such conditions reported the toxic effects in liver especially those on low protein diets were seen more susceptible (Bulusu, 1984, Singh, *et al.* 1988). However, grounds of dietary habits may be associated with pesticides toxicity to understand the exposure effects as well.

Pesticide toxicity associated with

In fact, the inappropriate protective measures during pesticide application practices are not changed even after witnessing consequences of toxic exposures. In this work small number of the subject group had seem using the respirators/cloth masks, while "sunglasses" were taken for their eye protection. District wise position of protective measures as indicated in Table 1 is not sufficient because most areas of Sindh province seen with less than 50% of such so called protection. Adapting the protective means during spray at nominal level may be due to hot climates particularly in selected crop seasons. Whereas overall behavior toward protective measures seem observed is not encouraging. However such conditions exist with little difference to the persisting conditions in Sri Lanka, Malaysia, and Thailand, those in addition had polythene bags used as “hand gloves”. The alternative is European recommended protection uniform like ‘space-mans’, which is unacceptable in such environment that may kill the farmers (Wasilewski, 1987). Along with poor protective measures in such environmental conditions and use of ‘backpack spray tanks’ to spray those increase the chances of greater exposure limits, may be reasoned for impaired health, especially in areas of Sindh province because these are out of control of the subject farmers.

Increasing rate of pesticide exposure is considered responsible for higher toxic effects. In this work area wise distribution of the farmers, who fall sick after repeated exposures to multiple pesticides was further analyzed for “ratio of variances” (Table 3). It was observed that subjects at ‘Jacobabad’ and ‘Shikarpur’ were highest affected. More exposures and hot climatic conditions at both districts, which is reported to enhance dermal absorption of many pesticides may reason for highest toxicity association. Second higher exposure effects were seen at Hyderabad and Khairpur districts. This was followed by moderate to mild affected areas; Badin, Dadu, Larkana and Sanghar. Changes in toxic effect levels among the districts may be distinguished by crop types cultivating tendency that varied at different geographical locations, which require the change in selection of pesticides to spray at respected areas. Furthermore the influence of pesticide exposures for generating the ill health conditions in the farmers was seen in this work (Table 3). Hence, ratio of pesticide exposures to each farmers may establish the concept; “larger the pesticide exposure ? higher the ill health”.

Some researchers suggest that different approaches are needed to prevent acute pesticide poisonings, such as banning the most highly toxic pesticides that available in Sindh and implementing alternative agricultural methods to reduce the use of pesticides (Brandt *et al.* 2001; Kishi *et al*. 1995; McConnell *et al.* 1993 and Soomro *et al*. 2003). Generally the lack of adequate legislation, ignorance of standards, poor labeling, illiteracy and lack of protective clothing increase the hazards to agriculture workers and environment (Ndoye, 1998; Yousefi, 1999 and Partanen, *et al*., 1999). Therefore the pesticide-related illness and injury surveillance programs are supported in many states (NIOSH 2004), which are needed to identify outbreaks and emergency pesticide health effects in local areas as well. Following these intimations the integrated pest management (IPM) and crop management have been suggested most suitable alternatives for safe environment and safety of the farmers' health.

5. Conclusion

Present work concludes the significant ill health conditions of farmers exposed to pesticides; Increased ratio of exposure; climatic conditions and poor protective measures were mainly responsible for higher level toxic effects. This describes the plans for the development of a pesticide control areas in Sindh that will help to elucidate where and why pesticides are used, potential risks to farmers' population and the health consequences after their exposure.

6. Suggestions

It is suggested that 'Toxic Exposure Surveillance Program' (TESP) may be brought about with proper legislation for safety of farmer's health. A commonly recommended solution to health conditions associated with pesticide exposures is to improve the dietary conditions of the farmers, to provide them health education and training, to promote the use of appropriate protective equipment and teaching farmers to handle pesticides carefully.

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S U R J

Relative Accuracy of Pearson (3) and Log-Pearson (3) Distributions using three parameter estimation methods for modelling Hydrological Flood Data of Indus River at Sukkur Barrage

SURJ

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Abstract

In this study, Pearson (3) and Log-Pearson (3) distributions are fitted on the data of flood peaks at Sukkur barrage, using Method of Moment (MOM), Maximum Likelihood Method (MLM) and probability weighted Moments (PWM) for quantile estimation ?^{2}–test, S–K test, probability plot correlation Coefficient (PPCC), root mean square errors (RMSE), coefficient of skewness (Cs), Coefficient of Kurtosis (C_k) and L – moment ratios are used for comparison and testing of the distribution and methods of etimation.

LP (3) appears better than P (3) while MLM is more efficient than MOM. A flood of 1.233 million cusecs is expected to pass through Sukkur barrage during next 100 years by fitting LP (3), using MLM. Thus there is a need for taking suitable steps to save the structure of the barrage as its present capacity is only 0.9 million cusecs.

Keyword: Pearsaon (s), & log pearson distributions.

1. Introduction

A knowledge of magnitude – frequency relationship should be used in the design of dams, high ways, bridges, water supply systems, and flood control structure. Frequency analysis is a tool in effective design. It avoids over designing which though result to increased safety, involves higher costs. The efficiency is achieved by relating cost to uncertainty using frequency analysis.

Expected differences in the results between the actual data and the estimated data will be in the magnitude at high return period T_r, i.e, at the tail of the density function and their estimation is faced with risk and uncertainty.

For uniformity, consistency and capability in planning and design of Water Management project, it is desirable that the same probability distribution be used by all agencies in the country. But it does not work, as length of data, choice of method of estimation; changes in the climate and construction of barrage upstream on the river affect the results of frequency analysis and the choice of probability distribution.

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Realizing the need of selection of a particular probability distribution and an efficient method of estimation we attempt to fit some suitable distributions on river Indus, at Sukkur. Various investigation propose different distribution to fit a particular type of hydrological random variables. The distributions contain parameters estimated from sample data. Mathematically, the more parameters in a function, the more flexible it is in fitting empirical distribution. More over, use of a given distribution I subject to the validity of estimation methods. Thus the selection of a probability distribution is an optimizing problem between the flexibility and reliability of the estimated parameters.

Inspired by the works of Butto, H.B and Shaikh, N.M [4], and Nixon [5]. We had fitted Gumbel and GEV distribution [11], Normal and Log-Normal distributions [10] to the data of flood peaks of Indus river at Sukkur, for 99 years. The results are as follows:

Table-01A Normal nd log normal distributions

Sampling Size	Distribution/ Curve (Best Method of Estimation)	Flood Estimates for 100 years (million cusecs)	Investigation
85	Faster-III	1.20	Bhutto & Shaikh
85	Hazen	1.21	Bhutto & Shaikh
99	Gumbel (MLM)	1.23	Memon & Shaikh
99	Log Normal (MOM)	1.25	Memon & Shaikh
43	Pearson Type-I	0.853	Nixon
76	PearsonType-II	1.24	Nixon

Design capacity of Sukkur barrage was 1.2 million cusecs in (1932). in (1941) due to some technical reasons capacity of the barrage had been reduced to 0.9 million cusecs. In (1976), 1.201 million cusecs flood had actually passed and more than. 1.1 million cusec had actually crossed the barrage four times, luckily without damaging the structure. Nixon [5] had calculated 7.7 lac cusecs as the mean annual flood for 43 years, and 11.5 lac cusecs for 76 years, at Sukkur . Fitting Pearson Type I skew curve on the data for 43 years, the upper limit is 8.53 lac cusecs and lower limit is 3.68 lac cusecs. But using the data for 76 years, the upper limit is 12.4 lac cusecs and that the flood of magnitude of 12.0, 11.0 and 10.0 lac cusecs are expected to occur once, thrice and even times in a century, respectively.

In this study P (3) and LP (3) have been fitted using MOM, MLM, and PWM, compared and tested using Goodness of fit test, C_s, Ck, L-moment ratios and S. E's of quantile estimates.

P (3) has been elected as it has been widely used in mny countries [7]. Matales and Wallis [8] compared the quantile estimates by P (3) using MOM and MLM Bucket and Oliver [6] recommend MLM for P(3). Haligram and Lele [14] had analyzed flood flows from 16 streams in India using P (3).

LP (3) has been selected as it has been reommended by the Water Recourses Council of U.S.A [7]. Askhar and Bobee [3] developed confidence intervals for P (3) and LP (3). Arrora and Singh [2] compared different methods of parameter estimation of LP (3) by monte carlo simulation. In general, P (3) fits annual floods data better than LP(3) but latter is recommended for flexibility [1]. One of the important problems related to the use of LP(3) is the variability in C_s. Infact, as $C_s \rightarrow 0$. LP(3) $\rightarrow$LN (2).

Data is collected form the office of Chief Engineer, Sukkur barrage, at Sukkur. Histogram is presented in Fig.1. Histogram and frequency curve are presented in Fig. II 95% Confidence Intervals for quantiles estimated by P(3) and LP (3) distribution using MLM along with observed and estimated floods are given in Fig. III and Fig. IV, respectively and plot of P (3) and LP (3), by MLM, together is shown in Fig. V. Mean, Median, Mode S>D, C_s, C_k, S.E's, Sample L-moments, Ist Quartile (Q_1), 3rd Quartile (Q_3), etc, are presented in Table–1. SPSS, Excel, Minitab and Data plot software were used for Statistical analysis.

Fig. 1.Histogram of peak floods discharge at Sukkur barrage (1901-1999)

Fig.II. .Histogram & Frequency Curve of floods peaks at Sukkur barrage (1901-1999)

Fig.III. Plot of P (3) Distribution Curve by MLM Methods, of Floods Peak of Indus River at Sukkur Barrage

Fig.IV. Plot of LP (3) Distribution Curve, by MLM, of Flood Peaks of Indus River at Sukkur Barrage

Fig.V. Plot of P (3) and LP(3) Distribution Curve, by MLM of Flood Peaks of Indus River at Sukkur Barrage (1901-1999)

Table –1 Basic statistics (Sukkur) 190-999

N	Mean*	Median*	Mode*	Min	Max
99	622.87	585.0	546.0	306	1200
(8.5)	(604.1)	(582.0)	(566.7)	(306)	(1200)
S. D	Q.D	C.V	S.E	C_s	C_k
205.7	102.5	0.35	20.8	1.120	3.68
(184.0)	(94.1)	(0.306)	(19.9)	(1.26)	(3.62)
Q_1*	Q_3*	D_1*	D_9*	T_3	T_4
484.0	689.0	407	99.7.0	0.228	0.181
(481)	(669)	(423.0)	(810.0)		

Note: The values in the parenthesis are for 85 year
- indicates value in 000-cusecs

2. Methodology

The probability distributions are fitted and the results are tested and compared ste p-wise as follows:

i Parameters of each distribution (by three methods of estimation) along with quantile estimates and their S. E's, for different return periods, are calculated.

ii Various goodness of fit tests. C_s, C_k etc, are used.

iii Ratios, Differences and Confidence Intervals are also displayed by tables and figures.

Theoretical details are given in [1] and [3]. An example of fitting P (3) by PWM is presented in Appendix.

Steps:

2.1 Testing the Goodness of Fit

The formulae as well as procedure for conducting $?^2$ –test, S-K test and PPCC are as discussed in [13].

2.2 Role of Skewness, Kurtosis and L-moments Ratios

The procedure adopted is same as in [13] and [1]. These relationships give on idea about the candidate probably distribution to be fitted on any given data..

3. Results and Discussion

(i) Descriptive Statistics (Table – 1)

Fig-1 shows that upper flood above 1.1 million cuecs have occurred 6 times and Fig-II shows that high floods above 750 thousand cusecs and between the ranges of (750-860), (860-980), (980-1090) and (1090-1200) thousand cusecs have occurred 6, 3, 4 and 6 times, respectively, from (1901-1999).

Mean > Median > Mode, C_s is 1.1 and C.V is 0.305. Thus the data is positively skewed (the results are similar to those for Guddu barrage).

The difference beteen Mean and median is substantial and increases with the sample size.

(ii) Parameter and Quantile Estimates

Table-II shows the values of parameters for P(3) and LP(3), estimated by the three methods. Table - III shows the quantile estimates and their S.E's, for various return periods for both the distributions. The quantile estimates compared in Table – IV A and are discussed as under:

Table-II. Parameters of P (3) and LP (3) Ditributions (Sukkur) (in 000's cusecs) 1901-1999

Distribution	Parameter	MOM	MLM	PWM
P (3)	α	115.10	115.4	142.79
	?	3.19	3.085	2.11
	γ	255.81	267.654	321.00
LP (3)	α	0.057	0.157	0.158
	?	29.35	382.51	380.0
	γ	-4.71	0.430	0.33

Table-III Quantile estimates and their S.E's (In parantheses) by P (3) and LP (3) (Sukkur) 1901-1999

Period T	Probability P	Quantic Magnitude (000) cusecs)					
		Pearson (3)			Log-Pearson (3)		
		MOM	MLM	PWM	MOM	MLM	PWM
5	20	774,708 (31.71)	771.749 (30.8)	768.95	771.915 (31.1)	765.64 (29.1)	762.6
10	10	897.249 (42.46)	892.769 (40.8)	989.55	906.049 (42.2)	879.72 (40.6)	887.7
20	05	1011.865 (53.07)	1006.169 (51.5)	1022.65	1040.647 (52.3)	988.13 (50.2)	1011.0

25	04	1047.643 (56.44)	1041.60 (55.1)	1061.87	1084.655 (54.8)	102.41 (51.3)	1046.0
50	02	1156.285 (66.82)	1149.279 (65.3)	1182.17	1224.558 (66.7)	1128.05 (61.1)	1165.0
73	013	1218.464 (72.81)	1210.958 (71.9)	1251.75	1309.116 (72.1)	1189.64 (68.6)	1224.0
100	01	1262.098 (77.04)	1254.263 (75.8)	1300.87	1370.511 (76.6)	1233.39 (72.8)	1268.7

Table –IV Tests of Goodness of Fit (Sukkur) 1901-1999.

$?^2$-Test		**S-K Test**		**PPCC**	**RMSE**	
α=5%	$?^2_{cal}$ P (3) LP (3)	α=5%	D_{cal} P (3) LP (3)	P (3) LP (3)	P (3)	LP (3)
5.99	5.93 5.81	0.136	0.179* 0.172*	0.9846 0.9848	0.0434	0.048

* Indicates non acceptance of null hypotheses.

Table-IV-A Ratios of Quantile estimates (Sukkur) 1901-1999 for different T_r

Ratio	**Distribution/Method**	**T_r**					
		10	20	25	50	75	100
Q_{MOM}/Q_{MLM}	P (3)	1.05	1.05	1.006	1.006	1.066	1.007
Q_{MOM}/Q_{MLM}	LP(3)	1.03	1.05	1.06	1.09	1.10	1.11
Q_{PWM}/Q_{MLM}	P (3)	1.01	1.016	1.02	1.03	1.035	1.04
Q_{PM}/Q_{MLM}	PL(3)	1.01	1.02	1.024	1.033	1.033	1.03
$Q_{LP(3)}/Q_{P(3)}$	MOM	1.01	1.03	1.04	1.06	1.07	1.09
$Q_{LP(3)}/Q_{P(3)}$	MLM	0.985	0.98	0.98	0.98	0.98	0.98
$Q_{LP(3)}/Q_{P(3)}$	PWM	0.986	0.99	0.985	0.986	0.98	0.976

Table-IV B. Ratio of S.E's (Sukkur) 1901-1999 for different T_r

Ratio	**Distribution/Method**	**T_r**					
		10	20	25	50	75	100

$S.E_{MOM}/S.E_{MLM}$	P (3)	1.04	1.03	1.03	1.03	1.02	1.02
$S.E_{MOM}/S.E_{MLM}$	LP (3)	1.04	1.06	1.07	1.08	1.05	1.05
S.E(LP-3)/S.E (P-3)	MOM	0.99	0.99	0.97	0.998	0.99	0.99
S.E(LP-3)/S.E (P-3)	MLM	0.995	0.97	0.93	0.94	0.95	0.96

(a) Pearson (3)

MLM gives the smallest quantiles and PWM gives the largest quantiles.

Q_{MOM} / Q_{MLM} varies from 1.006 to 1.05 and Q_{PWM} / Q_{MLM} varies from 1.01 to 1.04. The ratios are greater for larger T_r.

(b) Log-Pearson (3)

MLM gives the smallest quantiles while MOM gives the largest quanitles.

The differences between quantile estimates are smaller than for P (3).

$Q_{MLM} < Q_{PWM} < Q_{MOM}$.

Q_{PWM}/ Q_{MLM} varies from 1.01 to 1.03, greater for larger T_r

(c) P (3) . Vs. LP (3)

Q estimated by LP (3) are smaller than Q by P (3) using MLM and PWM, (1 % to 2 %), but are larger using MOM (1 % to 2 %).
Note: 1.25 and 1.23 million cusecs flood I expected at Sukkur barrage during next 100-years using MLM, for P (3) and LP (3), respectively.

(III) S. E's of Quantile Estimates (Table -III and IV B).

(a) Pearson (3)

S. E's by MOM are larger than by MLM (% to 4%) MOM is less efficient than MLM.

(b) Log-Pearson (3)

S.E.'s by MOM are larger than by MLM (4% to 8%), i.e. MLM is more efficient than MOM.

(c) P (3). Vs . LP (3)

The difference is up to 1% for MOM and up to 7 % for MLM. The S. E's by LP (3) are smaller than by P (3).

Thus LP (3) is better than P (3) is better tha P (3), specially for MLM.

Fig. III and Fig IV are the plots of P (3) and (3) distribution curves by MLM with confidence bands of 95%. Both the curves show that computed quantiles of P (3) and LP (3) distributions by MLM, give a better fit by passing in a straight line through its mean point (T= .33, $\bar{X}$ = 622.87 000 cusecs) and within the confidence bands of X1 (95%) and X_2 (95%), but LP (3) is superior than P (3) for MLM Fig. V is the plot for P (3) and LP (3) quantiles and both the curves pass through the straight line at mean point.

(IV) Teats of Goodness of Fit

Both the distributions are rejected on the basis of S-K test, but are accepted using $?^2$ test, PPCC and RMSE.

LP (3) is better than P (3) on the basis of PPCC and RMSE.

(V) C_s, C_k and L-moment Ratios:

Above table shows that both the distributions are acceptable on the basis of t_3 t_4 and C_s. More over, LP (3) is better than P (3) on the basis of C_s and C_k.
Note: t_3 and C_s for LP (3) are calculated using log of actual observations.

4. Findings

The data is +ly skewed, i. e. floods of high magnitude have occurred less frequently.

Quantile estimates by MLM are smallest for both the distributions, and are smaller for LP (3) than for P (3).

MLM is more efficient than MOM for P (3). LP (3), specially by MLM.Both the distributions are rejected by C_k and S-K test but accepted on the basis of $?^2$ - test, PPCC, RMSE, C_s and L-moment ratios.

LP (3) is better than P (3) by PPCC, RMSE and values of C_s and C_k.

1.23 million cusecs flood is expected at Sukkur barrage during next 100 years, by fitting LP (3), using MLM.

Table - V Values of Cs, Ck and L-Moment Ratios (Sukkur) 1901-1999.

Table (V) Model of P (3) and LP (3) Distribution

5. Suggestion

It is suggested to fit LP (3) distribution using MLM for prediction of occurrence of individual peak flood on the Indus river t Sukkur barrage. The Predicted flood by LP (3) using MLM I 1.3 million cusecs which I much higher than the 0.9 million cusecs designed capacity of the Sukkur barrage. Thus there is urgent need to take the appropriate measures to save the structure of barrage form occurrences of ny possible damage due to the above predicted flow which can occur t any time as environment changes.

* indicates rejection of H_0,	**Observed**	**Suggested for P (3)**	**App. Ample value for LP (3)**
T_3	0.228	0.228	0.220
T_4	0.181	0.140	0.139
C_s	1.120	1.120	1.100
C_k	3.680	4.880	4.815

Distribution	**Barge**	**Method**	**Model**
P (3)	Sukkur	MOM	$\hat{?}_T = (115.1 \times 3.19) + (255.8) + K_T \sqrt{(115.1)^2 \times 3.19}$
		MLM	$\hat{?}_T = (115.14 \times 3.09) + (267.6) + K_T \sqrt{(115.14)^2 \times 3.09}$
		PWM	$\hat{?}_T = (142.8 \times 2.11) + (321.0) + K_T \sqrt{(142.8)^2 \times 2.11}$
LP (3)	Sukkur	MOM	$\hat{?}_T = \exp [(0.057 \times 29 \times 35) + (-4.71) + K_T \sqrt{(0.057)^2 \times 29.35}]$
		MLM	$\hat{?}_T = \exp [(0.157 \times 382.5) + (0.43) + K_T \sqrt{(0.157)^2 \times 382.5}]$
		PWM	$\hat{?}_T = \exp [(0.158 \times 380.0) + (0.33) + K_T \sqrt{(0.158)^2 \times 380.0}]$

Appendix

An Example of Fitting P (3) Distribution by PWM to Annual Peak Flood Discharges Data at Sukkur Barrage (1901-1999)

a. Station Description

River: Indus
Barrage: Sukkur
Period of records: 99years
Data: See Fig-1

a. Computational Procedure

Step 1: $l_1 = 622.879$. $l_2 = 100.302$, $C_s = 1.120$, $C_y = 0.330$, $t_3 = 0.28$ and $t = 0.177$

Step 2: Parameters estimation by PWM method

Since $t_3 = 0.228$ is less then 1/3

$t_m = 3\,p\,t^2_3$

$= 3\,(22/7)\,(0.228)^2 = 0.490$

$$\hat{?} = \frac{(1+ 0.2906\ t_m)}{(t_m + 0.1882\ t^2_m + 0.0442\ t^3_m)}$$

$$= \frac{(+ 0.2906 \text{ x } 0.490)}{(0.490 + 0.1882\ (0.490)^2 + 0.0442\ (0.490)^3}$$

$= 2.114$

$$\hat{a} = \sqrt{p}\ l_2\ \frac{\Gamma(\hat{?})}{\Gamma(\hat{?} + ½)}$$

$\Gamma(\hat{?}) = \Gamma(2.114) = 1.055$

$\Gamma(\hat{?} + ½) = \Gamma(1.055 + ½) = \Gamma(2.614) = .444$

$$\hat{a} = \sqrt{p}\ (110.302)\ X\ \frac{1.055}{1.444}$$

$a = 142.799$

$\hat{g} = l_1 - \hat{a}\ \hat{ß}$

$= 622.879 – (14.799)\ (1.055) = 321.002$

The fitted quantiles by P (3) are obtained by

$$\hat{?}_T = \hat{a}\ \hat{ß} + \hat{g} + \hat{K}_T\ \sqrt{\hat{a}^2 \hat{ß}}$$

where

$$K_T = \frac{2}{C_s}\left\{\frac{C_s}{6}\left(m - \frac{C_s}{6}\right)+1\right\}^3 - 1 \quad C_s > 0$$

and m is given in Table VI

Step 3: Computation of design flood estimate

For T = 5, K_t, = 0.703, $\hat{?}$ = 768.953

For T = 50, K_T = 2.694, $\hat{?}$ 50 = 1182.166

For T = 100, K_T = 3.265, $\hat{?}$ 100 = 1300.87

Table-VI Values of the standard normal variate

T (Year)	2	5	10	20	50	100
m_T	0	0.842	1.282	1.645	2.054	3.326

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