Loess and Bee-eaters III: Birds and ground in the Punjab and the Indus region

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"Bee-eaters prefer to nest in loess." Zoltan Kerenyi, Emilia Ivok (2013)

Abstract

Part 3 of the study of loess ground and bee-eater birds concerns birds and ground in the north-western part of the Indian Sub-continent. Three species of bee-eaters are considered, relative to the Indus region: the Green bee-eater, the Blue-cheeked bee-eater and the European bee-eater. Loess in the Indus region is considered via the deterministic approach to loess deposit formation; the P events occur in the mountains of the western part of High Asia, particles are formed by the action of mountain glaciers. Major T actions involve the five rivers of the region which carry loess material into the Punjab plains. Subsequent T actions deliver loess material to local deposits, which provide nesting grounds for bee-eaters. To some extent the bee-

eaters define the loess. The Green bee-eater is small (c.16-18cm long) and lives over all of India and Pakistan- nesting ground is available everywhere. The larger bee-eaters (European and Blue-cheeked: c.25cm) are more constrained by ground properties- they require the ideal properties of loess ground (an ideal positioning relative to the Heneberg compromise) for nesting, and thus tend to define loess extent. Soil mechanics requires that more exact stress conditions are achieved when a relatively large nest tunnel is being constructed.

Keywords: Loess; Indus region; bee-eater birds; loess material production by mountain glaciers; loess distribution and bee-eater coincidence; nest tunnel size.

1. Introduction

The connection of loess and bee-eater birds has been explored in two previous papers (Smalley et al 2012b, McLaren et al 2014) and discussed in detail by Heneberg (2012); in this paper we focus on the loess deposits in N.W.India and neighbouring regions and on the Blue-Cheeked and Green bee-eaters. In some ways this is a continuation of the study of the 15N region in Africa and the Northern Carmine bee-eater. The demarcated ground is the same type of second-order loess as indicated on the Scheidig (1934) map and the approach is the same. We attempt to determine if it possible to produce a satisfactory sedimentological and geomorphological view of the critical region which explains the presence of material which can be described as loess- and the presence of a particular species of bee-eaters. The region needs a name, the 15N designation was very useful for the Northern Carmine bee-eaters and their associated ground, not precise but convenient and memorable. We propose the Indus region loess; this is a major region indicated on Scheidig (1934)

and Fry(1984) distribution maps and is a useful zone for initial focus.

We aim to show that this should be considered a loess region because large bee-eaters choose to nest there. We aim to show that bee-eaters nest in the Punjab and the Indus region because they are attracted by the loess deposits. This is small scale engineering; bird engineers test the ground and then construct quite elaborate nests and living quarters; bird engineers mimic human engineers. The concept of bee-eater as engineer has been discussed (Casas-Criville & Valera 2005).

2. The bee-eaters(species and sub-species)

We concentrate on three bee-eater species: the Asian Green Bee-eater (*Merops orientalis* Latham 1801)(fig.1), the Blue-cheeked bee-eater(*Merops persicus* Pallas 1773)(fig.2), and the European bee-eater (*Merops apiaster* L1758)(see Smalley et al 2012b for discussion). Distribution maps based on Fry(1984) are shown in figs 3 & 4. We have a very early speculation based on the size of these birds. The European and Blue-cheeked bee-eaters are relatively large, they are perhaps the largest of the bee-eaters, being about 23-26cm long (not counting tail extensions), they are relatively similar birds and they do interact (Kossenko & Fry 2008). The Green bee-eater, on the other hand, is the smallest of the bee-eaters, about the size of a sparrow, say 16cm long. This could affect the nesting. The ground requirements for a large tunnel are much more rigorous and restrictive than those for a small tunnel- which would give the Green bee-eater access to many more grounds than its larger cousins.

Fig.3 shows the breeding zones of the Green bee-eater (based on Fry 1984,pl.5). The sub-species are indicated: *M.o. viridissimus* is found in zone 1, in west Africa. Its breeding grounds overlap with those of *M.nubicus* which were discussed in McLaren et al (2014). *M.o.cleopatra*(3) is Nile based, and *M.o.cyanophrys*(4) favours the coastal

regions of the Arabian peninsula. *M.o.beludschicus* (6) is found in the region under consideration, this is an Indus region bird, but the species spreads all across India (Asokan et al 2003) and Bangladesh (*M.o.orientalis* 7) and into Burma and neighbouring countries (*M.o.ferrugeiceps* 8). Boehm's Bee-eater(*Merops boehmi*) 9 is found in southern Africa.

Fig.4 shows the breeding grounds of the Blue cheeked bee-eater (based on Fry 1984, pl.6). The sub-species are indicated: *M.p.chrysocercus* 1, and *M.p.persicus* 2. There is a well marked nesting zone in the Indus region, and *M.p.persicus* spreads to the west as far as the shores of the Mediterranean. One or two interesting outliers: in north-west Africa we speculate that there is a band of loess or loess-type ground immediately to the south of the Atlas mountain range, and that this accounts for that isolated observation of *M.p.chrysocercus*; which is also found at the northern bend of the Niger river- another possible site for loessic material (see McLaren et al 2014). In fig.4 some small occurrences of the Madagascar bee-eater *Merops superciliosus* are indicated: *M.s.superciliosus* 3, and *M.s.alternans* 4. Small occurrences of a bird very similar to *Merops persicus*.

3. Loess in India and Pakistan

The situation appears to be ideal for loess formation; there is a source for loess particles, there is a large river for transport, there is a desert for particle storage if required, there are landscapes for aeolian deposits, there are winds and climates and environments propitious for loess deposit formation. The simple deterministic model of loess deposit formation via a sequence of critical stages would appear to be well suited to the Indus region. There are reports and discussions of loess in this region(see Pant 1993, Ahmad & Chandra 2013) but initially we wish to consider a speculative set of landscapes, to manipulate a simple model of loess

deposit formation, and to look at the various factors which might be involved in delivering an Indus region loess deposit.

The Indus region under consideration is at the western end of High Asia, and it is from this geologically active region that the particles forming the loess deposits are derived (Owen et al 2003). A study of the whole of High Asia (Assallay et al 1998) has shown that this huge uplifted region provides silt particles for many important loess deposits. So a logical source of particles exists. The eastern end of High Asia provides particles for the great loess deposits of north China so it might reasonably be expected that the western end would act in a similar way as a particle producer. Silt material finding its way into the Ganges catchment is a considerable factor in the continuing fertility of a large region of north India.

The Indus is a loess river. If the Niger can be a loess river, so can the Indus. There is geo-energy available in the Indus region which is lacking in the Niger region and there is a reasonable expectation of considerable loess deposits. There is not much relevant literature, for example Smalley (1980), in his survey of world literature did not list any items about loess in India or Pakistan. By and large, there has not been a concentrated study of loess in India and Pakistan (but see Ahmad & Chandra 2013, Pant 1993). The conditions appear to be perfect for the formation of large deposits, to rival those in Central Asia and China, but there has been little investigation and next to no reporting. It is probably the Heidelberg effect again; it is easy to study loess when it is just outside your house and you are surrounded by impressive universities but not so easy when this situation is absent (as already pointed out for the 15N loess by McLaren et al (2014)). The particle forming P actions take place all across High Asia, driven by mountain glaciers; the rivers Amu Darya and the Yellow carry material to the west and to

the east to form loess deposits. It seems logical that the Indus should carry material to the south.

4. Bee-eaters(distribution)

Three species of bee-eater should be considered: the blue-cheeked bee eater, the little green bee eater and the European bee eater. The situation is more complex than in the European and African settings of parts I & II of this study. Distribution maps from Fry (figs 3 & 4) show a concentration of bee-eaters in the Indian sub-continent and in the Indus region.

The European bee-eater is a widespread species; it could be argued that it makes especially rigorous efforts to find suitable ground. It is interesting that its distribution reaches the Indus river- but the birds tend to stay to the west of the river, although they do spread across the Punjab plains. The European bee-eater prefers to nest on the western side of the Indus. It is feasible that the local geomorphology favours loess deposit formation to the west of the Indus; but not to the east, and this is suggested by the loess distribution shown in fig.5.

The Green bee-eater covers the sub-continent; it can be considered as a sort of default bee-eater for India and Pakistan- it can go anywhere. The range of the large bee-eaters is restricted (we would argue) by their size and the relative scarcity of the ideal loess ground.

In the Indus region European and Blue-cheeked bee-eaters nest together; there are mixed colonies, they must have similar nesting requirement (Asokan et al 2003). We are aware that Heneberg (2012) has warned against a too rigorous assignment of soil mechanics abilities to bee-eaters, but examination of the distribution maps for the European bee-eater (see Smalley et al 2012b) does suggest a remarkable affinity of European bee-eaters for loess ground. Kerenyi and Ivok (2013) have made a careful study of the European Bee-eater in the Gödöllő Hills in Hungary and clearly demonstrate the affinity for loess. The combination of

ground strength and ease of tunnelling (the Heneberg Compromise as discussed by Smalley et al 2012a) is closest to ideal in a loess deposit. Other ground types are used but the combination of short-range inter-particle bonds and the relatively small particle size in loess mean that it is close to ideal.

5. Scheidig in India and around

As in Smalley et al (2012b) and McLaren et al (2014) the comparisons of bird and ground distribution will be made with reference to the Scheidig world map of loess distribution (Scheidig 1934)(fig.5). And, as for the African studies (McLaren et al 2014) the loess involved is the "wahrscheinlich oder möglich" variety, i.e. the possible or maybe loess. This is where bee-eater studies might be useful in a sedimentological sense. If the larger bee-eaters really are loess detectors then the location of their nests is at least an indication of the probability of the local existence of loess ground.

Two types of loess appear on the seminal Scheidig map, there is the definite(nachgewiesen) loess, and there is the possible(wahrscheinlich oder möglich) loess. Most studies of loess, in any discipline, have focussed on the definite areas, where loess tends to be thick and well-mapped. Scheidig shows these major loess areas as North America, South America, a band across Western Europe, a concentration in Eastern Europe, China and New Zealand. One can examine the Scheidig map from the point of view of considering where the loess material came from, to form the demarcated deposits; and how it was formed in the source areas. There are two great areas connected with the widespread Pleistocene glaciations: North America and Ukraine and South-west Russia- these are the zones of glacial loess where the particles were formed by glacial grinding by the continental glaciers. The possible loess is a bit more elusive when it comes to asking questions about material origins. McLaren et al (2014) looking at the African

loess in the 15N zone cited three possible sources, each supplying a relatively modest amount of loess material. The Indus loess can be likened to the loess in the South Island of New Zealand. Here is a relatively simple situation where material is made in the mountains by mountain glaciers, transported by rivers into the plains, and eventually blown into position; the basic deterministic model of loess deposit formation via a series of realistic events. The Ravi river(see fig.6) could well be like the Rangitata and deliver loess material. A careful examination of fig.4 shows the possible loess in the Indus region. In the Lower Indus region the loess is all to the west of the river, in the Middle Indus Valley. In the Punjab the loess spreads across the Indus into eastern parts, where the Ravi and Sutlej rivers flow, where it might reasonably be expected.

6. Land and Landscape

Fig.6 is from Bridges (1990, p.160) and shows the critical regions of the Punjab and the Indus valley.

The Himalayas (P events)

With the onset of the Alpine orogeny, the sediments of Tethys were uplifted and folded to form the Himalayas but the area lying to the south of the mountains was sharply depressed where the Indian shield was pushed below the Asian landmass. As the uplift proceeded this depression was infilled with clastic material eroded from the rising mountains. Isostatic readjustment continues, so erosion is still providing large quantities of sediment which is being deposited on the flood plains and deltas and loess deposits of the Indus and the Ganges rivers. The Himalayas, at the western end of High Asia are the P regions for local loess deposits.

The Punjab plains (T & D events)

The 'land of the five rivers'(Bridges 1990, p159) lies mainly in Pakistan and is sharply defined in the west by the Sulaiman ranges and the Salt range to the north. The eastern watershed between the Indus and the Ganges is less obvious, there being no relief obstacle which can be identified as the hydrological divide. The rivers Indus, Jhelum, Chenab, Ravi and Sutlej all emerge from the mountain front and proceed to cross the plain, eventually becoming confluent with the Indus. The surface topography is made up of Pleistocene river terraces which can be traced as far downstream as Multan on the Jhelum-Chenab rivers. Here loess material is deposited and redeposited(T and D actions), to provide ground for larger bee-eaters to nest in.

The Indus Valley

The middle Indus valley is bounded on the west by the Kirthir and Sulaiman ranges which form the edge of the Baluchistan plateau. To the east lies the Thar desert. The alluvial plain of the Indus extends north-west towards Quetta in a pronounced embayment of the mountains.

7. Discussion

We appreciate, as Heneberg (2012) has pointed out, that ground material and texture are not the only factors determining the nesting behaviour of bee-eaters, but they can have a considerable influence. We do suggest that in the case of large bee-eaters the ground material factor may be more consequential than for small bee-eaters. Obviously most grounds are far from ideal and there may be ways of achieving an alternative position relative to the Heneberg compromise. In nesting ground a certain strength is required, to give tunnel stability, but the ground cannot be too hard- it must be possible for the birds to dig tunnels. The Heneberg compromise (see Smalley et al 2012a) balances the strength of the ground and its excavateability.

Sandy soils can move into an acceptable compromise position if the interparticle contacts can be enhanced. This is usually achieved by a small amount of clay. The clay mineral material, concentrated at the inter-particle contacts of the primary mineral sand particles, can add the required cohesion to the system.

8. Conclusions

There are significant loess deposits in the Indus region. There is a need for a simple, but definitive map of loess deposits in India and Pakistan. The existence of such a map would encourage the study of loess on the sub-continent. These significant deposits are exploited by bee-eater birds. Loess is close to the ideal ground for the construction of bee-eater nesting tunnels and we suggest that the presence of bee-eaters is indicative of the presence of loess ground. We further suggest that it is the larger bee-eaters which are the best indicators of loess, for good simple mechanical reasons. It is more difficult to build a stable large tunnel than it is to build a stable small tunnel.

So we offer two propositions; our conclusions are essentially only propositions. The evidence is diffuse; the maps that provide the distribution data are not precise. There are 'indications' of loess in the Indus region, and there are 'indications' of bee-eater activity. With a knowledge of the deterministic model of loess deposit formation, and observations of bee-eater behaviour in Europe and Africa it seems reasonable to suggest that bee-eaters nest in loess in the Indus region, and that loess distribution has some effect on bird behaviour.

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Figures

1. The Green Bee-eater(the Little Green bee-eater, the Asiatic Green bee-eater) *Merops orientalis* Latham 1801.
2. The Blue-cheeked Bee-eater *Merops persicus* Pallas 1773.
3. Distribution of Green Bee-eater; after Fry (1984,pl.5). Sub-species locations are shown: *M.o.viridissimus* 1; *M.o. flavoviridis* 2; *M.o.cleopatra* 3; *M.o.cyanophrys* 4; *M.o.najdanus* 5; *M.o.beludschicus* 6; *M.o.orientalis* 7;

M.o.ferrugiceps 8; Boehm's Bee-eater (*Merops boehmi*). Widespread distribution over all of the Indian sub-continent.

4. Distribution of Blue-cheeked Bee-eater; after Fry (1984, pl.6). Sub-species locations are shown: *M.p.Chrysocercus* 1; *M.p.persicus* 2. Madagascar bee-eater *Merops superciliosus* 3; *M.s.alternans* 4. Note the Atlas outpost, possibly local mountain loess used as nesting ground.
5. Scheidig loess distribution map. The old Scheidig (1934) loess distribution map; an old map but still the best. Observe the distribution of possible loess in the Indus region. Vertical shading- possible loess; cross-hatching- definite loess.
6. The Indus region; after Bridges (1990) The major sub-regions are shown: the Himalayas(for P actions); the Punjab plains (for T and D actions). The situation appears to be very like that defined in the simple deterministic model of loess deposit formation. Figure width is about 1500km.

Fig 1

Fig 2

Fig 3

Fig 4

Fig 5

Fig 6