Effects of Buried Environment on the Morphology and Trace Element Profile of Faunal Remains: An Experimental Study

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ABSTRACT

Present study was carried out mainly to know the effects of buried environment on morphology as well as elemental profile of the faunal remains. For this purpose we have collected 50 modern bone samples of goat, sheep and ox from different locations of the Garhwal region and these samples were buried in the ground in various places, at different levels of depth and pH as well. After four years all the buried bone samples were recovered and pretreated sequentially in the laboratory, examined morphologically and processed for getting the ash of each sample. Trace elements were estimated through spectrometry methods in Laboratory for archaeological chemistry, Wisconsin University, Madison, USA.

The morphological examination revealed that the bones buried in highly acidic and alkaline soil and at the level of 50 cm to 75 cm were proceeding towards the disintegration as they were recovered in bad condition, while other faunal remains which were buried in normal acidic and alkaline soil and beyond the level of 100 cm recovered in well preserved condition. However, elemental analysis also revealed that no any major changes in trace element profile has been observed among the faunal remains recovered in good conditions but in morphologically disintegrated faunal remains a significant change in the concentration level of different elements have been noticed. It clearly showed that both the factors are positively responsible for disintegration of archaeological remains.

INTRODUCTION

Archaeozoological studies have indicated that faunal remains are much more than a structural framework for supporting the body of an animal and similarly it is confirmed that the bone tissue also hold a large number of information about the individual to whom it is attached (Price 1989). Keeping in view of the same the faunal remains are being used for the reconstruction of palaeodiet and palaeoenvironment of past occupation. Therefore, dietary reconstruction has been an important aspect of archaeological and anthropological research.

To estimate the diet and dietary behavior of ancient human occupation, different workers have used various types of scientific and traditional methods. On the basis of scientific methods it is assumed that determination of the levels of particular trace elements preserved in bone provides a potential pathway for reconstructing the diet of extinct primate species and archaic human. Strontium, barium, magnesium, calcium and zinc are some most useful trace elements for dietary reconstruction. Reconstruction of palaeodiet through trace element analysis is estimated with the help of following basic principles as it has been established on the basis of a number of analytical studies:

- The higher concentration of Sr, Ca, Mg, Zn and lower values of Ba and Ba/Sr ratios clearly indicates the consumption of marine diet.
- Continuous intake of terrestrial diet deduces the concentration level of Mg, Sr and Zn in the animal bones while it increases the values of Ba and Ba/Sr ratios.
- Lower values of Mg in animal bone indicate the consumption of terrestrial diet, while higher values of the same indicate the consumption of marine diet.
- Carnivores generally have higher concentration of Zn in their bone than the herbivores.
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- Higher ratio of bone Sr-To-Ca and Ba-To-Ca represent a greater percentage of vegetable food in their diet and lower ratio of the same indicate greater percentage of meat in their diet.


But after studying the aforesaid studies, right now it has to be clarifying that for conducting the palaeodietary investigation the faunal remains recovered from different types of archaeological sites should be in good and well preserved condition. Present study was therefore carried out to know the effects of buried environment on morphological as well as elemental profile of the faunal remains which can be used as base line data.

**MATERIALS AND METHODS**

For the present study we have collected 50 modern bone samples of goat, sheep and ox from different locations of the Garhwal. These samples were buried in the ground in for places, at different levels of depth (i.e. 50, 80, 120 & 150 cm. levels) and different levels of pH as well at different region four years before the recovery of faunal remains. Selection of ground for site-A, B, C, D and E were selected on the basis of nature of soil such as just closed to the activity area of modern settlement, in barren land, in water logging land and in agricultural land respectively.

After four years all the buried bone from the respective sites were recovered and examined morphologically in the laboratory. The long bone samples were broken to expose the medullary cavity, and all the exposed surfaces were then abraded with the Dremel “moto tool” to remove non bone tissues/external contamination.

The abraded clean samples were broken into small pieces, a few millimeters in diameter, placed in a vial (20 cc polythene liquid scintillation vials with linear lids), rinsed with de-ionized water, covered again with de-ionized water and allowed in a Ultrasonic bath for thirty minutes. The liquid was then drained and after sonication with de-ionized water, the bone pieces in the same vials were covered with 1-Molar or 1-Normal acetic acid solution respectively and allowed to sit at room temperature for overnight. This was intended to remove much, even most, but not all of bone mineral. The acid washed bone were then rinsed with de-ionized water and dried in an oven at 80-90 degree Celsius for overnight.

From the dried bones, approximately one and half gram (1.5 gm.) of each sample was weighed into a pre-weighed as well as pre-labeled porcelain crucible. The weight of empty crucible and the weight of crucible plus bone were also recorded. The crucibles were then placed into a Muffle at 725-degree Celsius for eight hours to ash the samples. After 08 hours they were allowed to cool and weighed again with their ash contents, and the percentage of weight loss was determined for the purpose of indication of the amount of organic material in the bone.

For each sample, 50 milligram (0.50 gram) of bone ash was weighed into a disposable 16x25 mm Pyrex test tube. A reference controlled sample was also included in addition to the experimental samples. One milliliter of concentrated nitric acid is added to each test tube (using micropipette) and the tubes are placed in an aluminium heater block on a hot plate and heated to 100-120 degree Celsius for one hour. Later on, these samples were removed from the hot plate, allowed to cool, and diluted with 16 milliliters of 5% nitric acid to a total volume 17 milliliter. Each tube was then covered tightly with plastic film or parafilm or the fingertip of a plastic glove, and inverted ten times and shaken for well mixing of sample.
Finally the solution was then introduced directly into the spectrophotometer for elemental analysis. Elemental analysis was done with the help of Laboratory for archaeological chemistry, Wisconsin University, Madison, USA

RESULTS AND DISCUSSIONS

Results of the hydrogen ion concentration estimated in different levels of buried grounds are presented in Table-1 and Figure-1 which is indicating that the conditions of soil at site A, C and E were slightly acidic to moderately acidic while at site B and D it was slightly alkaline to moderately alkaline.

The morphological examination of faunal remains revealed that the bones buried in highly acidic and alkaline soil and at the level of 50 cm to 80 cm were proceeding towards the disintegration as they were recovered in bad and contaminated condition, while other faunal remains which were buried in normal acidic and alkaline soil and beyond the level of 100 cm recovered in well preserved condition. Besides this samples recovered from site B and D were also proceeding towards the contamination and it may be due to the effects of soil pH.

Earlier investigations on palaeodietary studies indicated that microbial activities are responsible for changing the trace element profile in some extent (Grupe and Piepenbrink 1989). However, it has also been observed by Aitkens (1976) that there are so many environmental factors which adversely affect the distribution of zinc in human skeleton. Meanwhile strontium change and crystallinity change in taphonomic and archaeological bones are well defined by the Tuross et.al. (1989).

In present study result obtained through spectrophotometer are calculated statistically and mean values of different elements for different experimental faunal remains are presented in Table-2 to 6 and Figures-2 to 6. The elemental analysis revealed that no any major changes in trace element profile was observed among the faunal remains recovered in good conditions but in morphologically disintegrated faunal remains, a significant change in the concentration level of different elements have been noticed (in site-A to E) at different buried levels which clearly showed that both the factors i.e. soil pH and as well as levels of buried site are positively responsible for disintegration of archaeological remains.

At the outset, it is to submit that we want to know the changes in the trace element profile and process of mineralization in the soil of different buried site which are still under analytical process. After getting the results of the soil trace element analysis the correlation of mineralization process between faunal remains and soil of the site can be established.

Table1. Hydrogen Ion Concentration (pH) in different Locations and levels of Buried Sites

<table>
<thead>
<tr>
<th>Buried Site</th>
<th>Surface</th>
<th>50 cm</th>
<th>80 cm</th>
<th>120 cm</th>
<th>150 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site-A</td>
<td>6.65</td>
<td>5.52</td>
<td>5.25</td>
<td>6.95</td>
<td>6.75</td>
</tr>
<tr>
<td>Site-B</td>
<td>8.25</td>
<td>7.56</td>
<td>7.56</td>
<td>7.56</td>
<td>7.56</td>
</tr>
<tr>
<td>Site-C</td>
<td>5.75</td>
<td>5.05</td>
<td>5.35</td>
<td>6.54</td>
<td>6.65</td>
</tr>
<tr>
<td>Site-D</td>
<td>8.12</td>
<td>7.58</td>
<td>7.75</td>
<td>7.85</td>
<td>7.98</td>
</tr>
<tr>
<td>Site-E</td>
<td>6.65</td>
<td>5.52</td>
<td>5.25</td>
<td>6.95</td>
<td>6.75</td>
</tr>
</tbody>
</table>
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Table 2. Concentration of Trace Elements in the faunal remains recovered from surface levels of Buried sites

<table>
<thead>
<tr>
<th>Trace Elements</th>
<th>Reference</th>
<th>Site-A</th>
<th>Site-B</th>
<th>Site-C</th>
<th>Site-D</th>
<th>Site-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca (x 1000)</td>
<td>397.25</td>
<td>484.45</td>
<td>385.57</td>
<td>475.53</td>
<td>398.87</td>
<td>479.89</td>
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<tr>
<td>Sr</td>
<td>276.12</td>
<td>375.55</td>
<td>235.5</td>
<td>362.06</td>
<td>258.42</td>
<td>360.21</td>
</tr>
<tr>
<td>Ba</td>
<td>165.52</td>
<td>239.86</td>
<td>188.66</td>
<td>283.43</td>
<td>139.55</td>
<td>248.75</td>
</tr>
<tr>
<td>Mg (x 100)</td>
<td>192.25</td>
<td>163.54</td>
<td>189.29</td>
<td>157.87</td>
<td>188.5</td>
<td>155.2</td>
</tr>
<tr>
<td>Zn</td>
<td>75.25</td>
<td>108.33</td>
<td>66.22</td>
<td>115.21</td>
<td>85.02</td>
<td>119.5</td>
</tr>
</tbody>
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Table 3. Concentration of Trace Elements in the faunal remains recovered from 50 cm Levels of Buried sites

<table>
<thead>
<tr>
<th>Trace Elements</th>
<th>Reference</th>
<th>Site-A</th>
<th>Site-B</th>
<th>Site-C</th>
<th>Site-D</th>
<th>Site-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca (x 1000)</td>
<td>379.352</td>
<td>485.33</td>
<td>361.25</td>
<td>460.57</td>
<td>357.52</td>
<td>444.23</td>
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<tr>
<td>Sr</td>
<td>395.54</td>
<td>268.42</td>
<td>398.22</td>
<td>298.22</td>
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<tr>
<td>Ba</td>
<td>265.75</td>
<td>299.55</td>
<td>208.26</td>
<td>328.66</td>
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<td>Mg (x 100)</td>
<td>252.25</td>
<td>425.48</td>
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<td>443.85</td>
<td>231.25</td>
<td>464.51</td>
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<td>Zn</td>
<td>78.5</td>
<td>118.25</td>
<td>92.22</td>
<td>103.42</td>
<td>82.42</td>
<td>108.08</td>
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Table 4. Concentration of Trace Elements in the faunal remains recovered from 80 cm Levels of Buried sites

<table>
<thead>
<tr>
<th>Trace Elements</th>
<th>Reference</th>
<th>Site-A</th>
<th>Site-B</th>
<th>Site-C</th>
<th>Site-D</th>
<th>Site-E</th>
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</thead>
<tbody>
<tr>
<td>Ca (x 1000)</td>
<td>395.85</td>
<td>472.16</td>
<td>394.66</td>
<td>442.05</td>
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<td>472.68</td>
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<td>Sr</td>
<td>378.54</td>
<td>269.58</td>
<td>365.5</td>
<td>299.5</td>
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<tr>
<td>Ba</td>
<td>175.75</td>
<td>286.93</td>
<td>169.57</td>
<td>292.57</td>
<td>188.86</td>
<td>269.57</td>
</tr>
<tr>
<td>Mg (x 100)</td>
<td>188.55</td>
<td>363.54</td>
<td>199.86</td>
<td>312.58</td>
<td>189.29</td>
<td>361.68</td>
</tr>
<tr>
<td>Zn</td>
<td>99.53</td>
<td>112.25</td>
<td>101.06</td>
<td>102.95</td>
<td>86.22</td>
<td>114.6</td>
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Table 5. Concentration of Trace Elements in the faunal remains recovered from 120 cm Levels of Buried sites

<table>
<thead>
<tr>
<th>Trace Elements</th>
<th>Reference</th>
<th>Site-A</th>
<th>Site-B</th>
<th>Site-C</th>
<th>Site-D</th>
<th>Site-E</th>
</tr>
</thead>
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<tr>
<td>Ca (x 1000)</td>
<td>391.25</td>
<td>487.89</td>
<td>398.85</td>
<td>437.32</td>
<td>415.37</td>
<td>463.51</td>
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<tr>
<td>Sr</td>
<td>485.63</td>
<td>325.21</td>
<td>456.45</td>
<td>322.22</td>
<td>509.42</td>
<td>373.1</td>
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<tr>
<td>Ba</td>
<td>159.82</td>
<td>238.65</td>
<td>139.1</td>
<td>283.43</td>
<td>185.63</td>
<td>256.75</td>
</tr>
<tr>
<td>Mg (x 100)</td>
<td>197.36</td>
<td>357.2</td>
<td>186.5</td>
<td>349.26</td>
<td>197.88</td>
<td>367.51</td>
</tr>
<tr>
<td>Zn</td>
<td>87.5</td>
<td>112.5</td>
<td>109.1</td>
<td>115.2</td>
<td>65.22</td>
<td>117.25</td>
</tr>
</tbody>
</table>
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Table 6. Concentration of Trace Elements in the faunal remains recovered from 150 cm Levels of Buried sites

<table>
<thead>
<tr>
<th>Trace Elements</th>
<th>Reference</th>
<th>Site-A</th>
<th>Site-B</th>
<th>Site-C</th>
<th>Site-D</th>
<th>Site-E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca (x 1000)</td>
<td>386.25</td>
<td>345.68</td>
<td>385.15</td>
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<td>139.5</td>
<td>147.57</td>
<td>173.57</td>
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<td>241.92</td>
</tr>
<tr>
<td>Mg (x 100)</td>
<td>249.36</td>
<td>259.68</td>
<td>237.58</td>
<td>239.86</td>
<td>236.29</td>
<td>237.53</td>
</tr>
<tr>
<td>Zn</td>
<td>102.32</td>
<td>105.6</td>
<td>108.95</td>
<td>105.06</td>
<td>107.22</td>
<td>106.56</td>
</tr>
</tbody>
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REFERENCES


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