Harappa Excavations 1986-1990

A Multidisciplinary Approach to Third Millennium Urbanism

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Cover art: Bowl on Stand H88-1002/192-17 associated with Burial 194a
in Harappan Phase Cemetery (see Figure 13.18).

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Complementary Approaches to Late Harappan Subsistence: An Example from Oriyo Timbo

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Understanding the interplay between subsistence systems and settlement patterns is crucial for interpretation of past economies and culture change. The Late Harappan (1900-1700 BC) in Gujarat, India, witnessed a significant increase in the number of settlements in the arid regions. This increase has been ascribed to shifts in land use patterns resulting from an increased emphasis on pastoral husbandry and the adoption of drought resistant summer crops, i.e., millets. This issue will be addressed using data from archaeobotanical and ethnographic studies complemented by carbon isotope analysis of cattle bones from the Late Harappan site of Oriyo Timbo, Gujarat.

Southeast of the site of Harappa, the geographical region comprising the modern Indian state of Gujarat is the southernmost extension of the Harappan cultural tradition known to date. The Harappan of Gujarat has a distinct regional expression, and excavations at a number of sites have revealed that a long history of Harappan presence can be defined in this region (Possehl and Raval 1989). Although on the periphery of the Harappan core area, Gujarat stands as a important region for the further understanding of the Harappan cultural sphere of interaction.

Gujarat appears to have been settled during the urban Harappan phase of the Indus Valley Tradition by populations from the greater Indus region. Radiocarbon determinations from the sites of Lothal and Surkotada suggest a date of ca. 2400-2300 BC for this settlement. Possehl notes that Rojdi, and many other sites in Gujarat, represent a specific—and newly defined—regional expression of the Harappan urban phase, which clearly is a part of the larger Harappan cultural entity (Possehl and Raval 1989).

While the Harappan is characterized by urban centralization, craft specialization, and diversified subsistence economy, the Late Harappan is defined by the retention of specific Harappan attributes but in a context of de-urbanization, expansion of settlements into new regions, changes in subsistence regimes, and the development of new regional traditions.

Understanding the interplay between subsistence systems and settlement patterns, as seen in the Greater Indus Valley, is crucial for interpreting past economies and culture change in general. In comparison to the Harappan (2500–2000 BC), the Late Harappan (1900–1700 BC) in Gujarat witnessed a significant increase in the number of settlements in the arid regions (Bhan 1989). This increase was accompanied by a decrease in average site size. These trends have been ascribed to a shift in land use patterns resulting from an increased emphasis on pastoral animal husbandry (Rissman 1985; Bhan 1989) and to the adoption of summer crops, i.e., millets (Possehl 1986). (In this paper, summer drought resistant crops will be generically referred to as 'millets'.) The cultivation of millets, which are summer and drought resistant crops, would have facilitated expansion into the arid regions of Gujarat. Very little is known about the impact of these cultigens on the Harappan subsistence economy. Here, the hypothesis is that they supplemented rather than replaced earlier subsistence practices, and they came to play an important role in the increased emphasis on animal husbandry and specialized food production systems in the Late Harappan.

Most of the suggestions regarding the Harappan subsistence regime are to a great extent hypothetical, but the use of multiple lines of evidence has considerable potential to contribute to the understanding of the processes and character of Harappan subsistence systems. Using the complementary methods of archaeobotanical analysis, ethnographic crop processing studies, and carbon isotope analysis of cattle remains, I am investigating the Late Harappan subsistence economy. My ethnographic research centers in the States of Gujarat and Andhra Pradesh, while the archaeobotanical data and the cattle bones for the carbon isotope analysis are from the Late Harappan site of Oriyo Timbo.

The Example of Oriyo Timbo

The second season of field research at the post-urban site of Oriyo Timbo, Gujarat, took place in 1989-90, and was a collaborative undertaking between the Gujarat State Department of Archaeology and the University Museum of the University of Pennsylvania. Oriyo Timbo was first excavated in 1981-82 by a team from the State of Gujarat and the University of Pennsylvania (Rissman and Chitalwala 1990).

The first season of excavations at the site revealed Oriyo Timbo to be a seasonally occupied camp inhabited during the Lustrous Red Ware period by pastoralists who may have undertaken a bit of cultivation (Rissman and Chitalwala 1990, Possehl 1990). Below this proto-historic camp was a distinct microlithic occupation with microlithics and a small amount of pottery. The relationship between these two occupations remains unclear and speculative. The second season of excavations were aimed at further investigating this relationship and at defining the Lustrous Red Ware settlement.

The 1989-90 field season at Oriyo Timbo entailed the excavation of six 5 × 5m grid units immediately south of the 'Western Operation' area of the 1981-82 excavations (see Rissman and Chitalwala 1990: Figure 1). Twelve stratigraphic layers of sediments were identified in the course of the excavation, but they comprised no more than three distinguishable occupations (Possehl 1990). The site is interpreted as having three distinct Lustrous Red Ware occupations, each associated with a series of compacted surfaces with features and concentrations of artifacts resting upon them. Between these are layers of less compacted sediment representing general fill. The first occupation is represented by stratum 6, with stratum 7 being the natural sediment; the second occupation is associated with stratum 5 and the final occupation is stratum 3. The extent and duration of these occupations cannot be determined at this time. Stratum 4, a softer compacted fill, is distinct from the compacted series of layers in stratum 5 that have high ceramic densities and also features associated with food preparation (i.e., chulas, a tandoor, ash pits).

Methods of Archaeobotanical Recovery

The objectives of the archaeobotanical recovery and analysis are essentially twofold: to gain an understanding of the nature of the subsistence economy and to elucidate spatial and temporal variations in the plant materials at the site. An ideally representative archaeobotanical assemblage would include all the plant species actually in use at a site, along with some indication of the relative importance of each species in antiquity. Adequate sampling from a sufficiently large number of contexts is imperative to provide such an assemblage. Therefore, systematic sampling was employed with a minimum volume floated of 10 liters per sample unless there was a defined feature. Contexts sampled include hearths, ovens, compact living floors, dumps, pits, and fill areas. Such sampling methods are necessary for the successful identification of macro-assemblages and localized associations related to different economic activities such as plant processing, consumption, and disposal. (For further details on recovery methods, see Reddy 1991.)

Archaeobotanical Analyses

The last (1989–90) season at Oriyo Timbo, resulted in the retrieval of archaeobotanical remains from 247 samples comprising over 3000 liters of unscreened dirt from six trenches. For this study only carbonized seeds were analyzed, with non-carbonized seeds being excluded due to the probability of they being modern intrusives.

To summarize the results, it is appropriate to say that there is strong evidence for the use of summer crops. These include crop plants such as *Eleusine, Panicum, Setaria,* and a variety of legumes and weeds. The plant remains occur in varying frequencies in all the trenches, but high concentrations occur in only three of the six trenches.

Stratigraphically there is patterned variation in the frequencies of carbonized seeds recovered, with strata 5 and 6 having higher frequencies of seeds than stratum 4 (Figure 10.1). This correlates well with the stratigraphic sequence of occupation floors and

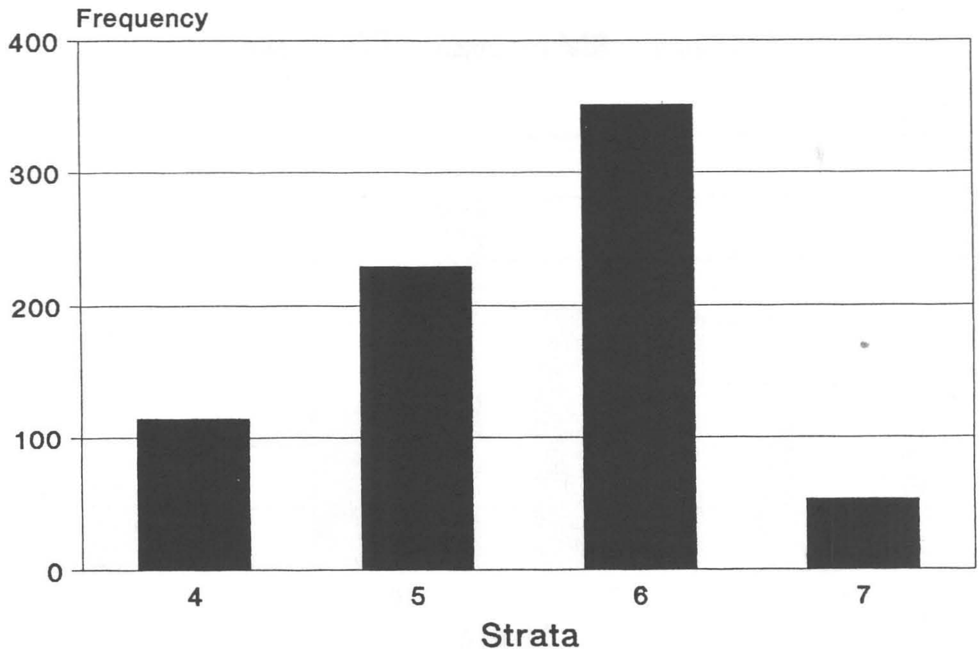

Figure 10.1: Oriyo Timbo (1989-90): Total identified carbonized seeds by strata.

features associated with food preparation in strata 5 and 6, while stratum 4 is primarily occupation fill.

In the analyzed samples, 36% are 'millets' and 31% are weeds (Figure 10.2). Among the millets, *Eleusine* comprises 20% of the total seed assemblage, followed by *Setaria* (8%), *Panicum* (6%), and *Pennisetum* (2%). Among the weeds, *Trianthema/Mollugo* (28%) comprises the highest percentage. Legumes constitute 5% of the total assemblage. Although the percentage of millets in relationship to other plants, such as the weeds and legumes, varies between trenches, the relative frequency of the different genera of millets is similar in all the trenches. (For a detailed report on the findings see Reddy 1991.)

At Oriyo Timbo the carbonized plant remains appear to be differentially preserved based on context. The distribution of carbonized seeds at the site seems not to be concentrated in any functional loci, such as hearths or ovens. In fact, the samples from these contexts show a relatively low density of seeds when compared to the general fill sediments from the different trenches (Figure 10.3). Contexts with the highest probability of fire (that is high temperatures) such as the hearth samples and the tandoor or oven fill contents and the oven wall, have the lowest frequency of carbonized seeds. Whether this correlation is a result of a lack of preservation due to the high temperatures in these contexts or a result of no seeds being associated or incorporated into these contexts will be explored through ethnographic modeling.

Whether these millets were cultivated at the site by the occupants or brought onto the site from elsewhere is still an unresolved question. However, given the relatively rich assemblage, the lack of storage heaps, and the high number of weeds associated with the summer crops, it is probable that they were cultivated by the site occupants. A thorough ethnographic study of summer crop processing geared to studying the patterns in product and by-product compositions will enable me to address this issue more effectively.

A second major question is the economic importance of the millets and the economic role of crop cultivation as compared to animal husbandry. Understanding of this issue should yield insight into the full character of this Late Harappan site and the regional expression of the late Harappan subsistence economy.

Archaeobotanical data alone is not adequate to address these questions; it has to be supplemented by other robust data sets. My approach is to integrate archaeobotanical analysis with ethnographic studies of crop processing and carbon isotope analysis of cattle bone from archaeological sites. To understand Oriyo Timbo, which has been interpreted as a pastoral settlement, one needs to consider the importance of crop cultivation, the role of cultivated crops for food and fodder, and the relative economic

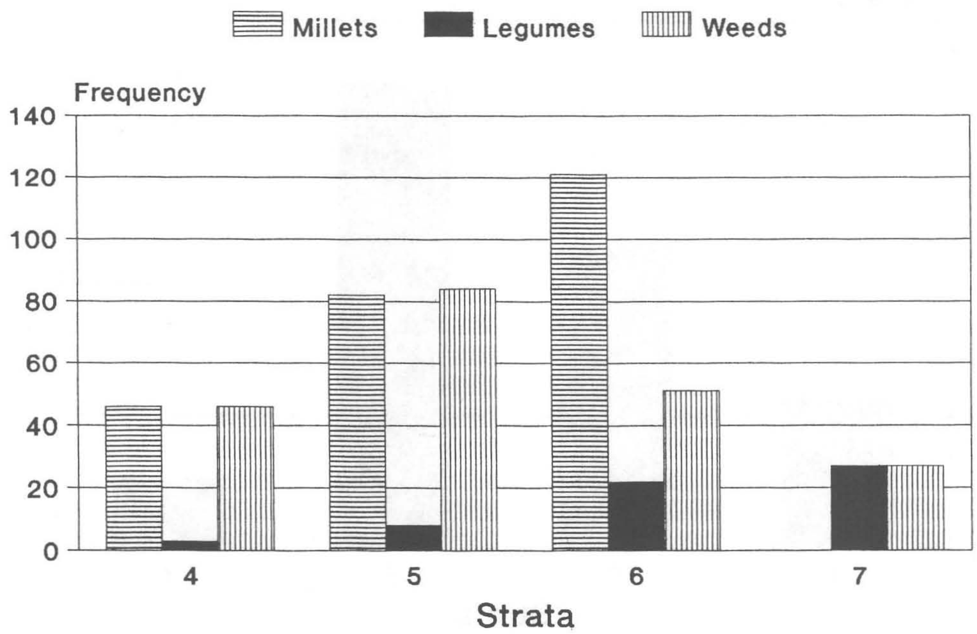

Figure 10.2: Oriyo Timbo (1989-90): Frequency ratios of carbonized millets, legumes, and weeds in different strata.

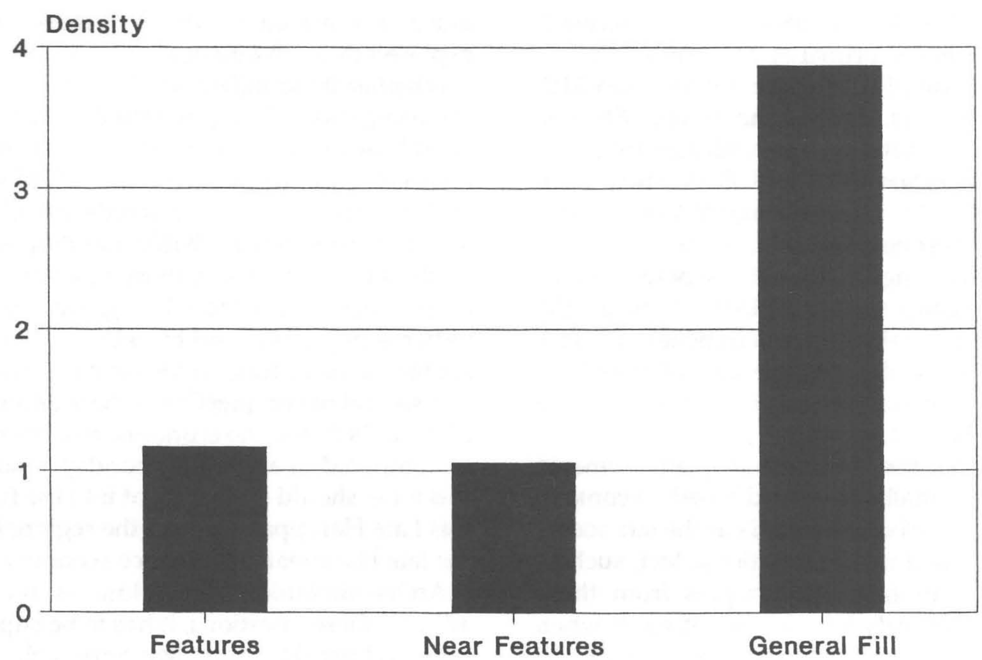

Figure 10.3: Oriyo Timbo (1989-90): Densities of seeds/10 liters.

dependence on cattle by the occupants. For a comprehensive investigation of these issues, the quantitative results from the three analytical methods I have selected need to be evaluated and thoroughly integrated.

Ethnographic Studies

The underlying objective of the ethnographic study is to determine whether the archaeobotanical samples recovered at Oriyo Timbo are representative of assemblages related to different crop processing stages and/or representative of assemblages which are distinctive for their use as human food or as animal fodder. The assumption behind this study is that each step of crop husbandry and grain processing has a measurable effect on the composition of crop products and by-products (Figure 10.4). These effects can be studied and 'cause and effect' models can be built and applied to archaeological samples, thus enabling inferences to be made on the archaeological use of specific crops.

My ethnographic research to date has confirmed that the wheat/barley/pulse models of crop processing developed by Hillman (1981, 1984) and Jones (1983, 1984, 1987) are not applicable for millet crops. This is because the harvesting methods are very different due to differences in plant morphology. Millet crops like *Sorghum*, *Pennisetum*, and *Eleusine* are harvested by cutting off the inflorescence heads only, which is different from the way wheat and barley are harvested. This initial variation in processing has a measurable effect on the composition of crop products and by-products (Figure 10.5).

The second observation from my research is that plant parts such as rachis remains, used in wheat and barley crop processing models, do not appear to be as suitable for distinguishing the different stages of millet processing. These plant parts in millets are fragile and not likely to survive in the archaeological record. It is possible, however, that other plant parts, such as spikelets of particular sizes and composition, may be more indicative of processing stages. The crop processing model I am developing for millet crops also relies on the relative variation in weeds for isolating the variables which define the different stages and uses. It is crucial to note, however, that the presence of weeds is quite often heavily dependent on the nature of cultivation. Alluvial flood plain cultivation (discussed below) could differ significantly from valley monsoonal cultivation in terms of composition of the crops fields due to non-human ecological variables.

In Andhra Pradesh, when millets are primarily grown for animal fodder, they are cultivated on flood banks of rivers. In such instances, due to the comparatively 'sterile' condition of the seasonally flood-deposited silts and clays on these river banks, the crop is poor but weeds are absent or very rare in the fields. This affects the forage quality, nutritive value and, most crucially, the composition of the crop processing by-products. Essentially, with such cultivation, the relative number of weeds in the products or by-products consumed by animals differs significantly from the number of weeds in the products and by-products of millet processing from plain and valley cultivation. This critical distinction is invaluable for interpretation of archaeobotanical assemblages from similar environs.

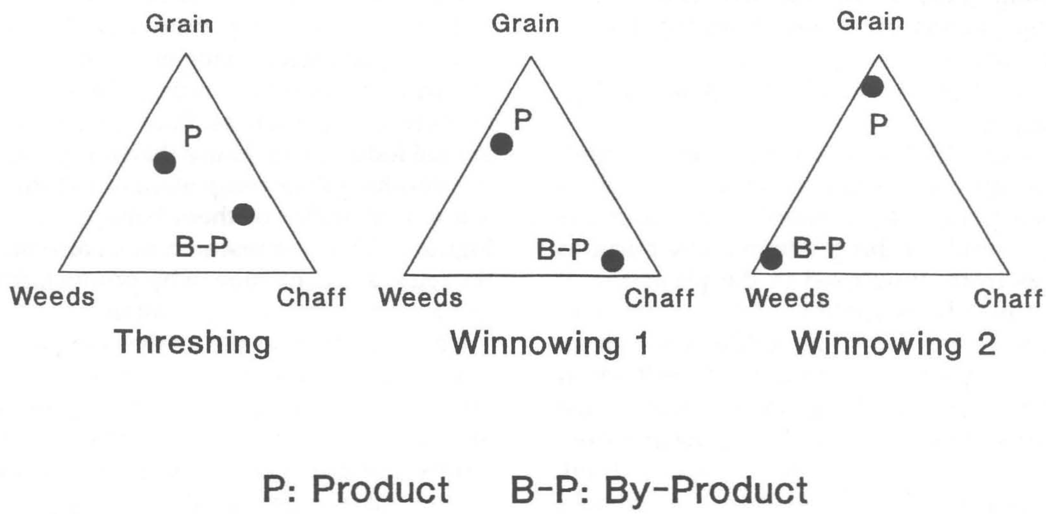

Figure 10.4: Hypothesized ethnographic crop processing product and by-product compositions.

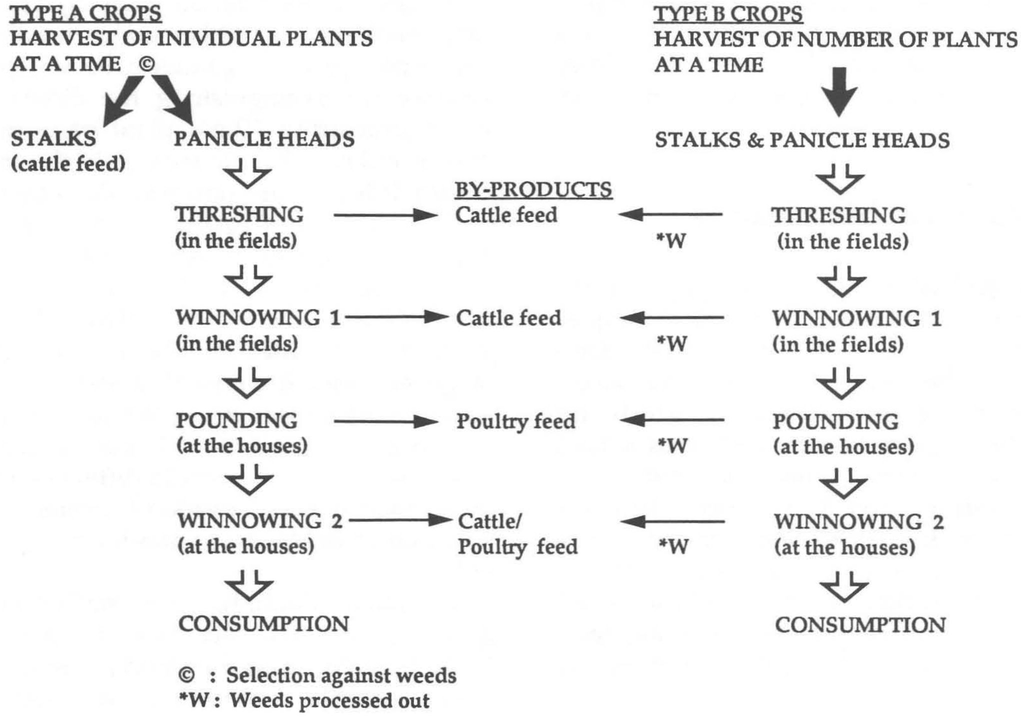

Figure 10.5: A preliminary predictive model for millet crop processing stages; TYPE A CROPS include *Sorghum bicolor*, *Pennisetum typhoides*, and *Eleucine coracana*; TYPE B CROPS include *Panicum miliare* and *Setaria italica*.

Of crucial importance during the ethnographic studies is defining contextual situations that could be archaeologically preserved. Which activities and contexts are most likely to produce archaeologically relevant materials? These would include, for example, the cleaning of grain before consumption, the location of this cleaning (particularly the distance from a hearth), and the discard of cleanings. Similarly, knowledge of the sediment composition of the living floors and how they are formed is invaluable for archaeological interpretation.

Miller and Smart (1984) have suggested that a significant percentage of archaeobotanical materials retrieved from living floors, hearths, and ovens is preserved as a result of dung intentionally burnt as fuel as well as from dung used in the plastering of floors. Thus it may be possible to identify the use of millet residues versus grains as fodder through an intensive ethnographic study of their compositions. It is possible, however, that the grains included in the dung could come from elsewhere (i.e., inclusions from where and when the dung was dropped, dried, packed, etc.) rather than directly from the animal's digestive system. These variables can be controlled and explained only after a thorough understanding of the source of seeds in archaeological sediments. Crop by-products are also often used as fuel in the Third World, but millet by-products rank quite low as attractive fuels when compared to wheat, barley, and sugarcane crop by-products (Barnard and Kristoferson 1985:79).

The shortcoming of such an ethnographic approach is that rarely do crop processing by-products from threshing and winnowing occur in the archaeological record as individual entities; often they are units of another entity such as floor plaster, animal dung, animal fodder, fuel, house thatching, and so on. While the threshing floor components are distinctive, there is a low probability of them being preserved archaeologically. Thus the research must also take account of the reuse and conflation of by-products from a number of stages and their interpretation.

Upon completing the analysis of the ethnographic fieldwork, the resulting models will be applied to the archaeological samples/contexts from Oriyo Timbo, allowing for a more robust interpretation of their nature and use in antiquity. There remains, however, the popularly perceived shortcoming of all such ethnoarchaeological studies, namely, the danger of direct analogy, and one has to be cautious of this when interpreting archaeological context through ethnographic modeling.

Carbon Isotope Analysis

I have chosen Carbon Isotope Analysis to try to identify the relative importance of millets as animal fodder at Oriyo Timbo. If millets were used as a major source of fodder, then the resulting high proportion in the animal diet of plants with C_4 photosynthetic pathways should be reflected in a relatively heavy carbon isotope signature ($\delta^{13}C$) of the animal bone collagen.[1] Ratios of the two stable isotopes of carbon, Carbon 13 (^{13}C) and Carbon 12 (^{12}C) in animal bone collagen have been used to determine the relative contribution of C_4 plants (such as maize and millets) versus C_3 plants (such as wheat and barley) to the diet of the consumer (DeNiro and Epstein 1978; van der Merwe 1982). Carbon isotope analysis can be employed here to determine the extent of millet use during the Late Harappan, because millets were the primary C_4 plants of economic importance in this area.

In such an investigation, however, one needs to consider the seasonality of fodder availability, mixed feeding on C_3 and C_4 plants, and the cultivation of millets both as food for humans and fodder for animals. Thus ethnographic studies are necessary to permit development of models for interpretation. The development of these models is a topic too large to discuss in this paper, but briefly, the chemistry of the animal bone collagen is ultimately dependent on a number of variables including nature of local sediments and vegetation, herding characteristics, nutritive value of forage, forage availability, forage selection, and potential of fodder intake (Figure 10.6). For archaeological application, only some of these variables can be observed and quantified through ethnographic studies. These include seasonality of fodder, forage nutritive quality, and selection by animal and herder.

My preliminary ethnographic observations of pastoralist and farmers in Gujarat during 1989–90 have shown that there is seasonality in the availability and consumption of fodder by cattle and goats. Often wild fodders such as *Cressa cretica* (commonly known as *bokhna*) are preferred over millets and other crops or their residues. *Bokhna* is readily available in winter and enhances milk production because its high protein content induces lactation. It is only used when fresh, and when available it is given primary preference. But as *bokhna* cannot be stored as dry fodder, it is used exclusively when available. Millets and other wild fodders are used during other seasons.

PLANT - ANIMAL INTERRACTION COMPLEX
a. Seasonality (Availability)
b. Forage Quality (Nutritive Value)
c. Herd Effects (Grazing, Browsing, Free Range)
d. Potential Intake (Age, Size, Condition, Type)

↓

ANIMAL FEEDING COMPLEX
a. Level of Intake
b. Digestion and Utilization of Nutrients
c. Selection by Animal & Herder

↓

FINAL ANIMAL PRODUCT
a. Dairy and Meat
b. Bone Composition

Figure 10.6: An animal feeding model.

Carbon isotope analysis cannot recognize such seasonality in fodder consumption, as bone collagen has a slow turnover rate. But what is of primary concern for questions related to the economic importance of millets to the occupants of Oriyo Timbo is the relative proportion of millets in the animal diet rather than the exact amount. Similar studies can be made on human bones, although none are currently available to me from Gujarat to conduct such studies.

A relatively heavy $\delta^{13}C$ signature from the cattle bones would imply that C_4 plants were consumed in greater proportions and that millets were a major contribution to the animal's diet. Modern samples of wild fodders from the area produce the lighter $\delta^{13}C$ values of C_3 plants so wild fodders would not confuse this issue. However one question would remain—whether millet grain or millet by-product was being fed as fodder. This distinction is significant because the use of millet grain for animal fodder would indicate that the crops were primarily grown for animals, whereas using only the millet residues for fodder implies that the crops were grown for both human and animal consumption. The difference has a significant effect on the interpretation of the subsistence economy. Although it may seem counterproductive to cultivate millets only for animal fodder, ethnographic data from traditional, non-mechanized farmers and pastoralists show that, very often, quick maturing millets are cultivated solely for animals as (1) insurance for lean periods, (2) a means for promoting lactation, and (3) a form of opportunistic cultivation.

The implications of a lighter $\delta^{13}C$ (C_3) signature are less straight forward but could have far reaching implications, particularly with respect to the 'pastoral' character of the site and the importance of cattle in the subsistence economy of Oriyo Timbo. If the animals are feeding on the wild fodder, then questions arise relating to whether a sizable herd really could be maintained in the environs around Oriyo. This is particularly problematic during the four month lean dry period every year. Therefore would the herd have to be taken to other locales during this part of the year?

Although carbon isotope analysis has its shortcomings regarding the detection of seasonality and other related processes, the signatures will provide insights into the long term proportional feeding of C_3 or C_4 plants.

Conclusion

To conclude, the Late Harappan phenomenon in Gujarat, although subject to considerable research, is yet to be fully defined. The region stands as an important component of the Harappan cultural tradition. Changes in settlement patterns and subsistence strategies during this period have been linked but the nature of and reason for this correlation are not yet understood.

With respect to the study of Harappan subsistence economy in Gujarat, the exact proportion of millets in animal diets is not as critical as relative long term changes in the dependence on different fodders, particularly millets versus other fodders. An increased emphasis on millets as fodder, or concentration on fodder cultivation in general during the Late Harappan of Gujarat, may indicate the emergence of a specialized subsistence system, with pastoral animal husbandry as an important and critical variable, perhaps similar to present day Gujarat. Such a change in subsistence economies, entailing specialized food production and intensification, would have far reaching implications for our understanding of the Late Harappan of Gujarat.

In sum, the integrated results of this research should further clarify the subsistence economy at Oriyo Timbo and shed more light on the Late Harappan of Gujarat in general thereby furthering our understanding of the nature of Late Harappan subsistence—be it a pastoral, agricultural, or a mixed system.

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Note

[1] The use of 'heavier' to indicate a less negative $\delta^{13}C$ value (richer in ^{13}C) and 'lighter' to indicate a more negative $\delta^{13}C$ value (less rich in ^{13}C) follows a practice noted by O'Leary (1981:553).

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