Origins of Specialized Pastoral Production in East Africa

The results of recent archeological research in the Loita-Mara area of Kenya offer new information on the timing and process of the development of pastoralism in East Africa. They suggest that a pattern of specialized pastoral production, similar to that of contemporary East African pastoralists such as the Maasai, was present in parts of East Africa 2,000 years ago. It may have developed as a result of new opportunities for increased pastoral production. A bimodal pattern of rainfall with a short dry season, similar to the modern climatic regime, appeared about 3,000 years ago, which allowed year-round milk production from cattle herds. The development of pastoralism in East Africa preceded agriculture and took place in a social and economic context of relationships between hunter-gatherers and pastoralists. Environmental opportunity, combined with cultural competition, may have provided the impetus toward pastoral specialization.

Pastoralists are generally defined as people who rely heavily on production from domestic herds, and who move herds to pasture (Dyson-Hudson and Dyson-Hudson 1980; Chang and Koster 1986). Although there are many pastoral societies in Africa, the origin and development of pastoralism has been most studied in the Near East. There, pastoralism has been strongly linked to the development of irrigation agriculture, specialized trade, and urban centers. Both early and recent pastoralists in the Near East have been portrayed as specialized traders producing for an outside market (Dyson-Hudson and Dyson-Hudson 1980; Gilbert 1983; Levy 1983; Rosen 1988; Spooner 1971).

In contrast to the Near East, most contemporary pastoralists in Africa are oriented toward subsistence production (Dyson-Hudson and Dyson-Hudson 1980). The majority rely on diversified production. Their primary focus is on milk, meat, and blood from livestock herds, but this diet is extensively supplemented by food acquired through hunting, fishing, foraging, and cultivation. East African groups such as the Karomojong, Turkana, Jie, and Kipsigis conform to this generalized subsistence pattern (Dyson-Hudson 1966; Gulliver 1955; McCabe 1987; Peristiany 1939; Schneider 1979). However, there are a number of East African groups, such as the Pastoral Maasai, Samburu, Borana Galla, and Rendille, who are, or have been in their recent history, highly specialized pastoralists (Baxter 1975; Jacobs 1975; Merker 1968; Schneider 1979; Spencer 1965, 1973). Although they may supplement their diet with food acquired from neighboring agricultural, pastoral, and hunter-gathering groups, their own food production activities are focused exclusively on cattle, sheep, and goat herds, with no systematic hunting or fishing for food, little foraging, and no agriculture until the last two decades (Baxter 1975; Bonte 1981; Schneider 1979).

The results of recent archeological research in the Loita-Mara area of southwestern Kenya suggest that, while the earliest pastoralists in East Africa were generalists, the specialized system of pastoral production based on cattle, sheep, and goat herds that is characteristic of parts of East Africa today was already present in southern and south-
western Kenya 2,000 years ago. The advent of a modern climatic regime with bimodal patterns of rainfall in East Africa about 3,000 years ago may have raised pastoral productivity sufficiently to make specialized cattle and small-stock pastoralism a viable mode of production. These changes took place in a social and economic context of interaction between hunters and gatherers and pastoralists, which may have encouraged specialization for cultural reasons.

The Earliest East African Pastoralists: A Diversified Subsistence Base

The first secure evidence for food production in East Africa is from Pastoral Neolithic sites in northern Kenya, which date to about 4,000 b.p. (Barthelme 1985). The term Pastoral Neolithic is used in East Africa to refer to all societies with a Later Stone Age lithic technology, ceramic vessels, and an economic base relying heavily on domestic stock (Bower et al. 1977). Subsistence in this period is best documented at the sites of GaJi 4 and GaJi 2, east of Lake Turkana (Figure 1), where Nderit pottery is associated with a faunal assemblage including sheep and goat, cattle, wild animals, and fish (Barthelme 1985; Marshall, Stewart, and Barthelme 1984).

On the basis of faunal, material culture, and site structure, these sites have been interpreted as pastoral encampments with a diversified subsistence base, where herding and fishing were combined with hunting. The role of cultivation in the subsistence system is unknown (Barthelme 1985). There are very few sites dating to this time period in southern Kenya and northern Tanzania, but those studied so far show a similar pattern of unspecialized use of animal resources (Bower 1988).

It has been suggested that food production in Kenya had its origins in the southern Sudan or Ethiopia, and that small numbers of people moved south from this area in response to increasing aridity in the Sahelian region, southern Sudan, and Ethiopia about 5,000 years ago (Ambrose 1984a; Barthelme 1985; Phillipson 1977). Parallels do exist between the unspecialized pattern of hunting, fishing, and herding subsistence among pastoralists of northern Kenya 4,000 years ago, and that from slightly older pastoral sites (ca. 5,000 b.p.) in the southern Sudan, such as Kadero. There, hunting, fishing, and herding were combined with shell collecting and intensive collection of wild cereals including millet, in an elaborate but unspecialized pastoral subsistence base (Gautier 1984; Krzyzaniak 1978, 1984).

Because food production is found later in the south and material culture is similar to that associated with food production in northern Kenya, it seems likely that the initial introduction of pastoralism to the central and southern Kenyan areas resulted from movements of pastoral populations from northern Kenya (Ambrose 1984a; but see Bower 1988 for a different view). Only after 2,600 b.p. are large numbers of pastoral sites found in southern Kenya. At the same time, Later Stone Age sites with a foraging economy (Eburran phase 5) persist in the central Rift Valley region of southern Kenya (Ambrose 1984a).

The occurrence of large numbers of Pastoral Neolithic sites in southern Kenya is associated with an increase in variation in material culture between archaeological sites. On the basis of differences in site location, lithic technology, ceramic style, and burial traditions, East African archæologists now recognize at least two different Neolithic "cultures"; the Elmenteitan, and the Highland Savanna Pastoral Neolithic (Ambrose 1984a; but see Bower 1988). Their presence in southern Kenya coincides with the first evidence for specialization in production from domestic herds in East Africa.

One of the questions often asked of archæologists is: Who were these early food producers and how do they relate to present-day East Africans? Attempts have been made to link archæological "cultures" with present-day linguistic groups. The most comprehensive of these links the Savanna Pastoral Neolithic with Southern Cushites, and Elmenteitans with Southern Nilotes (Ambrose 1982, following Ehret 1974; Odner 1972; Phillipson 1977; Sutton 1966).
Figure 1
The distribution of important Later Stone Age and Neolithic sites in Kenya and northern Tanzania.

Despite the intriguing nature of such correlations, there are a number of problems with this approach, not the least of which is the fact that ethnographers, linguists, historians, and archeologists use different kinds of information and as a result group cultures in different ways (see Sobania and Waller 1989 on differences between linguists and historians). Differences between archeological and ethnographic categories have recently been highlighted by several ethnoarcheological studies that have emphasized the complex and
variable nature of the relationship between material culture and ethnicity, and the dangers of making simple correlations between archeological "cultures" and ethnic or cultural groups (Herbich and Dietler 1989; Dietler and Herbich 1989; Hodder 1982).

Evidence for the Presence of a Specialized Pattern of Pastoral Production: Southwestern Kenya

Archeological survey and excavation in the Loita-Mara area of southwestern Kenya has documented, on the basis of lithics and pottery, both Elmenteitan and Savanna Pastoral Neolithic sites in the area. Sites are concentrated in the Lemek Valley at the western edge of the Loita Plains (Marshall and Robertshaw 1982; Robertshaw et al. 1990). Analysis of animal bones, site location, site structure, and artifact assemblages from the Elmenteitan sites of Ngamuriak and Sambo Ngige, and the Savanna Pastoral Neolithic site of Lemek North-East (Figure 1), suggest that specialized pastoral production existed in the Loita-Mara area of Kenya 2,000 years ago.

Ngamuriak

Ngamuriak is a large, open, single component site and has been interpreted as an Elmenteitan Pastoral Neolithic settlement (Marshall and Robertshaw 1982; Robertshaw and Marshall 1990). There are two radiocarbon dates on well-stratified charcoal from different areas of the site: GX-8534, 1940 ± 40 b.p. and GX-8533, 2135 ± 140 b.p. Elmenteitan artifacts found at Ngamuriak include Remnant pottery and stone tools made of obsidian blades or blade segments. Excavations were extensive, and the bone assemblage is large. About 62,000 faunal specimens were studied, 7.5% of which (4,656 specimens) were maximally identifiable.

The Fauna: Species Representation

Ninety-eight percent of the assemblage is from domestic taxa. In all, 2,228 cattle and 2,404 caprine (sheep and goat) specimens were identified. Based on the cranial morphology and size, cattle from the site have been identified as *Bos indicus* breeds or *Bos indicus*/*Bos taurus* crossbreeds, which represents the earliest known occurrence of *Bos indicus* in sub-Saharan Africa (Marshall 1989). Because turnover rate is greater for small than for large stock, cattle herds were probably considerably larger than small-stock herds at the site (Marshall 1986, 1990). Sheep and goat were present in approximately equal proportions.

Only 22 specimens attributable to wild taxa were identified. This figure is so small that it probably represents background densities of bone in the area (Marshall 1986). However, the presence of cut marks shows that at least one impala limb was intentionally butchered. Given the large numbers of wild animals in earlier Neolithic sites from the Sudan and northern Kenya, and the high biomass of wild ungulates present in the Loita-Mara area even today, the small number of wild animals in the archaeological sample from the area was unexpected. It appears to reflect a deliberate strategy of concentration on production from domestic herds, with very little or no hunting for food. This is similar to the present pattern among Maasai pastoralists in the area.

The Fauna: Livestock Culling Patterns

Culling patterns at Ngamuriak were derived through study of dental eruption and wear sequences (Table 1), and patterns of epiphyseal fusion, using the stages shown in Tables 2a, 2b, 3a, and 3b. These stages were calibrated by using ages of dental eruption and epiphyseal fusion in modern cattle.

Recent studies by anthropologists and veterinarians show that there are strong patterns of livestock culling among contemporary pastoralists throughout Africa. These culling patterns result from the desire to ensure herd growth and continuity of food production, despite the unpredictable nature of rainfall in many parts of Africa and cyclical
Table 1
Correlations between caprine and cattle dental wear classes and approximate age in months.

<table>
<thead>
<tr>
<th>Dental wear classes</th>
<th>Wear class markers (abbreviated)</th>
<th>Age in months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Caprines</td>
</tr>
<tr>
<td>Neonate</td>
<td>Unworn deciduous dentition</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Juvenile</td>
<td>Worn deciduous dentition, first molar early wear, pre-stage 5</td>
<td>&gt; 6</td>
</tr>
<tr>
<td>Old juvenile</td>
<td>Second molar in early wear, pre-stage 5</td>
<td>&gt; 12</td>
</tr>
<tr>
<td>Young adult</td>
<td>Third molar early in wear</td>
<td>&gt; 24</td>
</tr>
<tr>
<td>Adult</td>
<td>Dentition in full wear, third molar, stage 5</td>
<td>&gt; 27</td>
</tr>
<tr>
<td>Aged</td>
<td>Second molar, stage 6</td>
<td>&gt; 27</td>
</tr>
<tr>
<td>Very old</td>
<td>Third molar, stage 6</td>
<td>&gt; 27</td>
</tr>
</tbody>
</table>

events of drought and disease (Dahl and Hjort 1976). A high percentage of females is common in herds, and female cattle are often not culled at all, or only after reproductive age. There appears to be a great deal of variation in the timing of culling of males, but under optimum conditions they tend to be slaughtered after they reach an age when growth slows and weight is approaching its maximum. In stressed situations male animals may be culled shortly after birth, to reduce competition with humans and female calves for milk (Dahl and Hjort 1976; Semenye 1980).

Survivorship patterns were calculated for both cattle and caprines at Ngamuriak by determining the proportion of teeth and fused bones beyond each identifiable age marker. Because teeth all pass through the same sequence, all teeth were used to calculate all dental ages. However, different epiphyses fuse at different ages and no further age information can be derived after fusion. Therefore, bones that fuse at approximately the same age were grouped and survivorship calculated for these groups, rather than for the set as a whole.

Comparing survivorship with liveweight for both cattle and caprines shows a clear relationship between growth and culling (Figures 2 and 3). Cattle, which have a relatively abrupt weight gain, were not heavily culled until rapid growth had been under way for some time. Caprines gain weight more gradually, and culling was less concentrated at any given age. As with cattle, however, culling of caprines tended to take place late in the growth period.

Some of the early culling of caprines at Ngamuriak may have been influenced by the fact that, because small-stock herds grow about three times as fast as cattle herds, individual sheep and goat represent a smaller investment than cattle. As a result, small stock are killed much more readily than cattle by contemporary pastoralists (Dahl and Hjort 1976; Wilson 1982; Wilson, Peacock, and Sayers 1981; Wienpahl 1984). Given these factors, the culling peaks for small stock are surprisingly strong at Ngamuriak, as more than half the animals would have been close to maximum body weight (see Wilson 1978).

When taken together, the patterns of culling of both large and small stock at Ngamuriak indicate an overall management strategy of waiting until animals were close to maximum body weight before culling. This strategy is typical of pastoralists in an unstressed
Table 2a
Cattle mortality data at Ngamuriak, from dental eruption and wear.

<table>
<thead>
<tr>
<th>Age class</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonate</td>
<td>4</td>
<td>15.4</td>
</tr>
<tr>
<td>Juvenile</td>
<td>2</td>
<td>7.7</td>
</tr>
<tr>
<td>Old juvenile</td>
<td>4</td>
<td>15.4</td>
</tr>
<tr>
<td>Young adult</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Adult</td>
<td>14</td>
<td>53.8</td>
</tr>
<tr>
<td>Aged</td>
<td>2</td>
<td>7.7</td>
</tr>
<tr>
<td>Very old</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 2b
Cattle mortality data at Ngamuriak, from long-bone fusion.a

<table>
<thead>
<tr>
<th>Element fusion (approximate timing)</th>
<th>Not fused</th>
<th>Fused</th>
<th>N</th>
<th>Percent fused</th>
</tr>
</thead>
<tbody>
<tr>
<td>7–18 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>humerus DF</td>
<td>00</td>
<td>38</td>
<td>38</td>
<td>100.0</td>
</tr>
<tr>
<td>radius PF</td>
<td>00</td>
<td>23</td>
<td>23</td>
<td>100.0</td>
</tr>
<tr>
<td>1st phalange PF</td>
<td>05</td>
<td>57</td>
<td>62</td>
<td>91.9</td>
</tr>
<tr>
<td>2nd phalange PF</td>
<td>03</td>
<td>65</td>
<td>68</td>
<td>95.6</td>
</tr>
<tr>
<td>24–36 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>metacarpal DF</td>
<td>00</td>
<td>01</td>
<td>01</td>
<td>100.0</td>
</tr>
<tr>
<td>tibia DF</td>
<td>08</td>
<td>76</td>
<td>84</td>
<td>90.5</td>
</tr>
<tr>
<td>metatarsal DF</td>
<td>00</td>
<td>07</td>
<td>07</td>
<td>100.0</td>
</tr>
<tr>
<td>36–42 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>calcaneum F</td>
<td>16</td>
<td>12</td>
<td>28</td>
<td>42.9</td>
</tr>
<tr>
<td>42–48 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>humerus PF</td>
<td>04</td>
<td>09</td>
<td>13</td>
<td>69.2</td>
</tr>
<tr>
<td>radius DF</td>
<td>06</td>
<td>11</td>
<td>17</td>
<td>64.7</td>
</tr>
<tr>
<td>ulna F</td>
<td>02</td>
<td>02</td>
<td>04</td>
<td>50.0</td>
</tr>
<tr>
<td>femur PF</td>
<td>11</td>
<td>02</td>
<td>13</td>
<td>15.4</td>
</tr>
<tr>
<td>femur DF</td>
<td>03</td>
<td>07</td>
<td>10</td>
<td>70.0</td>
</tr>
<tr>
<td>tibia PF</td>
<td>09</td>
<td>15</td>
<td>24</td>
<td>62.5</td>
</tr>
</tbody>
</table>

*aDF = distal epiphysis fused, F = fused, PF = proximal epiphysis fused.*

situation, who are able to feed surplus animals until they reach an age when growth has slowed and maximum culling gains can be obtained.

The Fauna: Bone Breakage

The pattern of a specialized use of resources in unstressed conditions, suggested by species representation and culling patterns, is reinforced by patterns of bone breakage at Ngamuriak. There was a high level of fragmentation of bones at the site. Only one complete long bone was recovered from Ngamuriak, and most fragments were less than one-third their original length (mean proportions of original length: 0.24 for cattle, 0.31 for caprines). Long-bone ends were commonly fractured, although cattle long-bone ends were more broken up than those of caprines (Figure 4). Many cattle long-bone ends were one-quarter to one-third their original circumference and showed plane fracture surfaces probably resulting from heavy longitudinal and transverse chopping.
Table 3a
Caprine mortality data at Ngamuriak, from dental eruption and wear.

<table>
<thead>
<tr>
<th>Age class</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonate</td>
<td>8</td>
<td>11.6</td>
</tr>
<tr>
<td>Juvenile</td>
<td>16</td>
<td>23.2</td>
</tr>
<tr>
<td>Old juvenile</td>
<td>2</td>
<td>2.9</td>
</tr>
<tr>
<td>Young adult</td>
<td>12</td>
<td>17.4</td>
</tr>
<tr>
<td>Adult</td>
<td>27</td>
<td>39.1</td>
</tr>
<tr>
<td>Aged</td>
<td>4</td>
<td>5.8</td>
</tr>
<tr>
<td>Very old</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 3b
Caprine mortality data at Ngamuriak, from long-bone fusion.

<table>
<thead>
<tr>
<th>Element fusion (approximate timing)</th>
<th>Not fused</th>
<th>Fused</th>
<th>N</th>
<th>Percent fused</th>
</tr>
</thead>
<tbody>
<tr>
<td>6–10 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>humerus DF</td>
<td>16</td>
<td>52</td>
<td>68</td>
<td>76.5</td>
</tr>
<tr>
<td>radius PF</td>
<td>08</td>
<td>60</td>
<td>68</td>
<td>88.2</td>
</tr>
<tr>
<td>13–24 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st phalange PF</td>
<td>15</td>
<td>19</td>
<td>34</td>
<td>55.9</td>
</tr>
<tr>
<td>2nd phalange PF</td>
<td>07</td>
<td>13</td>
<td>20</td>
<td>65.0</td>
</tr>
<tr>
<td>metacarpal DF</td>
<td>00</td>
<td>02</td>
<td>02</td>
<td>100.0</td>
</tr>
<tr>
<td>18–24 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tibia DF</td>
<td>09</td>
<td>22</td>
<td>31</td>
<td>71.0</td>
</tr>
<tr>
<td>20–28 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>metapodial DF</td>
<td>33</td>
<td>09</td>
<td>42</td>
<td>21.4</td>
</tr>
<tr>
<td>30–36 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ulna F</td>
<td>14</td>
<td>05</td>
<td>19</td>
<td>26.3</td>
</tr>
<tr>
<td>femur PF</td>
<td>24</td>
<td>27</td>
<td>51</td>
<td>52.9</td>
</tr>
<tr>
<td>calcaneum F</td>
<td>07</td>
<td>07</td>
<td>14</td>
<td>50.0</td>
</tr>
<tr>
<td>36–42 months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>radius DF</td>
<td>25</td>
<td>11</td>
<td>36</td>
<td>30.6</td>
</tr>
<tr>
<td>humerus PF</td>
<td>18</td>
<td>08</td>
<td>26</td>
<td>30.8</td>
</tr>
<tr>
<td>femur DF</td>
<td>20</td>
<td>10</td>
<td>30</td>
<td>33.3</td>
</tr>
<tr>
<td>tibia PF</td>
<td>13</td>
<td>03</td>
<td>16</td>
<td>18.8</td>
</tr>
</tbody>
</table>

*DF = distal epiphysis fused, F = fused, PF = proximal epiphysis fused.

Because the small-stock bones were less fragmented than those of large stock, fragmentation is unlikely to have resulted from post-discard site formation processes such as trampling. Instead, the high level of bone fragmentation at the site suggests intensive use of within-bone nutrients. This suggests that animals were in good condition when they were slaughtered, because the bones of animals that are fat-depleted as a result of nutritional stress contain so few nutrients that they are seldom broken up (Speth 1983, 1987; Marshall 1990).

The focus on fat retrieval at this site is consistent with the needs of a high protein, low carbohydrate diet (Speth and Spielmann 1983; Speth 1987; Ambrose 1986). A high fat intake would be necessary if the diet consisted primarily of protein from livestock pro-
duction (milk, meat, and blood) with relatively few carbohydrates from cultivation or trading (Marshall 1990).

Other Categories of Information

Site location, site structure, and material culture support the interpretation of a primarily pastoral mode of subsistence at Ngamuriak and at other Neolithic sites in the Lemek Valley. Sites are typically found away from the river, on a very narrow range of gradients that occur at the break of slope at the foot of the hills forming the valley margin (Marshall 1986; Robertshaw et al. 1990). This pattern is similar to that of Maasai settlement in the area since 1947 (Marshall 1986; Robertshaw et al. 1990).

Siting of contemporary Maasai settlement appears to be dictated primarily by consideration of the needs of livestock herds (Western and Dunne 1979). Agricultural settlement seems less sensitive to gradient and more affected by soil type and proximity of water (see the location of early Iron Age sites in Kenya [Bower et al. 1977]). Since Neolithic settlement patterns in the Lemek Valley are similar to those of contemporary Maasai pastoralists, it is likely that the needs of livestock herds, rather than the requirements of agricultural production, influenced Neolithic settlement in the valley.

There are similar parallels between the internal structure of present-day East African pastoral domestic settlements and the Neolithic site of Ngamuriak. Features that East
Figure 3

African pastoral settlements have in common result mainly from the needs of livestock herds. Settlements are not permanent, and include clusters of relatively temporary house structures and stock enclosures. Houses belong to a number of families who usually share food and labor to some degree. Fenced livestock enclosures keep animals from straying at night and provide protection from predators and theft. Settlements are rarely reoccupied, or houses rebuilt, because of the buildup of dung and insect pests over time.

Although all pastoral settlements are occupied for a relatively short period, Maasai settlements are semi-permanent and may be occupied for between two months and ten years, usually about two years (Arhem 1985; Lamprey and Waller 1990; Spencer 1988). In contrast, Gabbra and Turkana groups are highly nomadic and move settlements at very short intervals, the Gabbra as often as every six weeks (Torry 1973), while the Turkana move at intervals that vary between several weeks and several months (Dyson-Hudson and McCabe 1985; McCabe 1987).

Though all pastoral settlements include clusters of relatively temporary houses and stock-holding areas, the size and spatial organization of settlements vary. Turkana and Samburu settlements are small, usually being made up of less than 10 families (Dyson-Hudson and McCabe 1985; Spencer 1973), while Maasai and Gabbra settlements are large, Gabbra settlements including as many as 41 households. In Maasai and Samburu settlements, houses are arranged within the thorn fence surrounding central stock-holding areas (Arhem 1985; Merker 1968; Spencer 1988, 1965), while Gabbra and Turkana
houses are often loosely grouped outside, but close to, stock fences (Torry 1973; Wienpahl 1984).

The site of Ngamuriak had a single major archeological horizon, and covered about 8,000 square meters. There was considerable spatial variation, with small areas containing large quantities of material culture, apparently refuse heaps, much larger areas containing very low densities of archeological material, and some places with traces of animal dung (Robertshaw and Marshall 1990). There was also an area of compacted mud surrounded by postholes, interpreted as a hut floor. The mud floor was thin and the postholes small, indicating that the hut was relatively insubstantial.

All these characteristics suggest that Ngamuriak was generically similar to modern pastoral sites. The single major horizon indicates there was no rebuilding, and the frailty of the hut structure suggests relatively short-term occupation. The size of the site, the spatial variation of artifact densities within the area, and the dung are consistent with the presence of livestock-holding areas. All major features of site structure suggest a focus on domestic stock and a degree of mobility characteristic of contemporary pastoral settlement.

It is difficult to establish whether cultivation took place on Neolithic sites in the Lemek Valley, because of problems associated with the preservation and retrieval of botanical remains from open archeological sites and the difficulties of interpreting negative evidence. No domestic plants were found, but floated samples were too small for this to be definitive (Marshall 1986; Robertshaw and Marshall 1990). However, there appears to be sufficient evidence to indicate that plant foods were not a major focus of local production. Few grindstones were found at Ngamuriak, and no stone axes or other agricultural implements were found at this or any other site in the Lemek Valley.

Other Sites in the Loita-Mara Region

While Ngamuriak is the largest site excavated in the Loita-Mara area, Sambo Ngige, another Elmenteitan site, and Lemek North-East, a Narosura-related Savanna Pastoral Neolithic site dating to about the same period, have faunal assemblages consisting entirely of domesticated animals (Marshall 1990). There is also unpublished evidence for similar patterns at other Elmenteitan sites on the Mara Plains (Siiriänen 1990, and personal observation) and on the Loita Hills (Cable and Robertshaw 1990; Mbae, personal...
communication, 1985; and personal observation). Taken together, the evidence from the Loita-Mara area suggests that settlement 2,000 years ago was pastoral in nature, and that domestic herds were the focus of food production.

Other Sites in Kenya

Faunal assemblages from sites in southern Kenya dating to between about 2,600 and 1,000 b.p. can be divided into two groups on the basis of species representation (Table 4). Those with high proportions of domestic stock and few wild animals, a pattern similar to the Loita-Mara sites, include: the Elmenteitan levels at sites of Enkapune Ya Muto and Maasai Gorge in the central Rift Valley, and probably the Remnant site on the Mau Escarpment (Ambrose 1984b; Gifford-Gonzalez 1985; Bower et al. 1977); and Savanna Pastoral Neolithic sites of Narosura at the base of the Loita Hills, Crescent Island Main in Lake Naivasha, and the Lukenya sites (GyJm 44, 48, and 52) of the plains east of the Rift Valley (Gramly 1972; Gifford-Gonzalez and Kimengich 1984; Onyango-Abuje 1977).

Of the faunal assemblages that have wild taxa well represented, only two are from major Elmenteitan or Savanna Pastoral Neolithic sites. These are the Elmenteitan site of Gogo Falls from western Kenya (Marshall 1986) and the Savanna Pastoral Neolithic site of Prolonged Drift in the Lake Nakuru basin (Gifford, Isaac, and Nelson 1980). The rest are from Eburran 5a sites. Sites that are thought to fit into this category include Naivasha Railway Rockshelter, possibly Crescent Island Causeway, and levels at Enkapune Ya Muto and Maasai Gorge (Ambrose 1984b; Gifford-Gonzalez and Kimengich 1984; Onyango-Abuje 1977).

Discussion

The very small proportions of wild fauna present on many Pastoral Neolithic sites from southern Kenya dating to the period between 3,300 and 1,300 b.p. indicate that the Loita-Mara sites are part of a larger pattern of specialized use of domestic animals. Specialized pastoral production cuts across synchronous archeological “cultures,” and perhaps eth-

Table 4
Proportions of domestic to wild mammals at major Later Neolithic and Eburran 5a sites in southern Kenya.

<table>
<thead>
<tr>
<th>Sites</th>
<th>Domestic (% NISP)</th>
<th>Wild (% NISP)</th>
<th>N (NISP)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neolithic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ngamuriak</td>
<td>99.5</td>
<td>00.5</td>
<td>4,653</td>
</tr>
<tr>
<td>Sambo Ngige</td>
<td>99.0</td>
<td>01.0</td>
<td>214</td>
</tr>
<tr>
<td>Maasai Gorge</td>
<td>96.8</td>
<td>03.2</td>
<td>218</td>
</tr>
<tr>
<td>Narosura</td>
<td>98.0</td>
<td>02.0</td>
<td>1,409</td>
</tr>
<tr>
<td>Lemeck North-East</td>
<td>100.0</td>
<td>00.0</td>
<td>574</td>
</tr>
<tr>
<td>Crescent Island Main</td>
<td>82.0</td>
<td>18.0</td>
<td>523</td>
</tr>
<tr>
<td>Prolonged Drift</td>
<td>23.0</td>
<td>77.0</td>
<td>1,581</td>
</tr>
<tr>
<td>Gogo Falls</td>
<td>53.6</td>
<td>46.4</td>
<td>612</td>
</tr>
<tr>
<td><strong>Eburran 5</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naivasha Railway Shelter</td>
<td>25.5</td>
<td>74.5</td>
<td>220</td>
</tr>
<tr>
<td>Crescent Island Causeway</td>
<td>92.1</td>
<td>07.9</td>
<td>392</td>
</tr>
</tbody>
</table>


aNISP = number of identifiable specimens, identified to taxon.
nic groups, being found among both Elmenteitan and Savanna Pastoral Neolithic groups in the central Rift Valley and the Loita-Mara area. I believe this reflects a deliberate choice by some Elmenteitan and Savanna Pastoral Neolithic groups living in a region with abundant wildlife to disregard this resource and to adopt a specialized system of production focused on domestic herds.

While the faunal evidence strongly suggests that domestic cattle, sheep, and goat herds were an important focus on the subsistence system, an obvious limitation of these data is that they do not provide good information on the relative importance of cultivation to food production. However, although there is disagreement over whether cultivation of grains or other foods played any part in the local system of production (Robertshaw et al. 1990; Marshall 1990), there is widespread agreement that the location of Pastoral Neolithic sites on the productive rangelands of Kenya, but not on the fertile agricultural areas of the eastern highlands occupied by later Iron Age agriculturalists, reflects the orientation of Neolithic groups toward animal husbandry rather than cultivation (Ambrose 1984a; Robertshaw and Collett 1983; Robertshaw 1989; Bower 1988). As at Ngamuriak, other features of Neolithic settlements, such as site structure, the lack of permanent houses, and the few implements associated with agriculture, such as hoes and grindstones, support this position. Although some agriculture could have been practiced on Pastoral Neolithic sites on the plains, it was clearly not a major focus of subsistence activities.

In contrast to the focus on domestic stock found in the Pastoral Neolithic sites discussed above, Eburran 5a sites of the region have faunal assemblages with high proportions of both wild and domestic animals (Table 4). Ambrose (1984b), on the basis of lithic assemblages and locations, interprets these sites as occupied by hunter-gatherers and explains the domestic fauna by suggesting contact with nearby pastoral groups, or perhaps a transitional stage to food production.

I have left until last discussion of the two Pastoral Neolithic sites with large faunal assemblages, Gogo Falls in western Kenya, and Prolonged Drift in the Lake Nakuru basin of the central Rift Valley. These are similar to the Eburran sites in preserving a mixture of wild and domestic fauna, and therefore exceptions to the concentration on domestic animals found on many Pastoral Neolithic sites. Although as these sites are exceptions to a fairly strong pattern of specialized pastoral production, they may be key to understanding the wider economic and social context of the Savanna Pastoral Neolithic herding adaptation.

Gogo Falls is the only Pastoral Neolithic site so far excavated in the western Kenyan region. It is a large, open site with Elmenteitan lithics and pottery (Collett and Robertshaw 1980; Marshall 1986). Fauna from Gogo Falls is extremely diverse. Fish bones are abundant, cattle and caprines are well represented, and a wide range of wild species are also present (Marshall 1986). The wild taxa are not as diverse as those common on most present-day hunter-gatherer sites, and domestic stock are of ages similar to those culled by pastoralists at other Elmenteitan sites. The site is of similar size and structure to open pastoral sites such as Ngamuriak, although it is a multicomponent site with a complex stratigraphy and considerably deeper Elmenteitan occupation horizon. It also preserves significant quantities of dung, suggestive of animal husbandry (Robertshaw, personal communication, 1983). For these reasons, despite the differences in faunal use between this and other Elmenteitan sites, I have hypothesized that this is an Elmenteitan pastoral site (Marshall 1986).

I believe the explanation for the observed mixed subsistence base of this Elmenteitan group may lie in the distribution of tsetse fly in the area. Much of western Kenya, including the Gogo Falls area, is infested by tsetse fly today. Given a similar climatic regime to the present, this is also likely to have been the case in the past (Lambrecht 1964; Collett and Robertshaw 1980). The resultant reduction in productivity from domestic herds (ILCA 1979) may have forced Elmenteitans of western Kenya to rely on alternative subsistence activities and a diverse subsistence base, including fishing, hunting, and possibly
cultivation. Further excavation in western Kenya is needed to test this hypothesis through investigation of the regional system of production. Other, as yet unpublished, faunal assemblages from Pastoral Neolithic sites in the Serengeti, a tsetse area, contain large numbers of wild animals (Bower, personal communication, 1984; Gifford-Gonzalez, personal communication, 1984) and may fit the Gogo Falls pattern of faunal use.

The site of Prolonged Drift, on the other hand, is of unclear affiliation in terms of material culture. Like Gogo Falls, it is a large, open site, and it has been interpreted on the basis of material culture and site location as a Pastoral Neolithic site (Ambrose 1984a). At Prolonged Drift, cattle are more common than caprine remains, and large ungulates are present in significant numbers (Gifford, Isaac, and Nelson 1980). Because of its unclear cultural affiliation and the fact that it seems to be an isolated site type in a region that has been archeologically explored, Prolonged Drift presents a different sort of problem in interpretation than Gogo Falls.

Gifford-Gonzalez has suggested a number of alternative explanations for this pattern, ranging from hunting by people with a pastorally oriented subsistence base to acquisition of domestic stock by people with a hunting and foraging subsistence base (Gifford, Isaac, and Nelson 1980). She points out that on the basis of the available evidence it is difficult to distinguish between these alternatives. At present there is not a strong case for arguing that Prolonged Drift represents a widespread pattern of seasonal use of wild faunas by pastoralists in the region. It is more likely that this site reflects the response of an individual group of pastoralists or hunter-gatherers to local or personal circumstances.

There are hints from small or unpublished faunal samples that in addition to the Elmenteitans of western Kenya, widespread use of wild faunas may have existed among pastoral groups in such areas as the Baringo basin. It should be borne in mind that both the dichotomy drawn here between wild and domestic faunas, and Ambrose's system of classification of the Savanna Pastoral Neolithic, while useful heuristic devices, highlight the extremes and tend to mask variability. Just as today, it is likely that in the past there was variation in subsistence both within and between pastoral groups and through time. Only further excavation and large faunal samples can clarify the variation in the broad patterns outlined here.

**Change in Subsistence**

There is a recognizable temporal component to variation in the subsistence bases of the East African Neolithic. A diversified pastoral subsistence, including hunting, fishing, herding, and unknown amounts of cultivation, appears to have been practiced by the first food producers to appear in East Africa, about 4,000 b.p. or somewhat earlier. By about 2,600 b.p. there is evidence for a specialized pastoral subsistence base among both Elmenteitan and Savanna Pastoral Neolithic groups in southern Kenya, oriented toward production of food from domestic herds, with exclusion of wild animal resources. At the same time, diversified pastoral subsistence continues to be found among some Elmenteitan and Savanna Pastoral Neolithic groups. Doubtless many social, economic, and ecological factors influenced the development of specialized pastoralism in East Africa. However, there is strong circumstantial evidence that a major change in rainfall patterns, which began roughly 3,000 years ago, was an important factor in the development of specialized pastoralism in East Africa.

Climate and vegetation in East Africa have varied considerably over the last 12,000 years. As a result of paleoclimatic research initiated in the 1960s (Coetzee 1967; Hamilton 1982; Kendall 1969; Richardson and Richardson 1972; van Zinderen Bakker 1964) some broad generalizations can be made about the climatic and vegetational history of the period (see Hamilton 1982; Livingstone 1975, 1980, for summaries). Between 10,000 and 8,000 b.p., temperatures were at modern levels, and conditions may have been wetter than at any time during the last 20,000 years (Hamilton 1982; Livingstone 1975). The trend toward warmer and more arid conditions may have begun by about 7,000 b.p., and there
is general agreement that the modern climatic regime was established by about 3,000 b.p. (Hamilton 1982; Livingstone 1975).

The details of this sequence, and local microclimatic patterns, are less well known than the overall trends. It has been argued that from 5,600 to 3,000 b.p. the climate in southern Kenya was generally warmer and drier than at present, as the three lakes in the central Rift Valley dried up long enough for sediment oxidation to occur (Richardson 1972; Richardson and Richardson 1972). At that time forests may have receded to higher altitudes than at present (Ambrose 1986). On the basis of clearly laminated sediments in the Lake Naivasha core, Richardson and Richardson (1972) also believe that a single, well-defined rainfall season existed until the present loosely bimodal system came into operation by about 2,500 b.p. (Hills 1978; Davies, Vincent, and Beresford 1985; see Figure 5).

This fits with a model for patterns of general atmospheric circulation proposed by Nicholson and Flohn (1980) to explain general environmental and climatic changes in Africa between 6,500 and 4,500 b.p. They suggest that during this period the Inter-Tropical Convergence Zone (ITCZ) was displaced northward as a result of increased thermal contrasts between the northern and southern hemispheres. This would have resulted in rains associated with the ITCZ reaching farther north into the southern Sahara than previously, with East Africa receiving a single rainy season per year. Although the field evi-

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**Figure 5**
The present distribution of bimodal rainfall regimes in Africa (following Walter, Harnickell, and Mueller-Dombois 1975).
idence in East Africa is still slender, it seems likely that by 2,500 years ago rainfall had increased to present-day levels, and that it fell in two distinct rainfall seasons, just as it does today.

A strong relationship between the present-day bimodal pattern of rainfall of much of East Africa and the productivity of East African rangelands and contemporary pastoral herds has been noted by several researchers (Dahl and Hjort 1976; Western and Finch 1986; Pratt and Gwynne 1977). The key to this relationship is milk production from domestic herds, which makes up a high proportion of the diet of most East African pastoralists (Dahl and Hjort 1976).

The milk production of cattle herds is strongly seasonal in areas with strongly seasonal rainfall. This results from the effect of rainfall on fecundity (Dahl and Hjort 1976). A healthy East African zebu cow will come into season roughly every two months, have an average 9.5-month parturition period, and may bear calves at intervals as short as 13 months. However, animals often fail to come into season or conceive when it is dry. As a result there are strong seasonal fluctuations in cattle breeding in sub-Saharan Africa. In areas with one rainy season and a long dry season, cattle tend to breed once a year, with conception taking place after the rainy season and calves being born during the next rains (Dahl and Hjort 1976).

In addition, the periods of lactation and the quantity and quality of milk produced is very sensitive to the quality of forage. There is a tendency for lactation to last much longer after birth (7–9 vs. 4 months) and for more milk to be produced in wet than in dry areas (Dahl and Hjort 1976). In addition, the fat content of the rainy-season milk may be double that of dry-season milk, and the protein content considerably higher (Dahl and Hjort 1976).

Thus, a long dry season and corresponding monoseasonal pattern of reproduction in cattle herds results in substantial seasonal shortages of milk provided by pastoral herds. In an area with a long dry season, some of the resulting shortage of food may be made up through other livestock products, including milk from goat herds and increased consumption of meat and blood. However, without supplementary forage these cannot make up the shortfall, and Western and Finch (1986) and Dahl and Hjort (1976) suggest that this explains why Sahelian-Sudanic pastoralists rely more heavily than East African herdsmen on agriculture, hunting, and fishing for subsistence.

For all of these reasons, the return of the Inter-Tropical Convergence Zone to equatorial areas and a modern-climate rainfall regime with a bimodal rainfall regime and short dry season to East Africa would have significantly increased the potential for milk production from pastoral herds in the region and allowed pastoralists to rely more extensively on cattle, sheep, and goat herds than in the past. Since this appears to coincide with the development of specialized pastoral production in the region and a dramatic reduction in hunting among some groups, the advent of a modern climatic regime in East Africa may explain the timing and process of the adoption of a specialized pastoral mode of production there.

The increased production potential of pastoral herds created by the advent of a bimodal rainfall regime may have been further enhanced by the introduction of Bos indicus cattle breeds to East Africa at this time (Marshall 1989). Bos indicus breeds are capable of lowering their metabolic rate as much as 40% in response to nutrient stress and thus reducing the energy costs of daily foraging and the amount of food and water needed to survive (Western and Finch 1986). Both weight and milk production recover more quickly after a drought in Bos indicus than in Bos taurus breeds (Phillips 1960, 1961; Western and Finch 1966:87; Lampkin and Lampkin 1960). Bos indicus is thus especially well adapted to the fluctuations in heat stress, water stress, and forage quality that are common in East Africa, and more productive than Bos taurus under such conditions (Epstein 1971; Frisch and Vercoe 1977; Ledger and Sayers 1977; Phillips 1960, 1961).
Cultural Considerations

Social anthropologists have suggested social and religious explanations for the orientation of East African herders toward cattle (Herskovits 1926:264–265), and a variety of economic reasons for their subsistence concentrated on production from domestic herds. Schneider, for example, argues that agriculture is not present among the wealthiest pastoral groups in East Africa because “the return on investment in animal husbandry is much more profitable than agriculture,” (Schneider 1979:104). Bonte suggests that pastoral specialization corresponds to the need to “produce an increase in the productivity of pastoral labour” (Bonte 1981:40). Despite the different emphases of individual formulations, it is clear that the social and economic context of the transition to specialized pastoralism is important to understanding the reasons for this change.

The East African archeological record as discussed here provides a context for considering these issues. The first point to consider is that a high level of dependence on domestic herds for production is a specialization that had developed in East Africa by 2,000 years ago, and not with the arrival, several hundred years ago, of the ancestors of contemporary pastoralists. Specialized pastoralism is therefore not exclusively associated with any particular culture, a conclusion that fits recent thinking about the flexibility of pastoral subsistence strategies in response to political or environmental stress (Waller 1988; Anderson 1988). Second, this development took place in the context of social and economic interactions between hunter-gatherers and pastoralists. I believe this may be a particularly important factor behind the choice of some pastoralists in East Africa to specialize in production from domestic stock.

Pastoral, agricultural, and hunter-gathering subsistence systems in East Africa appear to be both interconnected and complementary (Kenny 1981; Blackburn 1982). Recent studies have emphasized exchange relationships between contemporary hunter-gatherers and pastoralists (Berntsen 1976; Blackburn 1982; Kratz 1980, 1986), movement of people between groups (Kenny 1981; Spencer 1973; Waller 1988), and the role of symbolism and negative group definition in establishing ethnic identity and maintaining ethnic boundaries (Galaty 1982; Kenny 1981). Hunter-gatherers without cattle are looked down on by East African pastoralists (Galaty 1981, 1982; Kenny 1981; Kratz 1980; Spencer 1965), but their lack of cattle protects hunter-gatherers, because they possess little that pastoralists want (Blackburn 1982).

It is possible that the specialization of East African hunter-gatherers, such as the Okiek, in honey collection (Blackburn 1982; Kratz 1980, 1986), and their exchange of this commodity with neighboring pastoralists, may have provided a carbohydrate that reduced the need for plant foods in the pastoral diet. At the same time as active systems of exchange with hunter-gatherers may have played a role in making the pastoral specialization more viable, sociocultural factors such as the desire for differentiation may have played a part in the reduced importance of hunting to some pastoral groups in East Africa. Investigation of the period immediately preceding the advent of food production in Kenya, and interactions between hunter-gatherer and pastoral groups, could help test these suggestions.

Conclusion

Pastoralism with a diversified herding, hunting, and fishing subsistence base was present in East Africa by 4,000 b.p. A specialized system of pastoral production had developed in East Africa by between 3,000 and 2,000 b.p. The development of specialized pastoralism may have been based on opportunities for increased pastoral production that occurred at this time. These opportunities resulted primarily from the advent of a modern climatic regime and bimodal patterns of rainfall in the region by 3,000 years ago and may have been supplemented by the introduction of Bos indicus cattle breeds to East Africa at about this time.
In contrast with the Near East, the development of pastoral production in East Africa preceded agricultural development, and took place in the social and economic context of relationships between pastoralists and hunter-gatherers. The contact between East African hunters and pastoralists may have led to an emphasis on their differences and provided an impetus for the specialization that a more favorable rainfall regime and more consistently productive cattle allowed.

Many authors have pointed out the bewildering variation in social organization and subsistence that exists among contemporary pastoralists (Dyson-Hudson and Dyson-Hudson 1980; Spooner 1973). The conclusions drawn here support the perspective that pastoralism as a whole may be best understood through studies of local adaptations to specific ecological and social conditions (Dyson-Hudson and Dyson-Hudson 1980; Rosen 1988).

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Hodder, Ian

ILCA (International Livestock Centre for Africa)

Jacobs, Alan H.

Kendall, Robert L.

Kenny, Michael G.

Kratz, Corinne A.

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