AGROAL AND THE EARLY BRONZE AGE OF THE PORTUGUESE LOWLANDS

by

Katina T. Lillios *

Resumo: Povoados datados da Idade do Bronze inicial nas "Terras Baixas" do Sul de Portugal (2000-1500 AC) têm sido difíceis de identificar e, assim, o início do segundo milénio AC tem representado uma fase de fragmentação cultural ou um hiato cultural na Pré-história portuguesa. O povoado de Agroal (Vila Nova de Ourém), escavado entre 1988 e 1992, é o primeiro povoado datado pelo radiocarbono desse período. A estação tem fornecido dados que indicam actividades de pastagem (principalmente de *Bos*), agricultura intensiva, metalurgia do cobre e produção de têxteis. Nesse sentido, o Agroal demonstra alguma continuidade com os povoados da Idade do Cobre do Centro-Sul de Portugal. Esta comunicação sintetiza os dados obtidos nos povoados e enterramentos do Bronze Inicial nas "Terras Baixas" portuguesas e propõe um modelo explicativo das transformações dramáticas que ocorreram na transição da Idade do Cobre para a do Bronze.

Palavras-chave: Bronze Inicial. Mudança cultural. Centro-Sul de Portugal.

INTRODUCTION

The central problem that has plagued research on the Copper to Bronze Age transition in Portugal has been the lack of sites dated to the Early Bronze Age (2000-1500 BC). As a whole, radiocarbon dates for the later prehistory in Portugal are not abundant, and, as a result, attributions of late prehistoric material have relentlessly tossed on a stormy sea of conjectures, inconsistencies, and far-flung comparisons with the Spanish evidence.

Agroal is the first site in Portugal that has been securely dated to the Early Bronze Age. As such, it offers a unique means by which to evaluate previous chronological attributions, and, in particular, to understand why this period has presented such challenges to investigators in the past. Most importantly, it is currently the best available gauge by which to monitor the cultural changes that occurred between the Copper and Bronze Ages of the Portuguese lowlands.

* Department of Anthropology and Sociology. Ripon College, Ripon, WI 54971 USA.

In this paper, I present the results of survey and excavation which were conducted under my direction at Agroal between 1988 and 1990. This research revealed that Agroal was inhabited during both the Bronze Age (Early and Late), and Middle Ages; most of my discussion here, however, will concentrate on the Early Bronze Age occupation of the site. Although Agroal had been noted as early as the 1940s by the Portuguese archaeologist J. Camarate França (Castro 1973), it had not been excavated prior to 1988.

Throughout this fieldwork, I was particularly concerned with the following questions:

1) how do the artifacts, faunal assemblage, and context of Agroal compare to those of other well-defined Copper and Bronze Age sites,

2) what about the Early Bronze Age, as represented by Agroal, has rendered this period difficult to identify archaeologically, and, how might this problem be rectified in future survey programs, and

3) what was the nature of the subsistence economy and scale of social interactions at Agroal.

Environment of the Nabão Valley and Agroal

The site of Agroal is located on a hilly ridge (elev. 150 m) that overlooks a sharp bend in the Rio Nabão, at the confluence of the Nabão and the Ribeira dos Chãos (Fig. 1). The site extends approximately 700 m east-west, and 100 m north-south along this ridge.

The geology of the Nabão is succintly described by Barnett (1985):

"The Valley of the Nabão is situated in a series of horizontal limestone beds of Jurassic through Miocene Age that extend west to the Atlantic coast. The topography is hilly and karstic; caves and underground channels are abundant. A fault marks the eastern boundary of the Nabão Valley, separating it from the Orduvician and Silurian quartzites, conglomerates, and metavolcanics to the east that are drained by the Rio Zêzere. Pre-Cambrian granites and schists dominate the geology further to the east".

Flint is available in many areas along the Nabão, some within a few minutes walking distance from Agroal; material for groundstone tools, such as amphibolite cobbles, can be found within a day's walk.

The soils typical of the hills are degraded Alfisols (Red Mediterranean Soils, 'terra rosa'). Generally, the topsoil and A horizons have eroded away; the red, clayey Bt horizon is left exposed. Preliminary analyses of the soils that pre-date Bronze Age deposits at Agroal have indicated that the hill was covered by much less degraded soils during the site's Bronze Age occupation. These analyses will be discussed below.

Forests of pines (*Pinus pinaster*) dominate many of the hilltops of the Nabão; more common, however, are dense patches of kermes oak (*Quercus coccifera*), rock rose (*Cistus monspeliensis*), spurge (*Euphorbia characias*), wild olive (*Olea oleaster*), and expanses of fragrant herbs, such as rosemary (*Rosmarinus officinalis*) and lavender (*Lavandula* sp.). The year-round grazing of small herds of goat and sheep prevent the regeneration of the primary vegetation. Of the cultivated species, the olive and the grape are the most common.

In comparison to the hills in the Nabão Valley, the valley bottom is lush and fertile. Small dense plots of vegetable gardens, orchards, and vineyards, are maintained with the use of hand tools and animal-drawn irrigation systems.

The vegetation which covers the site primarily consists of oak shrubs, herbs, and olive groves (fig. 2). In many areas, the limestone bedrock is exposed, suggesting a long of history of human use. The only area along the ridge currently cultivated is a 100x100m depression located between two hillocks in Zone 2.

On the south slope of Agroal, a magnificent fresh water spring emerges and drains into the Nabão. Descriptions of this spring constitute most of the early published references to Agroal.

"At this spring of Agroal, there is a large opening of water, that originates within craggy eminences and extremely high rocks where eagles are nursed; these peaks are, therefore, known as the Peak of the Eagle. In the village (of Agroal) it already enters with the arrogance of a river... From it emerges a great amount of water with such a strong current that it turns many olive presses and mills...

...Although this river is born with severity, it flows always through a fertile and delightful land, until, when accompanied by many brooks, it is carried off by the Rio Zêzere..." (Costa 1868-9:109-110)

It is, in fact, the vegetation associated with the spring which gives the name to the area. 'Agroal' is derived from the Portuguese word for watercress (*Nasturtium officinale*), or *agrião*, which in the 1930s grew "in luxuriant festoons" (Guimarães 1932), and is still collected today for use in salads and soups.

This year-round spring at the base of Agroal provides an abundance of clean, cold water (2 million liters per 24 hours) (Guimarães 1932:8), and was probably an important factor in the initial settlement of the area in prehistory.

METHODOLOGY

Introduction

The principal goals of the fieldwork at Agroal were the following:

1) to establish an occupational chronology for the site and determine the nature of these occupations,

2) to identify the boundaries of the site during its occupations, and

3) to discover reasonably undisturbed deposits of Bronze Age material.

These were achieved by a combination of mapping, surface collection, soil phosphate testing, test pitting, and excavation. The general procedures followed for each of these activities, as well as processing and analytical techniques, will be briefly described below.

Mapping

Mapping was carried out in 1988 and 1989, during which the following maps were produced: a site plan (1:2000) (Fig. 3), indicating topography and architecture, plans (1:10) of pits and trenches excavated, and sections (1:20) of excavated pits and trenches. The site plan was produced with the use of a transit and stadia rod, using as a site datum a geodesic benchmark easily identified on the Portuguese Army map for the concelho of Vila Nova de Ourém (Serviço Cartográfico do Exército 1983). The site was divided into four zones (1-4), each similar in their topographic situation and modern land use practices.

Surface Collection

Surface collections were undertaken between in 1988 and 1990, in Zones 1-4. All surface artifacts were collected, whether diagnostic or undiagnostic, and their location, by zone, was noted. This was carried out in order to determine the areas where excavation would be most productive. Prior to excavations in 1988 and 1989, Zones 1-4 were traversed. At these times, Zone 4 was under a pine forest and no material below the layer of pine needles was recovered. However, in 1990, during which another survey was carried out, this pine forest had been cleared and the soil turned over for the planting of eucalyptus; an abundance of prehistoric artifacts was, at this time, recovered. The discovery of this material was instructive in indicating that the site was larger than previously suspected, and, since many of the artifacts were diagnostic and similar to other excavated material from Agroal, it was possible to confirm the chronological attribution of the site.

Soil Phosphate Testing (Field Method)

A pilot study was undertaken in the spring of 1988 to test the suitability of applying phosphate analysis as a pre-excavation survey technique. Soil phosphates have long been known to be rough indicators of the degree of human activity. Their elevated values in soils are known to be the result of organic refuse disposal, cultivation, manuring, or the decomposition of organic building remains (Dauncey 1952; Arrhenius 1963; Sjöberg 1976). The technique used to determine soil phosphates in the field was Eidt's Ring Chromatography Field Test (RCFT) (Eidt 1984). This simple field test involves a two-step process of phosphate extraction, with a solution of ammonium molybdate and hydrochloric acid, and reduction, with a solution of ascorbic acid and distilled water. The intensity of the color change (to blue) of the soil on ash-free filter paper in combination with these solutions reflects the relative quantity of available phosphates in the soil. The reactions were stopped at the end of 2.5 minutes, with a solution of sodium citrate and water, and assigned a value, on a scale from 0-5; 0 meant no color change, 5 meant a thick blue band formed around the soil sample on the filter paper.

The RCFT is known to be an imprecise method of measuring soil phosphates since available phosphates form only a portion of the total phosphate levels of a soil. Nevertheless, it was thought to be worthwhile to compare the results of this technique with the results from other pre-excavation testing techniques, such as collection of surface artifacts and determination of deposit depth.

A 100 meter north-south transect was measured in Zone 3, where there was considerable surface artifactual material and visible architecture. Sub-datums were established every 10 meters. Depth to bedrock, weight of surface artifactual material within a 2m radius of each sub-datum, and phosphate levels, using the RCFT, were plotted. As figure 4 shows, the RCFT produced results similar to those of the other two more traditional survey techniques; it was also fast and non-destructive.

Test Pitting

In the spring of 1988, a 0.5 x 2.0m test pit (pit 1) was opened along a path on the north slope of the hill. This area was chosen because it was the area in which ceramics (carinated, burnished, hand-made) and animal bones had been found. Excavation proceeded by following natural layers, which were visible in the cut, screening (with 4mm mesh), and soil sampling at each layer. By the end of the 1989 season, a 9m² extension of this test pit had been excavated.

Excavation

Excavations were carried out in two six-week seasons in 1988 and 1989. Crew members included volunteers and students from the United States, Europe, Australia, and South America. Crew size ranged from five to ten individuals.

Excavations were concentrated in Zone 3, where the greatest abundance of surface artifacts and architecture was noted. Two types of excavation strategies were employed. First, systematic sampling of different areas on the hilltop and hillslope was carried out. This was done so that all general areas would be covered, even if they did not yield surface artifacts. Pits opened under this strategy include pits 58-9/70-5, 52, and 60-9/76-82. Pits were also opened along discontinuous transects in order to determine the relation between features, such as Structures A and B (pits 2-5, 6-9, 10-5, and 16-23). This second strategy was also employed to relate known to unknown areas, such as upslope and downslope from pit 1 (i.e., pits 38-9, 42-5, 46-9, 53-6).

Excavation proceeded by following the natural stratigraphy. Natural layers greater than 10cm were further subdivided into 10cm artificial levels; 20cm artificial levels were sometimes used in areas where the stratigraphy was thought to be comparable to another known area. Digging was carried out with trowels, and where necessary, small picks. All soil was screened in 4mm screens; all artifacts and 'ecofacts' found in screening, including charcoal, bones, and seeds, were retrieved. In addition, samples from all artificial levels (designated by letters) within all natural layers (designated by numbers) were collected for soil analysis and flotation.

Processing and Recording

Processing and recording of the finds recovered occurred both in the field and in the United States. All artifacts were washed, and, if they had broken in the field or in transport they were glued together with a glue soluble in acetone (i.e., Uhu). All diagnostic artifacts (ceramic rims, bases, handles, with decoration, metal, lithics, bone, glass) were labeled individually, noting the excavation year and the pit, layer, and level in which they were found. For example, an object with a number of AG.88.5.4A.4 was excavated in 1988, and recovered in pit 5, level 4, layer A (which would be the first 10cm of layer 4). '4' was the individual reference of that object, which differentiated it from AG.88.5.4A.5, etc. Non-diagnostic artifacts were bagged together by layer and level, and not labeled individually. Some reconstruction, particularly of ceramics and bones, occurred after labeling. Each fragment from a reconstructed vessel or bone kept its individual number, so that it was possible to determine from a reconstructed piece whether there was mixing between the levels in which the fragments were found. In this way, I was able to establish, for example, that there had been considerable mixing (from roots or burrowing animals) in Structure B (pits 16-23); many of the reconstructed vessels were made from pieces found in different levels.

Most diagnostic artifacts from prehistoric levels were photographed and drawn, much of the Medieval material was similarly recorded.

Soil and flotation samples were recorded using a different series of numbers, also indicating the layer and level in which they were taken. For soil analyses, including determinations of texture, color, pH, chemical composition, approximately 100 grams were collected. For flotation, samples of 8 liters of soil were collected. Flotation was carried out by mixing water from the spring at Agroal, stirring, and pouring the surface layer into a screen covered by cheesecloth. The cheesecloth was later folded, and set outdoors to dry.

Analyses

Ceramics. Diagnostic ceramics were sorted by decoration, rim form, and base form. Macroscopic identification of clay inclusions were made with the assistance of Howard Snyder (Yale University, Department of Geology and Geophysics).

Lithics. Classification by form and raw material were made of the flaked and groundstone lithics found at Agroal. Michael Chazan (Yale University, Department of Anthropology) provided assistance with classification; Howard Snyder helped in the identification of raw materials.

Metals. The metal objects recovered in Bronze Age contexts included a fishhook and a crucible. Samples of these materials were taken and analyzed for their physical and chemical consistuents by David Killick (Harvard University, Peabody Museum).

Fauna. All fauna was identified using comparative collections at Yale University (Peabody Museum, Osteology Collection and Department of Anthropology). Each bone was identified by genus and species, if possible, body part, and side. Dr. Richard Meadow (Harvard University, Peabody Museum) assisted in these identifications.

Cementum deposition analyses were carried out on some of the well-preserved teeth by Margaret Beasley (University of London) in order to determine seasonality patterns at the site (Bourque, Morris, and Spiess 1978). Examination of the cementum banding patterns offers information as to the age and season of death. In all mammals, two bands of cementum are produced, one in the winter months, one in the summer months. The band produced in the winter months is thin and dark; the band produced in the summer is wide and light. Once the tooth is sectioned, and examined under a high-power microscope, it is often possible to examine the outer edge of the tooth (root area) and determine which of the two bands is situated at the outermost layer, reflecting conditions at death. The age at death is determined by counting the bands, dividing by two (as two are produced a year), and adding the age in which the tooth is known to erupt in the species. The results of these analyses are summarized in Table 5 and discussed below.

Soils. Analyses of particle size, pH, organic matter, and soil macronutrients were conducted at the Connecticut Agricultural Experiment Station, using procedures outlined in Wilde et al. 1979.

In addition, sequential fractionation of soil inorganic phosphates (Eidt 1984) was carried out by Dr. Robert Brinkmann at the State Soils Laboratory of the University of Wisconsin-Milwaukee. Phosphorus is an element found in all living things, which is extremely stable and strongly binds with iron, aluminum, and calcium cations. Unlike carbon and nitrogen, it does not volatilize (Eidt 1984:26). Phosphate analysis, thus, has been attractive to archaeologists interested in determining site boundaries and use-areas (Lippi 1988; Cavanagh, Hirst, and Litton 1988) and has had a long, albeit checkered, history in archaeology (Eidt 1984:33-8). The principal cause for the setbacks, and resultant skepticism (Cornwall 1958:195) in archaeological applications of phosphate analysis has been the confusion relating to the **total phosphate** value of a soil, or the total value of those phosphates both available and unavailable for plant uptake, and its **available phosphates,** which form only a small percentage of the total phosphates. Soils of low-base status (low pH) were thought to leach soil phosphates, when in fact, pH only effects those phosphates held in the available form.

In order to quantify the different forms of phosphates in soils, Eidt (1977) adapted the procedure of sequential fractionation of inorganic phosphates, first developed in the 1950s by the soil scientists Chang and Jackson (1957), to archaeological purposes. The technique allows for the identification of soils enriched by human activities through the isolation of the three fractions of inorganic phosphates: Fraction I corresponds to loosely bound aluminum and iron phosphates, Fraction II to the occluded aluminum and iron phosphates, and Fraction III to calcium phosphates. When settlement, or any other soil enriching activity ceases, the iron and aluminum cations that were loosely bound gradually occlude as Fraction II phosphates (Eidt 1984: 42). The ratio of Fraction II to Fraction I was thought by Eidt to be a relative dating technique (Eidt 1984:43). The results of phosphate fractionation analysis carried out on the soils at Agroal and their relevance to understanding the economy and ecology of the Early Bronze Age occupation of the site are discussed in this paper.

Charcoal. Charcoal recovered in excavation and flotation were identified by Lucinda McWeeney (Yale University, Department of Anthropology)..

CHRONOLOGY

Absolute Dates

Agroal was first occupied in the Early Bronze Age, abandoned, and then reoccupied between the 13th and 17th centuries A.D. The following radiocarbon dates for these two phases have been obtained.

Phase I - Bronze Age
3560 +/- 145 BP (GX-15390-G), bone collagen, calibrated to 2360-1520 BC
3570 +/- 205 BP (GX-15390-A), bone apatite, calibrated to 2280-1680 BC

Phase II - Medieval
670 +/- 50 BP (WIS-2081), charcoal (*Olea* sp. and *Crataegus* sp.)
450 +/- 50 BP (WIS-2082), charcoal
310 +/- 50 BP (WIS-2083), charcoal

The material used to provide the Bronze Age dates were fragments of uncarbonized animal recovered in level 2, of pit 1. The Medieval dates were taken on charcoal recovered in pits 10-5, level 3 (WIS-2081, 2082) and pits 16--23, level 5 (WIS-2083) (Steventon and Kutzbach 1990).

Stratigraphy

Levels that contained Bronze Age material were either mixed with Medieval objects (such as those in pits 32-3, 38-9, 60-9/76-84), or unmixed and secondary (such as those in pits 1/24-7/40-1/50-2, 53-6, and 58-9/70-5). In general, the site has suffered a good deal of post-depositional disturbance, including erosion, ploughing/tilling; and compaction. These factors have rendered the unequivocal dating of structures quite difficult; most of these structures appear to be, however, Medieval in date.

SUMMARY OF OCCUPATIONAL HISTORY

Based on the documentary and archaeological evidence recovered during two seasons of excavations, the history of Agroal can be summarized into six major occupation and abandonment phases:

Phase I. Pre-occupation phase. Post-Pleistocene to pre-Bronze Age occupation (ca 10,000-2000 BC). Duration- ca 8000 years. No evidence for human occupation exists for Agroal prior to the Bronze Age.

Phase II. Bronze Age occupation (2000-1000 BC). Approximate size of settlement- 6 ha for Early Bronze Age, 12 ha for Late Bronze Age. Duration- ca 1000 years. The Early Bronze Age phase at Agroal was radiocarbon-dated; the Late Bronze Age determination was made by the comparison of the ceramics to those from the site of Outeiro do Circo (Parreira 1971-5). No structural remains have been discovered, although it is possible that the Medieval structures on the site were made of reused Bronze Age building materials.

Phase III. Abandonment phase. Post-Bronze Age to pre-Medieval (1000 BC-AD 1300). Duration-ca 2300 years. While there is currently no archaeological evidence for occupation at Agroal during this phase, it is difficult to state that the land was not used (i.e., for grazing, hunting, gathering, cultivation).

Phase IV. Medieval occupation (AD 1300-1640). Approximate size of settlement-8 ha. Duration- ca 350 years. Dating for this occupation phase, derived from radiocarbon determinations and coinage, is quite secure. Numerous structures are in association with this occupation, including enclosure and terrace walls, domestic structures, and a possible animal pen.

There are faunal remains for this phase (N=630), with ovicaprids predominating (83%). Some cattle (2%) and pig (4%) were also recovered. During this phase, Agroal was apparently the site of a farm owned by the Order of Christ (successors to the Knights Templars in Portugal), as suggested by the discovery of a limestone stela in Zone 2 as well as the copper ring from pits 38-9, both with the cross of the Order represented. Based exclusively on the archaeological and architectural evidence, it appears that Zone 2 was devoted to the cultivation and processing of crops, while Zone 3 was devoted to the maintenance of domestic animals, the processing of their products, as well as their slaughter.

Phase V. Post-Medieval occupation (AD 1640-present). Duration-ca 350 years. During this phase, there appears to have been a shift from occupation on the hilltop to the base of the hill, at which is situated the year-round spring. The earliest documentary records for Agroal date to this phase (AD 1641-1645) and relate to the spring and various waterwheels situated in the area along the Nabão (Câmara Municipal de Tomar 1968:218-44). In the 1800s, Agroal continued to be known for the spring, and in particular for its associated mills used to produced olive oil (Costa 1868-9:109). Later, in the early 1900s, the area between the Structures A and B was used briefly as a field (unmanured) for the cultivation of corn. Photographs dating to the 1940s show relatively little vegetation covering the hilltops; the local inhabitants attribute this to the cutting of bushes for fuel.

Current land use activities, which include agriculture and grazing, probably minimally affect evidence for earlier activities, since they are concentrated in a few areas outside the principal occupational zones.

THE EARLY BRONZE AGE AT AGROAL

Ceramics

Pits 1/24-7/40-1/50-2 (level 2). Approximately 1000 ceramic fragments were found in this 5 cu m area; roughly 120 were rim fragments from different vessels. The fabric and surface treatment of these ceramics are fairly homogeneous; all are handmade. The predominant inclusions are quartz grains, limestone fragments, and organic matter. The fabric color ranges from a buff, red-orange, brown or black; the color variation seems primarily due to different firing conditions. The only decoration found in these ceramics are 'mamilos', or small knobs, placed either along the rim or on the body of the vessel. Typically, both the exterior and interior surfaces are burnished. The one base fragment with which it was possible to reconstruct a base diameter shows that at least some vessels were flat-based. Base fragments from round-bottomed vessels, common in Early Bronze Age burials, may be underrepresented at Agroal since these can be indistinguishable from body fragments.

The ceramics from these pits have been classified into four major form types- I, II, III, and IV. Type I includes carinated vessels. Subtypes have been designated based on the relationship between the position of the rim and carination. Type Ia is composed of vessels whose rims extend to the same diameter as the carination; Type Ib is composed of vessels whose carinations extend beyond the diameter of the rim (Fig. 4).

Type II includes non-carinated vessels with curved profiles. Type IIa includes bowls with a curved, open profile (Fig. 5); Type IIb is composed of bowls with a curved profile and constricted neck.

Type III includes non-carinated vessels with straight, but non-vertical profiles, similar to the 'tronco-cónico' forms of Bronze Age vessels in northern Portugal (Bettencourt 1988) (Fig. 6).

Type IV is characterized by vessels with straight, vertical profiles. Whether the vessels are round- or flat-bottomed is uncertain, given the size of the fragments recovered (Fig. 1). These vessel types are comparable to those of ceramics excavated at other Bronze Age settlements in the Estremadura, such as Quitéria and Pessegueiro (Silva and Soares 1981:141-180) and Bronze Age dolmens in the Beiras (Senna-Martínez 1983-4).

Lithics

Both flaked and groundstone tools constitute the Early Bronze Age lithic assemblage at Agroal. Included in this short discussion are those recovered from unmixed and mixed deposits. The raw materials used for the stone tool industry are flint and quartzite for the flaked tools and quartzite and amphibolite for the groundstone tools. The flint and quartzite are local materials; the nearest source of amphibolite is ca. 40km to the east of Agroal.

The flaked tool industry is quite simple. The quartzite industry is composed of cortical elements, both large and small, and flakes taken from river cobbles. The assemblage of flint artifacts is primarily debitage from the production of blades. One possible sickle blade and a point are the only two retouched flint tools.

The groundstone industry represented at Agroal's Early Bronze Age levels consists of two quartzite grinding/hammerstones.

Metal

Evidence for a metallurgical industry at Agroal was limited to ceramic crucible fragments and a copper fishhook. The metal droplots in the crucible and the fishhook are composed of arsenical copper. The fishhook is similar in form to others found on Copper and Bronze Age settlements in Portugal, such as Rotura (Silva 1966-7:169), Leceia (Cardoso, Soares, and Silva 1983-4:66), and Pessegueiro (Silva and Soares 1981:177). The source of the ore used in the crucible and the fishhook is not certain, although copper ores are known from the Lisbon area (100km from Agroal) and throughout northwestern and southern Spain (Coles and Harding 1979:9).

Fauna

A total of 524 animal bone fragments was recovered in Early Bronze Age levels in pits 1/24-7/40-1/50-2. While this sample is not large enough to be uncritically employed in comparisons with other assemblages, its internal consistency indicates that it can be used to derive significant conclusions on Early Bronze Age husbandry practices at Agroal. As mentioned above, the high density of faunal material and artifacts in this area suggests that this area represents a refuse deposit.

Table 1 indicates that approximately 50% of the faunal assemblage could be identified by species and animal part. Most of the bones were therefore quite fragmented, some apparently by butchery (cut marks) and others by carnivore chewing (gnaw marks).

TABLE 1
Summary of bones identified at Agroal

Total bones and bone fragments	**524**
Total bones identified by species	222
Percent bones identified by species	42.4
Total bones identified by bone element	209
Percent bones identified by bone element	39.9

The taphonomic history of this assemblage can be further elucidated by table 2, which shows the frequency of bone elements represented. What is most notable here is that those bones which predominate are those which do not provide meat, such as the skull, vertebrae, podials, metapodials, and phalanges. Those bone parts that are associated with most of the meat on animals, such as the long bones, are poorly represented. Such a distribution suggests that this assemblage is the refuse from a butchery area, and that those body parts which provided food, were taken elsewhere to be consumed.

TABLE 2
Frequency of bone elements at Agroal
(all species combined)

Bone Element	Total	Percent
Tooth	60	28.7
Cranium (no teeth)	46	22.0
Phalanx	15	7.2
Vertebra	14	6.7
Scapula	13	6.2
Metapodial	13	6.2
Podial	12	5.7
Rib	9	4.3
Radius	7	3.3
Tibia	6	2.9
Humerus	4	1.9
Pelvis	4	1.9
Femur	3	1.4
Ulna	2	1.0
Patella	1	0.5
Fibula	0	0.0

The next table (table 3) shows the proportion of animal species represented. Two points are clear from this table: 1) the assemblage from this area is predominantly of domestic animals, and 2) that *Bos* fragments constitute the majority of these bones. Such a distribution is suggestive of a highly specialized domesticate economy, not unlike that posited by Sherratt (1981) for other European Bronze Age sites. Cattle, according to Sherratt, were used for their milk, traction, and as means of transportation, and allowed second millennium BC populations in Europe, which may have been experiencing a certain pressure to compete for resources in the prime agricultural regions, to inhabit more marginal lands.

TABLE 3
Distribution by species of fauna recovered at Agroal

	Total	Percent
Bos	122	55.0
Ovicaprids	52	23.4
Sus (wild or domesticate)	45	20.3
Birds	3	1.3

Since cattle appear to have been a particularly important animal species in the economy of the site, the frequency of bone elements for that species was examined. Table 4 shows a similar distributional pattern as table 1; most of the bones represented are of non-meat parts. Thus, it also appears that beef was consumed, but in a different area from this apparently butchery/refuse area.

TABLE 4
Frequency of *Bos* bone elements at Agroal

Bone Element	Total	Percent of identified *Bos* bones (N=83)
Tooth	34	41.0
Phalanx	8	9.6
Cranium (no teeth)	7	8.4
Metapodial	7	8.4
Podial	7	8.4
Vertebra	5	6.0
Radius	4	4.8
Tibia	4	4.8
Pelvis	3	3.6
Humerus	1	1.2
Femur	1	1.2
Patella	1	1.2
Scapula	1	1.2
Fibula	0	0.0
Ulna	0	0.0
Rib	0	0.0

Further investigations were carried out in order to determine what the principal function of cattle were at the site. Of primary concern was whether cattle were kept for meat or for its secondary products, such as milk, traction, or transportation. Cementum deposition analyses of the *Bos* teeth were thus undertaken in order to determine the seasonality of the site's occupations. Margaret Beasley, of the University of London, performed the sectioning and analysis. In addition to cattle, pig and ovicaprid teeth were submitted for study; however, only the cattle teeth provided cementum bands that were well-preserved enough to indicate seasonality. Table 5 shows the results of those cattle teeth recovered in pits 1/24-7/40-1/50-2 that could be analyzed.

TABLE 5
Results of Cementum Analysis (Agroal)

Field #	Tooth	Age	Season at Death
AG.50.2.1	upper right third premolar	≥6 years	winter
AG.41.2.75	upper right third premolar	?	?winter
AG.50.2.252	lower left third molar	≥8 years	winter
AG.F.84	lower right third molar	5 1/2 years	early spring

Winter	=	November to end February
Early Spring	=	late February to early March

It is not realistic to reconstruct kill-of patterns on the basis of these four teeth. However, the patterns indicated do suggest that the cattle at Agroal were kept past their meat-producing prime, and possibly functioned as a source of milk or as draught animals. Cattle were also part of specialized culling practice; all the animals represented by these teeth were killed around the same time-during the winter/early spring. These data are consistent with a 'Secondary Products Revolution', as suggested by Sherratt (1981).

THE LATE BRONZE AGE AT AGROAL

Ceramics

Pits 53-6 (Levels 2 and 3A). The ceramics recovered in these levels differ somewhat from those in pits 1/24-7/40-1/50-2. Some of the forms represented are of vessels with curved, rather than sharply carinated profiles, and some are decorated in ways different from the above mentioned ceramics, such digital impressions along the rim ('digitada'). They are all, however, handmade and burnished. Parallels for these ceramics can be found in the Late Bronze Age assemblage from Bocas, Rio Maior (Straus et al. 1988) and Cabeço do Crasto, Seia (Senna-Martinez, Guerra, and Fabião 1986:21, 23).

Pits 58-9/70-5 (Levels 1 and 2). The ceramics from these levels are all hand-made and burnished, as those mentioned above, although the fabric and forms differ significantly. The clays used in these ceramics are predominantly micaceous; the fragments are in general much harder and tend to be from thinner-walled vessels than those in pits 1/24-7/40-1/50-2. The nearest source of micaceous deposits is the Rio Zêzere, located 4km east of Agroal. The profiles of the ceramics in these pits are both curved, as well as straight, and have flat bases (Fig. 8). Flat-based ceramics are considered to be diagnostic of the Late Bronze Age (Parreira 1971-5). Some fragments are decorated with notches or incised.

In addition to vessel fragments, one ceramic spindle whorl was found in these pits. It was undecorated, and is similar to a ceramic spindle whorl found at the Bronze Age settlement of Pessegueiro (Silva and Soares 1981:177).

Lithics

The groundstone assemblage recovered in Late Bronze Age levels consist of an amphibolite hammerstone and a quartzite grinding stone.

BRONZE AGE MATERIAL RECOVERED DURING SURVEY

The diagnostic artifacts recovered from the survey at Agroal could all be dated to the Early and Late Bronze Age. These included a ceramic fragment with digital impressions (Fig. 9), similar that found in what is believed to be an Early/Middle Bronze Age level at Agroal. One of most interesting finds, however, was a rim fragment with a hemispherical 'mamilo' and decorated with an impressed wedge-like pattern ('dentado'). Vessels with hemispherical lugs are known at the Early Bronze Age level at Cadaval (Cruz and Oosterbeek 1985:71, fig. 20); however, the only other parallel in its decoration as well as the 'mamilo' is an unpublished fragment excavated at Zambujal and recovered in level 5, believed to be an Early Bronze Age level (unpublished, Museu Municipal de Torres Vedras, field#: R-23-87-4/Z-R-12, M. Kunst: personal communication).

Numerous flint blades were recovered in the survey in an abundance not found through excavation. On one blade, in particular, silica gloss was detected, suggesting its use as a sickle blade. Finally, a 'mó movente' made of a micaceous schist, which is found 10km east of Agroal, was recovered. This grinding stone, in addition to the adze fragment and sickle blade, attest to agricultural practices at Agroal.

RESULTS OF PHOSPHATE FRACTIONATION

Phosphate fractionation was carried out on soil samples collected during excavation. As a way of assessing the degree to which these soils represented enriched areas due to human and/or animal activities, control soils in the area of Agroal were sampled and analyzed. These control soils were collected in areas with known land use histories.

Control soils sampled were ranked by total phosphate value, from highest to lowest. A control sample was taken from the Bt horizon of the soil developed over a Würmian cryoclastic deposit found approximately 500m north of Agroal (J. Zilhão: personal communication), and since it is not believed to have been significantly effected by human occupation, it provides a baseline total inorganic phosphate value to which the other samples can be compared. This value (224.6 ppm) corresponds to the average value for inorganic phosphorus in sedimentary rocks (ca 200 ppm) given by Eidt (1984a: 27). Organic refuse areas and fields (unmanured) resulted in the greatest enrichment of total phosphate levels. Settlement and manured fields would be associated with much higher values. The soils under natural vegetation had the lowest total phosphate levels.

Archaeological soils collected from Zone 3 were ranked by their total phosphate value. By comparing these values with control samples, it was possible to determine which soil physical and chemical characteristics were most stable over time, and thus which characteristic(s) were the best indicators of use activities. Since the persistence of these traits, however, is highly dependent on the nature of the particular land use activities (intensity and duration), pH of the soil, and time since abandonment of the site, the results from this investigation may not apply to all archaeological situations, e.g. in the tropics, where the cycling rate of organic matter is higher than in temperate zones, such as the Mediterranean (Birkeland 1984: 268-71).

Soil pH was found not to be persistent, as had been noted previously (Birkeland 1984: 268-71). Organic matter levels are, however, more so, as the value from the presumed Medieval animal pen (Structure C) is still fairly high, even after abandonment 350 years ago. Total inorganic phosphate levels proved to be surprisingly stable, as evidenced by a comparison of the total phosphate value of a modern corn field at Agroal (sample 105=441.8 ppm) to that of a corn field known to have been abandoned between 50 and 100 years ago (sample

36=463.0 ppm). In order to visualize the changes in soil enrichment over time, two variables were plotted against each other: Time (Fraction II/I) and Intensity (Total Inorganic Phosphates) (Fig 10). Scales were equalized by ranking the samples by the values for these variables. The samples have also been distinguished by the date for the majority of associated artifacts.

A number of observations and tentative conclusions can be derived from this plot. First, there is a rough correlation between the relative age (Fraction II/I) of the soils and their associated artifacts. The cases where the correlation appears to deviate from the expected pattern are, however, worthy of note. The soils associated with Bronze Age artifacts in the lower right hand corner of the plot appear to be quite 'young'. This would suggest that either the technique is faulty or that the artifacts and the soil were not deposited at the same time. These samples, however, correspond to a shallow soil that developed since the deposition of the artifacts; no horizon differentiation was evident here (pits 58-9/70-5). A low II/I ratio would thus be expected, based on the soil's immaturity. The 'old' soils associated with Medieval artifacts in the left half of the plot are also instructive. They were all collected from the area between Structures A and B, at the site of an abandoned corn field. Mixing of artifacts and soils would be an expected occurrence, given the recent history of the area.

It is also clear that there is a correlation between time and the intensity of these activities. In general, the 'older' the soil, the higher the level of enrichment. That the two occupational phases of the site are roughly comparable in duration makes it possible to suggest that there was a decrease in the population of humans and/or animals at the site between its Bronze Age and Medieval occupations. While this is difficult to test, the archaeological data reflecting production activities indicate that at least a larger number of these activities are represented in the Bronze Age occupational phase than in the Medieval, and is possibly associated with a higher population level. Secondly, it is also possible that a shift from year-round to seasonal settlement occurred. Thirdly, agricultural systems may have shifted from being intensive, possibly with manuring, in the Bronze Age to extensive in the Middle Ages. The use of secondary products of animal domesticates in the Bronze Age is already suggested by the discovery of a spindle whorl and the cementum analysis of the cattle teeth. That other secondary products, such as manure, might have also been exploited, is not unlikely. This process of 'extensification' is also suggested by the shift in cattle/ovicaprid ratio from the Bronze Age to Medieval occupations of the site. The Bronze Age faunal assemblage is characterized by a higher cattle to ovicaprid ratio than the Medieval assemblage.

DISCUSSION

One of the principal results from the excavations at Agroal is the identification and secure dating of an Early Bronze Age occupation - a period which has been believed to represent a sort of cultural hiatus in the Portuguese lowlands (Straus et al. 1988:83). The recovery of abundant cultural material in well-dated levels was critical to the evaluation of chronological attributions of other late prehistoric sites. Finally, the faunal remains and soils sampled from Agroal permitted, for the first time, the reconstruction of the economy and ecology of an Early Bronze Age settlement in Portugal.

Perhaps the most significant conclusions derived from the excavations at Agroal is the recognition that the material recovered from Early Bronze Age deposits, in particular undecorated ceramics and stone tools, share many features, i.e., form and technique, with Copper Age material. Such a conclusion calls into serious question prior attributions of other Copper Age levels that do not have absolute dates. This continuity also transforms considerably models of cultural discontinuity which have traditionally been favored for the Portuguese lowlands. Discontinuity did occur, however, in the abundance and variety of decorated ceramics and flaked tool forms that are generally associated with Copper Age settlements.

The Bronze Age community at Agroal apparently subsisted on the products of plants and animals, both wild and domestic. Despite systematic flotation of all archaeological levels, no seeds were recovered. That sickle blades, a grinding stone, axes, and adzes were found, however, indicates that some exploitation of plant products was carried out. To what degree this was undertaken cannot be known at this point. More can be said regarding animal husbandry at Agroal. In particular, the recovered fauna and artifacts suggest the secondary use of animal domestics, in particular cattle. The mature cattle bones at Agroal suggest that these animals were not kept primarily as meat suppliers, but rather for their milk, transportation, or traction. As pack animals, these cattle would have facilitated travel and exchange throughout the hills of central and northern Portugal, as they do, in Portugal, to this day. The cattle would have also been a source of potential exchange goods, such as cheese, that could have been used to acquire agricultural products in the more arable zones. Cattle may have also functioned as indicators of wealth, as they are among some East African groups, like the Nuer.

The similarity of ceramic forms and decorations at Agroal and those of Bronze Age sites in northern and southwestern Portugal suggest such an exchange or the possibilities of emulation and population movement. The non-local origins of the amphibolite and copper ores represented at Agroal also point to interactions with non-local groups. No indication for the on-site production of groundstone amphibolite objects has been recovered; thus, it is possible that the axe, adze, and hammerstone were brought to the site in a finished form.

Agroal, during the Early Bronze Age, thus appears to have been a fairly small and relatively self-sufficient community. It increased in size during the Late Bronze Age, perhaps as a reflection of its strategic location near a reliable spring and successful exploitation of local resources. It also, however, probably engaged in regular interactions with neighboring communities, as evidenced by the presence of objects made from non-local raw materials, and the overall similarity of its artifacts to those of other Bronze Age sites in northern and southern Portugal.

The nature of the Bronze Age deposits and artifacts at Agroal has also provided indications as to why it has been so difficult to identify Early Bronze Age settlements in the past. Considerable erosion, apparently due to a rather intensive use of the land during this period, no doubt has contributed to the displacement of artifacts and occupational levels, making site identification a challenging endeavor. A site at which there is poor depositional preservation does not generally find itself the object of intensive study. If more is to be known of the Early Bronze Age in Portugal, however, it will be essential that archaeologists first recognize the importance of this period, and then devise effective survey and excavation programs to deal with the special problems of Early Bronze Age settlements.

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Est. I

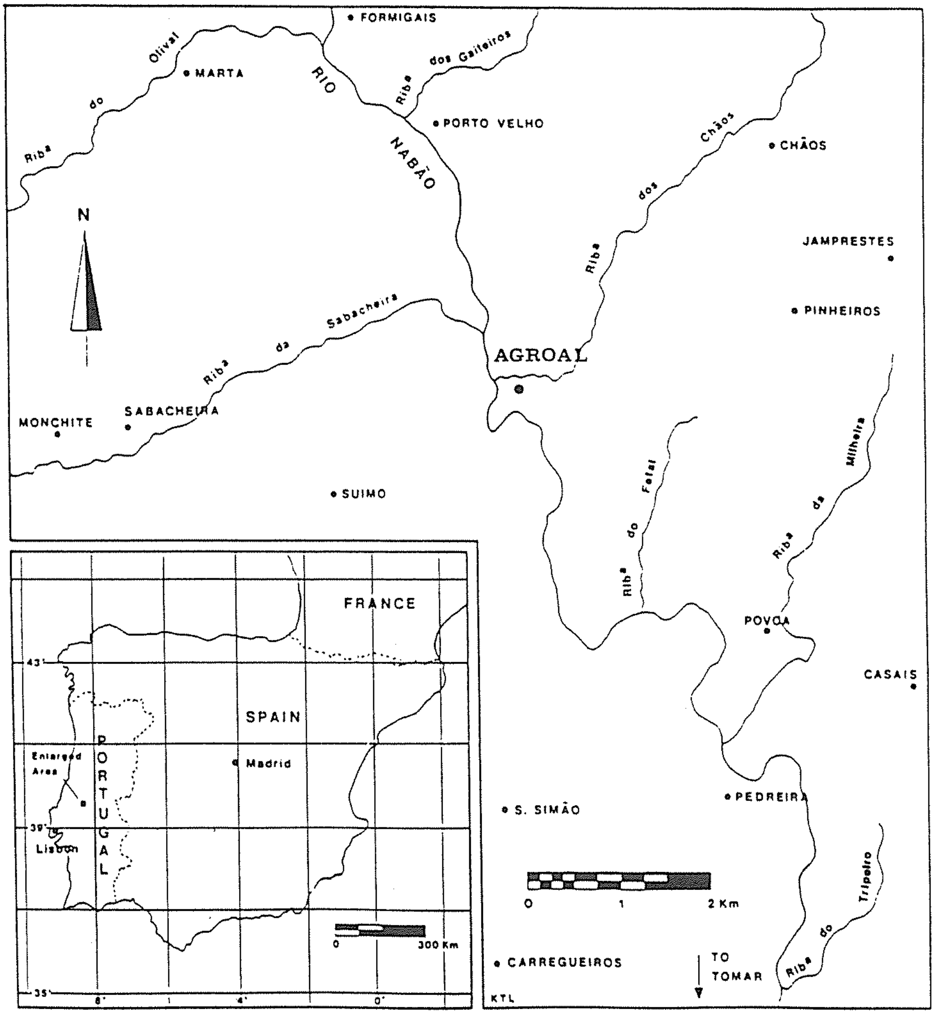

Fig. 1 — Agroal in Nabão Valley.

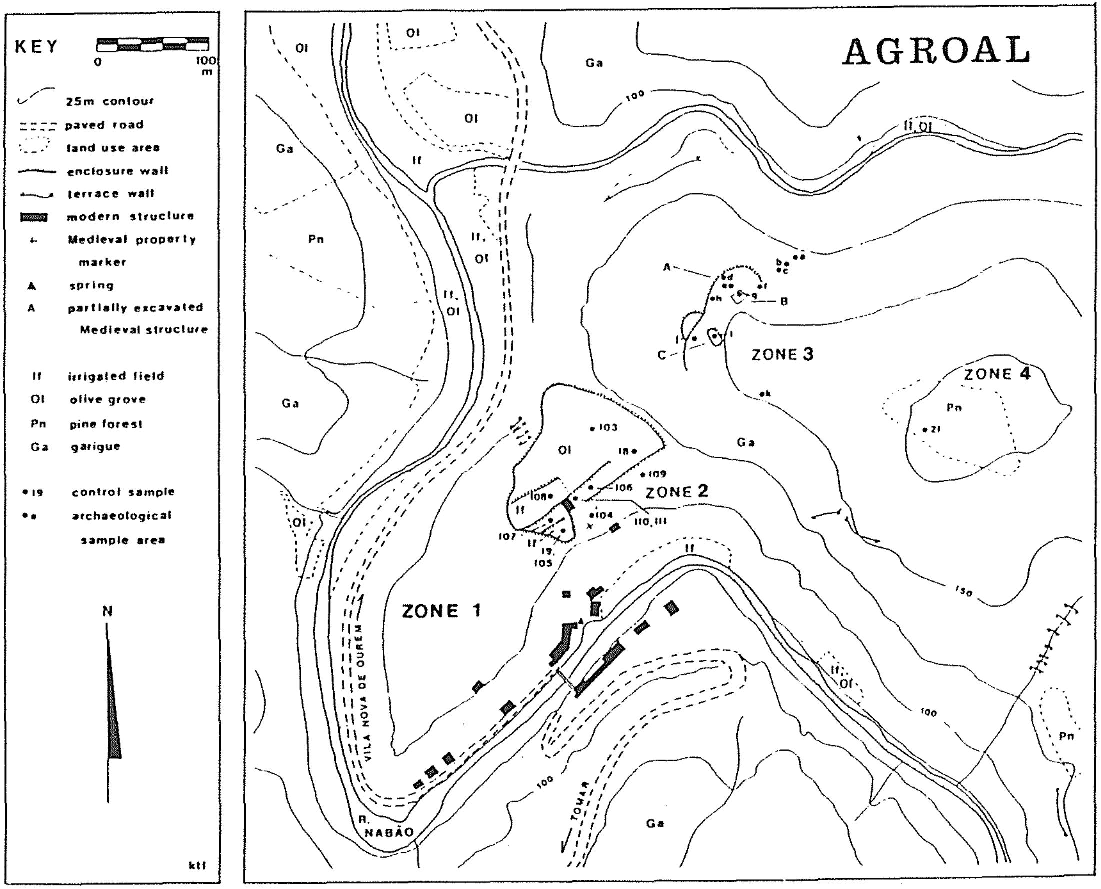

Fig. 2 — Land use at Agroal.

Est. II

Est. III

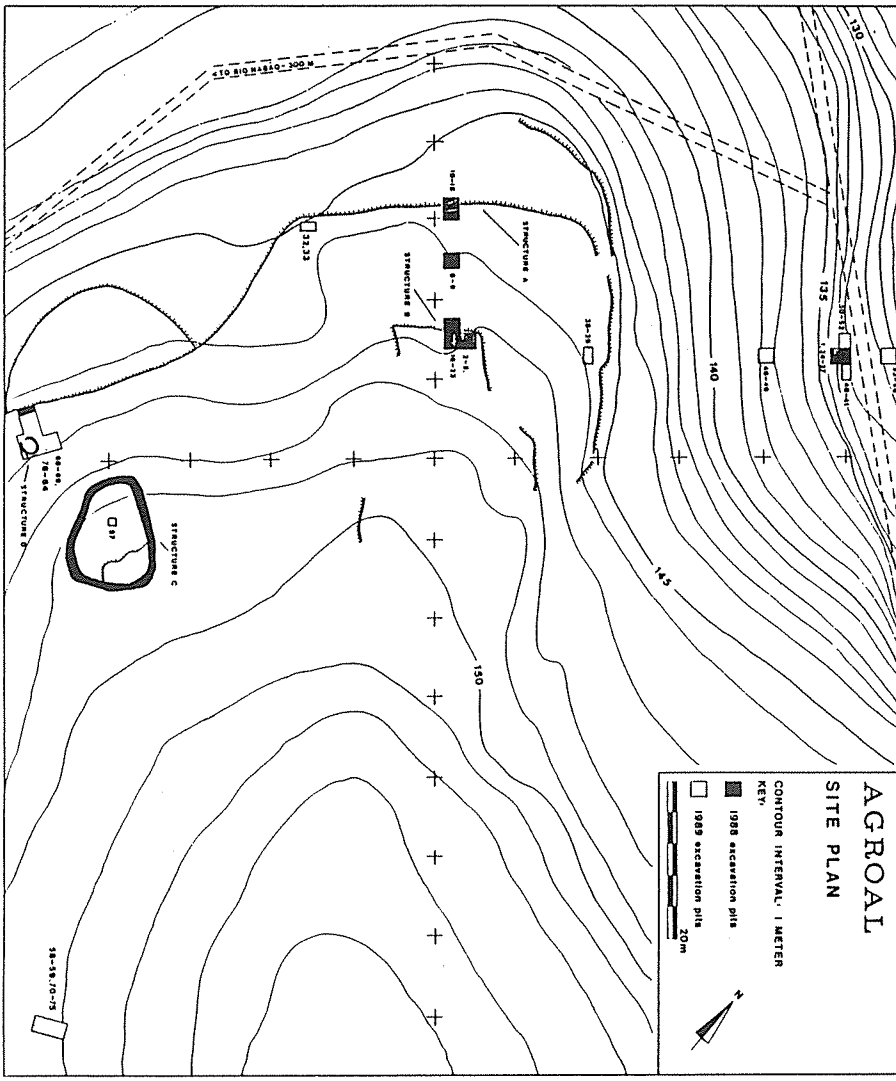

Fig. 3 — Site plan of Agroal.

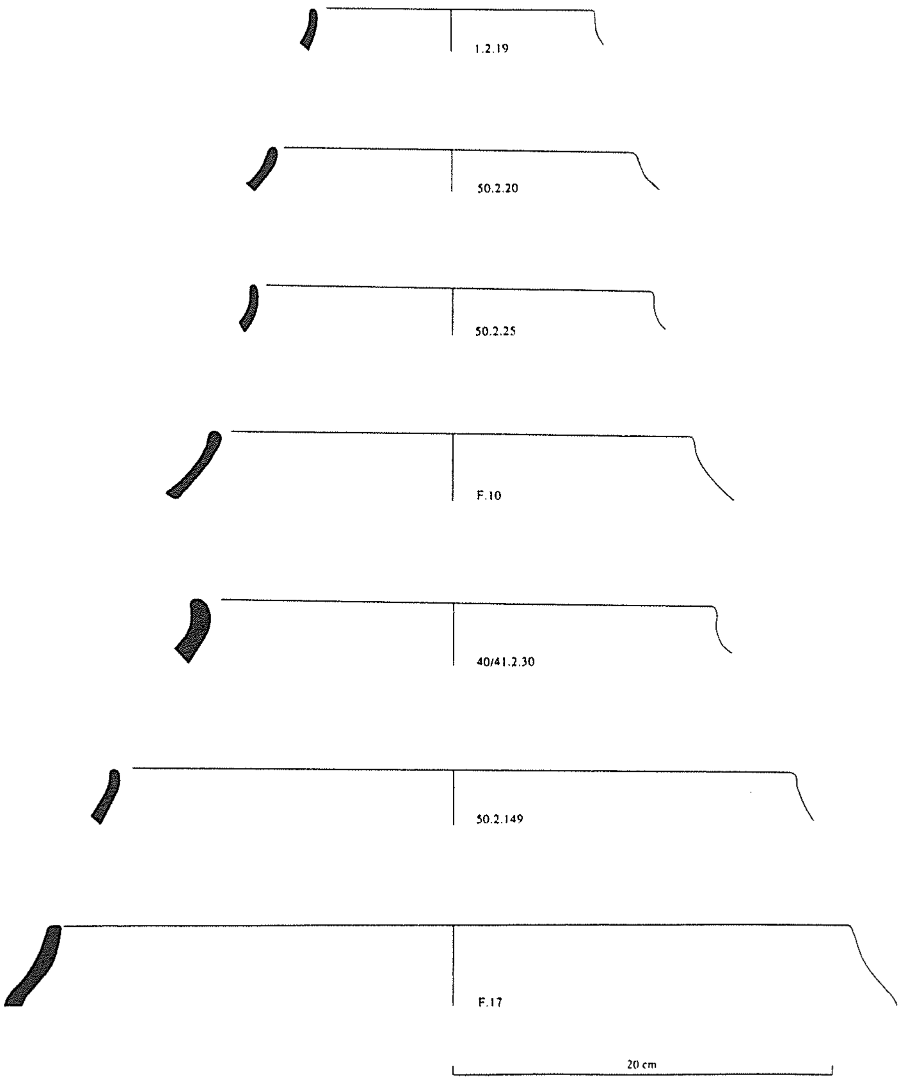

Fig. 4 — Type 1b Ceramics, Agroal.

Est. V

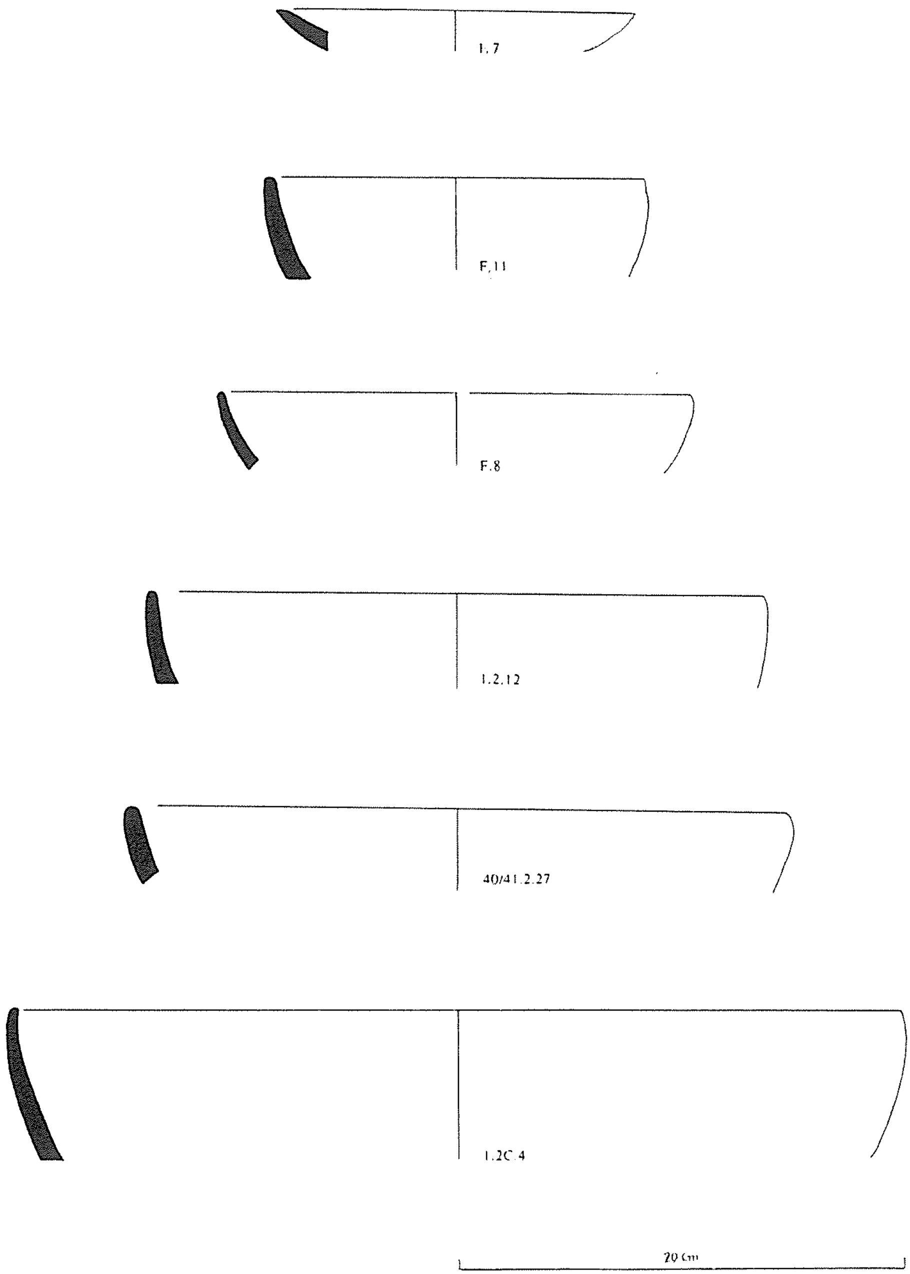

Fig. 5 — Type II 2 Ceramics, Agroal.

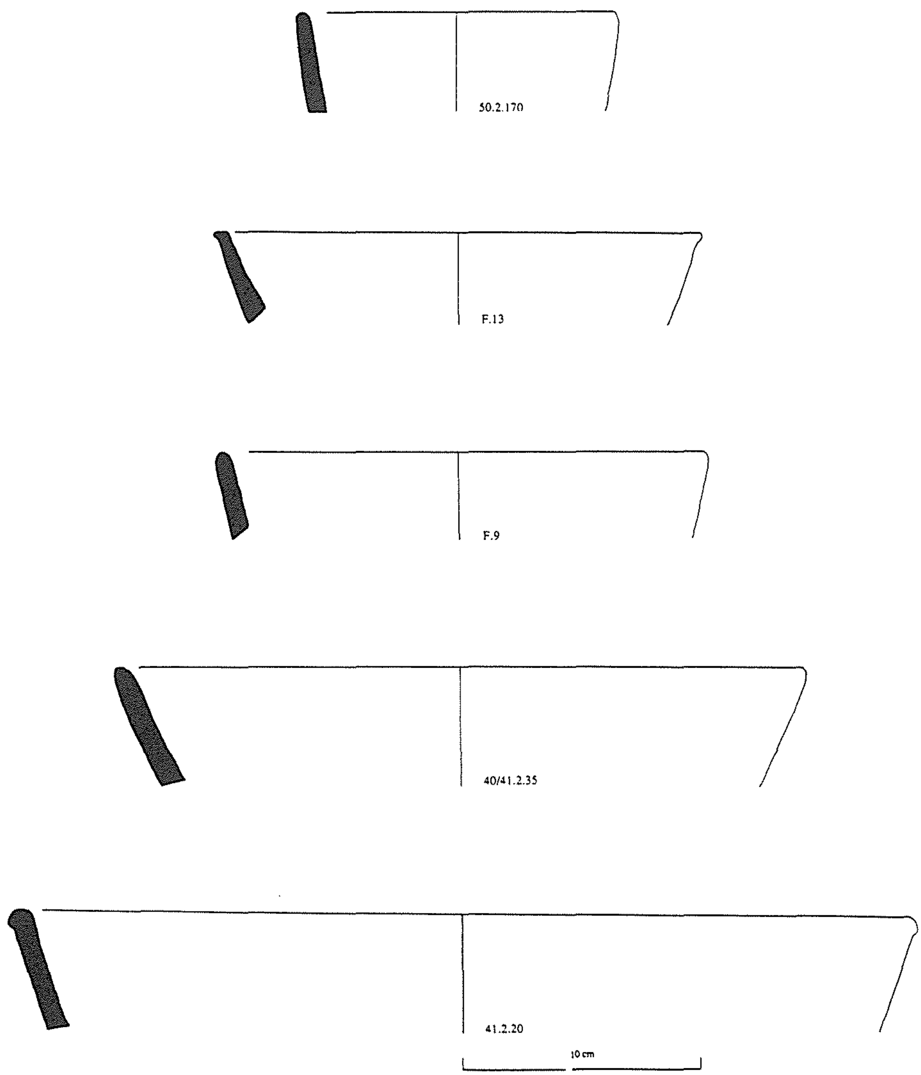

Fig. 6 — Type III Ceramics, Agroal.

Est. VII

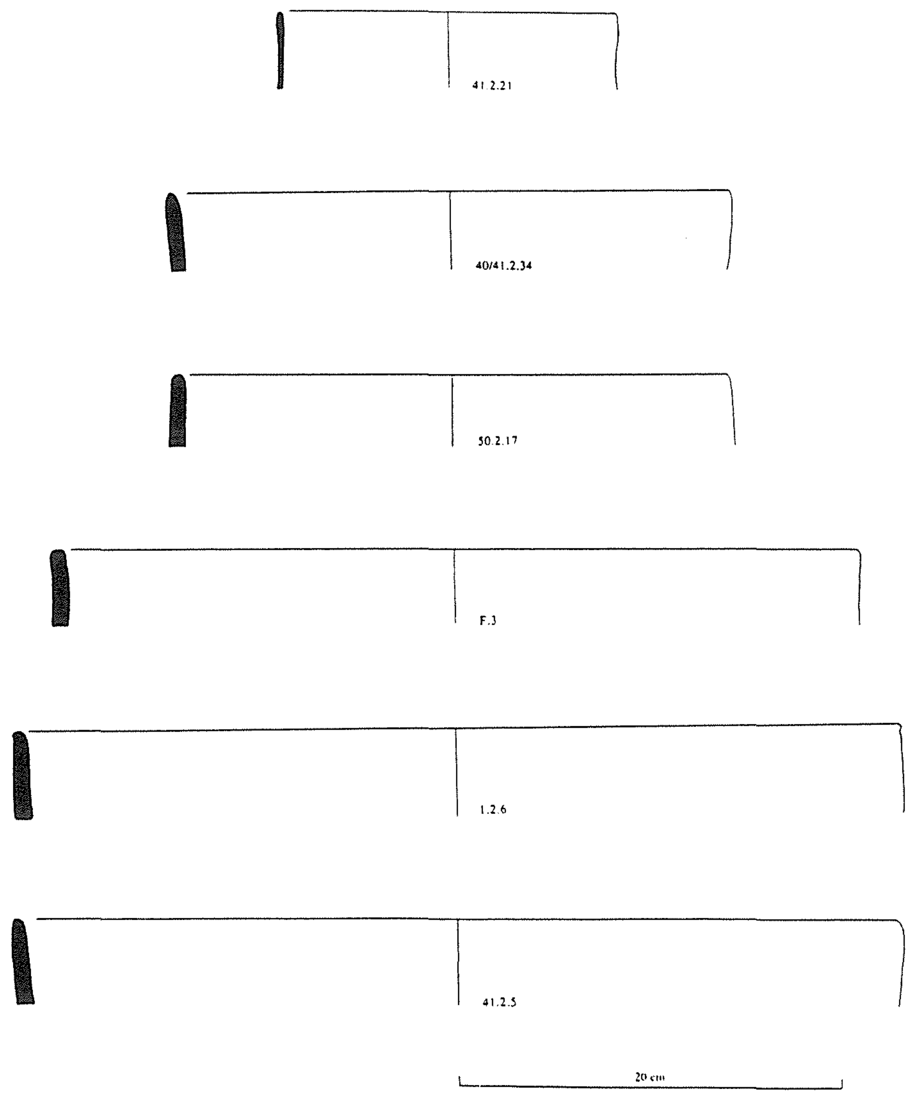

Fig. 7 — Type IV Ceramics, Agroal.

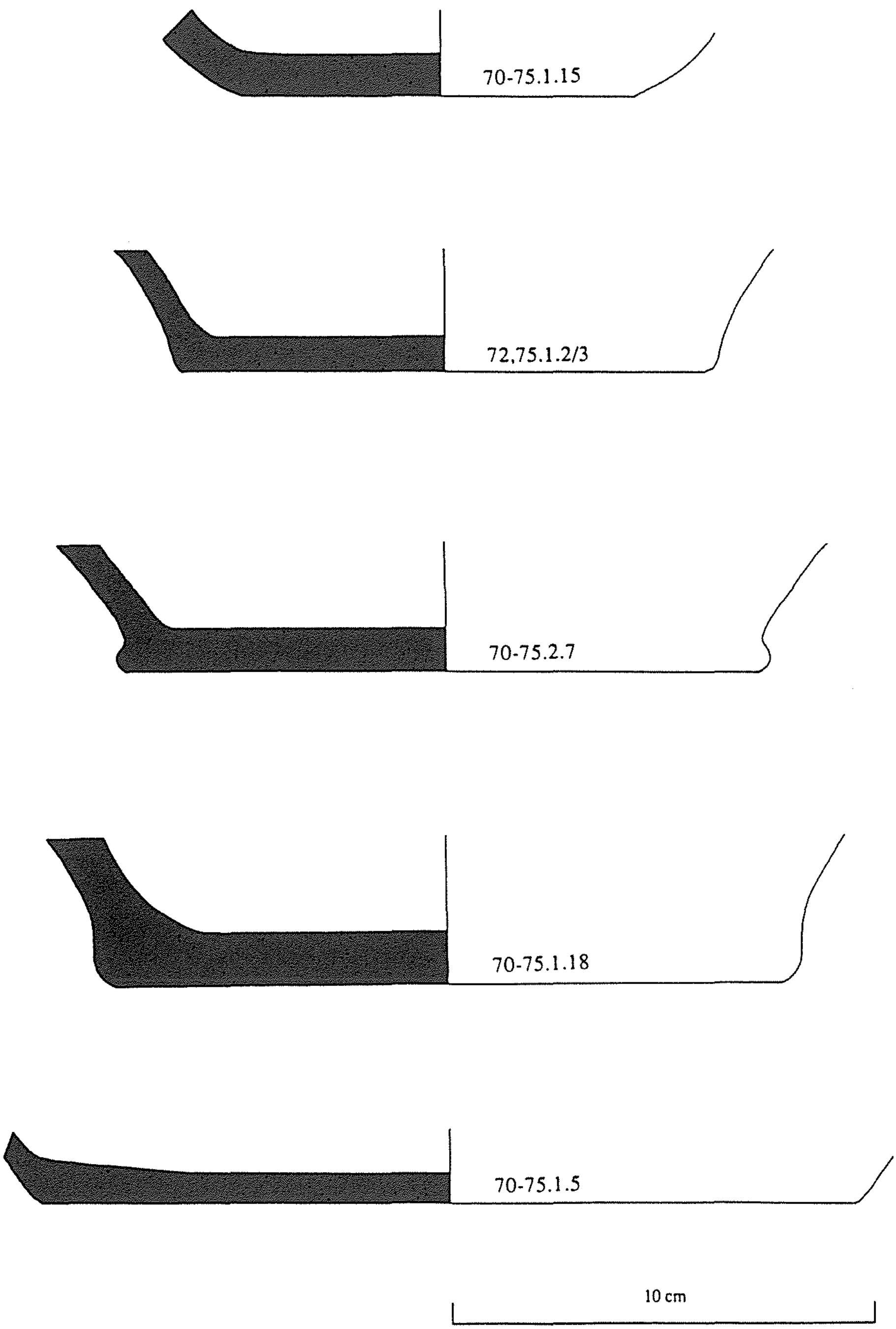

Fig. 8 — Flat-Based Ceramics from Pits 70-5, Agroal.

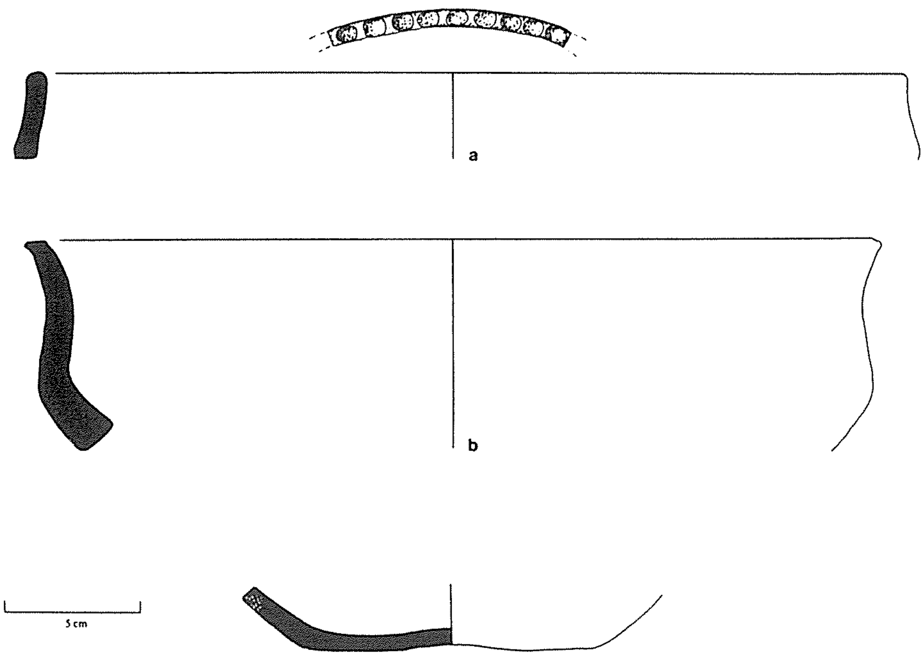

Fig. 9 — Ceramics from Agroal Survey Zone 1D (base of hill) (a: rim with impressions, b: rim with carination, burnished, c: fragment of flat-based vessel.

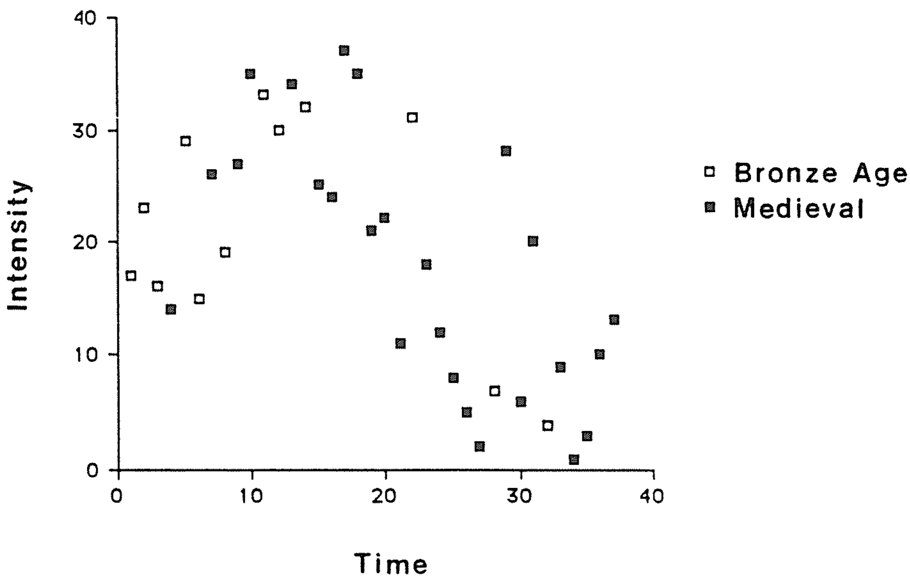

Fig. 10 — Graph of Intensity (Total P) over Time (Fraction II/I) of Soil Phosphate Enrichment.