Taphonomy of a village: the early 20th century site of Mariano Miró (Chapaleufú department, La Pampa, Argentina)

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Received 29 August 2013. Accepted 28 April 2014

ABSTRACT

The Mariano Miró archaeological site (Chapaleufú Department, La Pampa Province, Argentina) was a town of nearly 500 inhabitants, founded in 1901 and abandoned in 1911. From the Historical Archaeology perspective, this paper aims to reconstruct the taphonomic histories of surface artifact assemblages from the Mariano Miró ghost town. We analyze taphonomic processes at both the artifact and the assemblage level, considering multiple variables including size, thermal alteration, weathering, site topography, trampling, anthropic activities and burrowing animal activities. We use GIS to interrelate the selected variables and assess the roles of various taphonomic agents in shaping the characteristics and distributions of materials at Mariano Miró. The information pertaining to formation processes obtained from Mariano Miró is potentially useful for generating expectations for and understanding other sites in the region that exhibit similar taphonomic conditions.

Keywords: Mariano Miró; Ghost Town; Taphonomy; Historic Archaeology; GIS.

RESUMEN

TAFONOMÍA DE UN PUEBLO: EL SITIO MARIANO MIRÓ DE PRINCIPIOS DEL SIGLO XX (DEPARTAMENTO DE CHAPALEUFÚ, LA PAMPA, ARGENTINA). El sitio Mariano Miró (departamento Chapaleufú, Provincia de La Pampa, Argentina) fue un pueblo de casi 500 habitantes fundado en 1901 y abandonado en 1911. Desde la perspectiva de la arqueología histórica, se propone reconstruir las historias tafonómicas del conjunto artefactual de superficie de este "*Ghost town*". Los procesos tafonómicos son analizados desde la escala del artefacto y su distribución espacial considerando múltiples variables (tamaño, alteración térmica, meteorización, topografía del terreno, pisoteo, actividades antrópicas y animales cavadores). Se utiliza sistema de información geográfica (SIG) para interrelacionar las diferentes variables de análisis y evaluar la incidencia de los distintos agentes tafonómicos en las características y distribución de los materiales. Esperamos poder comprender la dinámica de formación que afectó al sitio y generar expectativas para contextos tafonómicos similares de la región.

Palabras clave: Mariano Miró; Tafonomía; Arqueología histórica; "Ghost town"; GIS.

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INTRODUCTION

After the so-called "Conquest of the Desert"[1], thousands of hectares of productive lands in southwestern Buenos Aires Province, Argentina were incorporated to the national territory. This led to economic expansion and the consolidation of the Nation State, which in turn led to Argentina's penetration of international markets (Oszlak 1997). Land was divided into lots and awarded to a small number of individuals, creating large latifundia. As different "social actors" –settlers, tenants, sharecroppers, migrant workers, farmers, merchants– began to occupy these spaces, the first rural villages developed. This process was accompanied by railway expansion that connected distant areas, peoples, ideas and merchandise. In this context, Mariano Miró began as a rural village in what, at that time, was the national territory of La Pampa; it was established by a train station of the same name in 1901 and abandoned in 1911. The present study contributes to our understanding of the dynamics of spatial occupation by the first tenants of villages in the current Pampean territory in the late 19th and early 20th centuries.

Currently, the only traces of Mariano Miró are abundant artifacts on the surface of a vast area (*ca*. 32,900 m^2), clear evidence that settlement attempts were not always successful. The remains of failed settlements constitute a significant part of the present regional identity. Many villages associated with capitalist production that, like Mariano Miró, were abandoned have been studied worldwide, contributing to an "Archaeology of abandonment" or "Archaeology of ghost towns" (Neville and Hooker 1997; Bell 1998; Vilches *et al*. 2008; Fuentes 2010; Lawrence and Davies 2010; Peyton 2012, among others).

As a first approach to the site, and in order to assess the integrity and resolution of the surface record, we aim to reconstruct the taphonomic histories of surface remains (glass, pottery, metal, bone, earthenware, among others) (Binford 1981). We analyze taphonomic processes at both the artifact level and material distributions through space, and assess a number of variables including topography, object size, thermal alteration, weathering, agricultural activities, trampling, and the action of burrowing animals. Our use of geographic information systems (GIS) allowd us to interrelate different variables and evaluate the effects of taphonomic agents on the condition and distribution of surface materials. In addition, we used a host of documentary sources such as maps, population censuses, agricultural censuses, photos and oral story-telling to provide data for the investigation. By these methods, we hope to understand the formation dynamics that affected the site and to derive expectations for understandin other regional sites with similar characteristics. Lastly, we hope the results of our taphonomic analysis will allow us probe social practices at the site such as those related to discard and cleaning during its occupation. Following Borrazzo, we take a taphonomic perspective:

> in every routine of archaeological work, it may provide a "diagnosis" –in terms of preservation conditions, resolution and integrity– for each record under study. It will help us understand and explain the complex genesis of current material patterns as well as recognizing the potential and limitations in the comparison of different samples at regional and supra-regional level (Borrazzo 2007: 147).

Taphonomic analyses are not usually applied in the field of historical archaeology, which is why we emphazise its inclusion within investigation protocols as a significant step towards the interpretation of historical archaeological sites and social practices of the past (Brittez 2009; Landon 2009; Weissel 2010; among others).

A TAPHONOMIC ITINERARY

Taphonomy was originally defined by Efremov (1940) as the study of the changes that animal remains undergo from their death to their burial, focusing on their transition from the biosphere to the litosphere. Although taphonomic studies were developed in paleontological and archaeological studies by the end of the 19th century, it was not until the second half of the 20th century that they reached their present expression (Lyman 1994). Processual archaeology and actualistic studies had a strong influence on the development of taphonomic research in archaeology, which was exponential growth beginning in the late 1960s–early 1970s (Mengoni Goñalons 1988; Borrero 2011). Taphonomic studies in archaeological research have focused on evaluating the resolution of samples and understanding the dynamics generated by diverse agents on organic remains (Gifford González 1981; Lyman 1994, 2010). Thus, it considers the incidence of anthropic and natural agents on the formation of the archaeological record.

In the last few years some researchers have gone beyond the original purview of taphonomic research, extending its theoretical-methodological precepts to the study of inorganic materials such as ceramics (Reid 1984; Ozán 2009; Fantuzzi 2010; Pérez Winter *et al*. 2010; Bernabeu Aubán *et al*. 2011), lithics (Hiscock 1985; Borrazzo 2004, 2007) and phytoliths (Piperno 1985). However, Lyman (2010), a staunch defender of "traditional taphonomy", denies the inclusion of such approaches within the scope of taphonomic studies, believing them to be within the field of formation processes (Lyman 2010). This conservative standpoint is untenable in the face of the new and numerous lines of inquiry that require expansion of analytical horizons to an "irrestrictive taphonomy" (Borrero 2011). That is why we prefer the following definition:

> Taphonomy today is much more than the study of the transition of organisms from the biosphere to the lithosphere; it is the study of the dynamic processes of modification of the original properties of all the components […] of any paleontological, archaeological or forensic assemblage, comprising its constituent materials and its context (Dominguez-Rodrigo *et al*. 2011: 5).

In this sense, we believe that the reconstruction of the taphonomic history of surface assemblages can provide information pertaining to aspects of sites that are often overlooked, especially in very large contexts and/or those where agricultural-livestock activities have been common.

ARCHAEOLOGICAL BACKGROUND

Over the last 30 years, numerous lines of research have been developed to analyze taphonomic evidence in the archaeological record, including the impact of plowing and trampling, and studies of alterations to inorganic materials such as pottery and glass. These studies are considered essential contributions to frames of reference that improve our taphonomic understanding of sites and archaeological assemblages at different scales. What follows is a brief introduction to research of significance to the present study. Although the cited works do not refer specifically to the same region or to similar environmental conditions, it is necessary to take them into account to assess the relevance of diverse processes, agents and effects in different contexts so that they contribute to our particular case study. The literature describing taphonomic research related to organic remains is vast and will not be considered in detail here (Binford 1981; Mengoni Goñalons 1988; Lyman 1994, among others).

Plowzone archaeology

The processes and effects on the archaeological record generated by agricultural tasks has been addressed in numerous studies based on experimentation, simulation and interpretation of surface and subsurface records (Roper 1976; Lewarch and O´Brien 1981a, 1981b; Ammerman 1985; Odell and Cowan 1987; Yorston *et al*. 1990; González de Bonaveri and Senatore 1991; Dunnell and Simek 1995; Nicholson and Malainey 1995; Gómez Romero 1999; Niknami 2003; Ots 2008; Harvey 2012, among others). Here we mention a few interesting results to contextualize our study. Plowzone research has focused on horizontal shifting and fragmentation of the archaeological record caused by plowing (Roper 1976; Lewarch and O´Brien 1981a, 1981b; Ammerman 1985; Odell and Cowan 1987; González de Bonaveri and Senatore 1991; Dunnell and Simek 1995; Ots 2008; Harvey 2012, among others). There are two main views of the impact of agricultural work on archaeological sites. The first states that the plow destroys the original spatial association of surface artifacts and moves materials laterally up to 15 meters from their original location (Roper 1976; Odell and Cowan 1987). The second proposes that even if the plow is a significant agent in the fragmentation and shifting of archaeological remains, it does not completely destroy spatial associations, moving materials less than 6 meters from their initial position (Lewarch and O´Brien 1981a, 1981b; Riordan 1988; Yorston *et al*. 1990; Clark and Schofield 1991; Dunnell and Simek 1995). Therefore, interpretations of concentrations as the results of activity areas, dumps and/or subsurface dwellings should still be possible in the plowzone.

Supporters of both views agree that because materials are moved in the direction of the plow, single-direction plowing causes a bigger shift than bi-directional plowing, which tends to average the effect (Roper 1976; Odell and Cowan 1987). Another issue on which researchers generally agree derives from experiments that helped determine that the effect of plowing on fragmentation of archaeological remains is averaged through time—initially causing a rapid reduction in material size that is later stabilized—and that it generates a distribution tending towards unimodal (Lewarch and O'Brien 1981a, 1981b; Odell and Cowan 1987; Dunnell and Simek 1995; Boismier 1997). Results of numerous studies designed to understand relationships between artifact size and displacement have been inconsistent. That is, some show increased shifting among larger objects whereas in others indicate a random correlation between size/distance (Trubowitz 1978; Lewarch and O'Brien 1981a, 1981b; Dunnell 1990). Furthermore, Ammerman (1985) has indicated a need to consider the slope of the terrain, and he reports that shifting is greater on steep slopes.

The effect of plowing on vertical movement has been studied thoroughly by Dunnel and Simek (1995), who suggest that the area most substantially affected by plowing ranges between 20 and 40 cm below ground surface. The equipment used and geomorphological features are significant factors conditioning the effect on vertical displacement of the archaeological record. In affected areas, archaeologists should expect removal, mixture, and fragmentation of smaller objects located on the upper portion of the plowzone, whereas below this area, bigger objects, unaffected by this agent, should be found (Yorston *et al* 1990; Boismier 1997; Diez Martin 2009). As with horizontal shifting, the effect would be averaged through time (Lewarch and O´Brien 1981a, 1981b; Boismier 1997).

This brief review summarizes some of the primary archaeological research on cultivated lands. Even when our results are not consistent with these findings, we will be able to establish a minimum/maximum effect of the impact of agricultural tasks in a site. We see an immediate need for experiments that take into account the particular characteristics of the study region (geomorphological features, rainfall patterns, type of crops, etc.) and their effects at particular stages in the agricultural cycle.

Trampling Studies

Trampling is another area of research useful in assessing the effects of anthropic and non-anthropic agents in the vertical and horizontal movement of archaeological remains, and in the damage they produce on artifacts. Trampling by humans, animals (large and small), and agricultural equipment has been evaluated by numerous researchers. Experiments designed to assess the effects of different types of trampling on different artifact types in terms of both damage and horizontal and vertical displacement (Gifford González *et al*. 1985; Olsen and Shipman 1988; Mc Brearty *et al*. 1998; Flegenheimer and Weitzel 2007; Lopinot and Ray 2007; Eren *et al*. 2010, among others). Research on the effects of human trampling on a diversity of materials including some historic and industrially manufactured ones (*e.g.*, ceramic, brick and handicraft pottery), are relevant to our study of the Mariano Miró assemblage (Gifford-González *et al*. 1985; Nielsen 1991). The type and compaction of sediments on which trampling took place are important variables given that penetrability diminish with increased substrate hardness (Nielsen 1991); all such studies confirm that when artifacts cannot penetrate the substrate, more damage results (Nielsen 1991; Flegenheimer and Weitzel 2007), whereas a soft substrate mitigates the effect and permits migration within the substrate (Gifford González *et al*. 1985). We will not devote attention to vertical artifact movement since this work focuses on surface assemblages.

Horizontal shifting due to trampling creates a clustered pattern towards the margins of the affected area, which may resemble a discrete concentration such as those associated with activity areas or dumps (Nielsen 1991). Concentrations have size patterns characterized by an absence of small objects, which are incorporated into the sediment, while medium and large artifacts move the most and are likely to be kicked (Nielsen 1991; Eren *et al*. 2010). Results obtained from experimentation indicate a problem of equifinality between the effects of plowing and trampling, which must be considered when interpreting archaeological records.

Studies of non-organic materials

Materials found at Mariano Miró are typical of late 19th – early 20th century industrial production and may not be directly comparable those used in actualistic studies; ideally, studies should be replicated using materials that match the particilar characteristics of the Mariano Miró collections. Alteration to ceramics are conditioned by its porosity, hardness and composition (Skibo 1992; Ozán 2009; Fantuzzi 2010). The pottery recovered at Mariano Miró was mass-produced and characterized by low porosity, a lack of inclusions and high hardness due to high firing temperatures (*e.g.*, earthenware, pottery, and porcelain, among others). Its properties are similar to those of glass, which is more resistant to chemical alterations, but more susceptible to mechanical damage because of their extreme fragility (Fantuzzi 2010). Due to their physical and chemical characteristics, glass is significantly affected by several agents. Surface alterations to glass artifacts have been characterized according to categories suggested by Pineau (2010):

- Iridescence: presence of gleaming caused by sandy sediments and heat.
- Chemical weathering (*intemperizado*): loss of original gleam caused by environmental conditions with no alteration of glass edges.
- Physical weathering (*erosionado*): opacity of fragments and grinding of borders and walls caused by abrasive action including rolling down slopes or contact with water and/or sand.

Alteration of metal artifacts cannot be assessed using the same analytical criteria since processes such as corrosion often preclude macroscopic observation of specimen surfaces. Although the contexts of the studies presented above differ from that of the present study, reviewing the taphonomic literature contextualizes our study of the surface record at Mariano Miró and helps us avoid issues of equifinality.

MARIANO MIRÓ SITE: HISTORICAL CONTEXT AND EARLY RESEARCH

Mariano Miró is located in La Pampa Province (Chapaleufú Department; 35° 01´ 31.1´´ S, 63° 48´71.1´´ W), on dune-like plains formed by aeolian deposition of sand during the Pleistocene (Figure 1). The expansion agricultural has significantly modified the landscape, destroying the dunes and caldén (*Prosopis caldenia*) forests that once predominated in this region.

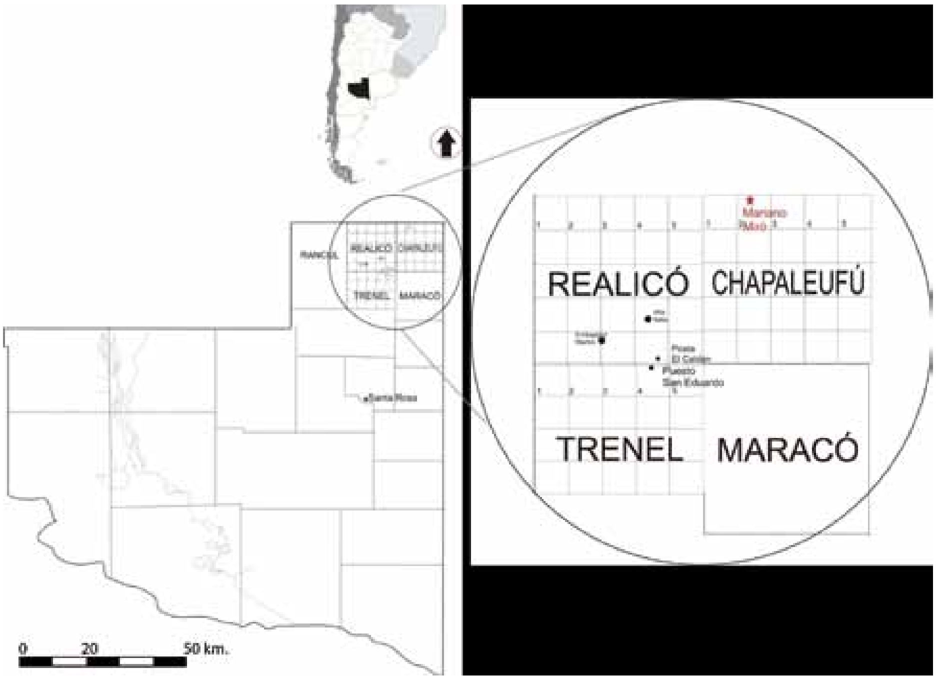

Figure 1. Location of the site Mariano Miró in the north of the province of La Pampa, Argentina.

The few remaining dune formations in the area have become fixed by vegetation, whereas disturbed fields have formed mollisols, making the region suitable for agriculture and animal husbandry. Studies of soil pH indicate slight acidity (pH 5.2 to 6.2) (Romano and Zinda 2007; Sainz Rosas *et al.* 2008). The region is considered humid, with an annual average rainfall of 800 mm, falling predominantly between October and March (Servicio Meteorológico Nacional).

The village of Mariano Miró was founded in 1901, adjacent to an eponymous railway station. According to data in the 1905 national Census of Territories, the village consisted of almost 500 inhabitants and a typical variety of stores related to agriculture and livestock. It is believed that the main part of the village was extended 3 ha south of railway station, although some occupation to the north is mentioned as well (*Apuntes para una nostalgia*, 1985; Giorgio 2008). The land where the town grew up was leased to the Santa Marina family. Around 1911, after the lease contract was cancelled, the village was abandoned and its inhabitants founded new villages in the region including Alta Italia and Aguas Buenas (presently Hilario Lagos). The abandonment of Mariano Miró was gradual, as shown by the census of 1912, which indicates 254 inhabitants and continued use of the railway station (National Institute of Statistics and Census; Archive of the Railway Friends Association). Documentation of Mariano Miró's decade of occupation is scarce, perhaps due to its very lack of success; as Jackson notes (1963 in Peyton 2012: 307) "Men have a tendency to forget rather than record disappointment and failure, so the story of the average camp has not won much space in old men's memoirs". This lack of documentation makes studies of oral history all the more important. Accounts from settlers of Hilario Lagos indicate that those who left Mariano Miró brought along tin plates, wood and every usable material to assemble their new dwellings (*Apuntes para una nostalgia*, 1985). Village abandonment was forced by the abusive and speculative policies of big landowners on which the lease system was based in Pampean territory, as well as the fact that lands were often sublet by colonizing companies (Cazenave 1971; Colombato 1995; Moroni 2007).

Presently, the place where the settlement was located is plowzone largely under soybean cultivation (Figure 2). For operative and visibility reasons archaeological fieldwork is performed after the harvest. Nonetheless, different crops (*e.g.*, corn, soybean) leave diverse visibility conditions in the field after the harvest. It is likely that these fields have been used for agriculture and pasturage since the village was abandoned, which has significant implications for modificaiton of the archaeological record and its context. In 2011, a local school teacher, Alicia Macagno, and her students from Rural School No. 65 collected surface materials from the old settlement as an initiative to rediscover

Figure 2. The Mariano Miró site covered by soybean cultivation in January of 2012

their past. They also excavated and removed a lot of material from a sector that we have geo-referenced and recorded on planimetries as Mmirop1[2]. At the 2011 Provincial Science Fair, Ms. Macagno's class presented their archaeological findings in the context of historical information pertaining to the abandoned village, after which the Cultural Research Department (Subsecretaría de Cultura de la Provincia de La Pampa) contacted our research team –directed by Alicia H. Tapia– to evaluate the archaeological site and recover the village heritage.

In April of 2011 the first contact was made with the school community of Mariano Miró and in August fieldwork began to determine the site's boundaries based on the distribution of surface materials. A 39,200 m^2 area south of the railway station was thus deemed the most likely area of occupation and targeted for the first topographic survey. In 2012, a systematic survey of the site was completed. The crew surveyed fourteen transects, oriented west to east and each divided into seven 40-meter segments labled A through G (Figure 3). Pedestrian survey was made with included use of a metal detector (Garret 1500 model) to identify concentrations of subsurface metals. Metal concentrations (N = 402) were found and subsequently mapped in two dimensions. Surface collection was performed by four surveyors walking in straight, parallel lines with a 2.5 -meter interval between them. Additionally, a 5 m^2 grid and a 4 m^2 trench were excavated.

Complementary to the fieldwork, the research team actively engaged with the community to communicate the results of archaeological research, to reinforce the importance of historic preservation and value of cultural heritage, and to increase local knowledge of the area's history; allowing them to the conservation of the local archaeological heritage (Pineau *et al*. 2013).

METHODOLOGY

Mariano Miró's taphonomic history was reconstructed through multi-scale (*e.g.*, artifact, site) analysis of multiple variables (Behrensmeyer 1991) including: (artifact) weathering, trampling, thermal alteration, size distributions in surface collections; (site) topography, geomorphology, and the effects of plowing burrowing animals.

Topography was studied during the 2012 field season and augmented with NASA's high-resolution images (30 meters per pixel), to create a topographic model. Caves of burrowing animals were mapped because their creation can cause movement, accumulation and/or dispersal of archaeological materials (Wood and Johnson 1978; Politis and Madrid 1988; Mello Araujo and Marcelino 2003; Frontini 2011; Frontini and Ecosteguy 2011; Salemme *et al*. 2012, among others).

Archaeological materials were sorted into three size classes: small (0.1 to 2 cm), medium (2.1 to 4 cm) and large (4.1 cm and over). The presence/absence of weathering, thermal alteration, trampling and plow marks was recorded. Weathering on vitreous fragments included both physical and chemical weathering (Sanford 1975; Purdy and Clark 1987; Pineau 2010). Weathering recording for ceramics followed criteria

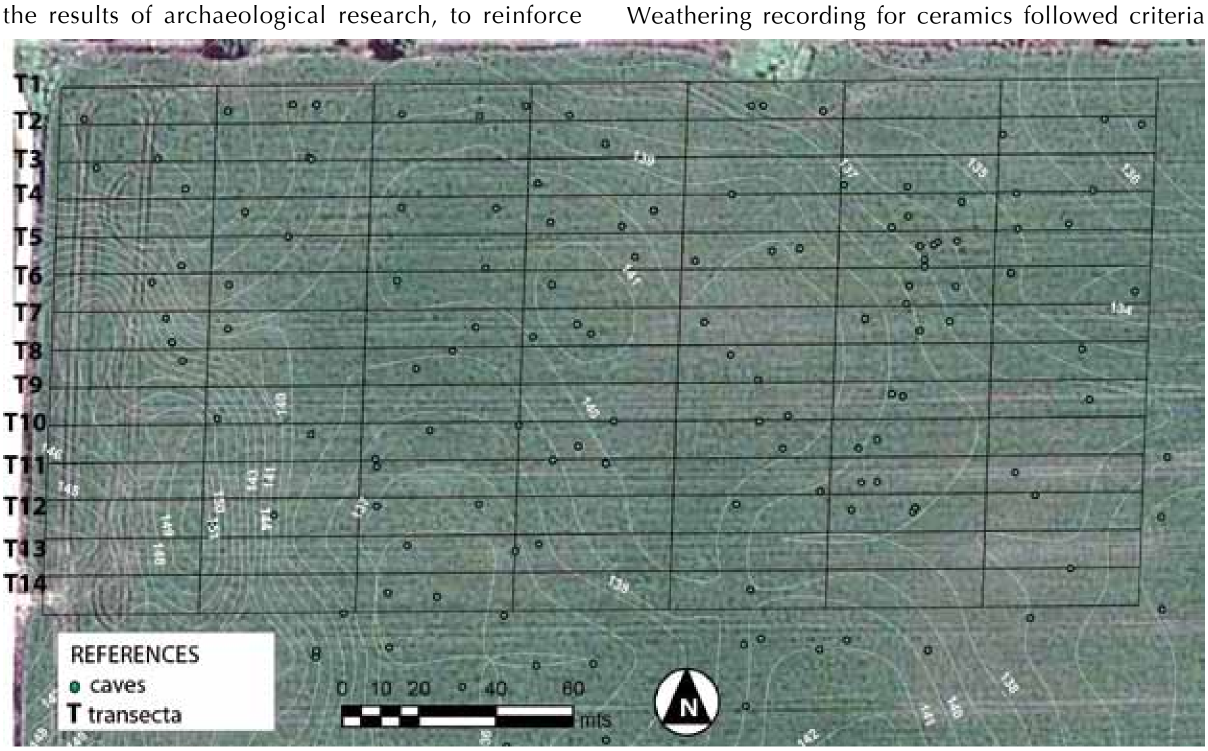

Figure 3. Map of the systematic survey of the site across 14 transects of 280 metres each.

similar to those for glass, since ceramics often have glazed surfaces. On bone, weathering was identified following Behrensmeyer (1978). In all cases, all modifications on all sides of each artifact were recorded (Lyman 1994; Ozán 2009). Effects of thermal alteration are not uniform across material types. For bones, we used the color scales suggested by Shipman and co-authors (1984). Thermal alterations to pottery were identified by black surfaces and/or nuclei (Buenger 2003). On glass, several featuers were considered indications of thermal alteration, including iridescent or crackled surfaces, or deformation (Pineau 2010).

Agricultural activities can have direct and indirect effects on the archaeological record. Direct impact includes plow marks on archaeological materials, such as scratches or fresh cracks. Indirect impact can be inferred from objects' sizes and spatial distributions. Maps of objects' spatial distributions and sizes can be overlain with satellite images that show plow turning marks to help determine whether plowing accumulated or shifted the materials. To understand the effects of trampling, we considered material size and displacement. However, multiple taphonomic agents cause similar correlations between the two variables. Thus, human, animal or equipment trampling may generate patterns that are easily confused with the shifting and fragmentation caused by plowing (Gifford-González *et al.* 1985; Nielsen 1991; Eren *et al.* 2010).

Given the complexity of the relationships between multiple variables, we used bidimensional modeling aided by geographic information systems (GIS; ARCGIS10 software and ArcMap complement). This software calculates the nearest points to each raster cell using the kernel density method and Gauss Kruger cartographic projection band 4.

We consulted documents, blueprints and photographs of Mariano Miró available in the Land Registry of Municipalidad (City Hall) de Santa Rosa, La Pampa; the Provincial Historical Archives (Santa Rosa, La Pampa); the Railway Friends Association; the Railway Museum "Scalabrini Ortiz;" the National Institute of Statistics and Census (INDEC); and the General Archive of the Nation (AGN). We believe that documentary sources and archaeological objects, as the material products of multiple social actors, are means to approach past representations and meanings in a comparative way (Gómez Romero and Pedrotta 1998; Carbonelli 2010; Pineau 2011). For this reason, we draw on both sources in the following analyses.

RESULTS

Characteristics of the surface sample and its distribution

We recovered 11,407 objects scattered across 32,900m^2 of Mariano Miró's surface. Materials were grouped by both raw material and functionality in the case of ceramics (pottery, porcelain, brick, tile, kaolin and earthenware). Also, for graphic display, we grouped uncommon materials (those with 30 or fewer specimens) into a "miscellaneous" category (plaster, tile, leather, sulphur, cement, wood, lithic, masonry, slate, kaolin and mortar). The sample contains a wide variety of materials, however glass (N = 8,324) and pottery (N = 1,125) predominate (Figure 4). Materials are predominantly medium-sized (55%) or small (46%), and though some large-size objects were found (9%). There is no clear relationship between artifacts' size and their topographic location. Based on their morphology, marks/backstamps and manufacturing techniques, most of the artifacts could be assigned to the late 19th or early 20th century. While some of the materials may be younger materials may be present, these would not make up a significant proportion of the assemblage.

There are concentrations of artifacts in the northwestern portion of the survey area, and lower frequencies in the southeast (Figure 5). That is, although materials are distributed across the site's surface, they cluster in several high-density patches. One of these concentrations is located in the northwest corner (section A, transects 1, 2 and 3). On elevated portions of sections B and C, two smaller concentrations were observed. A fourth concentration exhibiting low material density was detected at section E in transects 7, 8 and 9, close to the point Mmirop1. These four higher-density patches are composed of small- and medium-sized materials, whereas large fragments are notebly concentrated in sections B and C of transects 3, 4 and 5. Glass predominates in all concentrations. Material-specific concentrations were also observed for metal (section B, transects 3, 4 and 5; section E, transects 8 and 9), earthenware (section E - transects 5, 6 and 7), brick (section C, transects 1, 2 and 3),

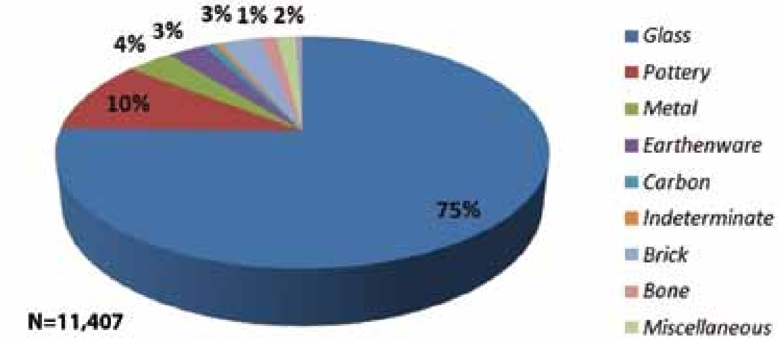

Figure 4. Amount of materials per category according to raw material.

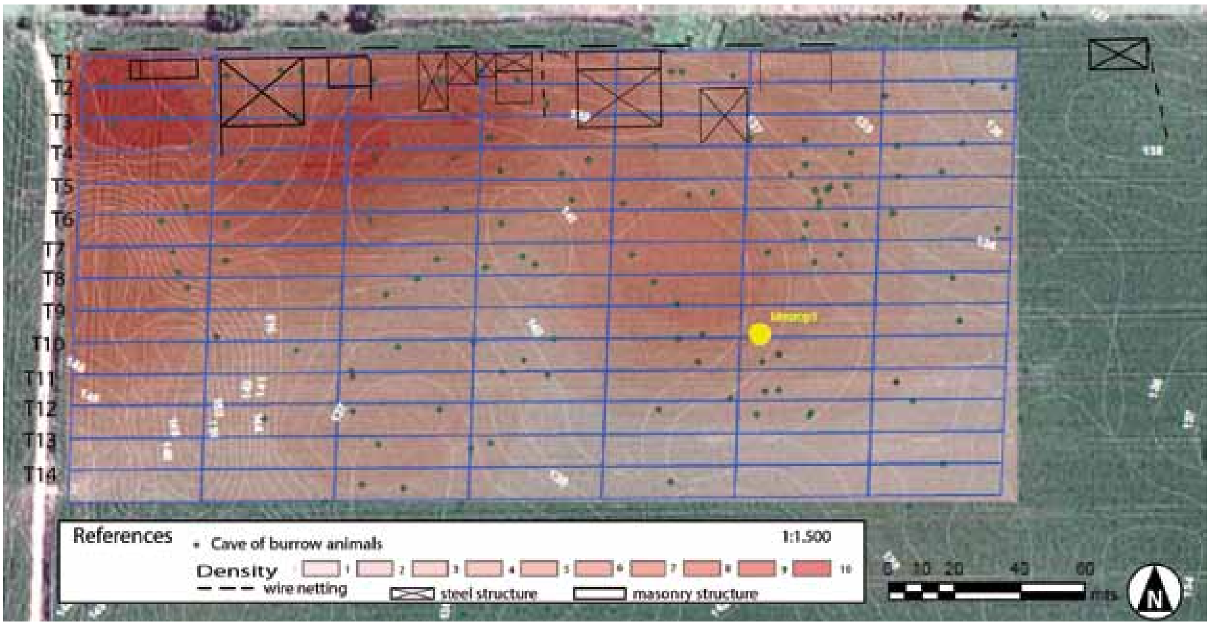

Figure 5. Distribution of surface materials with georeferenced tracing of the village's outline as indicated by documentary sources.

bone (section C, transects 3, 4 and 5), mineral coal (sections A and E, transects 1, 2 and 3), and pottery (section A, transects 1 and 2). The map of subsurface metal concentrations is consistent with surface artifact distributions (Figure 6). Furthermore, subsurface metal concentrations coincide with metal concentrations on the surface.

Alterations on materials

The analysis of surface materials shows that 1,397 (12.7%NR[3]) exhibit evidence of weathering. Of the weathered materials, 92% is glass and the remaining 8% is composed of bone and pottery; 66.6% of weathered artifacts are affected on a single side. The distribution of weathered artifacts is homogeneous across the first seven transects, with the exception of two concentrations in sections B and E, which coincide with a slope and plateau, respectively. Of the weathered artifacts, 33.4% showed signs of chemical weathering on both sides. Most of these were located in transect 2, sections A, C and E, which suggests they may have rolled down slopes in those sections. Weathering on glass and pottery was present as surface opacity, perhaps due to the relative acidity of the soil, which tends to promote chemical weathering these materials (Sandford 1975). Signs of mechanical weathering (erosion or corrasion) were not observed, despite the sandy substrate.

Evidence of thermal alteration was observed on 164 artifacts (1.5% NR) recovered from artifact concentrations in transects 3, 4 and 9. Glass represents 79% of the thermally-altered sample, pottery 9% and bone 8% (Figure 7).

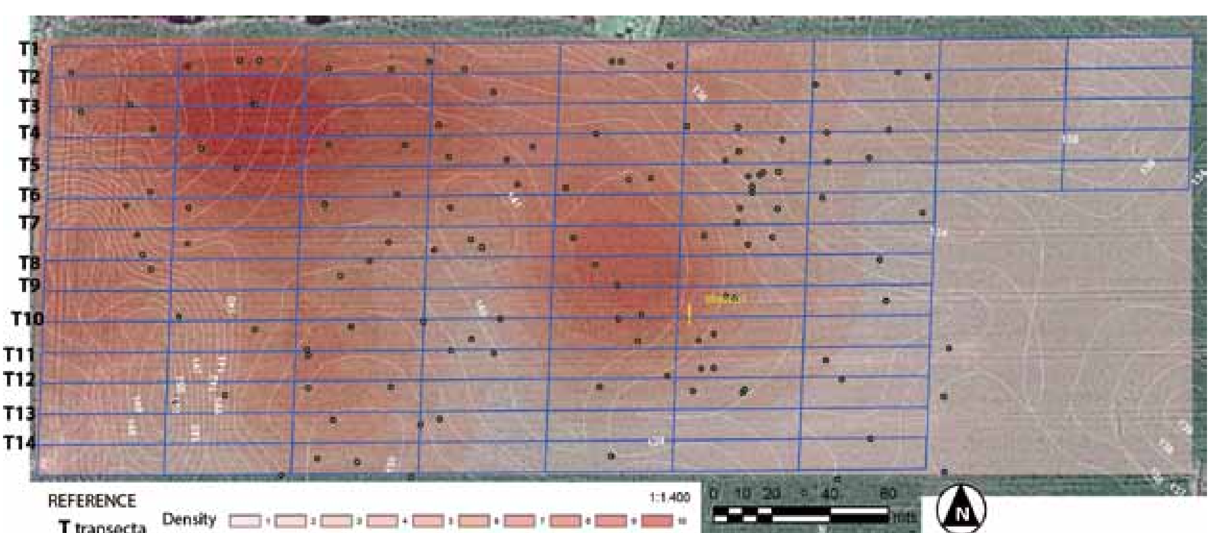

Figure 6. Density distribution of subsurface metal concentrations.

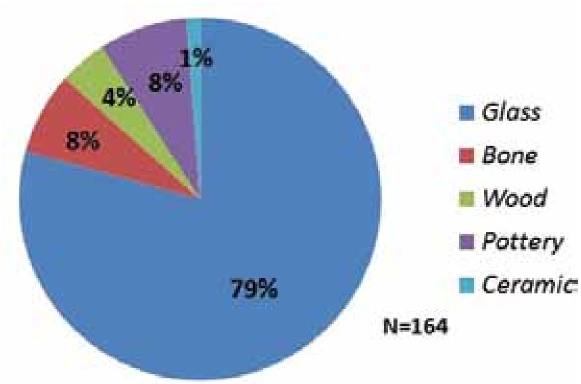

Figure 7. Thermal alteration percentage of those materials found on the surface.

Direct plow marks were recorded on very few objects (N = 51; 0.5%), particularly small- and medium-sized glass pieces. However, thorough evaluation of the effects of plowing requires consideration fragmentation and horizontal dispersion.

DISCUSSION

As mentioned, the abandonment of the Mariano Miró circa 1911 was a gradual process. During this process, the village's 500 inhabitants surely generated a differential discard pattern, with normal, daily refuse being augmented by discard associated with moving, which would show a high fragmentation rate (Peyton 2012). Thus, on the one hand, we found a diversity of material fragments representative of daily life in Mariano Miró, such as glass containers (bottles, perfume and pharmacy jars), earthenware bottles, several types of pottery and porcelain, fragments of a porcelain doll, bone remains and parts of metal utensils. On the other hand, we found remains related to the buildings, such as brick, tile, nails and wooden fragments, among other things. In this sense, it is virtually impossible to distinguish daily life in the village from village abandonment based on surface artifacts or their distributions. Abandonment of the village—a product of landowners' zeal for increased production—led to the demolition of structures after all reusable materials had been taken away (Figure 5). Ultimately, this resulted in a low-resolution archaeological record, making it difficult to differentiate based on surface remains events that occurred prior to abandonment from those that followed it.

Analysis and evaluation of taphonomic processes involved in the formation of the site over the course of a century offer a means of understanding the natural processes and—in a future research—the social practices that influenced site formation. The Mariano Miró site has been impacted by agricultural and livestock activities. Agricultural censuses in the study region from 1937 to 2008 reveal simultaneous use of different plowing equipment including chisels, coulters and discs through the 1990s (INDEC). Since 2000, landowners have practiced no-till farming, which causes little alteration relative to plowing, although heavy equipment can still affect the archaeological record (INDEC; Héctor Morales pers. comm. 2012).

Surface material distributions are affected by a variety of agents such as plowing, trampling, slope and gravity, and rainfall. To understand the specific effects of each agent on the archaeological record and to interpret our assemblage, we must consider the results of other studies. At the artifact level, such comparisons facilitated assessment of artifact size distributions, in this case dominated by medium/small artifacts and a low percentage of large objects (9%). Artifact size at Mariano Miró is unimodal, possibly as a result of fragmentation generated by plowing (Lewarch and O'Brien 1981a, 1981b; Odell and Cowan 1987; Dunell and Simek 1995; Boismier 1997). Furthermore, trampling on a sandy substrate is expected to bury smaller objects within the uppermost centimeters of the deposit while larger objects would remain on the surface (Baker 1978; Gifford González *et al.* 1985). However, this is not the pattern observed at our site. Nonetheless, we think plowing was not the primary agent responsible for material fragmentation since the type of sediment diminishes the possibility of artifact fragmentation; once artifacts are buried they do not encounter resistance as they would in a compact soil (Gifford González *et al.* 1985; Nielsen 1991). Although trampling may have had an influence on lateral displacement, particularly among larger artifacts that are prone to being kicked or dragged (Gifford González *et al.* 1985), it was not sufficient to create the expected size pattern at the site. Also, rainfall in addition to slope, may have moved some materials both downslope and laterally. Considering the heavy rainfalls at certain times of year, surface water may re-expose archaeological materials, though there is no evidence that this affected different sized materials differentially. The correlation between topography, rainfall and trampling, and the size of artifacts and their dispersal is not significant. Therefore, we suggest that, while they may have had some influence, the general patterns observed in the assemblage are likely the result of successive plowing that fragmented and dispersed artifacts over a wide surface (Yorston *et al.* 1990).

At the site level, we were able to determine that the distribution of remains are consistent with the locations of buildings indicated on village maps from 1902, produced by Ferrocarril Central Oeste (Archives of the Railway Museum "Scalabrini Ortiz") (Figure 5). Conversely, overlaying a map of burrowing animals caves (N = 80) on that of the spatial distribution of artifacts does not reveal a correlation. The material concentration in the northwest sector of the site could primarily be the result of plows turning around in that section, according to our interpretations of agricultural equipment tracks observed in satellite images provided by Google Earth and ESRI's server. Moreover, the slope in that sector could exacerbate artifact movement and accumulation initiated by plowing.

Previous studies indicate that plowhing should have high impact on altering archaeological context. Even though in low frequencies, clusters of certain artifact categories and thermally altered material at Mariano Miró are remarkable. The presence of thermally-altered materials in sectors with high artifact densities and concentrations of bones may support the hypothesis that these areas were trash dumps. There is a high proportion of thermally-altered materials among those collected by the school group in section Mmirop1, particularly the glass, pottery and wood. The frequency and pattern of artifacts with this alteration lead us to believe it was not caused by a natural fire or deliberate burning of the field to eliminate weeds (Whyte 1984; Bennett 1999; Coirini and Karlin 2011). It remains unclear, however, whether these concentrations correspond to structures or trash pits or are simply random, a question that requires stratigraphic data to fully resolve. Moreover, excavations are recommended more generally since all of the strategraphic agents considered here also influence vertical distributions of artifacts. Subsurface testing should be done in conjunction with the development of experiments designed to identify the taphonomic processes that influenced our study area in particular. In light of this, we reiterate the benefits of studying taphonomic processes at every archaeological site and taking both surface and stratified deposits under consideration (Lewarch and O'Brien 1981a, 1981b; Dunnell and Dancey 1983; Butzer 1989; Dunnell 1992).

CONCLUSIONS

Mariano Miró is an exceptional archaeological case: a village established by the railway that then succumbed to the advance of the agricultural frontier and landowners' speculative tendencies. Studies of ghost towns or the archaeology of abandonment typically deal with abandoned villages where at least some structures still stand, such as Newhouse, Frisco and Silver Reef (Utah, USA) or sites associated with mining activities in Australia, New Zealand or Chile (Neville and Hooker 1997; Bell 1998; Vilches *et al.* 2008; Fuentes 2010; Lawrence and Davies 2010). Only the New Philadelphia site (Illinois, USA) is similar to our case study, having been abandoned gradually circa 1869 and later razed to permit agriculture. None of these cases have been considered from taphonomic perspective, however, and their archaeological records were described as "intact," leaving aside descriptions of particular alterations (*e.g.*, roads, agriculture; Hargrave 2010). Despite differences in abandonment processes, material cultures, degree of preservation and approaches to their study, these sites share narratives about unsuccessful experiences that left traces on the landscape, memories and identities of the descendants of those upon whom an exodus was forced. Historic archaeology will help us understand the histories of those settlers in the region, and aid preservation of their material and immaterial heritage.

Consideration of diverse variables and scales of analysis allowed us to describe a complex process in which multiple agents acted over the course of the last century. We acknowledge that there are issues of equifinality when attempting to distinguish the effects of some agents. Nevertheless, we propose that plowing was the most significant taphonomic agent at Mariano Miró, fragmenting and moving artifacts. However, some of our observations suggest that plowing did not completely obliterate patterns generated during occupation and abandonment of the village. For example, the three largest artifact concentrations in section A of transects 1, 2 and 3; sections B and C of transects 3, 4 and 5; and section E of transects 7, 8 and 9 correspond to structures or loci, such as dumps used during the town's occupation or abandonment. These high-density patches consist of small- and medium-sized materials, whereas large fragments are primarily concentrated in sections B and C of transects 3, 4 and 5, where there are also numerous thermally-altered materials and bones. This also supports the idea that plowing disturbance was not sufficient to completely alter artifact clustering, though we are well aware that we do not yet have enough information to confirm this hypothesis. Toward this end, we will complete additional systematic surveys in the light of the data collected here. Stratigraphic information will improve our knowledge of the effects of taphonomic agents on artifacts' vertical displacement. Moreover, it is vital that we design experiments to helps us to understand the effects of agents involved in the formation and alteration of the material record in the study region. Finally, given the site's size and the possibility that some structures remain, we intend to conduct geophysical survey as well.

We believe that the surface record, despite its limitations, provides valuable information and can be used to understand both formation processes and social practices at a site (Butzer 1989; Dunnell 1992). A taphonomic perspective allows us to pose new questions and generate new expectations for interpreting the site. The study presented here highlights the importance of a taphonomic perspective for interpreting a site where all that is left of a community of 500 inhabitant are numerous fragments found on the surface.

Acknowledgements

We thank Mr. Jorge Alsina and Héctor Morales for their generous hospitality, and the communities of Hilario Lagos and Rural School No. 65 in Mariano Miró, particularly Alicia Macagno.

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NOTES

1.- In Argentinian historiography, the so-called "Conquest of the Desert" was set up as a series of military campaigns and actions carried out by the Argentinean Army against diverse indigenous people between the years 1878 and 1885 in the Pampean and Patagonian regions. Its outcome was the conquest of the territory and the control, reduction and genocide of the native inhabitants.

2.- An inventory of this collection registered 4,621 artifacts.

3.- The acronym NR is used to refer to the total Number of Remains.

4.- It would be difficult to identify the specific agent that caused trampling due to equifinality problems.