Chapter 12
Expanding the Scope of Actualistic Taphonomy in Archaeological Research

Karen Borrazzo

Abstract This chapter presents the application of actualistic taphonomy to the study of one of the inorganic remains produced by hominins since 3 million year BP up to historical times: lithic artifacts. As rocks are among the most durable raw materials employed by modern humans and their ancestors, differential preservation has conferred a leading role in archaeological research upon lithic artifacts. Indeed, lithics—flaked artifacts in particular—are the *proxy* for culture or anthropic presence most commonly used by scholars all over the world. This artifact-human relationship promoted actualistic research on flintknapping in archaeology but no similar effort was devoted to assessing alternative non-cultural (i.e. taphonomic) sources for flaked stone objects. Even though actualistic studies have already shown that taphonomic processes may produce lithic pseudomorphs, this fact is only rarely considered in archaeological practice and research design. Furthermore, it is commonly assumed that human products are different enough from any natural specimen to be detected by lithic analysts. However, the current lack of knowledge on non-cultural flaking processes and their byproducts prevents their identification in the archaeological record, thus undermining the accuracy and reliability of archaeological interpretations. This paper illustrates the contribution of actualistic taphonomy to study the inorganic remains of the archaeological record and its critical role in assessing the cultural versus natural origin of lithic specimens in Fuego-Patagonia (South America). Naturalistic and experimental research on rockfall and trampling presented here suggests that the effects of these taphonomic processes result in pseudoartifacts that progressively incorporate to the regional archaeological record.

Keywords Lithic taphonomy · Pseudoartifacts · Middle-range research · Experimental archaeology · Fuego-Patagonia

---

K. Borrazzo (✉)
CONICET, Instituto Multidisciplinario de Historia y Ciencias Humanas (CONICET-IMHICIHU), Buenos Aires, Argentina
e-mail: kborrazzo@yahoo.com.ar

Facultad de Filosofía y Letras, Universidad de Buenos Aires (FFyL-UBA), Buenos Aires, Argentina

© Springer Nature Switzerland AG 2020

S. Martínez et al. (eds.), *Actualistic Taphonomy in South America*,
Topics in Geobiology 48, https://doi.org/10.1007/978-3-030-20625-3_12

12.1 Introduction

Although the study of the fossil record nowadays encompasses dealing with numerous topics and methods to understand the history of its formation, taphonomy is unquestioningly a mandatory constituent of any paleo-research (e.g. Behrensmeyer et al. 1992; Behrensmeyer et al. 2000; Kowalewski and Labarbera 2004; Domínguez-Rodrigo et al. 2011). In archaeology, there is currently a general agreement among scholars dealing with a zooarchaeological and bioanthropological record on the necessity and benefits of incorporating taphonomy as a regular component of research (Gifford 1981, Lyman 1994; Pobiner and Brown 2005; Gutiérrez et al. 2007). More recently, several researchers highlighted the contribution of a taphonomic perspective to the study of other archaeological remains (Hiscock 1985; Valin et al. 2001; Barton et al. 2002; Borrazzo 2006; Mallol and Bertran 2010; Thiébaut et al. 2010; Domínguez-Rodrigo et al. 2011; Borrazzo and Weitzel 2014; Yeshurun et al. 2014, among others). Thus, theoretical and methodological approaches of taphonomy are becoming progressively (and decidedly) an integral part of archaeological research on the formation history of all the components of the record. As Borrero put it, archaeology should pursue an unrestricted or multi-service taphonomy to benefit from the integration (comparison and contrast) of taphonomic signatures on different types of remains (Borrero 2011, 2014).

In archaeology as in paleontology, actualistic research focuses on the study of present-day patterns and processes in contemporary settings to learn about the relationship between processes and effects. These lessons from the present aid and guide the interpretations of fossil data on the unobservable past processes that formed the historical records (Binford 1977, 1981; Behrensmeyer and Kidwell 1985; Gifford-Gonzalez 1989; Kowalewski 1999; Kowalewski and Labarbera 2004; Pobiner and Brown 2005). However, the recent character of present-day observations may limit their relevance to explain some features of the fossil record (Kowalewski 1999). Nevertheless, actualistic approach is always informative since it provides access to material situations in which the linkage between the responsible actor (taphonomic agent) and a trace (taphonomic effect) is unequivocal (Marean 1995; Pobiner and Brown 2005; Lin et al. 2017). The material expectations of models and hypothesis derived from actualistic research can be tested against the fossil record; differences and similarities emerging from the comparison of fossil data against expectations may suggest future directions of research (Lin et al. 2017).

The protocol outlined by Marean (1995) has been widely adopted as a general model for actualistic taphonomy in archaeology (e.g. Pobiner and Brown 2005; Álvarez and Alunni 2017). He differentiates two components in actualistic research: naturalistic and experimental studies. The former includes the direct observations of natural situations and sets the agenda for experiments; the latter improves the knowledge of trace-actor linkage as the analyst controls some parameters of the process (Marean 1995). Kowalewski and Labarbera (2004) make further distinction within actualistic research by identifying three strategies to acquire data, an observational approach (direct field observation and sample collection in modern settings) and two experimental approaches (field experiments and data collected in laboratory settings). According to Lin et al. (2017), experimental processes in archaeology include pilot studies and second-generation experiments. While the former detects potential material relationships, the latter verify the existence of those linkages by following a protocol to ensure repeatability and allow quantifiable results (Lin et al. 2017).

Due to the increasing recognition of the key role of taphonomy in the study of fossil records and the regional availability of "natural taphonomic laboratories", actualistic taphonomy has experienced a significant growth and diversification in South America (Ritter et al. 2016). In spite of the large contribution of actualistic taphonomy to archaeological research in the region (e.g. Cruz 2007; Gutiérrez et al. 2007; Massigoge and González 2012; Álvarez and Alunni 2017), its application to the study of lithicartifacts—usually the most frequent remains in the record—is still scarce (Borrazzo 2011a, 2013; Balirán 2014; Weitzel et al. 2014; Méndez Muñoz 2015; Carranza 2017; Carranza Elola and Méndez 2017).

This chapter aims to illustrate the contributions of expanding the scope of actualistic taphonomy into current topics of South American archaeology. It presents an actualistic research—that includes both naturalistic and experimental studies—focused on the taphonomic production of flaked stone objects (named pseudoartifacts, mimics or pseudomorphs) and its identification in the archaeological record. More specifically, the research summarized in this paper aims for contributing to two topics in archaeology. Firstly, while the early concern with the recognition of the complete repertoire of human flaked artifacts has prompted systematic archaeological and actualistic research in flintknapping (e.g. Johnson et al. 1978 and references therein) no comparable effort was devoted to natural or accidental flaking process (but see Warren 1914; Mason 1965; Nash 1993; Hosfield and Chambers 2003; Lopinot and Ray 2007; Demeter et al. 2010; Carranza Elola 2015, among others). Hence, the uneven knowledge on human and taphonomic flaking processes and byproducts prevents archaeology from achieving a more comprehensive and accurate understanding of the patterns displayed by the lithic record. Secondly, pseudoartifact is a topic relevant for current discussions in South American archaeology among which the lack of a taphonomic research program undermines argumentation (Aschero et al. 2017; Prentiss et al. 2015, 2016; Garvey and Mena 2016; Boëda et al. 2014, 2016; Aimola et al. 2014; Lahaye et al. 2013; Parenti 2015; Fiedel 2017; Fariña et al. 2014; Suárez et al. 2014; see Borrero 2015, 2016 for further discussion).

The results presented here are part of a larger lithic taphonomy research program conducted in Fuego-Patagonia (southern South America) for the last 15 years. Here I focus on the study of Casa de Piedra Roselló (CP), an archaeological site located in Chubut Province, Argentina (Castro Esnal et al. 2017a, b) (Fig. 12.1). Departing from naturalistic regional observations, two sets of experimental studies using the raw material available at the site were designed to assess the pseudoartifact component (or local taphonomic background noise, Borrero 2001, 2015). Actualistic data is applied to the analysis of an archaeological lithic sample collected at CP talus (Fig. 12.1).

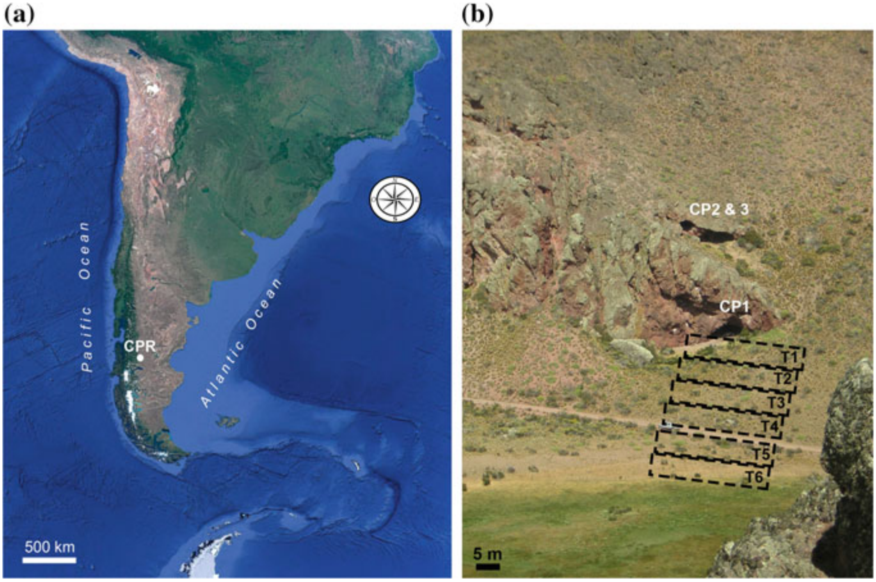

Fig. 12.1 **a** Location of the study area. **b** Casa de Piedra Roselló archaeological site and talus surface survey

12.2 The Role of Actualistic Taphonomy in the Archaeological Research on Pseudoartifacts

From a geological point of view, artifacts can be defined as a subset of rock fragments whose morphological properties were transformed by manufacture or human use. Thus, considering the morphological spectrum represented within the rock fragments universe, artifacts can usually be distinguished from natural clasts by displaying several unique traits that result from human agency and that are not replicated by natural or accidental processes (i.e. taphonomic processes). Nevertheless, there exists a morphological space shared by taphonomic as well as cultural lithic products. Pseudoartifacts, lithic mimics, or pseudomorphs are the natural lithic pieces that resemble artifacts (Breuil and Lantier 1965; Haynes 1973; Gillespie et al. 2004), while geofacts is the term reserved for geogenic mimics.

Among pseudoartifacts, the degree of similarity of their form (i.e. shape and size) with stone artifacts is also variable. In some cases, their non-cultural origin is easily established after performing a regular techno-morphological analysis. That is the case of the fragments produced by thermal fatigue ("cup-like" scars) or haloclasty (Warren 1914; Barnes 1939; Breuil and Lantier 1965; Andrews et al. 2004). But still remains a smaller portion of the morphological spectrum that can result either from cultural or taphonomic processes and that may be not detected by regular lithic analysis only (e.g. Mason 1965; Nash 1993; Borrazzo 2011b). Furthermore, from a technological perspective, the morphology of those pseudoartifacts may be interpreted as informal tools, by-products of rudimentary, simple technologies or resulting from the application of an expedient strategy within a context plenty of lithic raw material (e.g. Chlachula and Le Blanc 1996; Gillespie et al. 2004). Lyman (1984) addressed similar issues on pseudo-bone tools study.

A detailed examination of the natural and cultural pieces that look identical shows that, in spite of their different origins, the physical mechanisms operating during their production are the same: pressure and percussion (Warren 1914; Mason 1965; Cotterell and Kamminga 1987).

This chapter addresses the study of those common morphologies produced on stone by percussion and pressure as a result of either cultural or taphonomic processes (Barnes 1939; Mason 1965; Duvall and Venner 1979; Gillespie et al. 2004; Andrefsky 2014; Wiśniewski et al. 2014). I propose that before advancing behavioral interpretations, archaeologists need to undertake the taphonomic study of lithic assemblages and their context in order to assess the potential contribution of pseudoartifacts to the archaeological record (Mason 1965). Indeed, this is especially important for any archaeological context where raw material is locally available and not only a requirement for sites exhibiting old dates or exclusively "simple or expedient technologies".

Today, several issues condition the advance of pseudomorph research in archaeology. Firstly, the available taphonomic frame of reference is too general, ambiguous, and incomplete. We need detailed information on the effects that different processes acting upon different raw materials produce (e.g. Nash 1993; Luedtke 1986; Balirán 2014). Secondly, several discussions on pseudoartifacts have stressed the differences and overlooked the similarities exhibited by naturefacts (e.g. Boëda et al. 2014, 2016; Prentiss et al. 2015). Also, they have focused on mimics produced by mechanisms that do not operate in the flintknapping process (such as thermal stress or frost weathering, Andrews et al. 2004), which are relatively easy to detect with current lithic analysis protocols because their morphological attributes differ significantly from those of man-made artifacts. Note that the latter does not include the worrisome application of authoritarian criteria based on analyst expertise and knapping skill level to define the anthropogenic or non-anthropogenic origin of lithics (Mason 1965; Garvey and Mena 2016; Prentiss et al. 2016; Lin et al. 2017). Finally, we currently lack the knowledge on the lithic taphonomic background noise (Borrero 2001, 2015) of each study region, i.e. the aspect of rock fragments resulting from past and present taphonomic processes operating on locally available lithic raw materials.

Since archaeological knowledge about natural or taphonomic flaking is very limited, an actualistic taphonomy approach to pseudoartifacts research is adequate to provide information on the morphological effects of percussion and pressure on different lithic raw materials under non-technological situations.

12.3 Case Study

Casa de Piedra Roselló archaeological site (CP) (45.3°S, 71.2°W) is located within a ravine in the forest-steppe ecotone of Chubut Province (Castro Esnal et al. 2017a, b) (Argentina, Fig. 12.1a). It consists of three rock shelters (CP1, 2 and 3) eroded in the ignimbrite of Carrenleufú Formation. The cavities are located ca. 12 m above the bottom of the gully; both spaces are connected by a ca. 30 m long talus whose slope is 0–10° (Fig. 12.1b). The discontinuous vegetation cover of the talus includes bushes (*Berberis* sp. and *Senecio* sp.) and grasses (*Festuca* sp.). The substrate is fine sediment with gravel primarily derived from in situ weathering of the ignimbrite outcrop.

Cattle from the Roselló Ranch and wild animals frequent the CP ignimbrite outcrop looking for shelter. Dung, tracks, footprints, and carcasses record their presence at the site.

Excavations undertook at the main cave (CP1, Fig. 12.1b) provided evidence for human occupations between ca. 9000 yr BP and historical times. The stratigraphic sequence of CP1 has yielded an assemblage of lithic artifacts adequate for the study of changes and continuities in lithic technology in the area throughout the Holocene (Castro Esnal et al. 2017a, b).

All layers in CP1 stratigraphy included debris and tools on obsidian—largely from Pampa del Asador source, 270 km south of the site (Castro Esnal et al. 2017b). However, the predominant lithic raw material in the stratigraphic sequence since the early occupations is a local microcrystalline silicate that appears in veins within the Carrenleufú Formation (Castro Esnal et al. 2017a). Indeed, good flaking quality veins were observed on blocks as well as the walls of rock shelters 2 and 3 of CP (Fig. 12.1b). Nevertheless, current information suggests that artifacts made on CP chert were not deposited beyond the site.

12.4 Materials and Methods

12.4.1 Actualistic Observations

Pseudoartifacts research at Casa de Piedra Roselló implemented the two components of actualistic taphonomy. Naturalistic studies consisted of field observations of archaeological and non-archaeological loci within different geomorphic contexts of Mendoza, Neuquén, Río Negro, Chubut, Santa Cruz and Tierra del Fuego Provinces (Argentina) (Borrazzo 2006, 2011a, b, 2016; Borrazzo and Borrero 2015). They also included the collection of natural specimens to build taphonomic reference assemblage. Along with pseudoartifact sampling, this exploration of non-cultural lithic morphologies offered a general image on the range of taphonomic processes regionally available and their effects on different lithic raw materials. It is worth mentioning that taphonomic specimens collected for reference fulfilled several requirements (such as in situ refitting and the presence of detached fragments in anatomical position, Borrazzo 2016). In addition, detailed environmental information on the context of recovery of each sample was recorded. The information gathered through naturalistic studies guided the subsequent experimental research reported here.

Naturalistic data suggested that rockfall and trampling are two primary taphonomic processes with the energy required to change lithic morphology at a rock shelter context such as CP. Also, taphonomic specimens collected underscored the variability displayed by different raw materials subjected to the same taphonomic process. Departing from these general observations, experimental research was conducted to assess (1) the capacity of rockfall and trampling to produce pseudoartifacts on local CP chert nodules and, if that was the case, (2) providing a general description of the morphological attributes exhibited by those mimics. Together these data would allow estimating the contribution of taphonomic processes to local lithic assemblages. Overall, experiments seek to improve the accuracy of the link between processes and their effects on local chert at CP.

12.4.2 Experimental Research

Unlike rockfall effects, the modifications induced by trampling on the archaeological record are one of the topics more abundantly addressed in formation processes research (see Eren et al. 2010; Weitzel et al. 2014 and references therein). Notwithstanding the availability of experimental information on these taphonomic processes (especially for trampling), the variability recorded on naturalistic regional data indicated that it is imperative to conduct experiments using local raw materials to improve the conditions for taphonomic analysis. Therefore, two sets of experiments were designed to approach the formation processes of lithic assemblages at CP. All experimental pieces were painted with water-based paint to improve the visibility of modifications after rockfall and trampling processes in the subsequent analyses (Fig. 12.2).

In rockfall experiments, natural clasts of chert collected at CP talus (N = 22, Table 12.1) were deposited on a flat, dry loamy soil and a nodule of the same chert (initial weight: 222.4 g) was dropped (freefall[1] mode of motion, see Dorren 2003) from 1, 2, and 3 m high. The effects of rockfall impacts were recorded on the specimens deposited on the substrate. The freefalling rock (percussor) used during all rockfall experimental series was the same because neither its shape nor its weight underwent significant changes after rockfalls (final weight: 208.7 g). Chert pebbles and slabs used in the experiment have a fairly fresh surface. They are mostly angular, spherical to plate-like in shape what agrees with the scarce to no transport suffered by the nodules derived from in situ weathering.

---

[1] Although at least two other modes of motion take place on a talus after freefalling rockfalls (bouncing and rolling, Dorren 2003), experiments reported here focused on freefalling byproducts.

Fig. 12.2 Rockfall experiment. **a**, **b** Chert nodules before and after their preparation for rockfall experiments. **c**–**h** Specimen number 11 from its preparation and after receiving twelve rockfall impacts from 1 m high. **i** Specimen collected in Transect 2 on CP talus surface

Pieces in the 1 m height rockfall were subject to impacts individually until the specimen broke. As it was almost impossible to hit with the hammer an individual piece from 2 and 3 m high, pieces were deposited in groups of six and the hammer was dropped a hundred times per group (only effective hits were counted; when the hammer did not impact any specimen in the group, the thrown was repeated until it did).

Trampling was performed by a 60 kg individual wearing leather sole shoes. Experimental pieces (N = 42 flakes, Table 12.1) were manufactured by flintknapping from CP chert nodules. Two plots were set on different substrates: a soft substrate (dry loamy soil) and a hard substrate (paving stone). Each experiment included four series of 10 min trampling (between 70 and 80 passes).

Table 12.1 Descriptive statistics of CP surface sample and experimental materials

	CP Surface assemblage		Experimental assemblage	
	Weight (g)	Size (mm)	Weight (g)	Size (mm)
N	151	151	64	64
Min.	0.05	10	0.05	15
Max.	169	80	166.2	75
Sum.	4172.2	6030	1663.4	2270
Mean	27.63046	39.933770	25.99062	35.46875
Std. error	2.799017	1.214325	5.07707	2.26231
Variance	1183.009	222.662300	1649.70600	327.55460
Stand. dev.	34.394900	14.921870	40.61658	18.09847
Median	13.2	40.0	3.3500	30.0
25 prcntil	5.3	30.0	1.0500	20.0
75 prcntil	40.1	50.0	41.6250	50.0
Skewness	2.114434	0.447631	1.85229	0.73236
Kurtosis	4.648714	−0.357027	2.90474	−0.70989
Geom. mean	12.274010	37.071640	5.27611	31.30994
Coeff. var.	124.481800	37.366540	156.27400	51.02652

12.4.3 Archaeological Sample

A surface survey was conducted on the main talus of CP (Fig. 12.1b). It included six parallel 25 by 5 m transects placed perpendicular to the talus main slope. Sampling units 1–6 (top to bottom of the slope) recorded variations in slope gradient (mean transect values: 4, 6, 8, 10, 5 and 0°, respectively). A gravel road separates transects 5 and 6 from the rest of the units (Fig. 12.1b). The sample obtained (N = 151, Table 12.1) was analyzed from a taphonomic and technological perspective (e.g. Borrazzo 2006, 2011a, b).

12.5 Results

12.5.1 Experimental Studies

12.5.1.1 Rockfalls

During the rockfall experiments, freefalls from all three heights produced crushes and retouches (i.e. small flake removals) on deposited chert pebbles and slabs. Impacts from 1, 2, and 3 m also detached larger flakes, although they seem to occur more often in higher rockfalls.

Table 12.2 Technological description of rockfall experimental specimens larger than 5 mm

Lithic class	**1 m**	**2 m**	**3 m**	**Total**
Debitage	14	25	23	62 (66.67%)
Tools	5	5	0	10 (10.75%)
Cores	1	3	2	6 (6.45%)
Unmodified pebble/slab	6	5	4	15 (16.13%)
Total	**26**	**38**	**29**	**93**
Debitage	**14**	**25**	**23**	**62**
Number of dorsal flake scars				
0	9	17	16	42 (67.74%)
1	4	7	7	18 (29.03%)
2	1	0	0	1 (1.61%)
3	0	1	0	1 (1.61%)
Flaked stone tools	**5**	**5**	**0**	**10**
Tool types ($N = 13$)				
Indet. retouched edge	3	4	0	7 (58.85%)
Notch	2	0	0	2 (15.39%)
Knife	0	1	0	1 (7.69%)
Denticulate	1	0	0	1 (7.69%)
Sidescraper	0	1	0	1 (7.69%)
Endscraper	1	0	0	1 (7.69%)
Cores	**1**	**3**	**2**	**6**
Number of blows				
1	1	0	0	1 (16.67%)
2	0	2	1	3 (50.00%)
3	0	1	1	2 (33.33%)

Note that the sum of tool types is larger than the count of ‘flaked stone tools’ because several specimens exhibit more than one tool type on their edges

After 483 freefalls, the original sample (22 nodules) resulted in 98 specimens. However, five small flakes (~5 mm) are excluded from the following analysis in order to maximize the comparability of experimental results with CP talus surface sample. No specimen smaller than 10 mm was recovered in the surface collection and its absence may be due to visibility conditions during the survey. Therefore, the experimental rockfall sample analyzed here onwards is composed of 93 pieces (Table 12.2). Based on their morphological features, the 16.13% of the experimental sample remained classified as pebble/slab without artifact attribute after techno-morphological analysis (Table 12.2).

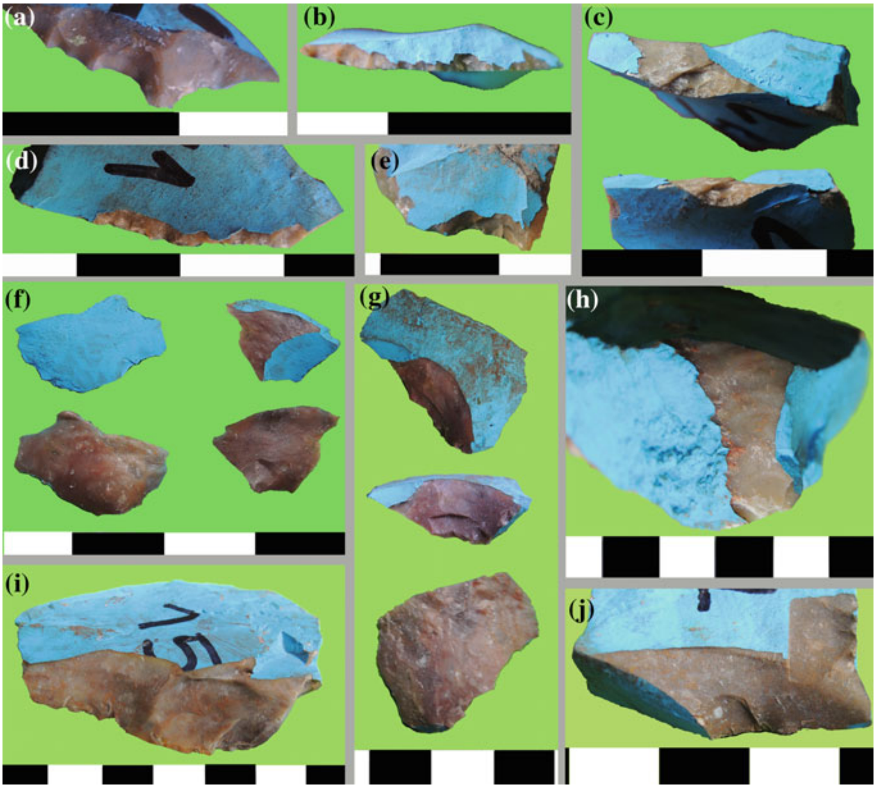

Fig. 12.3 Experimental pieces after trampling (**a**–**e**) and rockfalls (**f**–**j**)

Debitage (flakes, angular shatters, and debris) and tools comprise ca. 80% of the experimental rockfall sample (Table 12.2; Fig. 12.3). Cores represent 6.45% of the assemblage. Among debitage, pieces with none to one dorsal flake scar comprise 96.77% of the sample, although specimens without flake removals are the most frequent (Table 12.2). Only 1 and 2 m high rockfalls produced stone tools, which are dominated by nonspecific retouched edges (ca. 60%, Table 12.2, Fig. 12.3). However, several typological groups were recorded (notch, denticulate, knife, sidescraper and endscraper). Experimental specimens resembling cores exhibit only a few isolated blows; therefore, no formal core categories were identified in the experimental sample.

12.5.1.2 Trampling

After trampling experimental flakes, mimics of stone tools were recorded. They exhibited several techno-typological groups (e.g. Bordes 1961) that include different kinds of continuous retouched edges, serrated edges, retouched points, notches, and denticulates.

Fracture occurrence due to trampling process was high in both plots (55% in soft and 63.64% in the hard plot). However, the frequency of pseudotools was high on hard substrate only (45.45%). No pseudotool was identified after trampling in the soft substrate plot. Even though other experiments have already informed that flaking and fractures are more common when treadage occurs on a hard substrate (see Weitzel et al. 2014 and references therein), additional studies are required to further test our result on soft substrate. The tool types obtained after trampling on the hard substrate were notches (N = 4), long retouched edges (knife/sidescraper, N = 3) and restricted retouched edges (e.g. cutter, N = 5). Flakes produced by trampling were small ($\leq$5 mm) and therefore are not considered in subsequent comparative analyses.

12.5.2 The Analysis of Surface Lithic Assemblage

The spatial distribution of specimens was heterogeneous along the talus sampling units (Table 12.3), probably due to gravitational and visibility issues that will be addressed elsewhere. As it was observed in CP stratigraphic sequence, local chert is the most frequent raw material in the talus surface sample as well (83.44%). Non-chert rocks are especially frequent in transect 4 which also offered the largest lithic sample (Table 12.3). Tools (42%) and debitage (38.46%) are the most represented artifact classes in the non-chert subset and endscraper is the dominant tool type (54.55%).

Within local chert specimens in the CP talus sample, debitage (flakes, angular shatters, and debris) and tools are the most represented artifact classes (Table 12.4). Among the former, pieces with none to two dorsal flake scars comprise ca. 70% of

Table 12.3 Lithic raw material composition of CP talus surface collection

Raw material	T1	T2	T3	T4	T5	T6	Total
CP chert	16	17	13	34	29	17	126
Non-local chert	0	0	0	5	1	0	6
Rhyolite	0	0	0	1	2	1	4
Chalcedony	0	0	0	3	1	0	4
Shale	0	1	0	1	0	0	2
Basalt	0	0	0	1	0	0	1
Jasper	0	0	0	1	0	0	1
Obsidian	0	1	0	0	0	0	1
Opal	0	0	0	1	0	0	1
Quartz	0	0	0	1	0	0	1
Ignimbrite bedrock	1	0	0	0	0	0	1
Indet. rock	0	1	0	1	0	1	3
Total	**17**	**20**	**13**	**49**	**33**	**19**	**151**

Table 12.4 Technological description of CP chert specimens in talus surface sample

Lithic class	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**Total**
Debitage	12	10	8	20	15	7	72 (57.14%)
Tools	3	6	4	7	13	10	43 (34.13%)
Cores	1	1	1	4	1	0	8 (6.35%)
Indet. modified edges	0	0	0	3	0	0	3 (2.38%)
Total	**16**	**17**	**13**	**34**	**29**	**17**	**126**
Debitage	**12**	**10**	**8**	**20**	**15**	**7**	**72**
Number of dorsal flake scars							
0	2	2	0	4	3	1	12 (16.67%)
1	3	1	1	6	5	2	18 (25.00%)
2	5	1	3	6	4	1	20 (27.78%)
3	1	3	2	0	1	1	8 (11.11%)
4	1	2	2	1	2	0	8 (11.11%)
5	0	1	0	1	0	1	3 (4.17%)
6	0	0	0	0	0	1	1 (1.38%)
Indet	0	0	0	2	0	0	2 (2.78%)
Flaked stone tools	**3**	**6**	**4**	**7**	**13**	**10**	**43**
Tool type ($N = 58$)							
Sidescraper	0	2	0	1	7	4	14 (24.14%)
Notch	1	2	1	2	3	4	13 (22.42%)
Endscraper	0	2	0	2	2	1	7 (12.07%)
Indet. retouched edges	0	2	0	0	1	3	6 (10.35%)
Knife	1	0	1	1	2	0	5 (8.62%)
Woodscraper	0	0	1	1	2	0	4 (6.90%)
Denticulate	1	0	0	0	1	1	3 (5.17%)
Cutter	0	0	1	0	0	0	1 (1.72%)
Point	0	0	1	0	0	0	1 (1.72%)
RBO (restricted endscraper)	1	0	0	0	0	0	1 (1.72%)
Indet.	2	0	0	0	1	0	3 (5.17%)
Cores	**1**	**1**	**1**	**4**	**1**	**0**	**8**
Number of blows							
1	0	0	0	1	0	0	1 (12.50%)
2	1	0	0	2	0	0	3 (37.5%)
3	0	0	0	0	0	0	0 (0.00%)
4	0	0	1	0	1	0	2 (22.00%)
5	0	0	0	1	0	0	1 (12.50%)
6	0	1	0	0	0	0	1 (12.50%)

Note that the sum of tool types is larger than the count of ‘flaked stone tools’ because several specimens exhibit more than one tool type on their edges

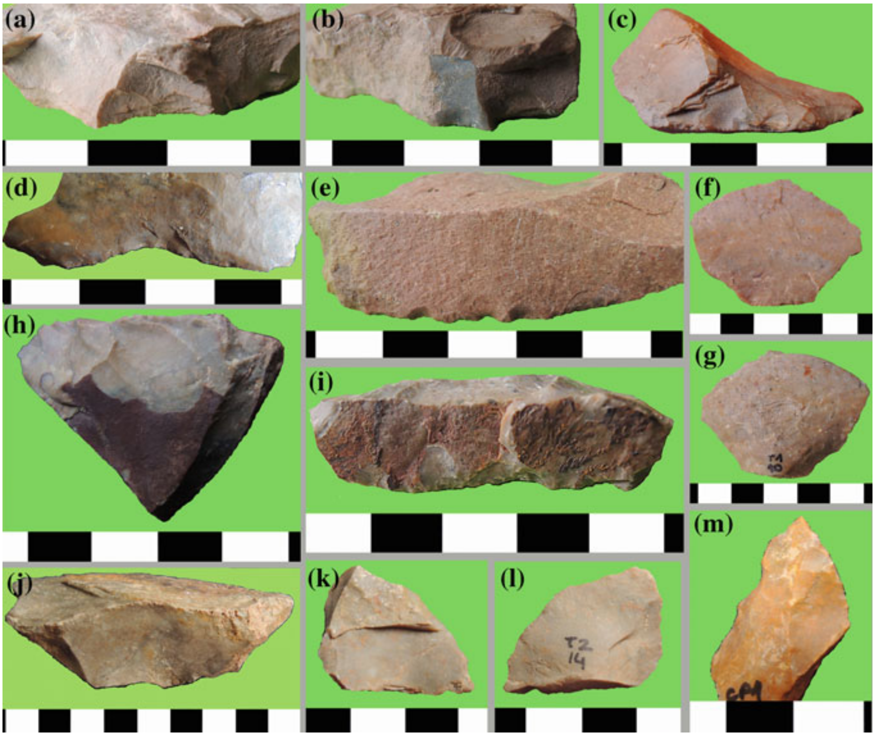

Fig. 12.4 Chert specimens collected from the surface of Casa de Piedra Roselló talus. **a**, **b** Woodscraper, note the less weathered flake scar on **b**. **c** Endscraper. **d** Notch. **e**, **i** Sidescraper. **f**, **g** and **k**, **l** Dorsal and ventral side of flakes. **h** Core. **j** Dorsal face of a flake with plunging termination. **m** Retouched point

the sample, although specimens with one and two scars are the most frequent. Cores represent 6.35% of the sample (Fig. 12.4).

12.6 Discussion

The results of rockfall and trampling experiments show that at least two of the taphonomic processes available at CP may produce pseudoartifacts when act upon the local chert. Indeed, pseudomorphs obtained in rockfall experiments included (pseudo) blanks, tools, and cores (Table 12.2) while treadage on chert flakes produced fundamentally (pseudo) tools. The following sections compare and discuss the morphological traits of experimental and talus lithic assemblages.

12.6.1 Debitage

A first issue highlighted by the comparison of data in Tables 12.2 and 12.4 is the higher number of blows recorded by talus flakes and cores. Rockfall experimental flakes exhibit lower dorsal scar counts; only the specimens in talus sample recorded four to six scars. Experimental flakes exhibit smaller values for length (mean: 14.56 vs. 36.18 mm; median: 12.15 vs. 34.75 mm) and width (mean: 16.35 vs. 31.61 mm; median: 13.75 vs. 30 mm) than complete flakes collected on CP talus surface. Also, the full range of length and width values recorded on the experimental specimens are contained within talus sample values.

As Nash (1993) noted, experimental flakes produced by rockfall are relatively short and wide (see also Luedtke 1986). A comparison of the length/width index values exhibited by complete flakes from both assemblages suggests that talus flakes are more elongated (L/W mean values 1.24 vs. 1.11), but the variance of both populations are significantly different ($f = 26.652$, $p < .001$), being higher in the experimental assemblage (L/W index values: talus = 0.5–3.5 vs. experimental = 0.4–5). A Mann-Whitney U test shows that there are no statistically significant differences in L/W median values between the samples ($U = 2048$, $p = .8511$).

Experimental flakes exhibit feathered (63.16%), plunging (10.53%), and hinge (7.02%) terminations. Flakes in talus assemblage also show feathered terminations as the most frequent type (69.39%), followed by hinge (12.24%), step (12.20%) and plunging (6.12%) terminations. The high frequency of feathered terminations in the present experimental sample contrasts with patterns observed in other rockfall studies (Nash 1993).

Cortical and flat striking platforms are the most frequent types among flakes of both experimental (61.90 and 28.57%) and talus (35.71 and 35.71%) samples. Crushed platforms are equally represented within both assemblages (ca. 5%). Dihedral striking platforms show different frequencies in talus and experimental samples: while they are well represented in the former (16.07%), their presence is scarce in the latter (2.38%). Filiform platforms are scarce in both talus and rockfall assemblages (5.36 and 2.38%, respectively).

These results suggest that taphonomic flakes like the ones produced during our rockfall experiments do not exhibit differential attributes that allow their identification within CP talus surface assemblage. Moreover, as it was already pointed out by other researchers (e.g. Mason 1965; Duvall and Venner 1979), the present study suggests that the differences between experimental and talus flakes are more quantitative than qualitative in nature. Further contextual studies need to explore the occurrence of larger and thus heavier freefall rocks at CP as well as if a larger number of rockfall events may have affected chert nodules deposited at the site. It is worth mentioning that during the talus survey, the presence of chert nodules and blocks larger than the ones used in our rockfall experiments were observed, thus suggesting that higher energy rockfall processes have taken place at the site. Therefore, their frequency and effects need further consideration.

12.6.2 Tools

As shown in Figs. 12.2, 12.3 and 12.4, several stone tools collected from the surface of CP talus display morphologies similar to those exhibited by the experimental samples after rockfalls and trampling. Indeed, the experiments produced almost all of the typological groups recorded within talus sample tools (Tables 12.2 and 12.3, see Sect. 12.5.1.2). It is worth mentioning that no formal tools on chert were recovered during the talus survey.

Mean value for tool size is 43 mm (Min.: 20 mm; Max.: 80 mm) in talus sample, 46 mm (Min.: 20 mm; Max.: 60 mm) in rockfall sample, and 26.5 mm (Min.: 20 mm; Max.: 45 mm) in trampling sample. Tool sizes recorded in trampling experimental assemblage are statistically different from talus (Mann-Whitney U = 84, $p < .01$) and rockfall (Mann-Whitney U = 18.5, $p < .01$) samples, but no statistical difference was recorded between rockfall and talus tool sizes (Mann-Whitney U = 202.5, $p = .5607$). Mean value for retouched edge angle in talus sample (N = 58 edges) is 70.8° (Min.: 30°; Max.: 105°), while rockfall sample (N = 13 edges) value is 76.9° (Min.: 45°; Max.: 110°) and trampling sample (N = 12 edges) value is 54.6° (Min.: 40°; Max.: 75°). Tool angles recorded in trampling experimental assemblage are statistically different from talus (Mann-Whitney U = 24, $p < .01$) and rockfall (Mann-Whitney U = 107, $p < .01$) samples, but no statistical difference was recorded between rockfall and talus tool angles (Mann-Whitney U = 314.5, $p = .2744$). Thus, talus and rockfall sample exhibit virtually identical mean values for tool size and retouched edge angle. Differences exhibited by trampling specimens are probably due to the small size of the blanks (flakes) used in the experiment.

It should be considered that the current and past presence of larger trampling agent at CP, such as guanaco (*Lama guanicoe*) and puma (*Felis concolor*), as well as introduced European livestock (cattle, sheep, and horses) indicates that trampling experimental results should be considered minimum values for the expected effects of local larger trampling agents.

12.6.3 Cores

The relative frequency of ‘cores’ is virtually identical in both experimental and talus samples (6.45 vs. 6.35%, Tables 12.2 and 12.4). Mean number of blows recorded on specimens from surface assemblage is larger than values exhibited by experimental pieces that resemble cores (3.7 vs. 2.2 blows per piece). However, as the rockfall rate averaged by CP talus surface sample is unknown, this difference between the assemblages may be indicating that the number of experimental rockfall events was below the mean number of impacts the specimens from talus collection experienced in average throughout their depositional history. A comparison of flake scars length on cores from both assemblages shows no statistically significant differences between their medians (Mann-Whitney U = 29, $p = .724$); however, flake scar width means are statistically different between the talus and experimental core samples (Mann-Whitney U = 11.5, $p = .034$). This latter result together with data provided by L/W rate on complete flakes suggests that talus assemblage averages conditions not present in the experiments conducted so far.

In sum, this research shows that taphonomic processes produce lithic specimens indistinguishable from artifacts. The comparison of experimental rockfall assemblage with specimens collected at CP talus highlighted the existence of morphological similarities suggesting that lithic assemblages from CP may include a taphonomic component (pseudoartifact) as well. As Mason (1965) earlier observation made it clear, an evaluation on the genesis of fractured stone can detect quantitative differences between natural versus artificial objects if it is conducted in an aggregate manner, that is to say, if both natural and artificial objects are considered as groups and not as single specimens. Moreover, "Simple examination of isolated specimens on the bases of personal opinion is unlikely to give a valid conclusion. Each object should be considered in terms of its context and as part of a series large enough for random or deliberate agencies to express themselves in comparison with all the relevant natural fractures" (Mason 1965: 3).

Current experimental data suggests that flakes equal or smaller than 30 mm in length and 54 mm in width, with three or less dorsal flake scars and cortical, flat, dihedral, filiform or crushed platform are likely to be produced by ~200 g freefalling rocks. When we apply these criteria to assess the potential taphonomic contribution to CP talus debitage sample, we find that only 21 out of 66 complete chert flakes can be disregarded as unlikely taphonomic specimens.

12.7 Conclusions

This chapter explored the potential effect of two taphonomic processes (rockfall and trampling) in the formation (and transformation) of the lithic record of Casa de Piedra Roselló archaeological site, a complex of rock shelters located in Patagonia (South América) with evidence of hunter-gatherer occupations since Early Holocene. Chert of good flaking quality is available at the geological formation where the rock shelters were formed and human groups used that raw material during the entire occupation span. Rockfall on chert pebbles and slabs takes place inside the shelters and on the talus as fragments removed from inner walls or outer cliff faces due to weathering fall downslope. The second process explored here was trampling, which is probably the ubiquitous taphonomic process for Fuego-Patagonian surface assemblages (Balirán 2014; Weitzel et al. 2014).

Considering that the two taphonomic processes explore here have been operating at the site since before the arrival of humans, I conclude that at least special attention should be given to the analysis of those pieces manufactured on local chert at Casa de Piedra Roselló. Moreover, the results presented emphasize the need for further experiments with larger samples adequate for statistical analysis in order to test and expand the pool of patterns recorded here. Field experiments (Kowalewski and

Labarbera 2004) at CP and second generation experiments (Lin et al. 2017) emerge as mandatory next steps in our taphonomy actualistic research.

In addition, this Patagonian case study shows that the application of a taphonomic perspective to the analysis of lithic assemblages is always informative even though unequivocal evidences of human agency are present at the archaeological contexts under study. In the latter case, this will allow assessing the human and taphonomic contributions to the lithic record. Consequently, a general outline in pseudoartifact research is needed to evaluate the taphonomic component within any lithic assemblage. Based on the present study, several of its primary constituents and aims can be advanced. First, research should focus on characterizing the natural availability of the lithic raw materials represented in the assemblage under study and the regional taphonomic background noise. Second, it needs to identify the local taphonomic agents and processes available at the site today and in the past, paying particular attention to their spatial range (that is to know the local context and its dynamic). Third, it is necessary to undertake naturalistic observations and experimental research using local raw materials. Besides mechanics (Cotterell and Kamminga 1987), several studies have underscored that variations in the physical properties of different lithic raw materials can condition the morphological patterns exhibited by flaked specimens (Goodman 1944; Nash 1993; Amick and Mauldin 1997, McBrearty et al. 1998; Gillespie et al. 2004). Therefore, pseudoartifact evaluation needs to be raw material-specific at some point of the actualistic research. In addition, further studies on rockfall need to assess the variability introduced by bouncing and rolling, the modes of motion taking place on the talus after freefalling (Dorren 2003). Finally, the comparison of local technological patterns against the regional technological background will highlight morphological continuities or discontinuities that may deserve further research (Mason 1965; Borrazzo 2011b).

Overall, actualistic taphonomy research indicates that we need to learn from non-archaeological contexts to get a more comprehensive understanding of the archaeological record.

Acknowledgements I am grateful to Sergio Martínez, Alejandra Rojas, Mariano Verde and Fernanda Cabrera for organizing the first *Workshop on Actualistic Taphonomy in South America* (Montevideo, October 9–11, 2017) and inviting me to participate in this volume. Analía Castro Esnal and Cecilia Perez de Micou directed fieldwork at CP and provided CP photograph. Thanks to María Laura Casanueva, Florencia Ronco, Lucía Gutiérrez, Cecilia Gutiérrez, and Esteban Ali Brouchoud who collaborated in field work. To the Roselló, Solsona, and Pérez del Barrio families for their kind and permanent support to archaeological studies. Luis Alberto Borrero encouraged and made insightful comments throughout all stages of this taphonomic study. This paper was draft as part of a postdoctoral study at Facultad de Filosofía y Letras, Universidad de Buenos Aires, Argentina. This research was funded by the Agencia Nacional de Promoción Científica y Tecnológica [PICT2015-2141 "Estudios de tecnología y tafonomía lítica en el sitio Casa de Piedra (Aldea Beleiro, Sudoeste de Chubut)"] and CONICET (República Argentina).

References

Aimola G, Andrade C, Mota L, Parenti F (2014) Final Pleistocene and Early Holocene at Sitio do Meio, Piauí, Brazil: stratigraphy and comparison with Pedra Furada. J Lithic Stud 1(2):5–24

Álvarez MC, Alunni D (ed) (2017) New perspectives in actualistic taphonomy in Argentina: limitations, contributions, and archaeological implications. J Taph 15(1–3)

Amick DS, Mauldin RP (1997) Effects of raw material on flake breakage patterns. Lithic Technol 22(1):18–32

Andrefsky W (2014) Fingerprinting flake production and damage processes: toward identifying human artifact characteristics. In: Graf K, Waters M, Geobel T (eds) Paleoamerican odyssey. Texas A&M Press, College Station, pp 415–428

Andrews BW, Murtha TM, Scheetz B (2004) Approaching the Hatch Jasper Quarry from a technological perspective: a study of prehistoric stone tool production in Central Pennsylvania. Midcont J Archaeol 29(1):63–101

Aschero C, Faundes Catalán W, Bobillo F (2017) Cacao 1: lithic evidence and mobility ranges during the Pleistocene in the Atacama Puna (Antofagasta de la Sierra, Catamarca, Argentina). In: Alberti J, Borrazzo K, Buscaglia S, Castro Esnal A, Elías A, Franco N (eds) 11th international symposium on knappable materials “From tools tone to stone tools”, Book of abstracts, IMHICIHU-CONICET, Buenos Aires, p 116

Balirán C (2014) Trampling, taphonomy, and experiments with lithic artifacts in the Southeastern Baguales Range (Santa Cruz, Argentina). Intersec Antropol 3:85–95

Barnes A (1939) The differences between natural and human flaking on prehistoric flint implements. Am Anthropol 41(1):99–112

Barton CM, Bernabeu J, Maura JE, García O, La Roca N (2002) Dynamic landscapes, artifact taphonomy and landuse modeling in the Western Mediterranean. Geoarchaeology 17(2):155–190

Behrensmeyer AK, Damuth JD, DiMichele WA, Potts R, Sues H-D (eds) (1992) Terrestrial ecosystems through time. The University of Chicago Press, Chicago

Behrensmeyer AK, Kidwell SM (1985) Taphonomy’s contributions to paleobiology. Paleobiology 11(1):105–119

Behrensmeyer AK, Kidwell SM, Gastaldo RA (2000) Taphonomy and paleobiology. Paleobiology 26(4):103–147

Binford LR (1977) General introduction. In: Binford LR (ed) For theory building in archaeology. Academic Press, New York, pp 1–13

Binford LR (1981) Bones: ancient men and modern myths. Academic Press, New York

Boëda E, Clemente-Conte I, Fontugne M, Lahaye C, Pino M, Daltrini Felice G, Guidon N, Hoeltz S, Lourdeau A, Pagli M, Pessis AM, Viana S, Da Costa A, Douville E (2014) A new Late Pleistocene archaeological sequence in South America: the Vale da Pedra Furada (Piauí, Brazil). Antiquity 88:927–955

Boëda E, Rocca R, Da Costa A, Fontugne M, Hatté C, Clemente-Conte I, Santos JC, Lucas L, Felice G, Lourdeau A, Villagran X, Gluchy M, Ramos MP, Viana S, Lahaye C, Guidon N, Griggo C, Pino M, Pessis A-M, Borges C, Gato B (2016) New data on a Pleistocene archaeological sequence in South America: Toca do Sítio do Meio, Piauí, Brazil. PaleoAmerica 2(4):286–302

Bordes F (1961) Typologie du Paleolithique Ancien et Moyen. Impriméries, Delmas, Bordeaux

Borrazzo K (2006) Tafonomía lítica en dunas: una propuesta para el análisis de los artefactos líticos. Intersec Antropol 7:247–261

Borrazzo K (2011a) Tafonomía lítica en la estepa patagónica: experimentación y registro arqueológico de superficie. In: Borrero LA, Borrazzo K (eds) Bosques, Montañas y cazadores: investigaciones arqueológicas en Patagonia Meridional. CONICET-IMHICIHU, Buenos Aires, pp 127–153

Borrazzo K (2011b) Tafonomía lítica y pseudoartefactos: el caso de la península El Páramo (Tierra del Fuego, Argentina). Intersec Antropol 12:155–167

Borrazzo K (2013) Tafonomía lítica y modelo de la dinámica eololacustre del norte de la bahía San Sebastián (Tierra del Fuego, Argentina). Rev Comechingonia 17(1):149–169

Borrazzo K (2016) Lithic taphonomy in desert environments: contributions from Fuego-Patagonia (Argentina). Quat Int 422:18–29

Borrazzo K, Borrero LA (2015) Taphonomic and archaeological perspectives from Northern Tierra del Fuego, Argentina. Quat Int 373:96–103

Borrazzo K, Weitzel C (eds) (2014) Taphonomic approaches to the archaeological record. Intersec Antropol 15(3)

Borrero LA (2001) Regional taphonomy. Background noise and the integrity of the archaeological record. In: Kuznar LA (ed) Ethnoarchaeology of Andean South America. Contributions to archaeological method and theory. International Monographs in Prehistory, Ann Arbor, pp 243–254

Borrero LA (2011) La función transdisciplinaria de la arqueozoología en el siglo XXI: restos animales y más allá. Antípoda 13:267–274

Borrero LA (2014) Multi-service taphonomy. Shells, garbage and floating palimpsests. Intersec Antropol 15(3):13–20

Borrero LA (2015) Con lo mínimo: los debates sobre el poblamiento de América del Sur. Intersec Antropol 16:5–38

Borrero LA (2016) Ambiguity and debates on the early peopling of South America. https://doi.org/10.1080/20555563.2015.1136498

Breuil H, Lantier R (1965) The men of the old stone age (Palaeolithic and Mesolithic). St. Martin's Press, New York

Carranza ME (2017) Análisis tafonómico de conjuntos líticos de superficie en la costa norte del golfo San Matías (Rio Negro, Argentina). Intersec Antropol 18(1):91–101

Carranza Elola JJ (2015) Tecnología y tafonomía lítica del sitio quebrada Quereo: metodología para abordar conjuntos líticos ambiguos del Pleistoceno tardío en la costa de Los Vilos. Unpublished undergraduate thesis, Universidad de Chile, Santiago

Carranza Elola JJ, Méndez C (2017) Lithic taphonomy at the Quebrada de Quereo site: addressing the problem of anthropogenic ambiguity in Late Pleistocene assemblages. In Alberti J, Borrazzo K, Buscaglia S, Castro Esnal A, Elías A, Franco N (eds) 11th international symposium on knappable materials "From toolstone to stone tools", Book of abstracts, IMHICIHU-CONICET, Buenos Aires, p 199

Castro Esnal A, Pérez de Micou CB, Casanueva ML (2017a) Early Holocene occupation of the forest-steppe ecotone of Southern South America: evidence from Casa de Piedra de Roselló Cave (Chubut, Patagonia Argentina). Paleoamerica. https://doi.org/10.1080/20555563.2017.1330102

Castro Esnal A, Stern C, Pérez de Micou C (2017b) Geochemical studies of archaeological obsidian artifacts from both stratigraphic and surface contexts in Aldea Beleiro Village, SW Chubut (Patagonia, Argentina). Magallania 45(1):123–135

Chlachula J, Le Blanc R (1996) Some artifact-diagnostic criteria of quartzite cobble-tool industries from Alberta. Canadian J Archaeol 20:61–74

Cotterell B, Kamminga J (1987) The formation of flakes. Am Antiq 52(4):675–708

Cruz I (2007) Avian taphonomy: observations at two Magellanic Penguin (Spheniscus magellanicus) breeding colonies and their implications for the fossil record. J Archaeol Sci 34:1252–1261

Demeter F, Edoumba E, Duringer P, Bacon A-M, Sytha P, Bano M, Laychour V, Cheangleng M, Sari V (2010) Reinterpretation of an archaeological pebble culture from the Middle Mekong River Valley, Cambodia. Geoarchaeology 25(1):75–95

Domínguez-Rodrigo M, Fernández-López S, Alcalá L (2011) How can taphonomy be defined in the XXI Century? J Taph 9:1–13

Dorren LK (2003) A review of rockfall mechanics and modeling approaches. Prog Phys Geogr 27(1):69–87

Duvall JG, Venner WT (1979) A statistical analysis of the lithics from the calico site (SBCM 1500A), California. J Field Archaeol 6(4):455–462

Eren MI, Durant A, Neudorf C, Haslam M, Shipton C, Bora J, Korisettar R, Petraglia M (2010) Experimental examination of animal trampling effects on artifact movement in dry and water saturated substrates: a test case from South India. J Archaeol Sci 37:3010–3021

Fariña RA, Tambusso PS, Varela L, Czerwonogora A, Di Giacomo M, Musso M, Bracco R, Gascue A (2014) Arroyo del Vizcaíno, Uruguay: a fossil-rich 30-ka-old megafaunal locality with cut-marked bones. P Roy Soc B (Biol Sci) 281. https://doi.org/10.1098/rspb.2013.2211

Fiedel SJ (2017) Did monkeys make the pre-clovis pebble tools of Northeastern Brazil? PaleoAmerica 3(1):6–12. https://doi.org/10.1080/20555563.2016.1273000

Garvey R, Mena F (2016) Confronting complexities of artifact-geofact debates: re-analysis of a coarse volcanic rock assemblage from Chilean Patagonia. Lithic Technol 41:114–129

Gifford DP (1981) Taphonomy and paleoecology: a critical review of archeology's sister discipline. Adv Archaeol Method Theor 4:365–438

Gifford-Gonzalez D (1989) Ethnographic analogues for interpreting modified bones: some cases from East Africa. In: Bonnichsen R, Sorg M (eds) Bone modification. University of Maine, Institute for Quaternary Studies, Orono, pp 179–246

Gillespie JD, Tupakka S, Cluney C (2004) Distinguishing Between naturally and culturally flaked cobbles: a test case from Alberta, Canada. Geoarchaeology 19(7):615–633

Goodman ME (1944) The physical properties of stone tool materials. Am Antiq 9:415–433

Gutiérrez MA, Miotti L, Barrientos G, Mengoni Goñalons G, Salemme M (2007) Taphonomy and zooarchaeology in Argentina. BAR International Series, Oxford

Haynes CV (1973) The calico site: artifacts or geofacts? Science 181:305–310

Hiscock P (1985) The need for a taphonomic perspective in stone artefact analysis. Queensland Archaeol Res 2:82–95

Hosfield R, Chambers J (2003) Flake modifications during fluvial transportation: three cautionary tales. Lithics 24:57–65

Johnson L, Behm JA, Bordes F, Cahen D, Crabtree DE, Dincauze DF, Hay CA, Hayden B, Hester TR, Katz PR, Knudson R, McManamon FP, Malik SC, Müller-Beck H, Newcomer MH, Paddayya K, Price-Beggerly P, Ranere AJ, Sankalia HD, Sheets PD (1978) A history of flint-knapping experimentation, 1838-1976 [and comments and reply]. Curr Anthropol 19(2):337–372

Kowalewski M (1999) Actuopaleontology: the strength of its limitations. Acta Paleontol Pol 44(4):452–454

Kowalewski M, Labarbera M (2004) Actualistic taphonomy: death, decay, and disintegration in contemporary settings. Palaios 19:423–427

Lahaye C, Hernandez M, Boëda E, Felice GD, Guidon N, Hoeltz S, Lourdeau A, Pagli M, Pessis AM, Rasse M, Viana S (2013) Human occupation in South America by 20,000 BC: the Toca da Tira Peia site, Piauí, Brazil. J Archaeol Sci 40:2840–2847

Lin S, Rezek Z, Dibble H (2017) Experimental design and experimental inference in stone artifact archaeology. J Archaeol Method Theory. https://doi.org/10.1007/s10816-017-9351-1

Lopinot N, Ray J (2007) Trampling experiments in the search for the earliest Americans. Am Antiq 72(4):771–782

Luedtke B (1986) An experiment in natural fracture. Lithic Technol 15(2):55–60

Lyman RL (1984) Broken bones, bone expediency tools and bone pseudotools: lessons from the blast zone around Mount St. Helens, Washington. Am Antiq 49(2):315–333

Lyman RL (1994) Vertebrate taphonomy. Cambridge University Press, Cambridge

Mallol C, Bertran P (eds) (2010) Geoarchaeology and taphonomy. Quat Int 214

Marean C (1995) Of taphonomy and zooarchaeology. Evol Anthropol 4(2):64–72

Mason RJ (1965) Makapansgat limeworks fractured stone objects and natural fracture in Africa. S Afr Archaeol B 20(77):3–16

Massigoge A, González M (ed) (2012) Taphonomic approaches in archaeology: current topics and methods from Southern South America. Quat Int 278

McBrearty S, Bishop L, Plummer T, Dewar R, Conard N (1998) Tools underfoot: human trampling as an agent of lithic artifact edge modification. Am Antiq 63(1):108–122

Méndez Muñoz V (2015) Historias Depositacionales de conjuntos líticos en la Transición Pleistoceno-Holoceno en el Sitio Valiente, Provincia del Choapa. Unpublished undergraduate thesis, Universidad de Chile, Santiago

Nash DT (1993) Distinguishing stone artifacts from naturefacts created by rockfall processes. In Goldberg P, Nash DT, Petraglia MD (eds) Formation processes in archaeological context, Monographs in world prehistory, vol 17. Prehistory Press, Madison, pp 125–138

Parenti F (2015) Old and new on the same site: putting Vale de Pedra Furada into a wider context. A comment on Lahaye et al. 2015. Quat Chronol 30:48–53

Pobiner BL, Brown DR (2005) Applying actualism: considerations for future research. J Taph 3(2):57–65

Prentiss AM, Walsh MJ, Barnett KD, Murphy MM, Kuenstle J (2015) The coarse volcanic rock industry at Rio Ibáñez 6 West, Aisén Region, Patagonian Chile. Lithic Technol 40(2):112–127

Prentiss AM, Barnett KD, Walsh MJ (2016) The coarse volcanic industry at the Río Ibáñez 6 West Site, Chilean Patagonia: assessing geogenic versus anthropogenic processes. Lithic Technol 41(2):130–138

Ritter MDN, De Francesco CG, Erthal F, Hassan GS, Tietze E, Martínez S (2016) Manifesto of the South American School of (Actualistic) Taphonomy. Palaios 31:20–24

Suárez R., Borrero LA, Borrazzo K, Ubilla M, Martínez S, Perea D (2014) Archaeological evidences are still missing: comment on Fariña et al. Arroyo del Vizcaíno Site, Uruguay. P Roy Soc B (Biol Sci) 281:20140449. https://doi.org/10.1098/rspb.2014.0449

Thiébaut C, Coumont M-P, Averbouh A (2010) The taphonomic approach: an archaeological necessity. In Thiébaut C, Coumont M-P, Averbouh A (eds) Mise en commun des approaches en taphonomie. Actes du workshop Nº 16, X Congress International de I’UISPP, pp 21–28

Valin L, Masson B, Caspar JP (2001) Taphonomy at Hermies, France: a mousterian knapping site in a Loessic Context. J Field Archaeol 28(3/4):419–436

Warren SH (1914) The experimental investigation of flint fracture and its application to problems of human implements. J Roy Anthropol Inst Great Britain Ireland 44:412–450

Weitzel C, Borrazzo K, Ceraso A, Balirán C (2014) Trampling fragmentation potential of lithic artifacts: an experimental approach. Intersec Antropol 3:97–110

Wiśniewski A, Badura J, Salamon y, Lewandowski J (2014) The alleged Early Palaeolithic artefacts are in reality geofacts: a revision of the site of Kończyce Wielkie 4 in the Moravian Gate, South Poland. J Archaeol Sci 52:189–203

Yeshurun R, Bar-Oz G, Kaufman D, Weinstein-Evron M (2014) Purpose, permanence, and perception of 14.000-year-old architecture contextual taphonomy of food refuse. Curr Anthropol 55(5):591–618