Journal of Archaeological Method and Theory
https://doi.org/10.1007/s10816-018-9389-8

New Insights into Use-Wear Development in Bodily Ornaments Through the Study of Ethnographic Collections

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Published online: 05 September 2018

Abstract
The use of microwear analysis has made substantial contributions to the study of archaeological bodily ornaments. However, limitations persist with regard to the interpretation of use and the reconstruction of systems of attachment, hampering a holistic understanding of the diversity of past bodily adornment. This is because the complexities of ornament biographies and the resulting wear traces cannot be grasped exclusively from the study of experimental reference collections. In this paper, we propose to bridge this gap in interpretation by systematically researching ethnographic collections. We conducted a microscopic study of 38 composite ornaments from lowland South America housed at the Musée du quai Branly (Paris). These objects involve organic, biomineral, and inorganic components, attached through different string configurations. The combined use of optical and 3D digital microscopy at different magnification ranges provided a thorough understanding of wear trace formation, distribution, and characterization. We demonstrate how individual beads develop characteristic use-wear in relation to one another and to the strings. We further challenge common assumptions made in the analysis of archaeological ornaments. In sum, this research addresses methodological and interpretative issues in the study of bodily adornment at large, by providing insight into the biographies of objects that were actually worn in a lived context. In the future, our results can be applied as reference for a more effective understanding of the use of ornaments worldwide.

Keywords Ornaments · Use-wear · Hard animal materials · Ethnographic collections · Lowland South America · Object biography

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10816-018-9389-8) contains supplementary material, which is available to authorized users.

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Introduction

Bodily adornment is a prevalent feature of human societies, whose richness and variability are attested in both ethnographic and archaeological contexts. Ethnographic sources have shown that ornaments are often associated with symbolic systems, ethnic identity, and personhood (Miller 2009; Roach-Higgins and Eicher 1992; Seeger 1975; Strathern 1979; Turner 1995, 2012; Wiessner 1982). For this reason, ornaments are thought to provide a window into social, cultural, and cognitive aspects of past human societies otherwise elusive in the archaeological record (DiPaolo Loren 2009; Joyce 2005; Kuhn and Stiner 2007; Moro Abadía and Nowell 2015; Newell *et al.* 1990; Vanhaeren and d'Errico 2006; White 1992; White and Beaudry 2009; Wright and Garrard 2003). Great efforts have thus been put into the study of ornament assemblages from a wide variety of contexts and time periods. Microwear analysis forms a key method in assessing the biographies of ornaments, in particular their production and use. Many researchers have carried out experimental programs, replicating techniques, toolkits, and sequences of production (*e.g.*, Álvarez Fernández 2006; d'Errico *et al.* 1993; d'Errico *et al.* 2005; Francis Jr 1982; Gurova *et al.* 2013; Mărgărit *et al.* 2016; Melgar Tísoc 2012; Sax and Ji 2013; Tátá *et al.* 2014; Velázquez-Castro 2012; Vidale 1995; Yerkes 1993). Experiments generally focus on certain variables considered to be relevant in a given study; this control allows the researcher to establish a relation between observed production microtraces and specific variables (Adams 2010; Bamforth 2010; Outram 2008; Reynolds 1999). In its turn, the study of use-wear has offered insight into how individual ornaments integrated composite constructions. However, few studies have addressed the conditions under which this type of wear develops, in spite of the abundance of research dedicated to the observation of use-wear in archaeological ornaments.

Experimental studies focused on the use of beads include both the actualistic wearing of ornaments (Álvarez Fernández 2006; d'Errico 1993a; d'Errico *et al.* 1993; Mărgărit 2016; Minotti 2014; Verschoof 2008) and the (mechanical) replication of use-wear in a clinical setting (Brasser 2015; d'Errico 1993a, b; d'Errico *et al.* 1993; Langley and O'Connor 2016; Rainio and Mannermaa 2014; Vanhaeren *et al.* 2013). On the one hand, actualistic experiments provide a more accurate reference collection, as artifacts are subjected to conditions that are more similar to those of the past: they rest against the human body and may be worn during a range of quotidian activities. On the other hand, a mechanized system is capable of more easily isolating and adding variables, in addition to including longer durations or more intense use. Use duration and intensity are relevant variables to explore, as certain raw materials seem to require different periods of time to develop use-wear of comparable extent (*e.g.*, compare results for 3-month-long use of beads in Mărgărit 2016 and Verschoof 2008; also Álvarez Fernández 2006).

There are, nevertheless, a number of limiting factors in the creation of experimental ornament use-wear reference collections, whether they are actualistic or clinical. First, the differential preservation of raw materials in the archaeological record results in a partial view of past ornament components. A large variety of organic bead and string materials may have been part of a composite ornament but left no evidence in an archaeological site. Second, beads can be integrated in multiple types of ornaments, for instance bracelets, necklaces, anklets, aprons, and earrings. It is generally not possible to know the exact ornament type a studied artifact was part of, although well-preserved burial contexts can provide a wealth of information. This is an issue because the specific attachment system and composition of each ornament type have been shown to affect the distribution of use-wear (Langley and O'Connor 2016; Vanhaeren *et al.* 2013). Third, ornaments can be placed directly against the human skin, which may have paint or oils, or on top of clothing made of a variety of materials. Added substances and contact materials must be taken into account, as they affect the formation of use-wear. Fourth, wearing an ornament cannot be reduced to either a specific task or activity; in other words, it cannot be completed or finished, unless the components fall apart. Furthermore, it is not clear how different activities carried out while wearing an ornament may affect use-wear formation, such as dancing, hunting, fighting, or bathing. In sum, it is nearly impossible to tackle all such variables in experimental programs.

An alternative approach has been the study of composite ornaments belonging to ethnographic museum collections (Cristiani *et al.* 2014; Langley and O'Connor 2015; Wright *et al.* 2016). Thus far, this type of research has been conducted alongside the study of archaeological assemblages and, for this reason, has focused on specific ornament typologies and raw materials. Its main concern has been to provide comparison between ethnographic and archaeological microtraces in the context of specific case studies. Such collections can offer a great variety of use scenarios and provide (potentially highly developed) use-wear formed in a daily or ceremonial context. Differences between ethnographic and experimental collections can be connected to the specific *savoir-faire* involved in object production, length of usage, multiple types of use, storage, cleaning (or lack thereof), maintenance, and other forms of curation of objects over time (Choyke 2006; González-Urquijo *et al.* 2015; Hamon and Le Gall 2013; Stone 2011; Van Gijn 2014a).

In the study of archaeological artifacts, inferences are made concerning the presence or absence of use-wear, the relative degree of usage, and the system of attachment. However, such interpretations often implicitly reduce the lives of ornaments to a linear sequence that proceeds from raw material acquisition to stringing and, eventually, to discard. This assumed linearity dictates how we interpret ornaments to the exclusion of evidence that suggests that ornaments can have complex object biographies (*sensu* Kopytoff 1986), being restrung, repaired, broken apart, hidden away, widely exchanged, or kept as heirlooms over generations (*e.g.*, Chaumeil 2004; Ewart 2012; Lillios 1999; Oliveira 2017; Wiessner 1982). This is because assessing such specific intentionalities and biographies archaeologically is rather challenging. In this sense, the study of ethnographic ornaments may help us challenge commonly held assumptions in the analysis of archaeological artifacts, such as the idea that a necklace is a homogenous construct, in which all components have the same biography (Frieman 2012; Van Gijn 2017; Walker 2009; Woodward 2002). The ornament as a heterogeneous assemblage of components can be connected to the particular agentive capacities that it was expected to hold. Furthermore, any approach to ornaments that aims to focus on their communicative or agentive roles in society has to address the incompleteness of the archaeological record: a presumably complete necklace will be missing essential components. The choice for specific materials may not be related to an intrinsic value; rather, it may be connected to the presentation of such material in a specific composition together with other bead types and raw materials. In this sense, ethnographic composite ornaments can provide a more holistic picture of bodily adornment that should serve as reference for archaeological research—both from a methodological and conceptual standpoint. Their study can aid us in reconceptualizing the biographies of ornaments and the way the use of beads has been regarded in archaeological and anthropological research.

In the present paper, we provide new insights into the formation of use-wear in bodily ornaments. Rather than studying a specific type of ornament, a systematic research of a varied assemblage was carried out. Different ornament types were selected from indigenous South American collections of the Musée du quai Branly - Jacques Chirac in Paris (henceforth, MQB). The goal is to elucidate the relation between use-wear, systems of attachment, and contact materials. First, the present paper will evaluate how microwear research of ethnographic ornaments can be optimally conducted. The challenges involved in the analysis of complex and fragile composite objects must be clearly addressed. Second, the performances of three types of microscopes are evaluated: a stereomicroscope, a metallographic microscope, and a 3D digital microscope. While the first two have traditionally been used in use-wear research, the use of high magnification optical microscopy has been somewhat limited in the study of ornaments, especially of ethnographic ones. Furthermore, we apply for the first time the 3D digital microscope with a rotary head to the microwear study of ornaments and demonstrate how its use aided with handling and observation issues encountered during the study of composite objects. Third, this study characterizes use-wear across different raw materials and ornament types. The evidence will then be contrasted to common assumptions in the study of archaeological ornaments, such as whether specific wear trace distributions can be correlated to certain attachment systems. The study therefore constitutes a reference for future interpretations, providing a window into the biographies of ornaments actually worn in a lived context and into how this use affected their surfaces. It ultimately aims to bring us a step closer to understanding how artifacts retrieved from archaeological sites once composed whole objects that were integrated in the social fabric of past societies.

Material and Methods

Ethnographers and voyagers have often recorded numerous and diverse bodily ornaments among indigenous communities from the lowlands of South America. Depending on the ethnic group, there is great typological and material diversity, further varying according to age group, gender, social position, and other affiliations, such as to clans or moieties (Albisetti and Venturelli 1962; Lévi-Strauss 1936; Ribeiro 1988; Seeger 1975; Turner 1995). Recent anthropological studies have stressed the mythical and social importance of ornaments in the region, as well as their agentive and prophylactic capacities (Chaumeil 2004; Erikson 2001; Lagrou 2013; Ladeira 2007; Miller 2009; Oliveira 2017; Santos-Granero 2009, 2012; Walker 2009). Collaborations between museums, anthropologists, and indigenous communities have provided new information and perspectives on Amerindian collections (*e.g.*, Françozo and Van Broekhoven 2017; Oliveira 2017; Silva and Gordon 2013; Shepard Jr *et al.* 2017; Van Broekhoven 2010). Nevertheless, approaches focused on the analysis of the biographies of ornaments are still missing. This pronounced diversity, combined with the lack of previous studies, led to the choice of lowland South American ornaments as the focus of this study.

More than 12,000 objects from the lowlands of South America make part of the collection of the MQB, encompassing items collected as early as the sixteenth century up to the present day (Delpuech *et al.* 2013). As a result, the collection presents considerable regional and cultural variability, alongside a long and complex history. Among such objects, 38 bodily ornaments were selected for the present study due to their composite nature. Composite ornaments offer a contrast to the disconnected beads commonly recovered in the archaeological record. Most objects were collected between the late nineteenth and twentieth centuries in the context of scientific expeditions. They represent a broad range of ornament types and raw materials. The typological variability allows us to build a rich use-wear reference collection with diverse systems of attachment and bead raw materials. This study brings together objects belonging to 17 ethnic groups, in addition to three objects with unknown provenience. Diverse geographical regions are encompassed, notably Amazonia ($n = 22$), Central Brazil ($n = 6$), and the Gran Chaco ($n = 6$). The most prevalent indigenous communities represented in this study are the Bororo from Central Brazil ($n = 6$), the Guaycurú ($n = 5$) from the Gran Chaco, and the Capanahua from the Peruvian Amazon ($n = 4$).

In general, each composite ornament involves a supporting attachment system, in the form of strings or woven bands, and a range of attached components. Necklaces constitute over 60% of the sample ($n = 23$), whereas ornaments of other types are present in lower numbers: bracelets ($n = 3$), ear ($n = 4$) and nose ($n = 2$) ornaments, a labret ($n = 1$), and a baby sling ($n = 1$). Noncomposite ornaments are additionally included: two labrets (71.1936.48.163 and 71.1884.29.38) and two ear discs (71.1884.29.29.1–2). Such artifacts are generally underrepresented in the archaeological record, being identified only when they present a characteristic morphology. Therefore, the analysis focused on understanding the distribution and characteristics of use-wear on artifacts that were inserted directly into the skin. Glues, dyes, and other residues of unknown origin and functionality are present on 18 objects, in all but two cases added directly to the string.

Whereas the collection of the museum encompasses large numbers of objects made of feathers, plant fibers, wood, and seeds, we gave preference to ornaments with mineral and biomineral beads, pendants, and plaques. These raw materials are comparable to those typically found in the archaeological record. At the same time, material diversity within the same object formed a relevant factor in the sample selection, since it offers insight into the wear traces formed as a result of the interaction between different bead materials during use (bead-on-bead wear). Table 1 provides an overview of the studied ornaments. Mollusk shell components are by far dominant in the selected sample, with a total of 21 objects including them (55.3%). Of this total, eight are objects with only shell components and 11 are composed of shell and a single other material. Animal teeth are present in 23.7% of the objects, most commonly in combination with other materials, such as bone, seeds, and nuts. Similarly, bone components (18.4%) are always accompanied by other raw materials, with the exception of the noncomposite bone labret. Lithic materials are generally poorly represented in ornaments from the lowlands (Ribeiro 1988); here they are present in the form of a quartz and two rock crystal pendants (7.9%). Nuts, seeds, glass, porcelain, and feathers only appear alongside other raw materials. Use-wear on seeds, glass, and porcelain will not be discussed here, even though it was often observed on the studied objects.

Table 1 Studied objects, including inventory number, type, provenience, individual components, and main types of use-wear observed. Taxonomical identifications followed by a * were made on the basis of available literature or information provided by the MQB's database, rather than by specialists. (B) refers to Bivalvia and (G) to Gastropoda

Inventory no.	Object type	Provenience	Components			String material	Use-wear
			Raw materials		Types		
71.1980.61.27	Baby sling	Peru, Ucayali department, Urubamba River, Matsigenga	Teeth	Peccary canines and incisors (*Tayassu* sp.)	Automorphic	Cotton	Rim polish Rim deformation Erasure of manufacture traces/natural patterns Polish on the edges No use-wear on some components
			Bones	Peccary long, squamosal, sphenoid bones (*Tayassu* sp.) Tapir scapula, mandible, basin (*Tapirus* sp.)	Elongated pendants Double-perforated pendant		
			Shell (G)	*Corona incisa* or *C. regalis*	Automorphic		
			Seeds	Indet.	Automorphic		
			Nuts	Indet.	Automorphic		
71.1929.8.292	Bracelet (fragment)	Brazil, Acre State, Capanahua	Shell (B)	Unionoida order	Disc beads	Cotton	Polish on the edges Erasure of manufacture traces/natural patterns Residue Perforation cannot be observed
71.1900.47.14.1	Bracelet	Peru, Ucayali River, Capanahua	Teeth	Monkey canines (*Aotus azarai*)	Automorphic	Cotton	Rim polish Erasure of manufacture traces/natural patterns Polish on the edges Flattening

Table 1 (continued)

Inventory no.	Object type	Provenience	Components: Raw materials		Components: Types	String material	Use-wear
71.1900.47.14.2	Bracelet	Peru, Ucayali River, Capanahua	Teeth	Monkey canines (*Aotus azarai*)	Automorphic	Cotton	Rim polish Erasure of manufacture traces/natural patterns Polish on the edges Flattening
71.1929.8.81	Nose ornament	Brazil, Acre or Amazonas State, Kanamari	Shell (B)	*Anodontites* sp.	Crescent-shaped	Indet. plant	Shell: no use-wear Wood: surface damage Wood: rounding
			Glass		Disc beads		
			Wood	Indet.	Cylindrical stick		
71.1929.8.225	Nose ornament	Brazil, Acre or Amazonas State, Kanamari	Shell (B)	*Anodontites* sp.	Crescent-shaped	Indet. plant	Shell: no use-wear
			Glass	Indet.	Disc beads (glass)		
71.1884.29.38	Labret (noncomposite)	Bolivia, Santa Cruz department, Vallegrande Province, Chiriguano	Wood	Indet.	T-shaped (short)	NA	Surface damage Polish Residue (?)
71.1936.48.150	Labret (noncomposite)	Brazil, Mato Grosso State, Vermelho River, Bororo	Bone	Mammal tibia, jaguar (*Panthera onca*)*	T-shaped (long)	NA	Polish Deformation Erasure of manufacture traces/natural patterns
71.1936.48.163	Labret	Brazil, Mato Grosso State, Vermelho River, Bororo	Shell (B)	Unionidae family	T-shaped mouth piece Double-perforated plaques	Cotton	Surface damage Bead-on-bead wear (damage) Residue
			Feather	Macaw (*Ara chloropterus*)	NA		

Table 1 (continued)

Inventory no.	Object type	Provenience	Components			String material	Use-wear
			Raw materials		Types		
71.1884.29.29	Necklace	Bolivia, Santa Cruz department, Vallegrande Province, Toba (Guaycurú)	Shell (B)	Unionidae family	Double-perforated rectangular pendants	Cotton	Rim polish Rim deformation Flattening Bead-on-bead wear (scratches)
71.1900.47.7	Necklace	Peru, Ucayali River, Capanahua	Shell (G)	*Pomacea* sp.	Drop-shaped pendants	Cotton	Rim polish Rim deformation Polish on the edges Bead-on-bead wear (damage and scratches)
			Nuts	Indet.	Drop-shaped pendants		
71.1900.47.9	Necklace	Peru, Ucayali River, Capanahua	Shell (G)	Indet. gastropod	Drop-shaped beads	Cotton	Rim polish Rim deformation Polishing on the edges Erasure of manufacture traces/natural patterns Bead-on-bead wear (flattening)
			Nuts	Indet.	Drop-shaped beads		
71.1971.30.62	Necklace	Brazil, Amazonas State, Upper Solimões, Tikuna	Nuts	Tucum* (*Astrocaryum* sp.) Inajá* (*Maximiliana martiana*)	Zoomorphic pendants	*cf. Astrocaryum chambira**	Rim polish Rim deformation Rounding of the edges Erasure of manufacture traces/natural patterns Bead-on-bead wear (widening of perforation)
			Seeds	Indet.	Automorphic		

Table 1 (continued)

Inventory no.	Object type	Provenience	Components			String material	Use-wear
			Raw materials		Types		
71.1881.34.75	Necklace	Colombia, Vichada River, Guahibo	Tooth	Caiman (Caimaninae family)	Automorphic	Indet. plant	Rim polish Rim deformation Polish on the edges Erasure of manufacture traces/natural patterns Bead-on-bead wear (microbreakage) Residue
			Rock crystal		Automorphic		
71.1881.34.78	Necklace	Colombia, Vichada River, Guahibo	Rock crystal		Automorphic	Indet. plant	Polish Residue Attachment sector partially concealed
70.2015.8.34	Necklace	Colombia, Amazonas department, Tikuna	Teeth	Peccary canines (*Tayassu* sp.)	Automorphic	Indet. plant (*A. chambir-a*?*)	No use-wear observed
			Bone	Flat bone (frog?)	Elongated pendants		
			Seeds	*Ormosia* sp.* *Coix lacryma-jobi**	Automorphic		
			Nuts	Tucum* (*Astrocaryum* sp.)	Automorphic		

Table 1 (continued)

Inventory no.	Object type	Provenience	Components			String material	Use-wear
			Raw materials		Types		
71.1880.7.14	Necklace	Peru, Amazonas department, Marañón River, unknown ethnonym	Shell (B)	Unionidae family	Drop-shaped pendants	Cotton	Rim polish Rim deformation Polish on the edges Erasure of manufacture traces/natural patterns Bead-on-bead wear (microbreakage and deformation)
			Glass		Disc and spherical beads		
71.1881.34.28	Necklace	French Guiana, Wayana	Shell (G)	*Megalobulimus* sp.	Double-perforated rectangular plaques	Cotton	Rim polish Rim deformation Erasure of manufacture traces/natural patterns Bead-on-bead wear (damage and scratches)
71.1884.29.63	Necklace	Bolivia, Santa Cruz department, Vallegrande Province, Toba (Guaycurú)	Shell (B)	Unionoida order	Disc beads	Indet. plant	Rim polish Rim deformation Erasure of manufacture traces/natural patterns Bead-on-bead wear (scratches)

Table 1 (continued)

Inventory no.	Object type	Provenience	Components			String material	Use-wear
			Raw materials		Types		
71.1884.102.40	Necklace	Chile, Tierra del Fuego, Hoste Island, Yamana	Shell (G)	Margarella violacea	Automorphic	Sinew (whale?*)	Polish Deformation Flattening Bead-on-bead wear (damage)
71.1903.13.20	Necklace	Colombia, Ecuador, or Peru, Amazonia, Shuar/Achuar	Bone	Bird femurs (*Nyctidromus* sp.*)	Cylindrical pendants	Indet. plant	Rim polish Polish on the edges Bead-on-bead wear (deformation, residue) Residue
			Feather	Toucan (Ramphastidae family)	NA		
			Porcelain		Disc and tubular beads		
71.1908.22.1524	Necklace	Ecuador, Shuar/Achuar	Shell (B)	*Mycetopoda* sp.	Crescent-shaped pendants	Indet. plant	Rim polish Erasure of natural patterns Surface damage Perforation cannot be fully observed
			Glass		Disc beads		
71.1929.8.36	Necklace	Brazil, Amazonas State, Juruá River, Kulina	Shell (B)	Unionidae family	Double-perforated rectangular pendants	Monocot plant (*A. chambira*?*)	Rim polish Rim deformation Polish on the edges Erasure of manufacture traces/natural patterns

Table 1 (continued)

Inventory no.	Object type	Provenience	Components			String material	Use-wear
			Raw materials		Types		
71.1929.8.83	Necklace	Brazil, unknown ethnonym	Bone	Bony fish vertebrae	Automorphic	Indet. plant	Rim polish Polish on the edges Erasure of manufacture traces/natural patterns Bead-on-bead wear (flattening, deformation, residue)
			Tooth	Monkey canine (*Cebus* sp.)	Automorphic		
			Porcelain		Disc beads		
71.1939.88.693	Necklace	Brazil, Mato Grosso or Rondônia State, Pimenta Bueno River, Kabisiana	Shell (B)	Unionoida order	Disc bead	Cotton	Rim polish Rim deformation Erasure of manufacture traces/natural patterns Bead-on-bead wear (scratches)
71.1948.76.296	Necklace	Brazil, Tiquié River, Bará	Milky quartz		Cylindrical pendant	*cf. Ananas erectifolius* (Bromeliaceae)*	Rim polish Rim deformation Polish on the edges Erasure of manufacture traces Residue
			Bone	Hawk-eagle talons (*Spizaetus* sp.)	Automorphic		
			Teeth	Peccary canines (*Tayassu* sp.)	Automorphic		
			Seeds	Indet.	Automorphic		

Table 1 (continued)

Inventory no.	Object type	Provenience	Components			String material	Use-wear
			Raw materials		Types		
71.1948.76.297	Necklace	South America, unknown ethnonym	Teeth	Caiman (Caimaninae family) Peccary canine (*Tayassu* sp.)	Automorphic	Indet. plant	Rim polish Polish on the edges Bead-on-bead wear (deformation and scratches) Residue
			Bone	Clavicle (turtle?)	Automorphic		
			Wood	Indet.	Hour-glass shaped beads Elongated pendants		
71.1964.39.42	Necklace	Paraguay, Caazapá department, San Juan Nepomuceno, Arroyo Moroti, Aché (Guayaki)	Teeth	Monkey canines (*Cebus* sp. and *Alouatta cf. caraya*)	Automorphic	*cf. Urera baccifera* (Urticaceae)*	Rim polish Rim deformation Bead-on-bead wear (root deformation) Residue (?)
71.1964.119.23	Necklace	Brazil, Pará State, Zinho River, Kayapó	Shell (B)	Mycetopodidae family	Trapezoid pendants	Cotton	Rim polish Polish on the edges Bead-on-bead wear (damage and scratches)
			Glass		Disc and spherical beads		
71.1971.30.82	Necklace	Brazil, Amazonas State, Upper Solimões River, Tikuna	Bone	Monkey humeri (*Cebus* sp.) Indet. long bones (*cf.* agouti, *Dasyprocta* sp.)	Tubular beads	*cf. A. chambira* (Arecaceae)*	Rim polish Polish on the edges Erasure of manufacture traces Bead-on-bead wear (polish and scratches)
			Seed	Indet.	Automorphic		

Table 1 (continued)

Inventory no.	Object type	Provenience	Components			String material	Use-wear
			Raw materials		Types		
71.1971.43.26	Necklace	Brazil, Mato Grosso State, Upper Xingu River, Mehinaku	Shell (G)	Megalobulimus oblongus	Double-perforated rectangular plaques	Cotton	Perforation cannot be fully observed Rim polish Erasure of manufacture traces/natural patterns
71.1933.72.638	Necklace	Argentina, Formosa Province, Estero Patiño, Guaycurú	Wood	Indet.	Figurative pendant	Wool (indet. animal)	Polish Erasure of manufacture traces Attachment area cannot be directly observed Residue
			Porcelain inlay		Disc bead		
71.1884.29.24.1	Ear ornament (noncomposite)	Bolivia, Santa Cruz department, Vallegrande Province, Toba (Guaycurú)	Wood	Indet.	Disc	NA	Surface damage Erasure of manufacture traces Residue (?)
71.1884.29.24.2	Ear ornament (noncomposite)	Bolivia, Santa Cruz department, Vallegrande Province, Toba (Guaycurú)	Wood	Indet.	Disc	NA	Surface damage Erasure of manufacture traces Residue (?)

Table 1 (continued)

Inventory no.	Object type	Provenience	Components			String material	Use-wear
			Raw materials		Types		
71.1936.48.168.1	Ear ornament	Brazil, Mato Grosso State, Vermelho River, Bororo	Shell (B)	Unionidae family	T-shaped attachment piece Double-perforated rectangular plaques	Cotton	Bead-on-bead wear (damage) Residue
			Feather	Macaw (*Ara macao*) Parrot (*Amazona cf. aestiva*)	NA		
71.1936.48.168.2	Ear ornament	Brazil, Mato Grosso State, Vermelho River, Bororo	Shell (B)	Unionidae family	T-shaped attachment piece Double-perforated rectangular plaques	Cotton	Bead-on-bead wear (damage) Residue
			Feather	Macaw (*Ara macao*)	NA		
71.1936.48.195.1	Ear ornament	Brazil, Mato Grosso State, Vermelho River, Bororo	Shell (B)	Unionidae family	Rectangular plaques with 2–3 perforations	Cotton	Bead-on-bead wear (damage) Residue
			Feather	Macaw (*Ara chloropterus*)	NA		
71.1936.48.195.2	Ear ornament	Brazil, Mato Grosso (state), Vermelho River, Bororo	Shell (B)	Unionidae family	Rectangular plaques with 2–10 perforations	Cotton	Bead-on-bead wear (damage) Residue
			Feather	Macaw (*Ara chloropterus*)	NA		

The taxonomical identification of animal components was based on visual examination and comparison with specimens from the collections of the Muséum National d'Histoire Naturelle (MNHN). The process was particularly easy when the parts (or fragments) were sufficiently large or distinctive to be identified immediately or very quickly according to the morphology, the biometry, or any diagnostic features (certain bones, teeth, shells, feathers, *etc.*). In this case, the identification was based upon external characteristics: pattern of coloration in relation to dimensions (*e.g.*, feathers, shells), visual and touching aspects (odor in some cases), and anatomical features. Anatomical characteristics of bone are considerably different between mammals, birds or reptiles, and fishes. Bone density, thickness, type of porosity, bony structures, and traces of vascular vessels can provide good indications of the animal taxon. Identifications of bony elements were only made when a sufficient number of such traits were available. Generally speaking, the methodology used is the same as for archaeozoological investigations. Regarding dental elements, the same method used for bone artifacts was applied, *i.e.*, the size of the tooth or of the worked part was used to reconstruct the size of the original animal. The shape and general morphology of the tooth was also fundamental, allowing to distinguish a monkey from a carnivore, for example. In relation to the shells, identification was quite easy, given their good state of preservation; the more complete the organic material is, the easier it is to identify them.

In the case of small or highly worked fragments, the first step was to determine what the used part is. From this point, it was possible to estimate the size of the original animal, then to compare the considered fragment with reference collections or literature. Finally, the possible species was selected on the basis of physical criteria mentioned above. It could also be necessary to check the distribution of the identified species in relation to that of the ethnic group considered. Depending on the level of certainty, the identifications were made to the family, genus, or species level. Some fragments remain without precise identification, especially when highly modified. Identifications followed by question mark or by "sp." represent the most reasonable proposition according to observed traits. In this study, only external methods have been used, without any help of molecular analysis. Finally, reference collections are fundamental, as well as prior experience.

State of Preservation

While postdepositional surface modification is not a concern for an ethnographic assemblage, other events during the biography of an object may affect its integrity. Overall, the components of the objects made from different raw materials presented well-preserved surfaces, sometimes covered by original residues or more recent additions. Breakages were noted on 14 objects, being restricted to few components. In contrast, the strings often presented pronounced use-wear, leading to the shedding of fibers and breakage. Most studied ethnographic ornaments have a long postcollection biography, during which they belonged to three different museums: the Musée d'Ethnographie du Trocadéro, the Musée de l'Homme, and, lastly, the Musée du quai Branly (Delpuech and Roux 2015; Delpuech *et al.* 2013; Grognet 2005). As demonstrated elsewhere (Falci *et al.* 2017a; also Breukel *et al.*, in prep.), modifications to the surface of artifacts carried out in museum contexts must be acknowledged, as they can affect microwear analysis. The change from one museum to the others resulted in the addition of successive glued identification tags and ink markings with varnish. Glued tags and ink markings coexist on nine specimens, while only ink with varnish is found on another 13 objects. They are placed directly on top of individual components, partially concealing their surface. Furthermore, the removal of identification tags, carried out at some point along their museum biography, also left macro- or microscopic traces of glue, which can mislead the interpretation of microwear (Fig. 1b–d). It was possible to note that new complementary strings were added to six objects prior to collection as a means of repairing them. The new strings could be identified on the basis of differential raw material or relative degree of wear. The wear displayed by the strings, the complex modes of attachment, and the presence of residues confirm that the objects have not been restrung after arrival at the museum.

Objects can present considerable dirt on their surfaces, such as dust, stains, sediment, and handling grease. Therefore, the cleaning of artifacts prior to analysis plays an important role in microwear studies, as a means of preventing the misinterpretation of traces. For instance, at low magnification, handling grease can be mistaken for the presence of use polish and rounding. At high magnification, it conceals the surface's microtopography (Fig. 1a). Depending on the raw material, cleaning can be carried out with different products, such as water and soap, alcohol, acetone, or other chemical solutions (*e.g.*, HCl, KOH, and H_2O_2) (Evans and Donahue 2005; Macdonald and Evans 2014; Van Gijn 1990, 2014a). An ultrasonic bath can also be used in combination with these products. However, such types of thorough cleaning were considered to be potentially damaging to the studied objects, as they often involve organic and fragile components. For the present research, only individual components were cleaned, making use of ethanol, carefully applied with cotton buds. Areas with original residues

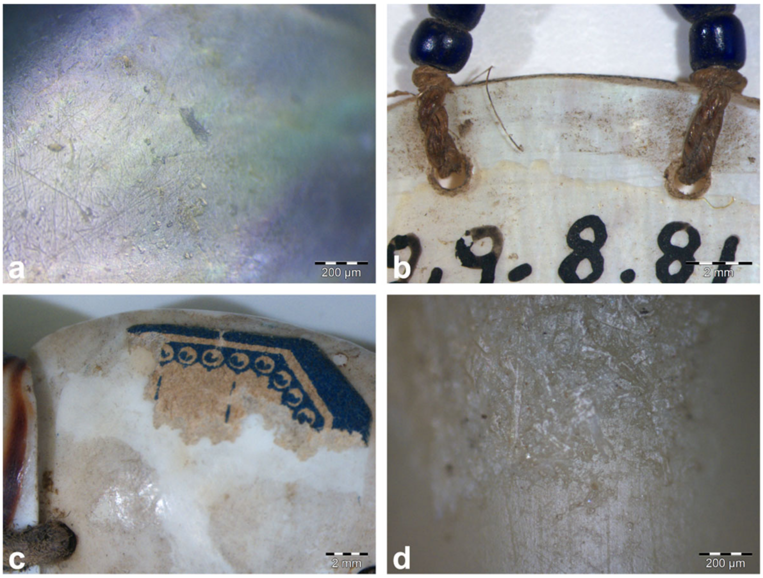

Fig. 1 Postcollection modifications on individual components of the studied objects, including handling grease (**a**), ink marking with varnish (**b**), and remains of glued identification tags, directly visible (**c**) and only observable with high magnification (**d**). MQB inventory numbers: 71.1884.102.40 (**a**), 71.1929.8.81 (**b**), 71.1881.34.28 (**c**), and 71.1936.48.150 (**d**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

were avoided during cleaning. Excessive postcollection handling may lead to the formation of wear traces on the studied objects, which can be confused with original use-wear. However, this problem could be ruled out on the basis of two factors: (1) the individual components in composite pieces are not often handled due to their fragile attachments, and (2) original use-wear has a distinctive distribution, being often located only on certain sectors of the individual components, rather than on their entire surfaces.

Methods of Analysis

The present study was conducted at the Atelier de Conservation et Restauration of the MQB. The microwear analysis of objects involved the combined use of low- and high-magnification microscopes. In the first stage of analysis, an Olympus SZX7 stereomicroscope was used, with magnifications of 8–56. We identified traces and residues on ornaments, recording their location, association to each other, and characteristics. This could be done relatively fast and comprised the observation of all components in a given object (*i.e.*, all the beads in a necklace). In the second stage, an Olympus BX51 microscope was used with incident light and magnifications of 40–200. It allowed for the observation and analysis of the surface's microtopography and polish, which can be diagnostic of materials an artifact has been in contact with. This stage of analysis was time-consuming; thus, it was restricted to two to four components depending of the object. Through the combination of the two magnification ranges, the observed traces could be better contextualized and interpreted. The main goal was to record all microwear on the objects, including the technology (techniques, toolkits, and production sequence), use-wear (characteristics and distribution), residue, and preservation of individual components.

In the present paper, we will focus exclusively on use-wear. Traces recorded on individual components include polish, rounding, deformation, smoothing of manufacture traces and natural patterns, flattening, surface damage, microbreakages, and scratches. Such features were further characterized by their location in relation to the attachment and to other components, brightness, presence of fine striations, distribution, directionality, and invasiveness. The latter was assessed by the degree to which the use polish entered the interstices of used sectors, in comparison to the surrounding surface. Intensity of use could be qualitatively assessed by evaluating to what extent natural and man-made surface features appear rounded, erased, or deformed. Wear traces were recorded on different analysis forms: a general form for low magnification analysis of an object and supplementary forms for each individual component analyzed with high magnification. Figure 2 summarizes the terminology used to describe the location of use-wear on individual components.

Microwear analysis has been applied to artifacts made of minerals, stone, bone, shell, and wood, thus proving its suitability for their study (*e.g.*, Buc 2011; Caruso Fermé *et al.* 2015; Cuenca-Solana *et al.* 2017; Dubreuil and Savage 2014; Kononenko *et al.* 2010; Lammers-Keijsers 2007; Lavier *et al.* 2009; Ollé *et al.* 2016; Sidéra and Legrand 2006; Van Gijn 1990, 2005, 2006, 2014a, 2014b). To our knowledge, it has not been previously applied to artifacts made of nut (palm endocarps); here, we evaluate which information can be gained by their study, in comparison to more commonly researched raw materials. The interpretation of microwear as correlated to

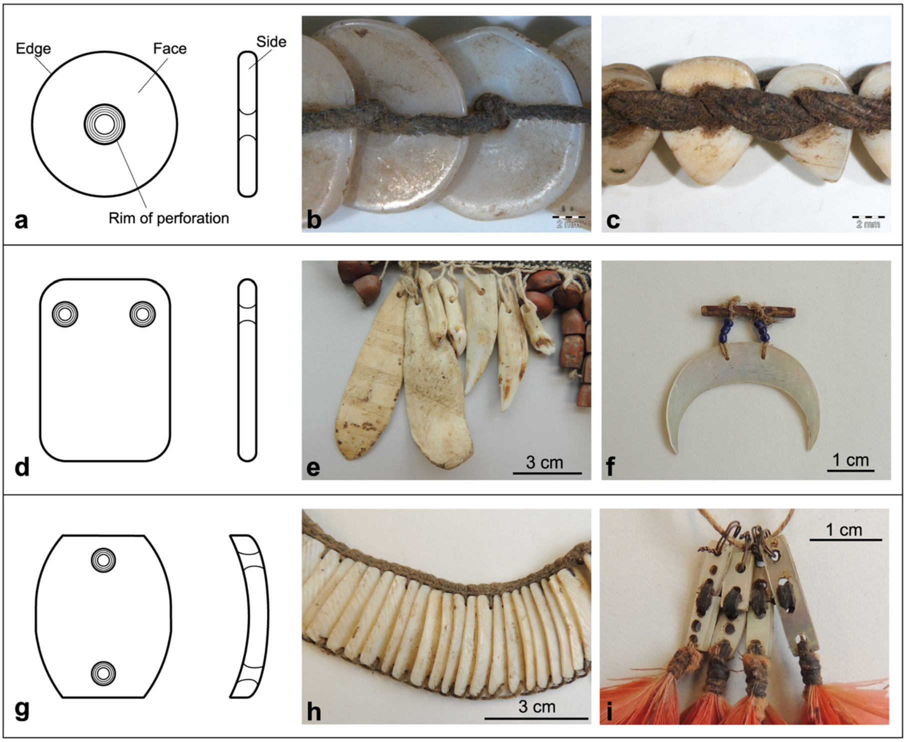

Fig. 2 Terminology used to describe individual components and use-wear distribution on them: beads (**a**–**c**), pendants (**d**–**f**), and plaques (**g**–**i**). Note that perforation position and number in relation to the general shape of a component is used as diagnostic of type. MQB inventory numbers: 71.1939.88.693 (**b**), 71.1900.47.9 (**c**), 71.1980.61.27 (**e**), 71.1929.8.81 (**f**), 71.1971.43.126 (**h**), and 71.1936.48.195.1 (**i**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

specific activities was based on previous studies, especially on those focused on the replication of ornament use-wear. There are, however, important differences between ethnographic objects and archaeological artifacts: ethnographic ornaments are often large, composite, and fragile. In addition, they have many individually connected parts, being therefore difficult to carefully handle and to stabilize under a microscope. This contrasts to the archaeological ornaments, which are often small single items that can be easily fixed on a regular microscope plate. As a consequence, it was necessary to modify the protocol, which was originally designed for the study of archaeological specimens. A similar issue has been previously noted by Kononenko *et al.* (2010), leading them to use a Dino-Lite USB digital microscope for low-magnification analysis. Here, the stereomicroscope was adapted to a free arm, thus allowing the microscope's height to be changed according to each studied object. Conversely, the metallographic microscope had a short working distance, preventing the analysis of certain objects (*e.g.*, 71.1964.39.42 and 71.1884.29.24.1–2). Furthermore, stabilizing individual beads or pendants under the microscope's incident light at a 90° angle also proved to be difficult, as they were still attached to each other in a composition. Another limitation to analysis was that use-wear is predominantly located under the strings of attachment. As these strings cannot be removed, the analysis often had to focus on partially broken or loosely attached components. Despite the limitations, the use of high magnification proved to be important, as it provides direct visualization of the microtopography and state of preservation of a surface. This was central in (1) verifying the traces observed with lower magnifications; (2) differentiating between handling grease and use polish; (3) recognizing natural patterns, damage, striations, and glue remains; and (4) characterizing use-wear according to different contact materials.

A third microscope was used in order to tackle some of the noted limitations and to evaluate its general usefulness for use-wear analysis: a 3D digital microscope (HIROX KH-8700) with magnifications of 20–160 and a Rotary-Head adapter (HIROX AD-2016RLM). The adapter includes a rotating prism that allows 360° view of an object. This mechanism made the observation of difficult-to-reach areas possible, without the constant manipulation of the objects. In addition, it provided views of a given feature from different angles in relation to the light source and a better understanding of the shape and characteristics of the observed traces. The 360° view could also be made into videos that provided an invaluable 3D recording of the characteristics and distribution of traces (see Videos 1–6). All components in each object were analyzed with this microscope. This model does not replace the metallographic microscope, as its light configuration (dark field vertical lighting) and image quality prevent the observation of microtopographical features of wear polishes. At the same time, it provided superior magnifications in comparison to the stereomicroscope, thus allowing for better observation and descriptions of microtraces. The data provided by each microscope proved to be complementary, leading us to rely on the combined use of the three models for the study of this collection (Fig. 3).

Use-Wear Patterns Across Materials

In the following, we discuss use-wear patterns according to the raw material of the individual components, as the properties of each have been shown to influence wear formation. The data will be further organized according to use-wear types and how these relate to both attachment system and composition of each object (*i.e.*, the neighboring beads and string material). The observed use-wear types develop in connection to one another and will only be divided here in order to highlight how, where, and in which conditions they occur. Finally, the challenges faced during analysis and their implications for interpretation are also discussed.

Shell

Mollusk shell is probably the material category that has received the greatest attention in ornament use-wear studies (*e.g.*, Bonnardin 2008, 2012; Breukel 2018; d'Errico *et al.* 1993; d'Errico *et al.* 2005; Falci *et al.* 2017a, b; Lammers-Keijsers 2007; Mărgărit *et al.* 2016; Taborin 1993; Vanhaeren *et al.* 2013). Abundant studies have recorded use-wear patterns on automorphic shell ornaments, that is, on shells that underwent only minor technological modifications before being integrated into a composite ornament. Xenomorphic shell beads and pendants have received comparatively minor attention, in particular complex figurative carvings (Falci *et al.* 2017a). The sample studied here is primarily composed of shell beads, pendants, and plaques, encompassing freshwater,

Fig. 3 Compared microscope performance in use-wear observation: stereomicroscope (**b**), metallographic microscope (**c**), and 3D digital microscope (**d**–**f**); **b**–**d** illustrate the same perforation on a freshwater bivalve pendant, while **e**–**f** show opposing sides of another perforation. All images (**a**–**f**) taken from the same necklace. MQB inventory number: 71.1929.8.36. ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

land, and marine specimens. Mollusks present different layers, with different microstructural arrangements. The microstructure varies according to shell taxa and has an impact on the shell's working properties and wear development (Claassen 1998; Cuenca-Solana *et al.* 2017; Debruyne 2014; Szabó 2008).

Freshwater Bivalves

The majority of shell species were identified as freshwater bivalves ($n = 15$; 71.4%); however, most specimens cannot be attributed to a species or genus. Most pendants and plaques can be described as nearly flat shell fragments, with at least one nacreous face. In addition, many specimens present a natural dark layer (periostracum), which has been partially ground off. There is considerable variability in attachment systems in the sample, with only two necklaces (71.1884.29.63 and 71.1939.88.693) having beads attached in a similar way (Fig. 4j, g).

Seven shell objects present clear evidence of having been worn as bodily adornment, identified by the combination of multiple use-wear types present on their components. The first use-wear type, observed on 10 objects, was the formation of polish and rounding on the rim of the perforations from which the artifacts are suspended (Figs. 4b, i, l and 5h, i). Such traces tend to develop directly under the string. The sectors of the hole that are not in constant contact with the string still display fresh drilling traces and a ragged aspect (Fig. 3). In four objects, string contact additionally led to the deformation of the rim. This can be characterized as the formation of a depression adjacent to the perforation rim in a specific direction (a "notch," see Fig. 4k) or the general widening of the hole. The shape of the pendants and the positioning of the hole may also be connected to the presence of rim deformation, as they may cause greater string tension (*e.g.*, 71.1880.7.14) (Fig. 4a–d). The characteristics of the deformation can also vary on different faces of a same component, as observed on two disc bead necklaces (71.1884.29.63 and 71.1939.88.693) (Fig. 4g–l; Video 1). On one face of the beads, notches with specific directionality were formed following the string position; on the other face, a general widening of the rim occurred, due to the presence of two thick strings. On another necklace (71.1884.29.29) (Fig. 5a–c), slight notches are seen on one face, while only flattening on the other. The notches on the nacreous face are caused by direct contact with the string, while the flattening on the back of the pendants is connected to the presence of a woven cotton band (Fig. 5d–f). In this face, the rims are still fresh because the string is not in direct contact with the rim, but the surrounding surface is flattened and whitened due to the placement of the band.

Polish formation and rounding also occurred on the sides and edges of eight ornaments. On a macroscale, it can be characterized by the smoothening of manufacture traces, sharp edges, breakages, and microremovals. With high magnification, it can be recognized as a bright, invasive, and smooth polish developing on top of previous traces, accompanied by fine and multidirectional scratches. It is likely the result of contact between the ornaments and the human body during use. The partial or complete erasure of natural shell patterns and manufacture traces was observed on eight objects. It occurred on different areas of the ornaments, especially in and around the rim of perforation (Fig. 4c, f). Depending on the extent of wear, the erasure of traces may also happen on the faces and sides of ornaments that are in contact with the human body. On the Bororo labret (71.1936.48.163) (Fig. 6a–c), there is extensive damage on the exterior face of the top plaque, which has a T-shape and would be inserted in the lower lip of the wearer. Damage is only seen on the top two plaques of the labret, probably resulting from the constant contact with saliva in the case of the top plaque and with the chin of the wearer, in the case of the second plaque (Fig. 6e). The other plaques in the composition do not present clear use-wear. The contact between individual components on six objects during use has created "bead-on-bead wear." Observed features include (1) microbreakage and deformation created by friction between the shell pendants and beads of a harder material, such as glass (71.1880.7.14, Fig. 4e, f; Video 2); (2) flattening, scratches, and the erasure of features on the backs of the components due to their partial superposition (71.1964.119.23, 71.1884.29.29, and 71.1939.88.693, Fig. 5j–l); and (3) damage to the ends of the Bororo plaques that are tightly attached to each other (71.1936.48.163, Fig. 6f).

Fig. 4 Use-wear types on ornaments with freshwater bivalve components. MQB inventory numbers: 71.1880.7.14 (**a**–**f**), 71.1939.88.693 (**g**–**i**), and 71.1884.29.63 (**j**–**l**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

No clear use-wear was observed on the Bororo earrings (71.1936.48.168.1–2 and 71.1936.48.195.1–2) (Fig. 6g–l) and on the Kanamari nose ornaments (71.1929.8.81 and 71.1929.8.225) (Fig. 2f). These objects are composite ornaments that were inserted directly into the skin through the use of perishable attachment components. In the case of the nose ornaments, wooden sticks perform this function; for the Bororo earrings, attachment strings would have been used, but they are missing. The Bororo plaques appear unused, with well-preserved periostracum and production traces (Fig. 6h, l). However, it must be highlighted that, during use, the shell components would not necessarily be in constant contact with the wearer's skin, limiting the formation of wear traces even in used specimens.

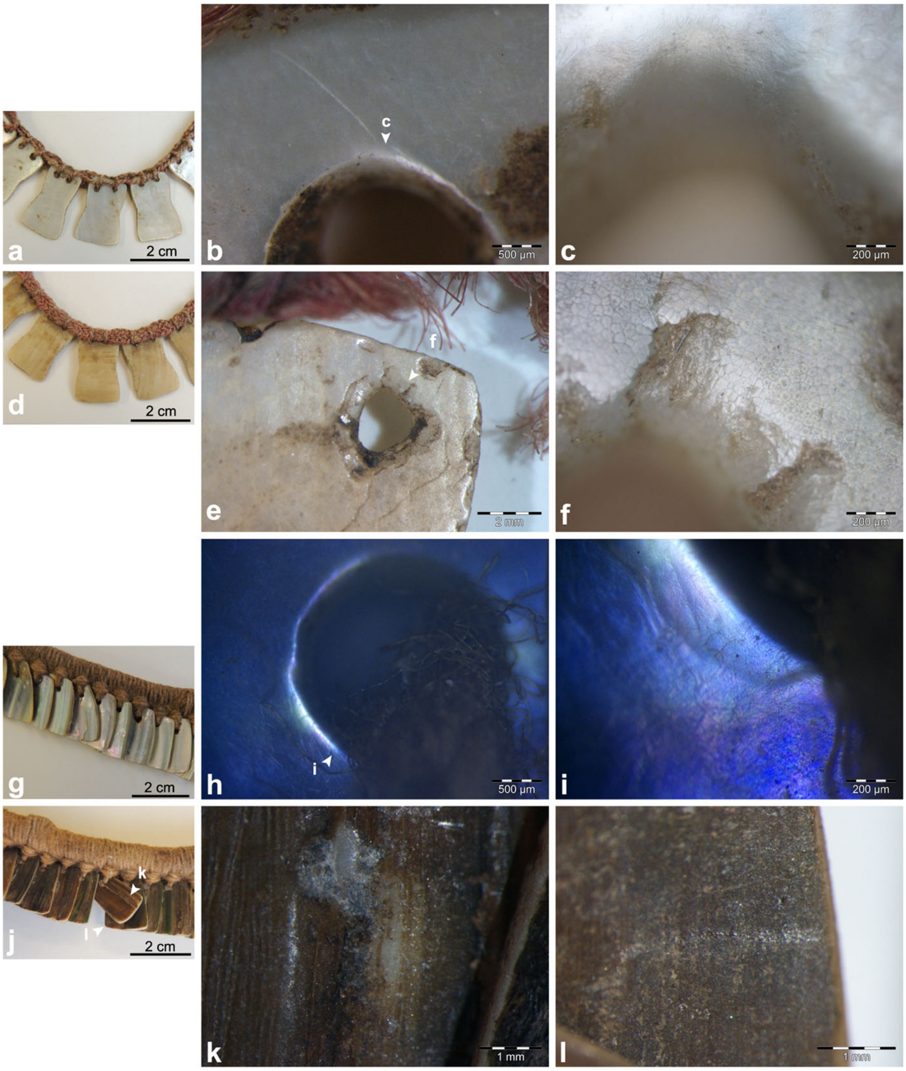

Fig. 5 Use-wear types and on ornaments with freshwater bivalve components. MQB inventory numbers: 71.1884.29.29 (**a**–**f**) and 71.1964.119.23 (**g**–**l**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

Gastropods

Terrestrial, freshwater, and marine gastropods are represented in the studied collection. Rounding and polish on the perforation rim were observed on five objects (83.3%), although observation was limited on some specimens. For instance, the tight string attachment on the top perforation of the Mehinaku plaques (71.1971.43.126) limited the observation of use-wear (Fig. 2h). In contrast, the attachment of the lower perforation is relatively loose, resulting in less pronounced use-wear development. In the Yamana necklace (71.1884.102.40) (Fig. 7a–c), the string is connected to a relatively thin "bridge" of shell in between the lip and the perforation, thus rendering it fragile and

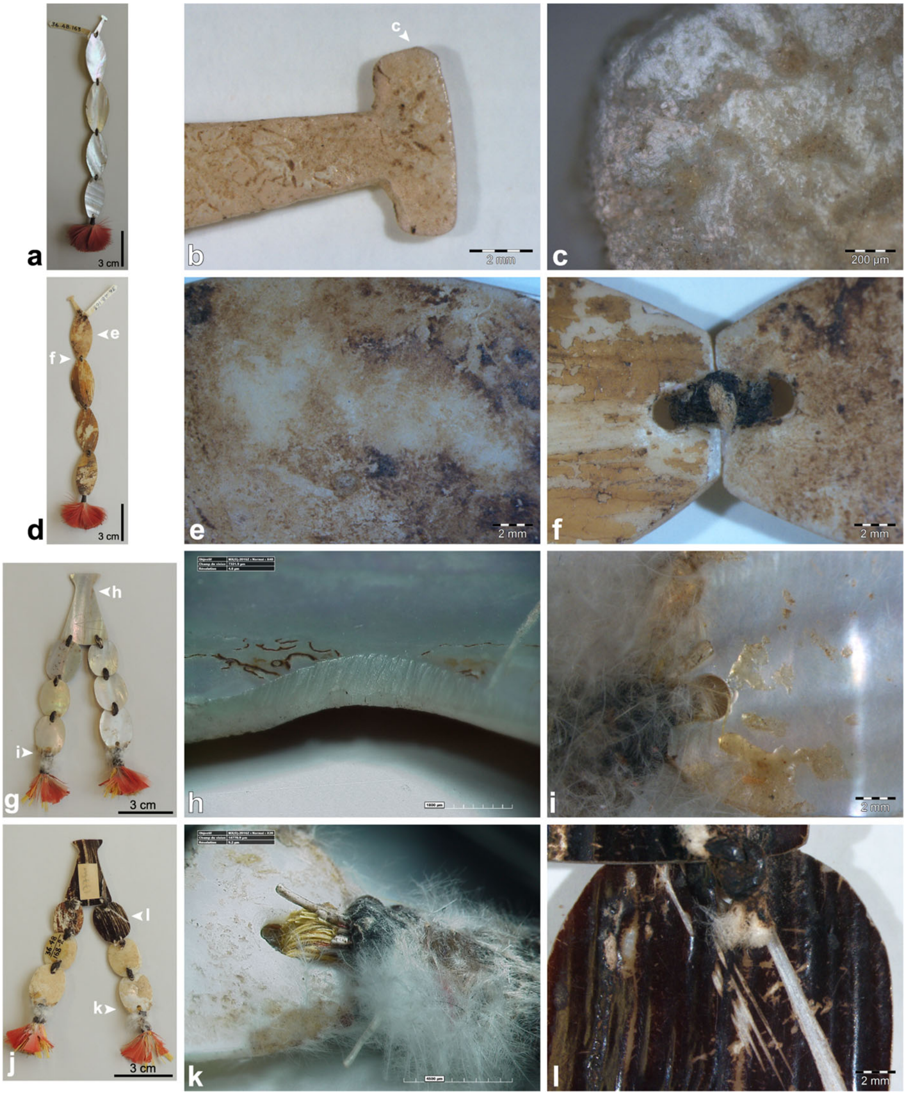

Fig. 6 Use-wear types on ornaments with freshwater bivalve components. MQB inventory numbers: 71.1936.48.163 (**a**–**f**) and 71.1936.48.168.2 (**g**–**l**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

difficult to handle. Rounding and polish are present exclusively on the parts in contact with the braided sinew. These areas are also greasy, flattened, and display microdamage as a result of permanent contact with the sinew.

Rim deformation was observed on four necklaces. Notches are seen on the perforation rim of the Wayana plaques (71.1881.34.28) (Fig. 7d, g), being more pronounced on their back than on the front. This is because only one string is passing between the holes of neighboring plaques in the front (Fig. 7d–f), while two strings are passing on the back (Fig. 7g–i). Rim deformation is also very pronounced on the Capanahua necklaces: on the beads (71.1900.47.9) (Fig. 8a–c), the presence of two strings attached in different

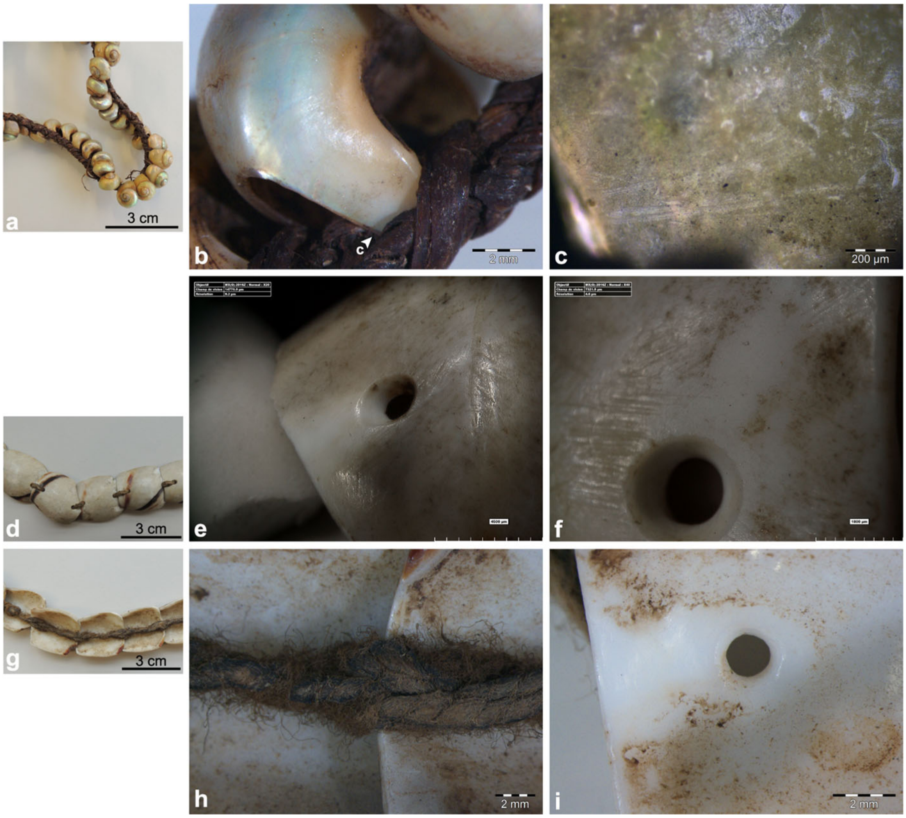

Fig. 7 Use-wear types on ornaments with gastropod shell components. MQB inventory numbers: 71.1884.102.40 (**a**–**c**) and 71.1881.34.28 (**d**–**i**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

directions resulted in the general widening of the perforations, creating at the same time side notches. This is also accompanied by the rounding of the material that remains under the strings. The attachment of the *Pomacea* sp. necklace (71.1900.47.7) is relatively loose, which means that the pendants can move more freely (Fig. 8d–g; Video 3). Despite this, the perforation rim presents side notches on most specimens. The presence and orientation of the notches are, however, not as regular and predictable as on the other ornaments. They can be present on both sides of the rim and on both faces of a pendant or only on one side or face. This variability in the placement of the notches could not be related to the specific position of a given pendant on the necklace; it may therefore be also related to other parameters that are not easily controllable, such as the size of each pendant and the specific shell layers used in its production. Such parameters vary considerably in this necklace, especially pendant length and thickness.

Manufacture traces and natural patterns were partially erased on five objects, in particular, on the areas adjacent to the strings on the shell plaques (71.1881.34.28 and 71.1971.43.126) (Figs. 2h and 7d–f). All specimens present edge rounding and polish. Short and bright fine scratches can be observed associated with polish on the edges and

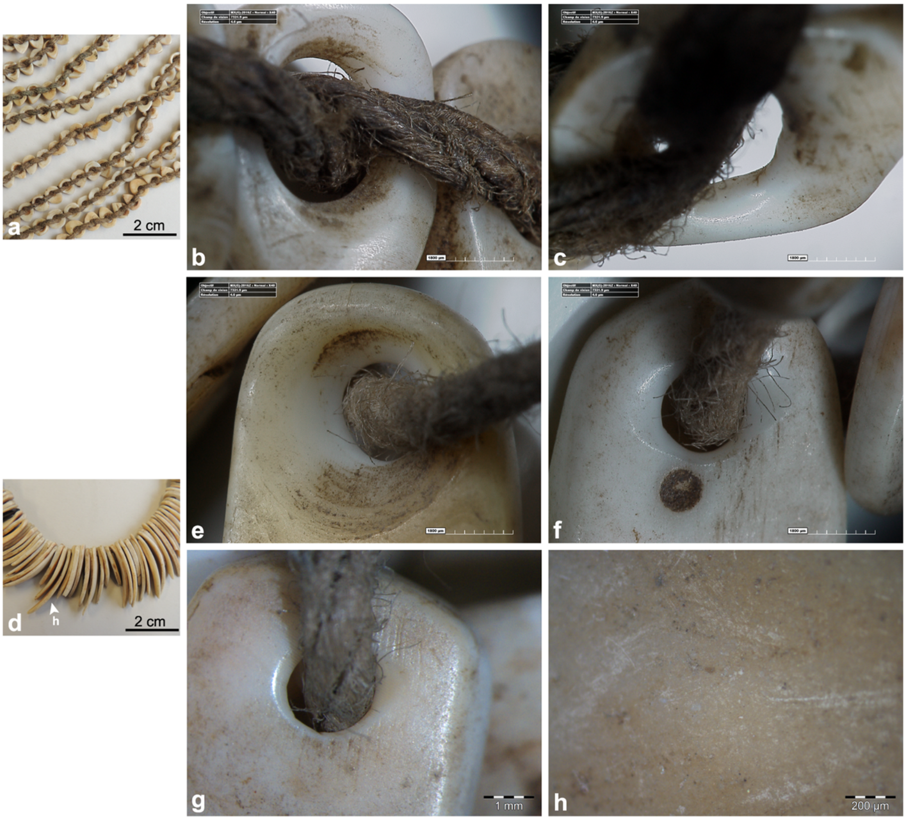

Fig. 8 Use-wear types on ornaments with gastropod shell components. MQB inventory numbers: 71.1900.47.9 (**a**–**c**) and 71.1900.47.7 (**d**–**h**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

on the perforation rim of all specimens. Bright and randomly distributed scratches are observed on the *Pomacea* sp. pendants (71.1900.47.7) (Fig. 8h), on top of a surface that appears damaged with high magnification. The combined presence of the traces on the center of the pendants, where they are in contact with each other, suggests that such features are caused by bead-on-bead wear. The beads on the other Capanahua necklace (71.1900.47.9) (Fig. 8b, c) present slightly flattened sides due to the placement of beads side by side in the same string loop. On the Wayana necklace (71.1881.34.28) (Fig. 7f), bead-on-bead wear is recognizable on the areas where each plaque is partially placed on top of another one. This area of contact presents a damaged shell layer, thus being whiter, scratched, and lacking grinding traces. With high magnification, the damaged sectors can be clearly differentiated from the used areas adjacent to the perforation, which are greasier, brighter, and present a characteristic use polish. Finally, the shells of the Yamana necklace (71.1884.102.40) (Fig. 7a) are in constant contact, as the top of the body whorl of one specimen touches the lower part of the whorl of the next one. The resulting wear can be characterized by the formation of a white abraded patch on the area of contact.

Osseous Materials

Ornaments made of bones and teeth have also been the focus of considerable use-wear research (*e.g.*, Cristiani and Borić 2012; d'Errico 1993a; Mărgărit *et al.* 2016; Poulmarc'h *et al.* 2016; Radovčić *et al.* 2015; Rigaud *et al.* 2014; Vanhaeren and d'Errico 2003; Winnicka 2016; Wright *et al.* 2016). Both raw materials are relatively soft and develop diagnostic microtraces fairly quickly (Van Gijn 2005); this also means that postdepositional and curation traces may form quite easily, in particular those related to handling, storage, and cleaning (d'Errico 1993a; Graziano 2015). In total, 11 objects present components made of osseous materials, including teeth, bones, and hawk-eagle talons. In most cases, bone ornaments were produced through the removal of a blank from a long or flat bone, which subsequently went through several shaping and abrasive production stages. In contrast, the natural morphology was preserved on the teeth ornaments, as they were only removed from a mandible and perforated. The exceptions are the vertebrae beads, which did not require extensive modification, and some teeth ornaments that were ground, sawn, and/or decorated by incising and drilling.

Teeth

The teeth of five different animal species were used for nine objects, with peccary (*Tayassu* sp.) canines being the most common. Monkey teeth are also quite common, notably 86 incisors of *Aotus azarai* in two bracelets (71.1990.47.14.1–2) and *ca.* 900 canine teeth of *Cebus* sp. and *Alouatta cf. caraya* monkeys in a single necklace (71.1964.39.42). The attachment systems of three objects limited use-wear observation (71.1948.76.297 and 71.1900.47.14.1–2), whereas the teeth on two objects did not present use-wear (71.1980.61.27 and 70.2015.8.34).

Use-wear was observed on the teeth of seven objects, in particular as rim polish and rounding, accompanied by a general greasy aspect. This appearance is probably a result of contact with the human body, as rounding and polish on the edges are also recurrently present. The erasing of manufacture traces was also common, often in the form of partial elimination of drilling traces. In addition, decorative perforations and cut marks on the large caiman tooth (71.1881.34.28) have also been smoothened by use (Fig. 14d–f). Deformation of the rim is, once again, a less predominant use-wear type, only present in connection with specific attachment systems. Notches were formed on top of the perforations of the hanging peccary canines that make part of the Bará necklace (71.1948.76.296, Fig. 9c, d). Large worn down circular depressions are present around the perforations on the teeth of an unprovenienced necklace (71.1948.76.297) (Fig. 9e–g). This deformation is produced by contact with wooden beads that are tightly placed next to the teeth. With high magnification, fine, short, and bright scratches are visible in the polish of the area, distributed in multiple directions. In another necklace (71.1929.8.83) (Fig. 10f, g), the tooth is in contact with a knot made with the string, which led to the formation of a concavity around the tooth's perforation. This feature is only seen on the face that is in contact with the knot, but not on the other face. The other face is in contact with a vertebra bead and appears slightly flattened, presenting scratches (Fig. 10h). The perforation on the caiman tooth (71.1881.34.28) is also deformed due to the presence of two thick strings. In the Aché necklace

Fig. 9 Use-wear types on ornaments with teeth components. MQB inventory numbers: 71.1964.39.42 (**a**–**e**) and 71.1929.8.83 (**f**–**h**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

(71.1964.39.42) (Fig. 10a), the perforations of the teeth were widened by contact with the nettle string. The teeth are tightly attached to each other, so that each tooth is in an angle in relation to the next one. The contact between the teeth led to deformation and flattening of their roots (Fig. 10a–c; Video 4). The deformation of the roots is, in this case, a product of bead-on-bead wear. In contrast, the teeth located closer to the end knot of the necklace are more loosely attached. In these specimens, the perforation is facetted and ragged, being clearly less worn (Fig. 10d, e).

Bone

Seven of the studied ornaments included bones of at least 10 different animal taxa, with mammals, fishes, and birds identified with certainty (Table 1). Use-wear was observed on the bones integrating all but two objects (70.2015.8.34 and 71.1948.76.296). Rim rounding and polish, alongside the erasure of drilling traces, were the most common use-wear types (Figs. 11 and 12). Smoothening of cut marks on the faces of tubular beads was observed on a Tikuna necklace (71.1971.30.82, Fig. 11a, b). On the Matsigenga baby sling (71.1980.61.27) (Fig. 13), use-wear is observed on only three out of six bone artifacts, where it is accompanied by the erasure of drilling traces and smoothening of incised designs. The extension of the use-wear also varies between the worn pendants (Fig. 13, compare d, g, i, and k). Rim deformation is only seen in a double-perforated pendant integrating the baby sling, but the direction of the deformed notches does not match the present attachment system (Fig. 13j–l). This suggests that the pendant had been previously used and that it was attached to this baby sling in a different position. A Bororo labret (71.1936.48.150) (Fig. 12d) is the only noncomposite and nonperforated bone object. It appears very rounded and with well-developed polish. The T-shaped attachment sector, which would have been inserted in the lower lip, is partially deformed, due to the extreme rounding of its edges (Fig. 12e, f). This is accompanied by a characteristic smooth, invasive, and scratched polish that superposes production traces. The latter can only be observed with high magnification (Fig. 12g, h), as the advanced degree of use-wear development has made the grinding traces invisible at low magnification.

On the Jivaro necklace (71.1903.13.20) (Fig. 11f), worn down circular patches are present on the areas of contact between the bones and the porcelain beads. While grinding traces can be recognized, suggesting that the concavities were created during manufacture, they have been smoothened and expanded by bead-on-bead wear. This contact also produced a bright and poorly linked polish, associated with a black residue (Fig. 11f–h; Video 5). Bead-on-bead wear also seems to be the main mechanism behind the formation of use-wear on two other necklaces. In the Tikuna necklace (71.1971.30.82) (Fig. 11a), the contact between the ends of the bone tubes produced a smooth surface, with use-wear only visible on the rim of perforation. With high magnification, the polish seems to cover most of the surface, but it is flat and restricted to the tops (Fig. 11e). In contrast, the contact with a seed bead created a more rounded aspect on the end of the bones (Fig. 11d). With high magnification, this polish is bright and invasive, displaying long scratches in multiple directions. In the vertebrae necklace (71.1929.8.83) (Fig. 12a), use-wear is recognizable on the vertebrae faces, which have become bright and slightly flattened due to bead-on-bead wear. The drilling traces have been partially smoothened on the walls of perforation and, on the specimens in contact

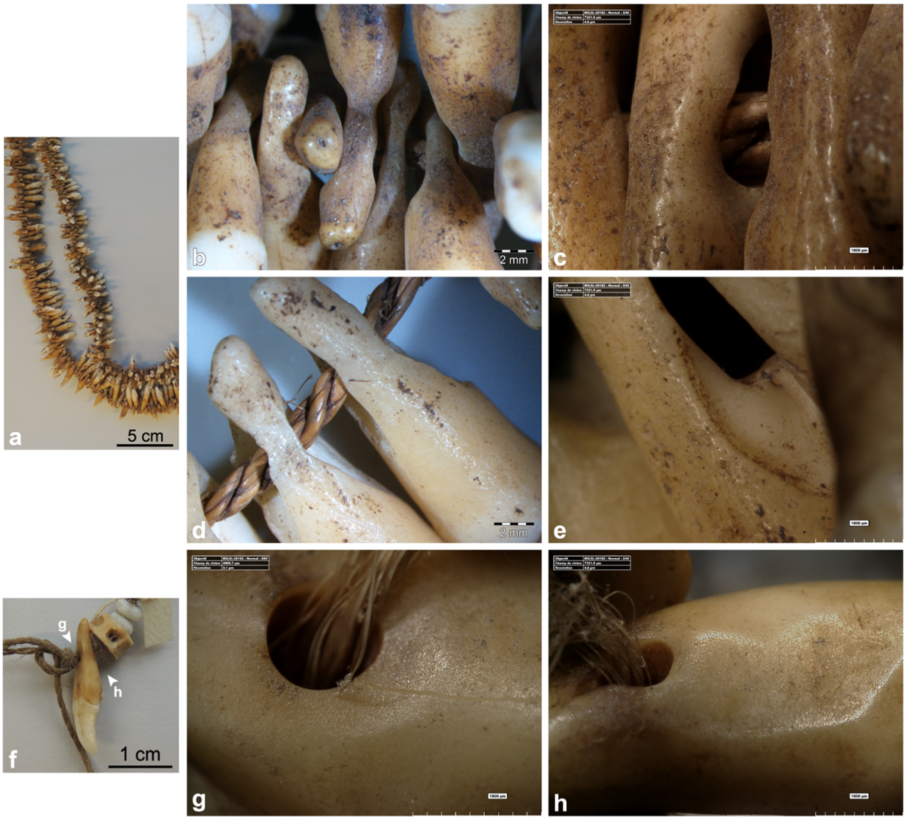

Fig. 10 Use-wear types on ornaments with teeth components. MQB inventory numbers: 71.1964.39.42 (**a**–**e**) and 71.1929.8.83 (**f**–**h**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

with porcelain beads, been covered in the black residue left by these beads. In addition, contact between vertebrae and porcelain beads led to the widening of the vertebrae's centrum. The hole at the center of each vertebra appears smooth, clean, and with a lighter color than the surrounding surface, due to the friction produced by the string (Fig. 12a–c).

Quartz

Studies focused on ornament use-wear on hard and brittle lithic materials are not common (Alarashi 2016), despite the abundance of studies focused on gemstone technology (*e.g.*, Groman-Yaroslavski and Bar-Yosef Mayer 2015; Gwinnett and Gorelick 1979; Kenoyer 1997; Roux 2000; Roux *et al.* 1995; Sax and Ji 2013). Quartz materials have received more attention in use-wear studies as flaked lithic tools (Clemente Conte *et al.* 2015; Fernández-Marchena and Ollé 2016; Ollé *et al.* 2016). It has been argued that polish in rock crystal only forms as a result of "highly abrasive activities with great pressure and after a relatively long working period" (Fernández-Marchena and Ollé 2016, p. 183). In addition, despite the shared basic chemical composition and hardness, quartz and rock crystal develop use-wear differently due

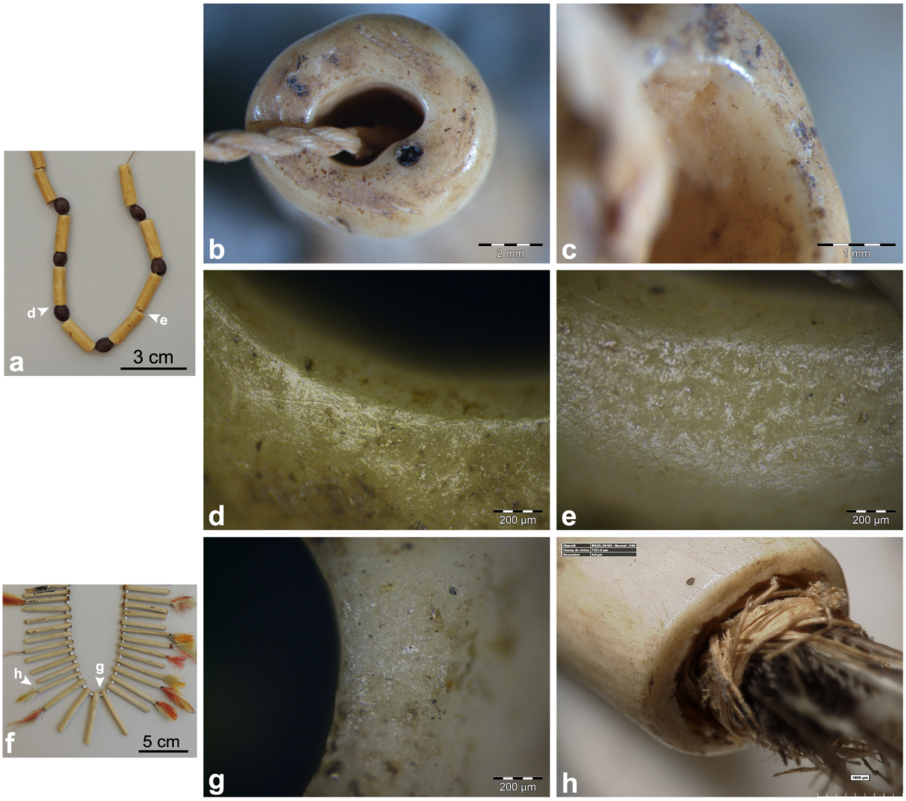

Fig. 11 Use-wear types on ornaments with bone components. MQB inventory numbers: 71.1971.30.82 (**a**–**e**) and 71.1903.13.20 (**f**–**h**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

to their specific material structures (Ollé *et al.* 2016, p. 166). Differences in the use-wear characteristics on the two materials were noted in the present study, although we cannot rule out the potential role played by the morphology of the components, string raw material, and length of use. A larger sample will help to properly address this issue in the future.

The Bará quartz pendant (71.1948.76.286) (Fig. 14a) is the only perforated specimen, displaying extensively developed string wear with clear directionality. The polish developed on the top of the perforation, at the same time smoothening drilling traces, microcraters, and cracks. With low magnification, the polish appears dull and is accompanied by a deformed notch on the perforation rim (Fig. 14a–c; Video 6). With high magnification, the polish is more invasive and less pitted than the surrounding manufacture polish, presenting some scratches. Despite the fact that the pendant is hanging loosely on the string, the use-wear on the perforation is extremely localized. This may be connected to the considerable weight of the quartz pendant in comparison to the other necklace components (two peccary teeth and the bird talons).

The two rock crystal pendants are secured by a string placed around the root end, together with adhesive residue (Fig. 14d, g). This string attachment hampers the complete visualization of the worn sectors. Additionally, it is not possible to observe the attachment area of the crystal that is inserted in a caiman tooth (71.1881.34.75)

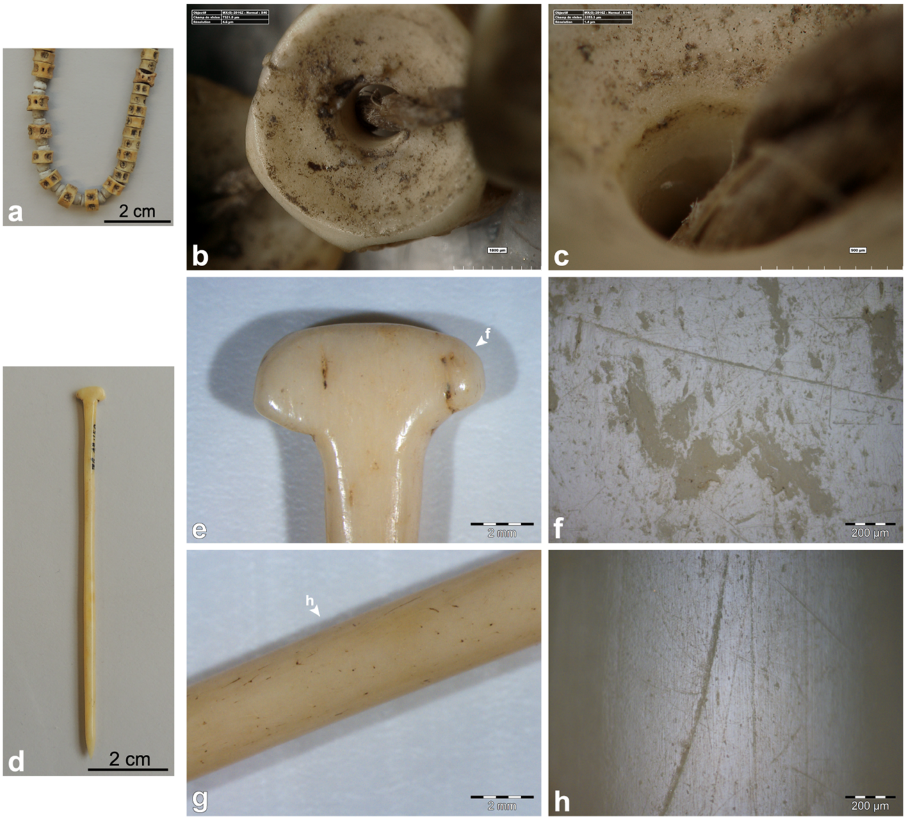

Fig. 12 Use-wear types on ornaments with bone components. MQB inventory numbers: 71.1929.8.83 (**a**–**c**) and 71.1936.48.150 (**d**–**h**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

(Fig. 14d), thus preventing the characterization of string wear. Minimal use-wear was observed on the body of the crystal, with the exception being a broken notch on its side, likely caused by brusque contact with the tooth during use (Fig. 14d–f). Rounding and the formation of a dull polish were observed on the other rock crystal pendant (71.1881.34.78) (Fig. 14g). Such traces could only be observed on areas where the string seems to have moved from its original position. However, the use-wear is less developed on this specimen, being characterized primarily by a discreet dulling of the surface (Fig. 14g–i). In this case, stress is only present on certain contact areas, due to the natural faceted morphology of the crystal. Use-wear is also partially concealed by string residue and by the ink marking and identification tag glued to the artifact. Despite such limitations, the analysis suggests that use-wear development on both milky quartz and rock crystal is characterized by rounding and the formation of a dull polish in contrast to the surrounding surface (Ollé *et al.* 2016).

Wood

While microwear studies have been conducted on wooden artifacts (Breukel 2018; Caruso Fermé *et al.* 2015; Lavier *et al.* 2009), research focused on use-wear of wooden

Fig. 13 Teeth (**b**, **c**), bone (**d**–**l**), and nut (**m**–**o**) components on baby sling (**a**), with (**g**–**o**) and without use-wear (**b**–**f**). Note different degrees of use-wear development on bone components. MQB inventory number: 71.1980.61.27. ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

ornaments is still missing, thus hampering the comparability of the traces described here. Considerable typological variability is found among the six objects with wooden components. All components are notably light-weight, in particular the Toba ear discs (Fig. 15a, d) in spite of their large size (*ca.* 6 × 3 cm). While the species used in their production among the Toba is indeterminate, similar discs were made with the *barriguda* tree (*Ceiba ventricosa*) among the Botocudo from eastern Brazil (Ehrenreich 2014, p. 75). In the Guaycurú necklace (71.1933.72.638) (Fig. 15m), the

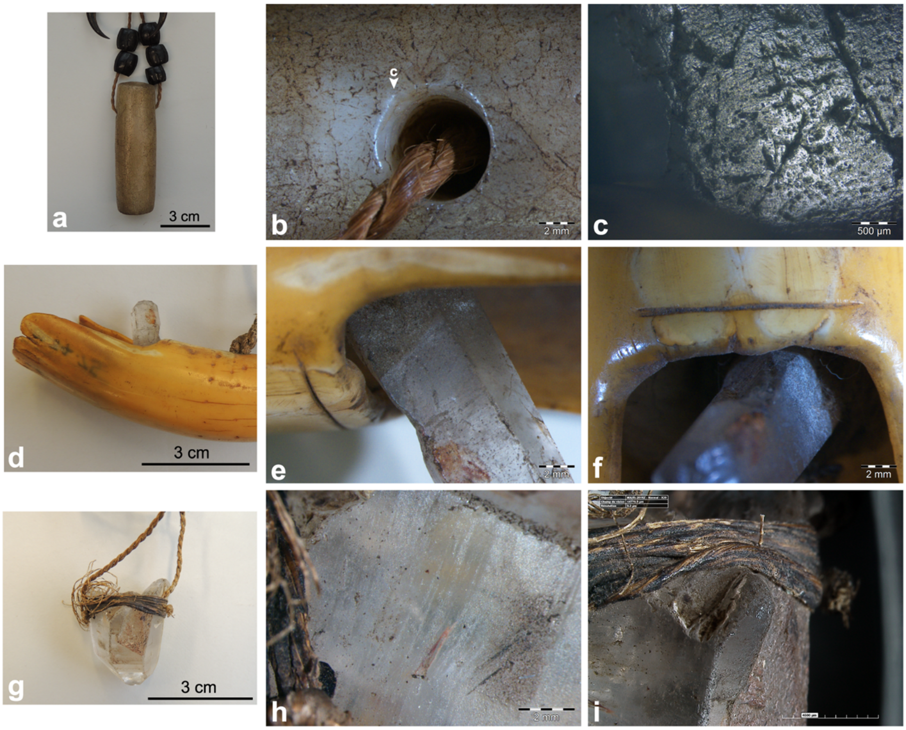

Fig. 14 Use-wear types on necklaces with milky quartz and rock crystal components. MQB inventory numbers: 71.1948.76.196 (**a**–**c**), 71.1881.34.75 (**d**–**f**), and 71.1881.34.78 (**g**–**i**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

pendants appear greasy and worn, but the position of the string inside a notched area prevented the direct observation of string wear (Fig. 15n). The back of the pendants has a more developed polish on its center, greasier, invasive, and with fine scratches in different directions. This polish stands out from the manufacture traces, being potentially connected to body contact during use (Fig. 15o). In the case of the nose ornament (71.1929.8.81) (Fig. 2f), the wooden attachment stick has a greasy appearance and some damage on its lower surface, which would rest against the nasal septum. However, this association is only tentative, relying primarily on low magnification, as the area cannot be directly observed with the metallographic microscope.

The main evidence of use on the other four objects is damage to the surface of the wood, rather than polish development. The observed damage patterns correspond to the way these objects would likely be used. By recording their extension, it is possible to establish which faces of the ear discs (71.1884.29.24.1–2) were placed against the skin and which ones faced outward. The former is light-colored and cratered (Fig. 15d–f), while the latter is darker and better preserved (Fig. 15a–c). This pattern corresponds to the slanted position of the discs in the earlobes, according to illustrations of the Botocudos wearing this type of ornaments (Branner 1893; photos by W. Garbe in Ehrenreich 2014). The damage distribution on the face in contact with the skin additionally suggests which disc was used in which ear: 71.1884.29.24.2 in the right and 71.1884.29.24.1 on the left. Damage patterns were also seen on the labret

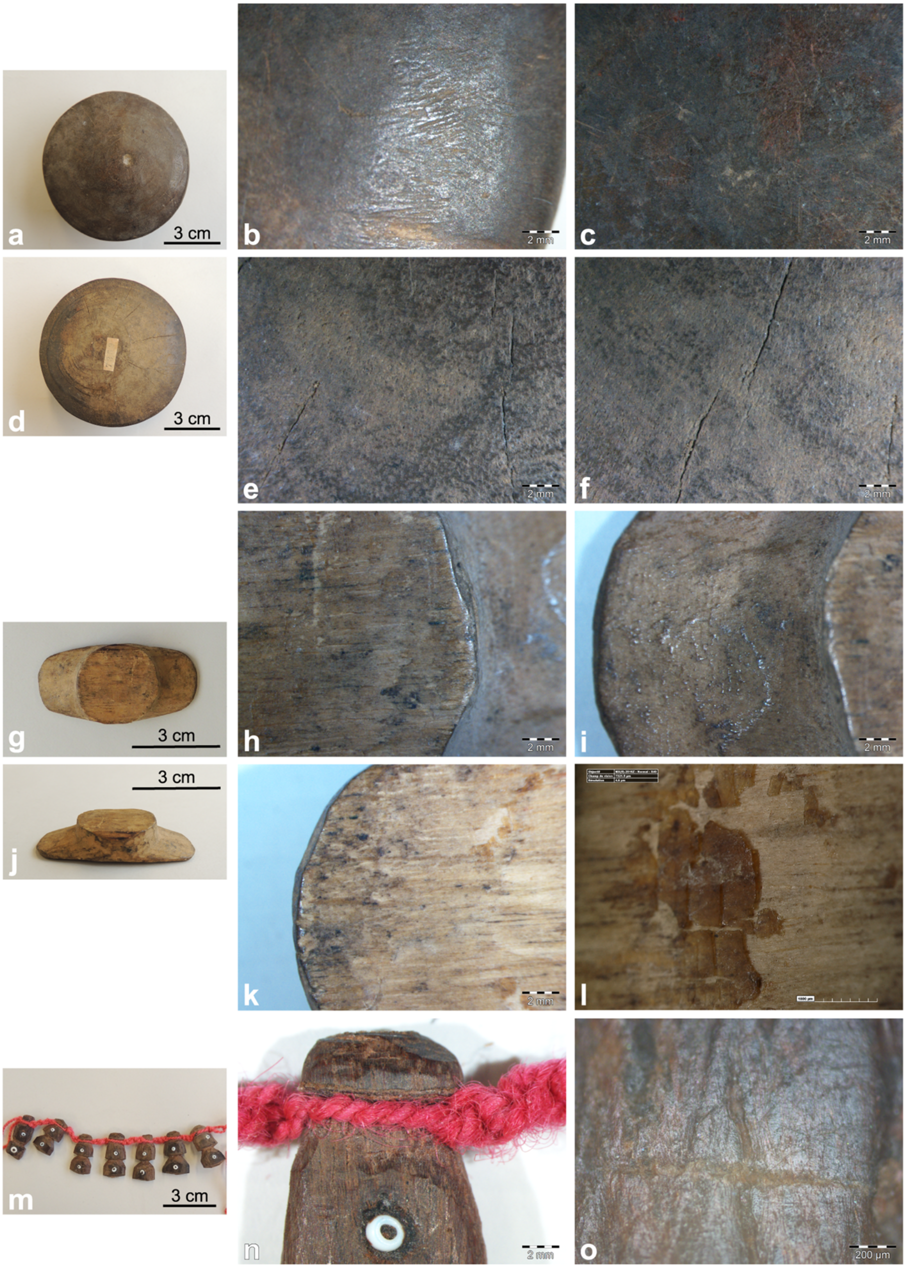

Fig. 15 Use-wear types on ornaments with wooden components. MQB inventory numbers: 71.1884.29.24.2 (**a**–**f**), 71.1884.29.38 (**g**–**l**), and 71.1933.72.638 (**m**–**o**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

(71.1884.29.38) (Fig. 15g, j), concentrated on the back of the "wings" and on the sides of the knob (Fig. 15i–k). The face of the knob, which would not be in contact with the skin during use, is better preserved (Fig. 15h). As with the ear discs, the damage can be tentatively attributed to contact with the human skin, which carries acidic bodily fluids capable of affecting the wooden objects' surface over a certain period of usage. However, the surfaces of the ear discs and labret are partially covered by identification tags, ink markings, and unidentified residues (Fig. 15l), limiting interpretation.

Nuts

Palm endocarps make part of many Amerindian ornaments, either serving as tinkling bells or as blanks for figurative and geometric carvings (Harding 2003; Ribeiro 1988). All studied ornaments made of nuts present use-wear, except for the sectioned nuts in one necklace (70.2015.8.34) (Fig. 9a). Use-wear appears as polish and rounding of the rim of perforation on three objects, sometimes associated with rim deformation. Erasure of manufacture traces and a general greasy aspect were also observed. The distribution of use-wear on the nut components of the Capanahua necklaces (71.1900.47.7 and 71.1900.47.9) is the same as on their shell counterparts (Fig. 16h–j). In fact, use-wear characteristics and distribution on nuts are largely comparable to those developed on the hard animal materials previously discussed. Different degrees of use-wear were observed on figurative pendants present in the same necklace (71.1971.30.62, Fig. 16a). Four pendants present use-wear more developed (Fig. 16b, d, f) than all other specimens in the necklace (Fig. 16c, *e.g.*): greater deformation of the perforation and nearly complete erasure of manufacture traces. In the place of manufacture striations, a bright polish with short and fine scratches in multiple directions can be observed on their surface with high magnification. The natural patterns of the *tucum* nuts have also been largely erased, giving them a darker color in comparison to the other specimens. The edges are markedly rounded, in particular on the back of the pendants, where a highly developed invasive polish is also observed. The pendants with more developed use-wear were probably reused in this necklace, after being removed from an older object. Bead-on-bead wear was only observed on the baby sling (71.1980.61.27) (Fig. 13): the nut pendants are stacked on top of each other, which led to polish development and slight deformation of the rim (Fig. 13m, o). Some polish is also observed on a narrow opening through which the string is inserted on the top of the nut (Fig. 13n).

Discussion: Interpreting Ornament Use-Wear

The systematic microwear study of ethnographic ornaments has provided insights into the characteristics and distribution of microtraces on the surfaces of individual components. In the following, the patterns observed across raw materials will be discussed, in order to assess how they relate to specific conditions, such as the type of attachment, contact materials, and composition of a given ornament (Table 2). The diagnostic value of the traces for archaeological analysis will be evaluated. Finally, we address how the observed patterns may challenge common assumptions or showcase the limits of archaeological interpretation.

Fig. 16 Use-wear types on ornaments with nut components. Note poorly developed use-wear (**b**, **d**, **f**) in contrast to highly developed traces (**c**, **e**, **g**) in components of the same necklace. MQB inventory numbers: 71.1971.30.62 (**a**–**g**), 71.1900.47.7 (**h**, **i**), and 71.1900.47.9 (**j**). ©Musée du quai Branly - Jacques Chirac, photos by C. Guzzo Falci, 2017

Use-Wear Characteristics, Distribution, and Diagnostic Features

Most raw material categories analyzed consistently presented the following use-wear types: (1) polish formation and rounding of the attachment area (generally, the rim of perforation), (2) its deformation, (3) the erasure of manufacture traces and natural patterns, (4) polish formation and rounding of the edges, (5) a general greasy aspect, and (6) bead-on-bead wear. Such traces were systematically observed, despite the generally different mechanical and chemical properties of the materials. Another type of use-wear, observed mainly on wooden artifacts and on a shell labret, was (7) damage to the worn surface. The first use-wear type is the most common and forms the main indication of use regardless of attachment system. Use-wear distribution on the rims and walls of perforation is extremely localized on most specimens. This was seen on objects in which the attachment is tightly secured, but not necessarily glued in place.

Table 2 Use-wear types observed according to attachment system and ornament composition. The number of objects with each configuration is informed between parentheses. Six objects are not represented in the table, as they do not present most types of use-wear

	Beads		Pendants/plaques					Elements inserted through the skin	
	Loosely attached ($n = 2$)	Tightly attached to the string and to other beads ($n = 4$)	Tightly attached to beads ($n = 4$)	Loosely attached ($n = 2$)	Tightly attached to string, but not to other pendants ($n = 7$)	Tightly attached to string and to other pendants ($n = 6$)	Tightly attached to other pendants, but not to the string ($n = 1$)	Noncomposite ($n = 4$)	Composite ($n = 2$)
String wear									
Polish	++	++	++	++	++	++	++	NA	+
Deformation	–	++	+	++	+	+	++	NA	–
Erasure of production traces and natural patterns	++	++	+	++	+	+	++	NA	–
Surface flattening	–	+	–	–	–	+	++	NA	–
Surface damage	–	–	+	–	+	+	–	NA	–
Body wear									
Polish	++	++	+	++	+	+	++	++	+
Deformation	–	–	–	–	–	–	–	+	–
Erasure of production traces and natural patterns	+	+	+	+	+	+	–	++	+

Table 2 (continued)

	Beads		Pendants/plaques					Elements inserted through the skin	
	Loosely attached ($n = 2$)	Tightly attached to the string and to other beads ($n = 4$)	Tightly attached to beads ($n = 4$)	Loosely attached ($n = 2$)	Tightly attached to string, but not to other pendants ($n = 7$)	Tightly attached to string and to other pendants ($n = 6$)	Tightly attached to other pendants, but not to the string ($n = 1$)	Noncomposite ($n = 4$)	Composite ($n = 2$)
Surface flattening	−	+	−	−	−	−	−	−	−
Surface damage	−	−	−	+	−	−	−	+	+
Bead-on-bead wear									
Polish	++	−	+	−	−	+	++	NA	−
Deformation	+	−	++	−	−	+	++	NA	−
Flattening	++	+	−	−	−	−	++	NA	−
Surface damage	−	+	++	+	−	+	−	NA	+
Examples	71.1971.30.82	71.1900.47.9	71.1880.7.14	71.1900.47.7	71.1884.29.29	71.1881.34.28	71.1964.39.42	71.1936.48.150	71.1936.48.163

++ feature present on all specimens, + feature present on some specimens, − absent feature, NA not applicable

The distribution of the traces follows the position where the string is most commonly resting and generating tension. For this reason, such distribution can be highly diagnostic of the placement of the string. In contrast, the rim polish on the pendants of the Capanahua necklace (71.1900.47.7) has a larger distribution than the immediate position of the string (Fig. 8e–g). Nevertheless, its location does correspond to the areas that the string is sometimes in contact with (Video 3), given that the attachment is relatively loose and the pendants can oscillate back and forth.

Rim deformation was observed on fewer specimens, both on objects with components fixed in place (71.1980.61.27, 71.1900.47.9, 71.1884.29.63, and 71.1939.88.693) and on objects with loosely attached components (71.1900.47.7 and 71.1948.76.296). In the study of archaeological assemblages, the presence of use notches to the sides of the perforation is generally interpreted as the presence of two strings placed in opposing directions, similar to the attachment of the Capanahua beads (71.1900.47.9) (Fig. 8a). In this necklace, the deformation of the perforation is characteristic of its attachment, as it is more pronounced on the areas right beneath the strings. In contrast, the position of the use notches on the other Capanahua necklace (71.1900.47.7) (Fig. 8d) cannot be directly correlated to string position. This highlights the interpretation limits associated with estimating necklace configurations from archaeological artifacts. Likewise, the top of the peccary teeth in the Bará necklace (71.1948.76.296) (Fig. 9c, d) has deformed notches, even though they are loosely attached on the string. This distribution may be connected to the presence of the quartz pendant on the center of this necklace. The quartz is larger and heavier than the other components, thus creating greater string tension. A localized and well-developed use-wear is also found on the quartz pendant itself (Video 6). The differential development of use-wear on the two perforations of the Mehinaku plaques (71.1971.43.126) (Fig. 2h) can also be indicative of the tension of the string attachment. The lower perforation does not present considerable use-wear, only some rounding and polish on an otherwise ragged rim. This is probably connected to the loose string attachment on this perforation, as opposed to the top one.

In sum, multiple factors affect the formation and distribution of string wear on ornaments: (1) the position of the string, (2) whether the string and the ornaments being hung are in a static or in a free-moving attachment, (3) the tension of the string attachment, and (4) the thickness and/or number of strings passing through the hole of a component. While the position of the string is a main factor, it is not possible to isolate it from other variables. Regarding the polish formed in association to string wear, it has been suggested that the presence of scratches is connected to the use of silica-rich plants as string raw material. However, no direct correlation between specific string raw materials and scratches within use-wear polishes was noted: scratches are part of the use polish produced by different string materials, such as cotton and palm fibers. Furthermore, strings attract and trap abrasives from both the human body and the environment during the use of ornaments. The dirt particles trapped in the string may account for the fine scratches observed in association to the polish. The erasure of manufacture traces was also a recurrent use-wear type observed, especially inside of the perforations, where drilling traces are smoothened. On other areas of a component, such traces are connected to contact wear, in particular with the human body. In most studied composite ornaments, the observed contact use-wear is primarily the result of objects loosely hanging against the body (naked or clothed). Scratches were often observed in association to the body-contact polish along the edges. They were likely produced by particles already present on the contact surface (possibly the human skin), similarly to what is suggested by d'Errico (1993a, p. 150) in relation to the formation of scratches in the polish produced by handling.

Bead-on-bead wear refers to the use-wear formed due to contact between two neighboring components of an ornament. It concerns the contact between beads or pendants of the same type or of different types and raw materials. It is not as common as the other use-wear types, being strictly connected to attachment systems where individual components touch each other. The contact between adjacent beads or pendants generates traces that are fairly diagnostic of the object's configuration. In many cases, bead-on-bead wear formed as a product of the mechanical interaction between two materials, when they abrade each other as a result of any movement. In this sense, it can be found in artifacts that were just strung together, but not actually worn. Its specific traits and distribution can be indicative of the way in which the components were attached in relation to each other and what materials they were made of. For instance, diagnostic traces were observed in the following cases: bone-bone and bone-seed contact (71.1971.30.82), vertebra-porcelain and vertebra-vertebra contact (71.1929.8.83), porcelain-bone contact (71.1903.13.20), and also glass-shell contact (71.1880.7.14). The use-wear created by comparable materials (bone-bone) or artificial materials (shell-glass) produces greater damage and abrasion, while the wear produced by softer and organic materials (seeds-bone) generates more rounding and a more invasive polish. The specific morphology of the components in contact also influences use-wear distribution, as evidenced by the wooden beads and teeth pendants (71.1948.76.297) (Fig. 9e–g).

While many traces can be recognized with low magnification, the combination of different microscopes proved to be central for a correct identification. For instance, while some scratches in the use polish may be visible with low magnification, their secure identification requires the use of a metallographic microscope. This is because other activities, such as polishing and bead-on-bead contact, may lead to the formation of linear traces, which cannot be properly distinguished with low magnification. Another example is the general greasy appearance attested on the components of many objects. While this appearance may serve as macroscopic indication of the use of an artifact, it may also result from a range of other activities, such as handling, transporting, or wrapping an artifact (Breukel 2013; d'Errico 1993a; Graziano 2015; Wentink 2006).

Different Degrees of Use-Wear

The variation in use-wear development between artifacts of the same type and raw material has been used by archaeologists as an indication of degrees of use within an assemblage (*e.g.*, Bonnardin 2008, 2012; Sidéra and Giacobini 2002; Sidéra and Legrand 2006; Van Gijn 2017). Controlled experiments corroborate the relation between intensity and extent of wear development and its duration (Mărgărit 2016). In the present research, different degrees of use-wear have been observed on the components of the baby sling and on the nut figurines necklace. The variation in use-wear can be interpreted in both cases as related to extent of use. In the baby sling, we see the gathering of individual components with different biographies, including freshly made and reused pendants, either highly or moderately used. On the other hand, beads integrating a necklace with a homogeneous biography may still present different degrees of use-wear development or may not even present all the types of traces that other components in the same object do. For instance, in the Aché necklace (71.1964.39.42) (Fig. 10a), the difference is connected to how tightly attached the teeth are in different sectors of the necklace. However, the causes of variability are not always clear. In some cases (71.1929.8.36, 71.1900.47.7, and 71.1900.47.9), differences in wear development cannot be safely correlated to different use trajectories for the components. Other factors may also influence wear development, such as the specific layer of the material used for the production of each bead, the thickness of the bead, and the positioning and nature of the drilled hole. All these variables can easily vary from bead to bead in the same composition.

In addition, we must consider other variables in the biographies of ornaments. As mentioned previously, six objects present evidence of the replacement of their strings, possibly due to degradation. The relative degree of wear of the new strings suggests that such replacements happened to the objects prior to collection. This type of "recycling" practice also stresses the complexity of the lives of ornaments. Discard and replacement of components may be important parts of the biographies of objects, but cannot be easily observed in the study of archaeological assemblages. The selection of beads with particular biographies to compose a new ornament may have held social and cosmological significance (Walker 2009), but has only seldom been noted in archaeological assemblages (Van Gijn 2017).

The Absence of Use-Wear

The presence of use-wear on most studied ornaments indicates that they were produced for use within the community and not just to be traded with collectors. At the same time, its absence on some objects highlights the fact that use-wear is not only the result of the friction between a string and a given raw material. The formation of string wear further involves the interaction with acidic bodily fluids (d'Errico 1993a, p. 168; Vanhaeren *et al.* 2013), as well as body paint, oils, and dirt particles. When interpreting objects that do not present use-wear, we are faced with a limit of this method of study. While use length can be suggested with some security by compared analysis of artifacts within an assemblage, it is not possible to establish whether an artifact has been worn sporadically or not been used at all. For instance, some ornaments may only be worn in specific ceremonies or by certain age groups, leading to the formation of little to no use-wear. Nevertheless, when analyzing the Bororo earrings (71.1936.48.168.1–2 and 71.1936.48.195.1–2) and the Tikuna necklace (70.2015.8.34), it became clear that not only the use-wear was absent, but also the dirt typically observed on used objects. In this sense, the analysis of ethnographic ornaments cannot determine that an ornament has definitely not been worn, but it does allow us to build a strong case for it. Even if the Bororo ear ornaments have not been worn, the individual plaques present residue added to the string (Fig. 6i, k) and bead-on-bead wear. These traces are the result of the attachment of the plaques, but not necessarily of their use. Exposed to the same conditions, archaeological artifacts would likely present the same traces. However, it is very unlikely that the "correct" interpretation (*i.e.*, having been strung, but not worn) would be reached. Similarly, the individual components would hardly be recognized as integrating ear or lip ornaments if recovered from an archaeological context. With the exception of the attachment pieces that have a T-shape and may develop characteristic use-wear on the external surface and edges, there is no distinguishable evidence of this particular composition and usage on the other plaques. In this case, the interpretation remains elusive.

Conclusion

In the last couple of decades, many studies have addressed the technology and use of archaeological ornaments, generally focusing on specific raw material categories. While material specialization is a common, and generally desired, feature of archaeological research, it is not necessarily an accurate portrait of how such artifacts were integrated within a living community. More often than not, ornaments are composite constructions, involving multiple materials: strings, bands, and a variety of bead and pendant raw materials. In order to bridge this gap, archaeologists have often referred to ornament compositions, uses, meanings, and social roles among traditional communities (*e.g.*, Bonnardin 2008; Falci *et al.* 2017a; Vanhaeren and d'Errico 2003). This microwear study of an ethnographic collection is a step further toward bridging this gap.

The primary goal of the present research was to create a reference collection that sheds light on the formation, characterization, and distribution of use-wear on ornaments from a lived context. This collection serves as a strong basis for interpreting traces on ornaments made of different raw materials recovered from a variety of contexts worldwide. It showcases many types of traces that can be searched for during the analysis of archaeological ornaments and how they may be interpreted. This study further demonstrates that the specific conditions of attachment influence ornament use-wear: raw material, morphology, and relative weight of the elements in contact, composition, tension and fixity of the attachment, body contact, among other factors. The study of this collection helps us broaden the scope of possible interpretations of beads, pendants, and plaques, not only in terms of how they were integrated in composite ornaments, but also of how they may have been taken apart, replaced, and/or discarded.

At the same time, it should not be understood as an ideal reference collection, as the objects are not the result of controlled experiments. Rather, this is a collection constituted in a lived context, which means that we cannot reconstruct every given situation an object has gone through. Its value lies precisely in the complexity of its biographies that resulted in the formation and superposition of traces in a less "orderly" manner when compared to experimental specimens. For this reason, the practical and interpretative limits to such a research have to be acknowledged and the ways they have been dealt with clearly stated. Previous research has not been sufficiently clear about such crucial issues. The different magnifications and visual possibilities afforded by each microscope had a crucial role in designing a critical, careful, and feasible analysis protocol for this assemblage. While the stereomicroscope served as the basis for initial interpretation, the 3D digital and metallographic microscopes permitted a more thorough understanding of the characteristics and distribution of microwear.

This research sheds light into the biography of a museum collection, as ethnographic objects display several traces that are witness to their specific histories. Therefore, microwear research can be used not only as a way to interpret archaeological artifacts but also as a standalone study. Future microwear research of ethnographic ornaments can shed light into the interactions between people and ornaments, in regard to their conceptualization, production, use, social role, and temporality. By focusing on the microtraces left on the surfaces of the objects and organizing them into specific biographies, such an approach will provide valuable insights for archaeologists and anthropologists regarding the multiple and active roles of bodily adornment in human societies.

Acknowledgments The authors would like to thank the assistance of the staff of the Musée du quai Branly - Jacques Chirac, in particular Dr. Christophe Moulherat for his contributions to the research. Céline Kerfant is additionally thanked for her input in the identification of plant fibers. Finally, the authors are also grateful to the editor and the four anonymous reviewers for their comments, which improved the manuscript considerably.

Funding This study was funded by the *Bourse d'étude pour la documentation des collections 2016–2017* of the Musée du quai Branly - Jacques Chirac and by the NWO Spinoza Prize awarded to Prof. Dr. Corinne L. Hofman in 2014. This research is part of the project NEXUS1492, which has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007–2013)/ ERC Grant agreement no. 319209.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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