EXARC JOURNAL 2021/1
19 Articles | Open Access

Reviewed Article:

Traces of Manufacture, Use, Repair and Modification Observed on Ethnographic Throwing Sticks and Boomerangs

Persistent Identifier: https://exarc.net/ark:/88735/10556

EXARC Journal Issue 2021/1 | **Publication Date:** 2021-02-25

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Throwing sticks and boomerangs are present in the collections of many French and international museums. Collected mainly in the 19th and 20th centuries by travelers, they were mainly analyzed from a stylistic point of view, to relate them to their region of origin. Some of these objects were made by the indigenous populations especially to be exchanged

with Europeans and only bear macro-traces of manufacture. However, many others can have additional various traces of use and repair which reflect a real function and which are often less studied. Indeed, these traces can shed light on the functionality of the object in relation to their physical characteristics, which determine their aerodynamic properties. However, these throwing weapons were not only used as projectiles. In some cases, a major modification of the object may have taken place to adjust it for a new use.

> “ This information helps to show the great diversity and vitality of production and use of throwing sticks and boomerangs, to bring them back to life in their functionality to evoke the culture and life of the populations who created them. In terms of scientific mediation, these details can help to challenge the museum visitor more, often reduced to admiring objects without an explanatory context, only invested with an aesthetic dimension, on which we can sometimes project abusive generalizations by default, a source of confusion, for the general public.

Throwing Sticks[1] and Boomerangs[2] in Museum Collections

Throwing sticks as well as Australian boomerangs are present in the ethnographic collections of many museums around the world. Mostly collected in the 19th and 20th centuries by settlers and travelers, these objects were mainly studied by focusing on their particular shape, and observing their engraved or painted designs, to relate them to their region of origin. This cultural classification has been particularly useful in defining a regional typology for Australian objects (Davidson, 1936; Jones 1996). Indeed, the majority of objects of this type, kept in public collections comes from this continent, as evidenced for example by their proportion within the collection of the Museum of Quai Branly (See Figure 1, left). In addition, museum’s collections do not reflect the full diversity of throwing sticks. The choices of the collectors are the reflection of aesthetic preferences and I was able to observe among the studied corpus a more marked selection of certain categories of objects, for example the returning models (boomerangs).

The term “boomerang” derives from several Dharug terms, an indigenous language group from the South East region of Australia. It would be a compression of two terms, bumarit and wumarang (Clark, 2012). This term exclusively designated the returning projectile which so fascinated the European colonizers. A recent study on the term “boomerang” (Butz, 2011) shows that these same colonizers extended, out of ease and ignorance, this indigenous term to all kinds of very different thrown objects, often not returning, maintaining a confusion that has continued to this day. Thus, today, this name is linked more to the evocation of the phenomenon of the return of these projectiles than to a specific category of objects.

If we consider the diversity of objects called "boomerangs", we see that a tiny minority have the return properties attributed to them. Moreover, only 10% of objects of this type, made by the Australian indigenous people, have real return capacities (Leroi-Gourhan et al., 1948). In addition, we can see that the proportion of boomerangs in museum collections (for example, up to 23% of Australian objects for the Quai Branly Museum, See Figure 1) does not reflect this low proportion on this continent (See Figure 1, left).

From the etymological origin of the term “boomerang”, one can perceive that we need to consider boomerangs more as a subgroup of throwing sticks, like specialized projectiles with a particular trajectory. This is confirmed when I tried to classify the throwing sticks according to all of their physical characteristics (and not just their general shape) which defines their aerodynamic property as a projectile. Thus, by considering their type of general shape, their symmetry, their type of ends, their type of section and their mass in relation to their surface, I was able to define more than 120 distinct classes in a database of about 300 studied objects. (Bordes, 2014), which demonstrates a great diversity.

It is also important to consider the other functions of these objects. Indeed, the throwing sticks, and in particular the asymmetrical throwing sticks which promote the grip on the longest blade, are frequently multi-functional objects. For the types of Australian objects, we can cite, for example, uses as melee combat weapons, as digging sticks, for lighting and fire management, for disarticulating game, and as a hammer stone to flake flint, in addition to their use as a projectile for hunting or war (Jones 1996). Thus, a total of twenty-six different functions were identified by bringing together ethnological information concerning throwing sticks from different continents (Bordes, 2014).

By crossing the ethnological information available on reference types, the physical characteristics of objects, and traces of use observable on their surface, it is possible to confirm and propose their various potential or real functions. Indeed, for example, only about two-thirds of the objects in the collection of the Quai Branly Museum bear traces of impacts, indicating their real function as a projectile (See Figure 1, right). On the other hand, other objects may have a potential function recognized for their type (ethnological information and physical characteristics), but never have been used for this purpose, before having been acquired by a collector, and finally by the museum. Indeed, in the nineteenth and twentieth centuries, many of these objects made by the Australian indigenous people were specially intended to be exchanged for goods imported from Europe.

Potential Contributions of Traces of Manufacture, Use, Repair, and Modification

The main contribution of the study of macro-traces observable on the surface of throwing sticks is to obtain information on the particular history of each object to improve knowledge

of their cultural and functional context, as well as other information, such as the date of their manufacture (Bordes, 2014; Bordes et al., 2015; Caruso Fermé and Aschero, 2020; Conard et al., 2020).

In particular, these traces make it possible to better specify their manufacturing technique. They can provide information on the shaping method or at least on the last phase of manufacture. Indeed, the last surface finish can result from the sequence of several usual manufacturing phases (rough shaping, shaping profile, finishing of the profile, and final polishing), which overlap.

In addition, some traces indicate whether the object was used for practical purposes or exclusively owned for the collection. The existence of repairs can reinforce the idea of prolonged use over time and attest to at least two different states of the object (before and after repair). Certain modifications can correspond to simple repairs, to a better adaptation to its use, but also sometimes to a radical change of function of the object.

Another contribution of the traceology of throwing sticks is to build a repository of the different types of traces which can serve as a reference for the study of older archaeological objects. Indeed, although their conservation is rare due to the nature of the perishable organic materials that constitute them, archaeological throwing sticks and boomerangs have been discovered for historical and prehistoric periods on European territory (Hess, 1975; Bordes, 2014). These ancient witnesses are in fact particularly numerous in Europe from the Neolithic period (Thomsen and Jessen, 1902; Ramseyer, 2000; Andersen, 2009). To cite an example, the comparison of the metal reinforcements fixed on the Gallic throwing stick found in 2010 on the Urville Nacqueville site in Normandy with those used on Indian Valari type throwing sticks, traditionally used by the Tamils in the south of India, confirmed the usefulness of such consolidation appliques on the archaeological throwing stick (Bordes et al., 2015).

Observable Traces on Traditional Objects

Manufacturing traces

It is often possible to spot traces of manufacture on throwing sticks belonging to heritage collections in museums[3] and during experimental work[4] , such as blows from cutting tools, traces of files or scraping, gouging (or adzing) etc. These traces are all the more marked as the woods used for the throwing sticks are generally dense woods, whereas more fibrous and softer woods make their reading less easy. Traces of metal cutting tools and from file use are frequently found on Australian throwing sticks dating from the early part of the twentieth century, which is consistent with significant use of metal tools for their manufacture. For this period, metal hatchet is commonly used in Australia for roughing and a file for finer profiling work (Jones, 1996). Traces of roughing can be seen quite clearly by faceting of the surface

when the final finish of the object has not erased them (See Figure 2a), while profiling with a file is indicated by fine grouped parallel lines (See Figure 2b,c).

On the other hand, fine wrinkles of scraping are produced by the regular passage of stone scraper equipped with a sharp thick edge which follows the surface of the work to remove wood gradually. They occur frequently on dense woods chosen for the manufacture of throwing sticks and boomerangs. Indeed, according to my personal throwing experiments, these projectiles benefit greatly from the qualities of dense woods in terms of mass, hardness, and resistance, to achieve greater ranges, produce effective impacts, and increase their durability (Clark, 2012). This explains, for example, the frequency of wood from trees of the acacia family used preferentially for Australian objects, but also sometimes for Indian or African objects. However, this quality of density can be found in other families of trees also in Europe (i.e., *buxus sp., quercus ilex*). Although this type of trace can also be produced by a sharp edge of a metal tool, I find through the manufacture of experimental models that it is faster to use their sharp metal edge to remove small cuts of wood than to undertake scraping. On the other hand, the lower sharpness of stone tools is less suitable for removing wood while cutting, but more useful for the scraping technique which requires only little energy, and allows precise profiling work, and avoids creating shocks on the surface of the wood that could weaken it. In general, according to tools I have manufactured, rather thick, but yet sharp stone edges (20-90° angle) are relatively efficient and sufficient for this type of work.

The presence of scraping wrinkles and the absence of a surface faceted with a metal tool or traces of file is therefore a good indicator of an old manufacturing method (nineteenth century or earlier). It is interesting to note that these fine wrinkles can be more or less wide, of variable amplitude, and more or less spaced. For example, we can find deep spaced wrinkles at the elbows (See Figure 2d). These being produced by the rebound of the cutting edge that follows the wood surface, they are accentuated at this point by following the significant variations in density of the compressed wood located precisely at the natural curvatures in trunk and branches. On the rectilinear parts of the blades, we can observe them shallower and more or less packed (See Figure 2e). The morphology of these traces probably depends on the complex conjunction of different factors linked to the physiognomy of the tool and its use (angle of the cutting edge, angle of scraping with the surface, speed of translation of the movement, etc.) (See Figure 2f).

The gouge (or adze) marks can be variable in size, shape, and regularity and depend on the tool used (See Figure 3). We know that from the nineteenth century onwards, Australian indigenous people adapted to attach active metal parts to the end of their adze, but that there were old examples provided with flint shards.

It is likely that the large adze traces that are typical on many kylies[5] and wirlkies[6 7 8] in the central Australian region were made by an adze with a metal end (See Figure 3f). Based on several personal experiments with this type of tool, it was difficult for me to produce such large marks with a stone-tipped tool. On the other hand, some traces of smaller adze marks visible on other examples are more compatible with the use of stone tools (See Figure 3a,b,c). Some throwing stick faces may exhibit extremely even “fish scale” gouge work while others have benefited from coarser work. Adzing is an innovative technique compared to scraping work and saves material removal time during the refinement of the object. These traces can be erased in the finishing phase by regularizing the surface or they are often left visible on many throwing sticks on purpose, thus playing a decorative role.

The recent absence of decorative grooving on the underside of the kylies and wirlkies from central Australia clearly shows that cutting tool shaping and then adze removal was a refinement step that preceded the regularization of the surface and the installation of the grooves (See Figure 4). Indeed, the oldest models, dating from the nineteenth century, have both sides regularized and fully grooved while more recent models do not have grooves on the lower surface (lower face) leaving the less visible surface only worked with an adze (See Figure 4a,b). Still others report an even greater shrinkage of the groove system which only partially covers the upper surface, omitting the gripping end (See Figure 4c,d). This change is probably guided by a progressive economy of this time consuming grooving work, but also a probable withdrawal from the ceremonial uses of this type of throwing stick, since these throwing sticks are used to be clapped together and their fluted surface used to produce sounds by rubbing a pair of them together during dances (McCarthy, 1961; Van der Leeden, 1967).

On some models, it can be noted that the irregular grooving appears to be the result of adze cuts along parallel lines (See Figure 3d and Figure 4d). We could deduce from this that the work of decoration, grooving, and finishing originates from an improvement of the work of refinement with the adze marks in more or less continuous lines. However, the aspect of grooving on throwing sticks, the origin and utility reason of which is still poorly understood, will not be presented here, as it would require further development which would be outside the scope of this article.

Traces of use

Traces of use are visible on some throwing sticks. The most obvious are the traces of use of fire, grip, and impact (Jones, 1996; Bordes, 2014).

The traces of use with fire are sometimes present on the length of the blades or only on their distal end, often on asymmetric throwing sticks whose grip facilitated this function. We can distinguish two uses of the throwing sticks in this case: fire management when the object was used to organize the hearth or safely handle a food or a heated object, and the ignition of fire

by friction (sawing) which was practiced by Australian indigenous people both with spear thrower edges and throwing stick edges. This use has been documented in particular for kylies in central Australia (Jones, 1996).

The two different uses related to fire can potentially be differentiated by the distribution of the charred zone: A throwing stick used for fire management will likely have an affected end both on its edges and on its two opposite surfaces (See Figure 5a). While use as a fire saw will probably produce a trace of charring limited to the edge used during friction, probably on the long blade (attacking or gripping blade) which has a more effective length for this use. (See Figure 5b).

Grip marks, which can take the form of engraved lines, in parallel lines or grids, can be located at the end of one blade and on one or both sides (See Figure 6). These traces can be crucial in determining the proximal (or grip) blade, especially in the case of symmetrical objects. This information, associated with the orientation of the sections of the object, the blade settings (incidence and dihedral angles) and the impact traces, makes it possible to confirm the laterality of the object (left or right handed). Indeed, used as a projectile, the throwing sticks do not have an equivalent trajectory according to the orientation of the faces with which they are launched, nor according to the choice of the blade used as attacking blade (or grip). This is due to the orientation of the airfoils and the blade settings which are optimized for a particular launch configuration (Bordes, 2011). This aspect can be drastic on a throwing stick, and an incorrect grip can reduce the accuracy and range of a straight-flying throwing stick or prevent a boomerang from returning correctly. Australian indigenous people had to be able to place all their confidence when firing and therefore could not afford to go wrong when quickly grabbing certain weapons to throw them. The gripping traces therefore indicate a real use of the object as a projectile, especially if it is associated with traces of impact.

When they are in abundance on certain edges, the impact traces can provide information on the direction of rotation of the object and confirm its actual use. Relative to my observation experience on throwing sticks belonging to museum collections, these traces of impact tend to accumulate more on the outside of the curvature and on the leading edges. This seems logical since the outer edge of these objects, having more angle opening than the inner edge, increases the probability of impact in this area when rotating the object. It is also quite logical to note that it is the edges advancing in the direction of rotation (leading edges) which are often the most damaged (See Figure 7a, b). These impact traces are related to the energy distribution undergone by a reduced surface area of the object at the time of impact and their appearance will therefore depend on the taper of the edge concerned. Thus on thin throwing stick like boomerangs with relatively thin tapered edges, they will often take the appearance of more or less deep “V” or “U” shaped notches, sometimes followed by tearing, or accompanied by a crack in the wood (See Figure 7c, d).

Traces of repair & reinforcement

Although infrequent, it is possible to observe traces of repair on the throwing sticks that can be distinguished from the reinforcements that are planned during the manufacture of these objects.

When, following an impact, a crack threatens the integrity of the projectile, a repair in the form of a vegetable or tendon ligature can be applied around the weakened area (See Figure 8). To hold it in place, a more or less wide notch is commonly made in the two opposite edges (See Figure 8b, c, d). This ligature can be reinforced with a natural resin (for example spinifex resin (Triodia pungens) in Australia), (See Figure 8b)

Installed as a preventive measure, the reinforcements are not totally traces resulting from the use of the object since reinforced throwing sticks may never have been used, but a few examples are presented here, since they ultimately play the same role as repairs and may look similar. The reinforcements can be made of different materials such as plant fibers braided in rope (See Figure 9e, f), skin sleeve (See Figure 9c, d) or even metal, in the form of fixed appliques (See Figure 9a, b).

Traces of modification

On a few rare occasions, traces of drastic modification of the object can be observed, modifying partially or totally its initial function. Two examples will be presented here.

The first concerns a type of pointed-ended 'V' shaped throwing stick typical of the Kimberley region, such as those collected from the coastal area near Derby and held by the South Australian Museum (See Figure 10). This type of object is frequently grooved on both sides and sometimes enhanced with bands of white ocher (See Figure 10a, b). The use of these projectiles is multiple. They are suitable for hunting birds as well as remote duels and fishing (Clement, 1904; Jones, 1996). The latter use is documented for the Kimberley region. This type of throwing stick, of small size and thickness, can be thrown through the surface of the water with sufficient penetration to knock out large fish, up to fifteen centimeters deep (See Figure 10f). This fishing is practiced at a shallow depth in areas of fish concentration (after a drop in the water level, or in a network of sandbanks), or in fish traps artificially constructed by man (Mulvaney and Kamminga, 1999; Humphries, 2007; Ulm, 2011).

For example, object N ° A5552 which has been heavily modified probably after damage or breakage of a blade tip (See Figure 10c). This was thus shortened and rounded, modifying the shape of the original throwing stick and restricting its other potential functions in favor of greater specialization in fishing. This modification is evident when one observes in particular the old grooved decorations which were cut by the trimming of the blade (See Figure 10d).

Indeed, if we observe the characteristic "L" shape of certain twentieth century metal versions of these fishing sticks (See Figure 10f), we understand that this modification made it possible to continue to use it with effectiveness for this activity, as evidenced by traces of shock at its modified distal end (See Figure 10e). However, its other functions were probably reduced as a result of this modification, either through the loss of airfoil for longer range use or the offensive aspect of one less pointed end. We therefore have here an opportunistic partial modification which increases the specialization of the object in one of its functions to the detriment of other uses.

A second case of modification concerns a symmetrical right-handed boomerang with a biconvex profile from the collection of the museum of Toulouse (See Figure 11a). The peculiarity of this object is that it was obtained from a larger throwing stick, by removing wood from the inner edge and visible trimming of the ends. This modification left rough tool marks on those same ends and flat edges on the inside of the bend that the manufacturer did not re-sharpen, and which are therefore very visible (See Figure 11b, c, d). Traces of tools from this second shaping are visible on both sides and a remainder of diamond engraving belonging to the engraved decoration of the initial object is still visible on the elbow, on the extrados side (upper side during the flight) (See Figure 11c). The presence of engraved decoration would seem to indicate a throwing stick with a straight flight since boomerangs only rarely have such engraved decorations before the mid-20th century.

Indeed, the traces of recent tools which came to cover an older scraped-wrinkled surface and the very abrupt retouch marks which seem to be the result of metal tools, could indicate a first object of the nineteenth century, retouched later, probably at the beginning of the 20th century.

In addition, other traces of use of interest were present on this object. In addition to a grip mark that was visible on the tip of the attacking blade (See Figure 11b), impact marks on the outer edge attest to its use as a projectile. Its blade settings make it a fairly heavy boomerang, suitable for a throw in strong winds, which requires a powerful throw, but with a good return capacity in these conditions. On the other hand, these curved flight capabilities were not to exist, or at least were considerably limited in the initial state of the object which was necessarily heavier, with a larger wingspan, and with wider blades.

This is therefore a real recycling of a throwing stick without return capacity, decorated with engraving (which could also come from another region) to a new boomerang-type object with returning capacity, leading to a change of function oriented towards play or bird hunting.

Conclusions and Perspectives

The observation of the macro-traces on the throwing sticks is complementary to the measurement of their physical characteristics and their stylistic and decorative study. They

make it possible to know whether the object has actually been used or not, to specify its dating and to confirm its functions. The accumulation of these traces on certain types of object allows access to the particular history of each object in terms of production, more or less long-term use and sometimes to show a notable change in use.

This information helps to show the great diversity and vitality of production and use of throwing sticks and boomerangs, to bring them back to life in their functionality to evoke the culture and life of the populations who created them. In terms of scientific mediation, these details can help to challenge the museum visitor more, often reduced to admiring objects without an explanatory context, only invested with an aesthetic dimension, on which we can sometimes project abusive generalizations by default, a source of confusion, for the general public.

Specifying the cultural context of each object is often not easy, especially for throwing sticks and boomerangs whose conditions and dates of collection are very diverse and often unknown. These contexts are complex and very diverse with, for example, more than 250 different indigenous language groups in Australia. The study of these artefacts must be deepened in the future by multiplying the approaches: study of their more detailed physical characteristics, studies of macro-traces, determination of the species of wood used etc., so as to be able to classify and group them more easily, not only within large collections of a museum, but also between different museum collections.

The study of macro-traces with naked eye or at low magnification could also be supplemented in certain cases by the observation of micro-traces at high magnification, and by surface spectroscopic analyzes (example: Raman and Infrared microscopy). Indeed, these latter methods can be helpful for the determination of traditional use of pigments, resins or grease layers on these objects (Bordes 2019). Additionally, the use of external 3D scanning or X-ray tomographic techniques to probe the internal structure of the objects can provide even more information (wood density calculation, minimum diameter of the piece of worked wood, shaping strategy, identification of objects constructed in pairs) (Bordes, 2019).

The constitution of detailed and systematic databases containing all this information could serve both as a reference for museums for the classification and museographic development and dissemination of collections, but also as a tool of comparison for archaeology. Indeed, the advance of scientific investigation techniques makes it possible to further exploit the study of the prehistoric use of tools and weapons made from organic materials such as wood, which necessarily occupied an important and still strongly under estimated place in ancient material cultures, compared to the most preserved and most studied remains, such as tools made of stone or hard materials (bones, reindeer antlers, etc.). Finally, the bio-cultural collections of throwing sticks and boomerangs are a cultural heritage of great interest in the

history of techniques, because they bear witness to the early taking into account of aerodynamics.

Acknowledgements

I would like to thank Magali Melandri (Quai Branly Museum), Philip Jones (South Australian Museum), Zeena McGreevy(Pitt Rivers Museum) and Sylviane Bonvin Pochstein(Toulouse Natural History Museum) to have granted me the access to all artefacts from the different corresponding museum collections.

1 The term throwing stick is general, and designates a tool consisting of one or more pieces of wood or more rarely other natural materials forming between them an angle of 0 to 180 degrees. These parts are generally called blades, more or less cut, which are launched in rotation in the air, in a plane of rotation. Boomerangs being only a particular and specialized category of throwing sticks having returning trajectory.

2 We will use the term boomerang only for objects that have a curved trajectory approaching 180 ° back to the launcher. Several words in different indigenous languages of South East Australia (eg., bargan, boomari), which later gave the word "boomerang", were clearly attached to this category of light throwing sticks. Later, the colonizers confused the different types of throwing sticks by placing under the same name, these light throwing sticks and other heavier hunting sticks. This confusion continues today. On the other hand, the classification of throwing sticks and boomerangs is a point that goes far beyond the subject covered in this article.

3 A corpus of 273 objects was studied: Quai Branly Museum(141), South Australian Museum(71), Pitt River Museum(41), Volkenkunde Museum(11), Toulouse Natural History Museum(9).

4 My experimental collection contains around 200 hand crafted throwing sticks, 87% of them with metal tools used for coarse shaping and stone tools (scraper) used for final shaping, and 8% of them manufactured only with stone tools, including initial wood piece cutting from tree.

5 A type of Australian indigenous throwing stick traditionally made in the Central Desert area. It is also the term most commonly used today by Australian indigenous people of many other regions to refer to throwing sticks.

6 Peculiar "number 7" or "gooseneck" shaped throwing stick traditionally made in the area around Tennant Creek by the Warrunmungu people and distributed throughout the central desert area of Australia.

7 The face of a throwing stick oriented towards the ground or towards the outside of the trajectory during its flight, is called the intrados. The other side, often visible to the launcher, is called the extrados and constitutes the “top” of the object. It is the one that is most commonly decorated.

8 For the throwing stick the two blades are not aerodynamically equivalent. The one whose edge outside the curvature traverses the greatest angle in the wake of the other is called the attacking blade. The other blade is therefore called the following blade. Traveling through one angle greater than the other, the attacking blade also acquires an intrinsic aerodynamic lift effect, always greater than the following blade. This blade is for Australian indigenous style throwing most often the gripping blade because it is the grip that gives the object the most rotation, but this is not necessarily always the case. The attacking blade is finally defined from the aerodynamic point of view with the direction of rotation of the object by its largest swept angle regardless of the grip of the object at the time of its launch.

Keywords throwing stick
weapon
ethnoarchaeology
use wear analysis

Country Australia

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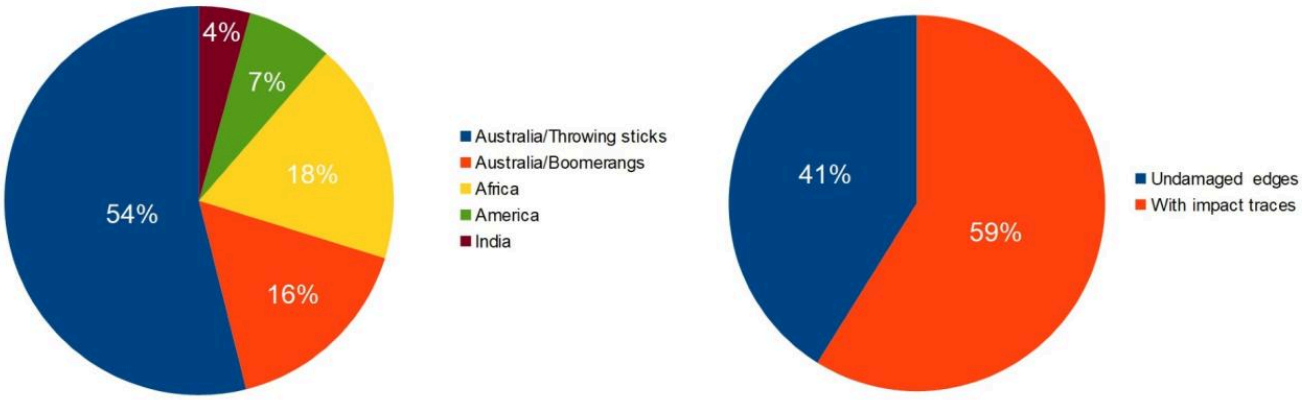

FIG 1. STATISTICS BY ORIGIN CONCERNING THE COLLECTION OF THE QUAI BRANLY MUSEUM WITH THE PROPORTION OF RETURNING OBJECTS (BOOMERANGS) RELATIVE TO OTHER TYPES (THROWING STICKS) WITHIN THE AUSTRALIAN COLLECTION (A) AND THE PROPORTION OF OBJECTS BEARING IMPACT TRACES (B) AGAINST OBJECTS HAVING UNDAMAGED EDGES, (2009, QUAI BRANLY MUSEUM, PARIS).

FIG 2. DIFFERENT TRACES OF SHAPING OBSERVED ON ETHNOLOGICAL THROWING STICKS: FACETING PRODUCED BY A METAL CUTTING TOOL ON N° 71.1957.2.52 5 (2009, QUAI BRANLY MUSEUM, PARIS) (A), TRACES OF FILE USE ON THE END AND ON THE EDGE OF N° ETH.AC.AU.10, 2019, (TOULOUSE NATURAL HISTORY MUSEUM) (B-C), LARGE SCRAPING WRINKLES PRODUCED AT THE ELBOW ON A THROWING STICK FROM QUEENSLAND, AUSTRALIA, (N° 1900-55-130, 2012, PITT RIVERS MUSEUM, OXFORD) (D), FINE SCRAPING WRINKLES PRODUCED ON N° ETH.AC.AU.15 (2019, TOULOUSE MUSEUM OF NATURAL HISTORY) (E), FINE SCRAPING WRINKLES OBTAINED ON AN EXPERIMENTAL JUJUBE (ZIZIPHUS SP.) THROWING STICK (2004, PRIVATE COLLECTION LUC BORDES, GIF SUR YVETTE) (F). IMAGES BY LUC BORDES

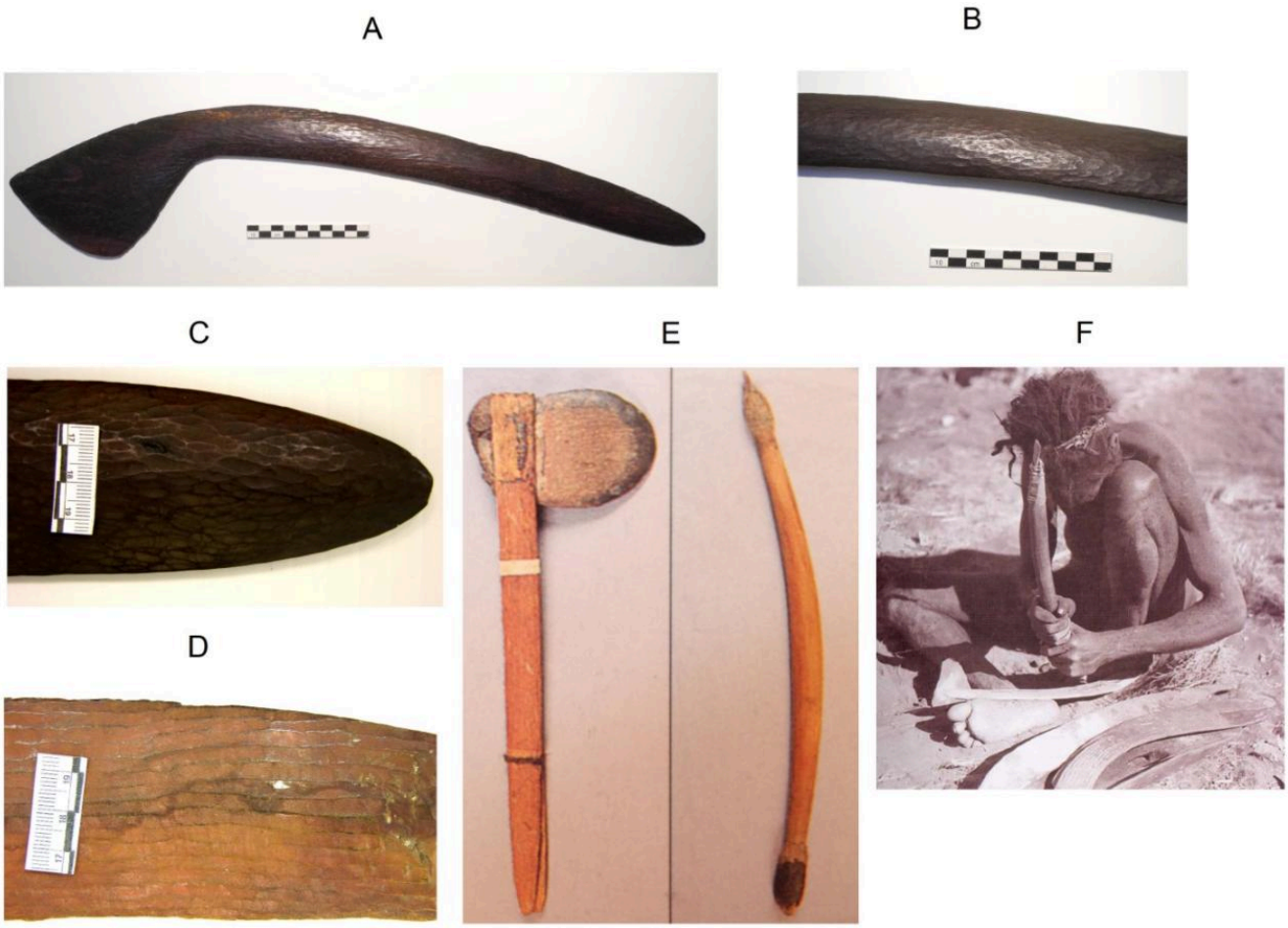

FIG 3. DIFFERENT TRACES OF WORK WITH A HAND ADZE. LIL-LIL TYPE OF THROWING STICK COVERED WITH FINE ADZE MARKS AND DETAIL (A-B) (N° 1884.25.15, 2012, PITT RIVERS MUSEUM, OXFORD). ADZE MARKS ON A THROWING STICK BLADE END (C) (71-1880-39-6, 2009, QUAI BRANLY MUSEUM, PARIS). ALIGNED ADZE MARKS, STARTING IRREGULAR GROOVES ON A KIMBERLEY AUSTRALIA THROWING STICK, (D) (N° 71.1958.43.13, 2009, QUAI BRANLY MUSEUM, PARIS). IMAGES BY LUC BORDES. EXAMPLE OF A STONE HATCHET AND DOUBLE ADZE WITH STONE ENDS (E) INDIGENOUS MAN USING A STONE ADZE FOR GROOVING KYLIES IN THE CENTRAL DESERT (F) (JONES, 1996, P20-21), (1930, ALICE SPRING).

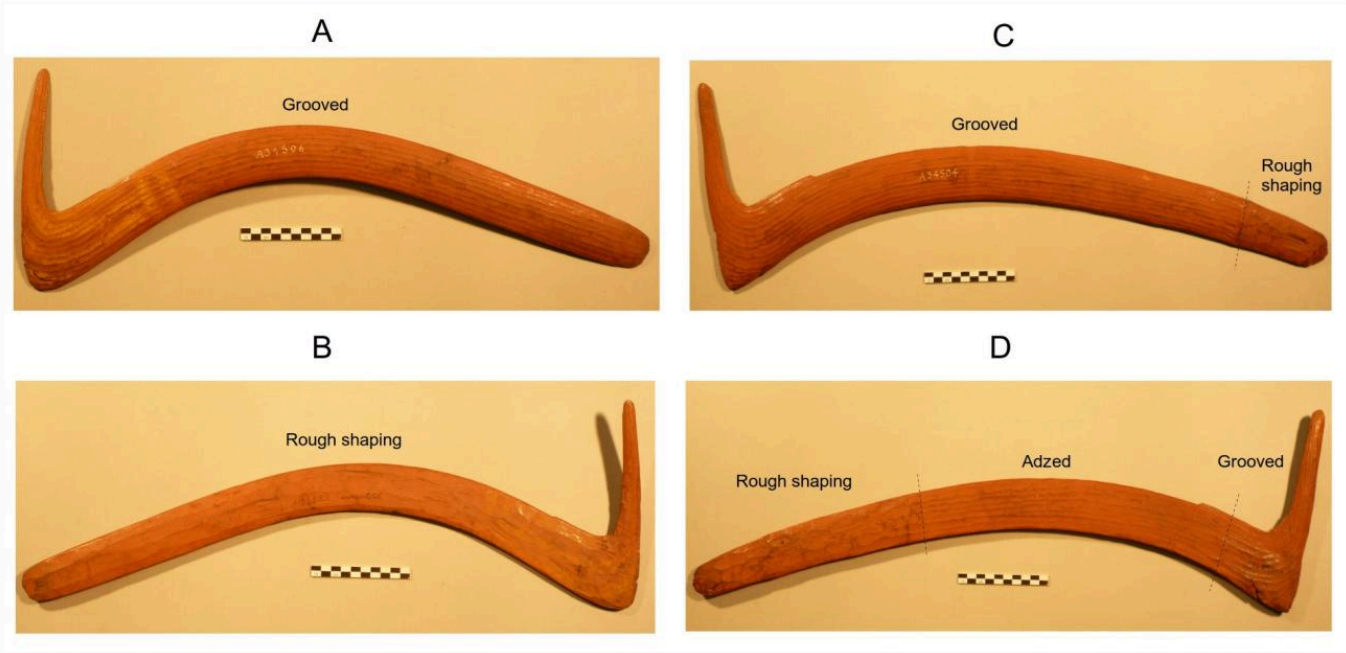

FIG 4. WIRLKI COVERED WITH GROOVES ONLY ON THE UPPER SURFACE (A), THE LOWER SURFACE HAVING BEEN LEFT AS IT WAS AFTER SHAPING WITH A CUTTING TOOL (B) (N ° A34506, 2010, SOUTH AUSTRALIAN MUSEUM, ADELAIDE). WIRLKI WITH INCOMPLETE GROOVING ON THE UPPER SURFACE WITH TRACE OF SHAPING ON THE END OF THE ATTACKING BLADE WHICH SERVES AS A GRIP (C). ON THE INTRADOS THE THREE MANUFACTURE STEPS ARE VISIBLE WITH A GROOVING COMPLETED ON THE END OF THE FOLLOWING BLADE, A REFINEMENT WITH A GOUGE IN THE CENTRAL PART AND ONLY A ROUGH SHAPING ON THE ATTACKING BLADE (D) (N ° A34504, 2010, SOUTH AUSTRALIAN MUSEUM, ADELAIDE). IMAGES BY LUC BORDES

FIG 5. ASYMMETRICAL CRESCENT-SHAPED THROWING STICK FROM QUEENSLAND, AUSTRALIA, WITH CHARRED FOLLOWING BLADE (SHORT DISTAL BLADE, LEFT) (2007, STÉPHANE JACOB PRIVATE COLLECTION, PARIS) (A). KYLIE FROM THE CENTRAL DESERT WITH ATTACKING BLADE (PROXIMAL LONG BLADE OR GRIP) BEARING TRACES OF CHARRING ATTESTING TO USE WITH FIRE (2010, SOUTH AUSTRALIAN MUSEUM DISPLAY CASE, ADELAIDE) (B).

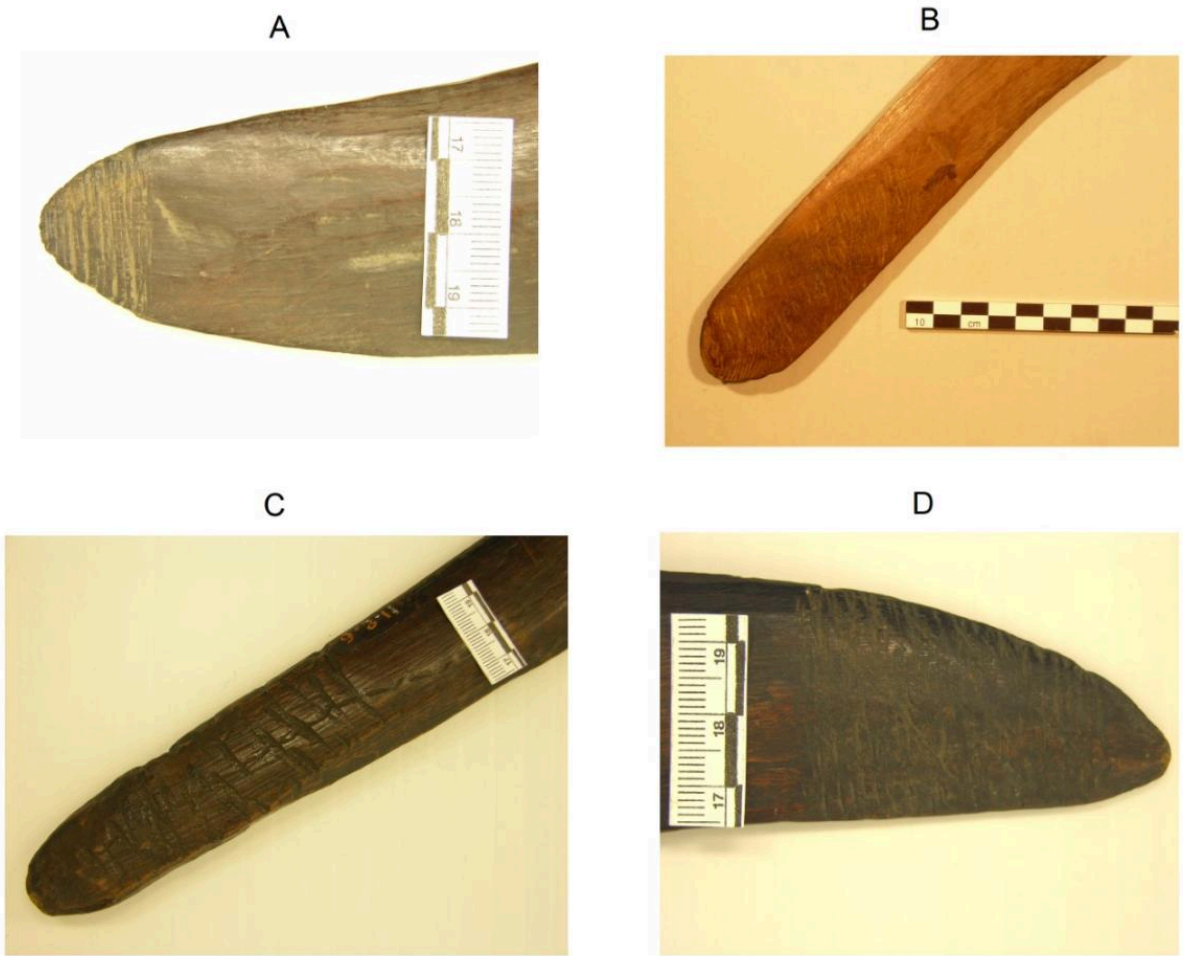

FIG 6. PARALLEL GRIP MARK ENGRAVED AT THE END ON N° 71.1884.86.2, (2009, QUAI BRANLY MUSEUM, PARIS) (A). GRIPPING ENGRAVING ON N° A48719, (2010, SOUTH AUSTRALIAN MUSEUM, ADELAIDE) (B). ENGRAVED GRIPPING LINES ON N° 71.1911.2.6, (2009, QUAI BRANLY MUSEUM, PARIS) (C). GRIPPING ENGRAVING ON N° 71.1962.72.94, (2009, QUAI BRANLY MUSEUM, PARIS) (D). IMAGES BY LUC BORDES

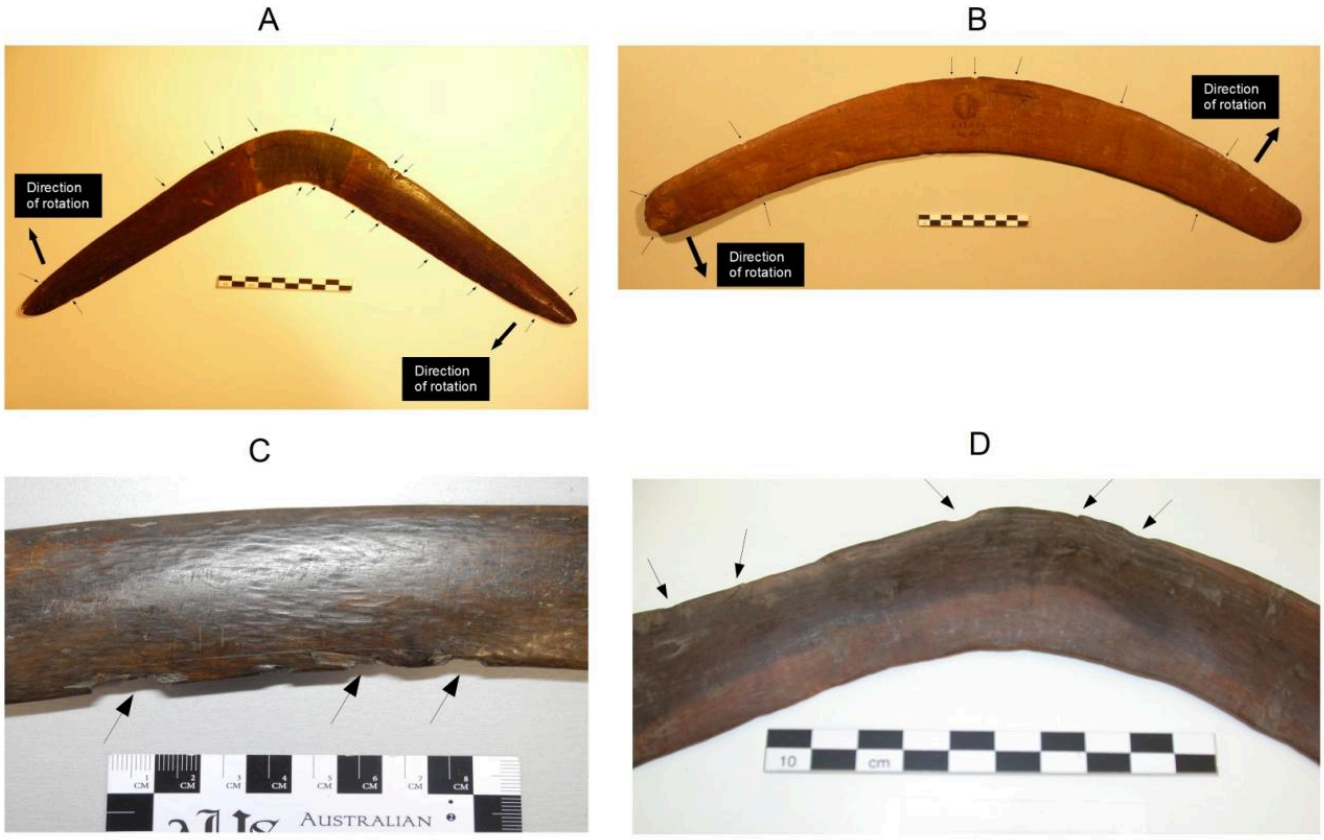

FIG 7. TRACES OF IMPACT NOTED ON A LEFT-HANDED 19TH CENTURY BOOMERANG (2007, STÉPHANE JACOB PRIVATE COLLECTION, PARIS) (A). IMPACT MARKS FOUND ON A BOOMERANG IN SOUTH AUSTRALIA (N° A32059, 2010, SOUTH AUSTRALIAN MUSEUM, ADELAIDE) (B). TRACES OF SHOCKS INSIDE THE BEND OF OBJECT N° ETH-AC-AU-12 (2019, MUSEUM OF NATURAL HISTORY OF TOULOUSE) (C). TRACES OF IMPACT ON THE OUTSIDE OF THE ELBOW OF A WESTERN AUSTRALIAN BOOMERANG (N° 71.1880.20.4 2009, QUAI BRANLY MUSEUM, PARIS) (D). IMAGES BY LUC BORDES

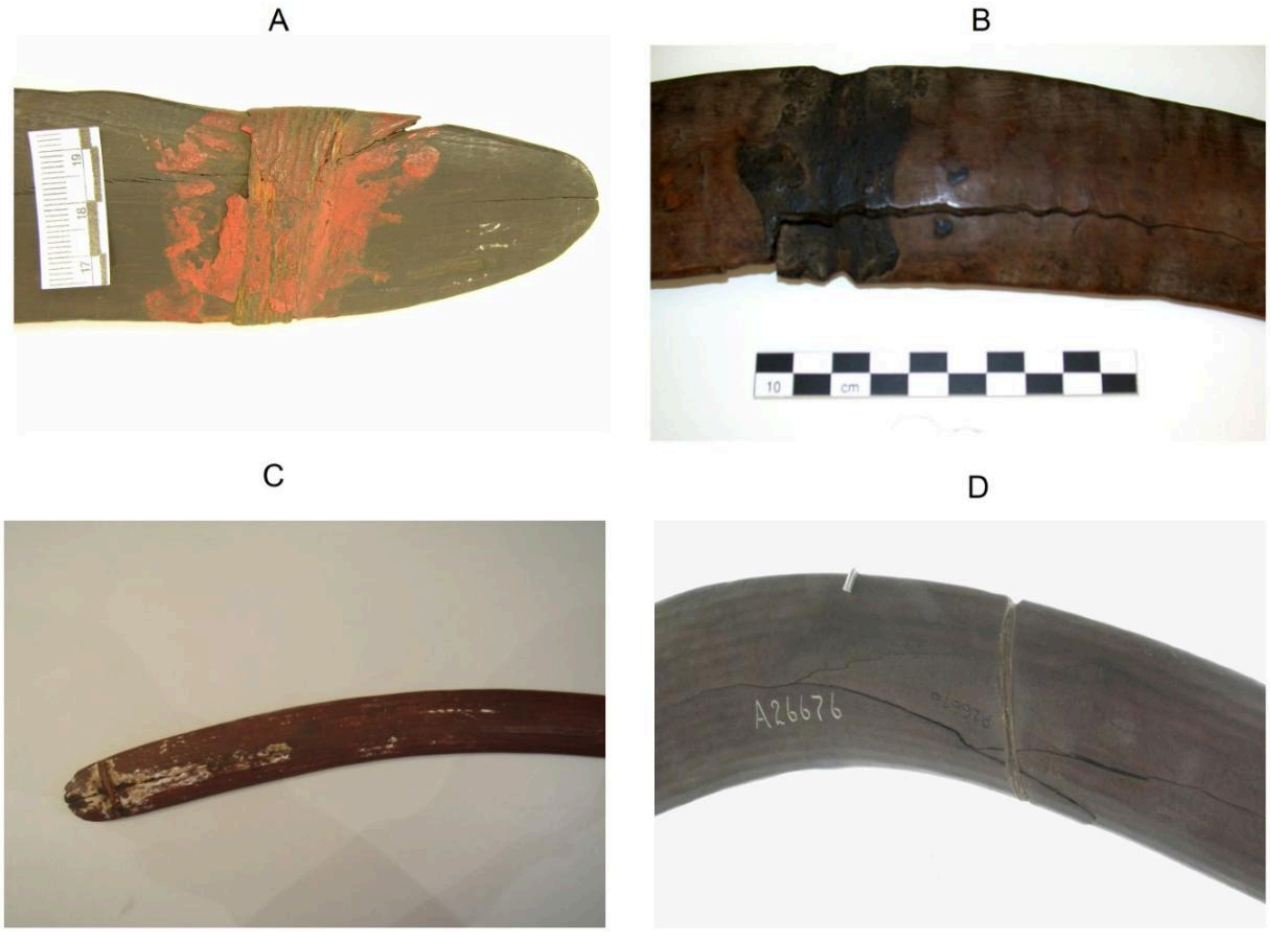

FIG 8. REPAIR OF THE BLADE END WITH A PLANT BINDING CEMENTED WITH RESIN AND COVERED WITH OCHRE (N° 71.1883.3.14, 2009, QUAI BRANLY MUSEUM, PARIS) (A). TRACES OF RESIN AND NOTCH FROM A MISSING REPAIR (N° 71.1883.29.20, 2009, QUAI BRANLY MUSEUM, PARIS) (B). TWO EXAMPLES OF VEGETABLE FIBER TIE REPAIR WITH NOTCH ON GROOVED THROWING STICKS FROM CENTRAL DESERT AREA (PRIVATE COLLECTION) (C) AND (N ° A26626, 2010, SOUTH AUSTRALIAN MUSEUM, ADELAIDE) (D). IMAGES BY LUC BORDES

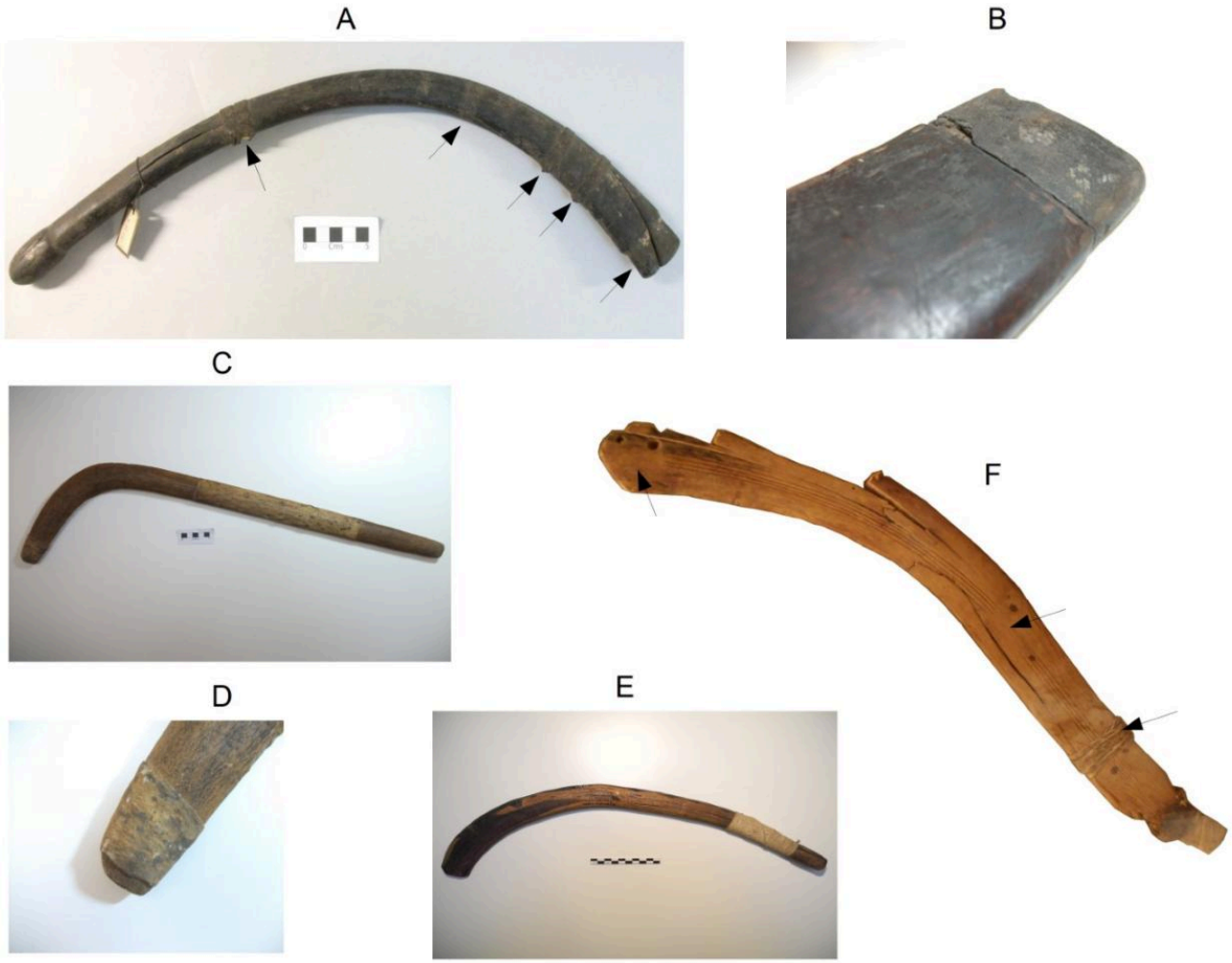

FIG 9. METAL REINFORCEMENT APPLIQUES ON AN INDIAN VALARI, (NO. 1923.28.16, 2012, PITT RIVERS MUSEUM, OXFORD) (A). DETAIL OF A METAL REINFORCEMENT APPLIQUE ON AN INDIAN VALARI, (NO.1884.25.42, 2012, PITT RIVERS MUSEUM, OXFORD) (B). SLEEVE MADE OF ANIMAL SKIN ON A THROWING STICK FROM SUDAN (DARFUR) (NO. 1954.5.99, 2012, PITT RIVERS MUSEUM, OXFORD) (C). DETAIL OF THE REINFORCEMENT OF ANIMAL SKIN ON THE FOLLOWING BLADE OF A THROWING STICK FROM SUDAN (DARFUR) (N ° 1954.5.99, 2012, PITT RIVERS MUSEUM, OXFORD) (D). ROPE REINFORCEMENT ON THE ATTACKING BLADE (PROXIMAL OR GRIP) ON AN INDIAN VALARI (N ° 1923.56.8, 2012, PITT RIVERS MUSEUM, OXFORD) (E). REMAINS OF VEGETABLE FIBER REINFORCEMENT ON THE ATTACKING BLADE OF A PUEBLOS RABBIT HUNTING STICK DATED BETWEEN -500 AND +500 AD, GRAND GULCH, UTAH. (2011, SHOWCASE OF THE NATIONAL MUSEUM OF AMERICAN INDIANS, NEW YORK). NOTE THE INTERRUPTION OF THE DECORATIVE GROOVING AT THE LOCATION OF TWO OTHER MISSING REINFORCEMENTS (F). IMAGES BY LUC BORDES

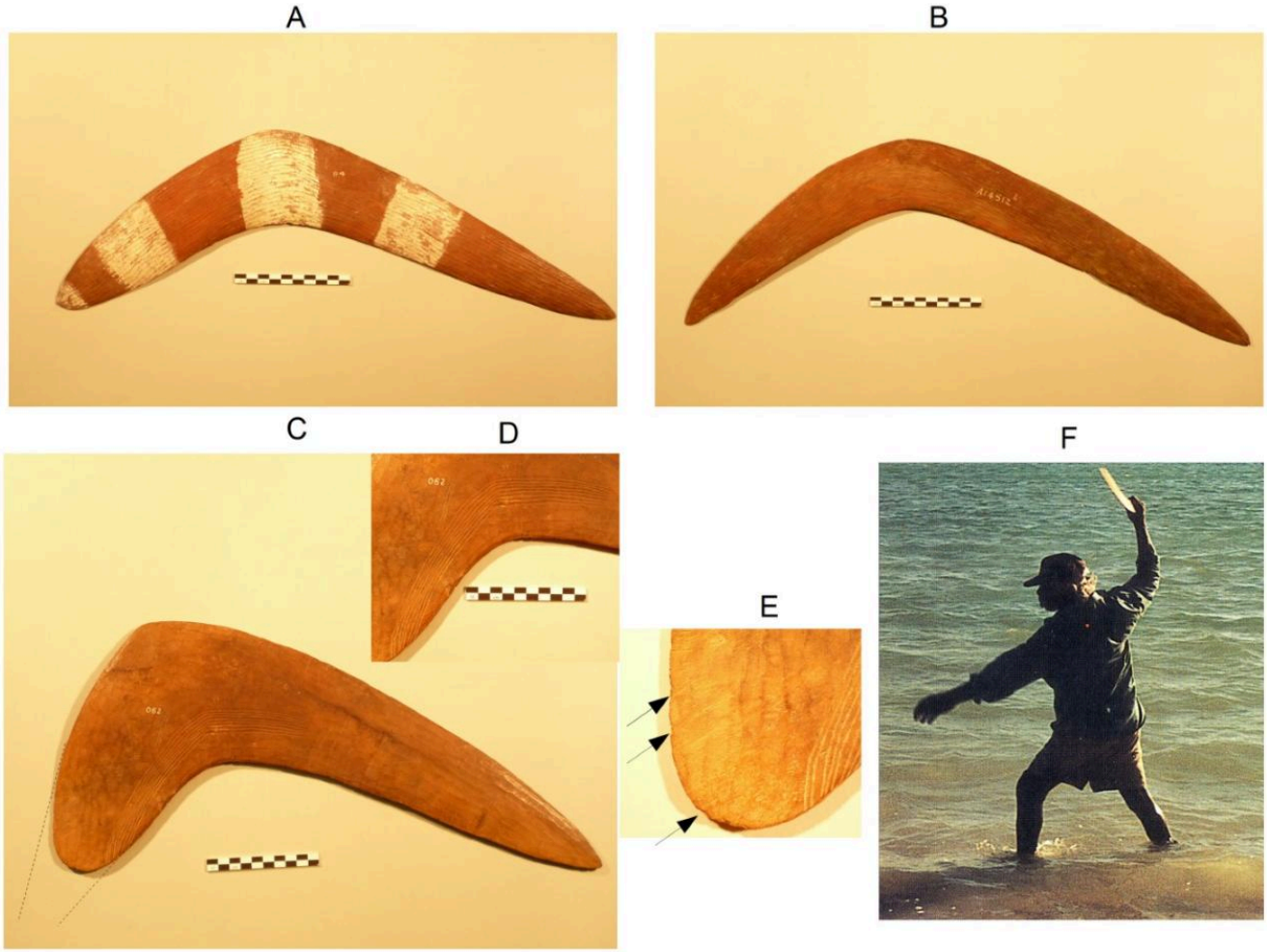

FIG 10. 'V' SHAPED THROWING STICK (NO. A5349E, 2010, SOUTH AUSTRALIAN MUSEUM, ADELAIDE) DECORATED WITH TRANSVERSE BANDS OF WHITE CLAY (A). "V" SHAPED THROWING STICK (NO. A14512, 2010, SOUTH AUSTRALIAN MUSEUM, ADELAIDE) (B). THROWING STICK (NO. A5552, 2010, SOUTH AUSTRALIAN MUSEUM, ADELAIDE) IN THE SHAPE OF A "V" TYPICAL OF KIMBERLEY WITH THE FOLLOWING BLADE (DISTAL) SHORTENED AND ROUNDED (SOUTH AUSTRALIAN MUSEUM) (C). DETAIL OF THE INSIDE OF THE ELBOW AND END OF THE BLADE FOLLOWING SHOWING THAT THE RETOUCHING OF THE BLADE CUT THE GROOVED DECORATION (D). DETAIL OF THE END OF THE FOLLOWING BLADE (DISTAL) SHOWING THE TRACES OF IMPACT ATTESTING TO THE CONTINUITY OF THE PRACTICAL USE OF THIS OBJECT AFTER ITS MODIFICATION (E). IMAGES BY LUC BORDES. AN INDIGENOUS MAN OF THE KIMBERLEY REGION USING A METAL THROWING STICK FOR FISHING (JONES, 1996, P53) (F).

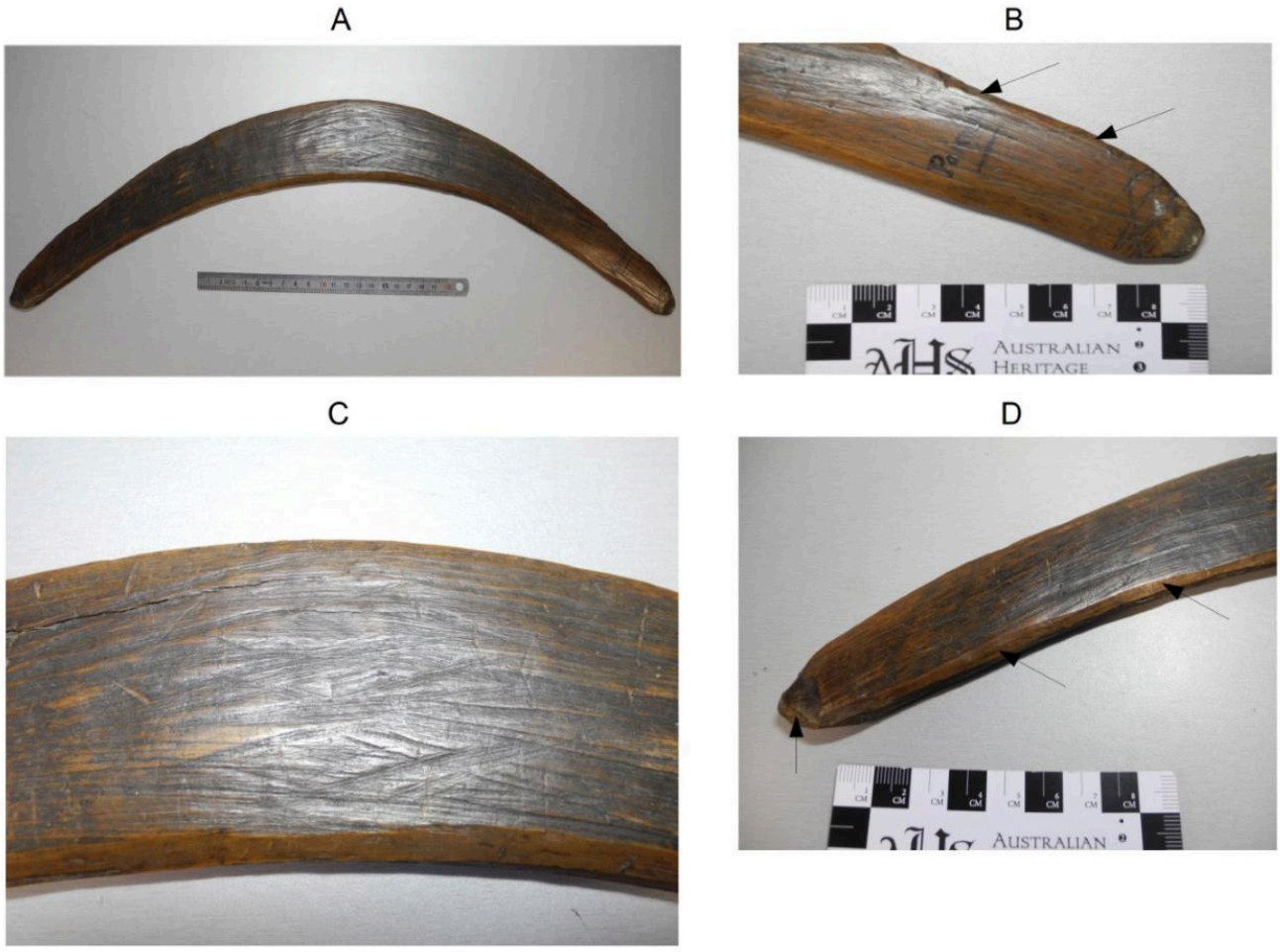

FIG 11. THROWING STICK RE-CUT INTO A BOOMERANG, (N° ETH.AC.AU.14, 2019, TOULOUSE NATURAL HISTORY MUSEUM), WINGSPAN 55 CM, MASS 163 G (A). DETAIL OF THE END OF THE ATTACKING BLADE SHOWING GRIP MARKS ENGRAVED IN CROSSES AND TRACES OF ABRUPT TRIM OF THE LEADING EDGE (B). DETAIL OF THE UPPER SURFACE OF THE ELBOW WITH A HALF-ERASED REMNANT OF DIAMOND SHAPE ENGRAVING (C). DETAIL OF ABRUPT TRIMMING OF THE EDGES ON THE FOLLOWING BLADE AND TRACES OF TOOL BLOWS ON ITS END (D). IMAGES BY LUC BORDES