A Gaulish Throwing Stick from Normandy: Experimental Study

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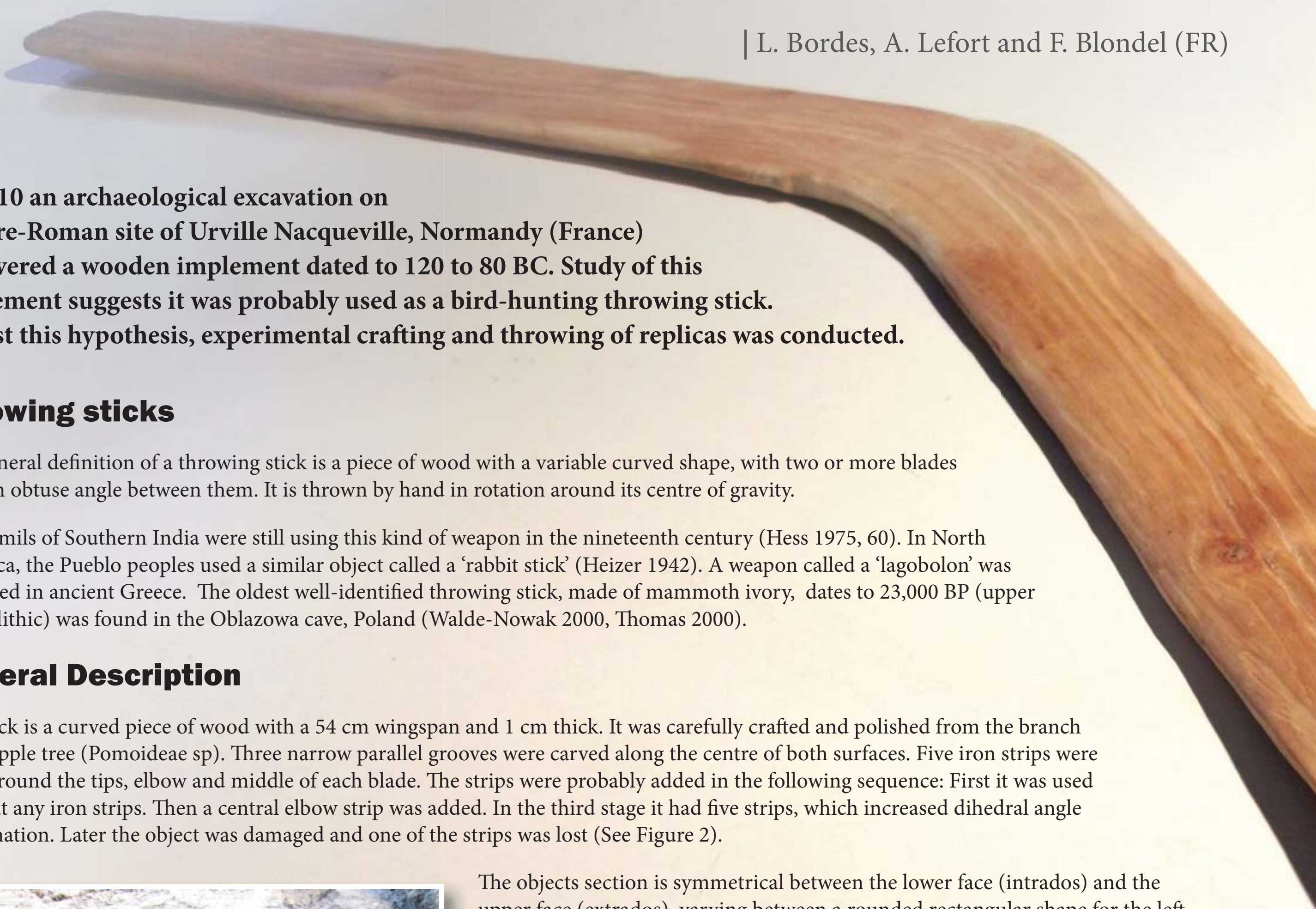

In 2010 an archaeological excavation on the pre-Roman site of Urville Nacqueville, Normandy (France) uncovered a wooden implement dated to 120 to 80 BC. Study of this implement suggests it was probably used as a bird-hunting throwing stick. To test this hypothesis, experimental crafting and throwing of replicas was conducted.

Throwing sticks

The general definition of a throwing stick is a piece of wood with a variable curved shape, with two or more blades with an obtuse angle between them. It is thrown by hand in rotation around its centre of gravity.

The Tamils of Southern India were still using this kind of weapon in the nineteenth century (Hess 1975, 60). In North America, the Pueblo peoples used a similar object called a 'rabbit stick' (Heizer 1942). A weapon called a 'lagobolon' was also used in ancient Greece. The oldest well-identified throwing stick, made of mammoth ivory, dates to 23,000 BP (upper Palaeolithic) was found in the Oblazowa cave, Poland (Walde-Nowak 2000, Thomas 2000).

General Description

The stick is a curved piece of wood with a 54 cm wingspan and 1 cm thick. It was carefully crafted and polished from the branch of an apple tree (Pomoideae sp). Three narrow parallel grooves were carved along the centre of both surfaces. Five iron strips were fixed around the tips, elbow and middle of each blade. The strips were probably added in the following sequence: First it was used without any iron strips. Then a central elbow strip was added. In the third stage it had five strips, which increased dihedral angle deformation. Later the object was damaged and one of the strips was lost (See Figure 2).

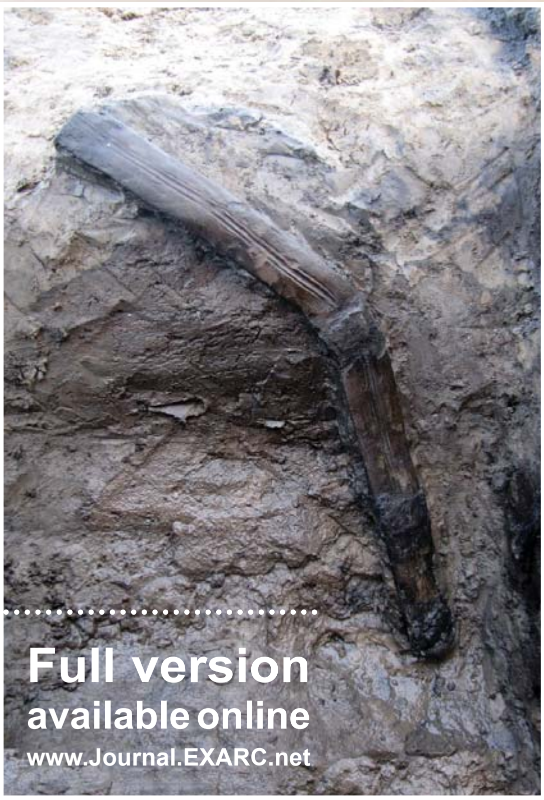

Fig 2. Picture of the artefact discovery along the enclosure trench (François Blondel)

The objects section is symmetrical between the lower face (intrados) and the upper face (extrados), varying between a rounded rectangular shape for the left blade, to a biconvex shape for the right. The consequence of this difference is that the biconvex attacking (right) blade is slightly lighter and takes more aerodynamic lift than the left following blade, which contributes to aerodynamic lift and a curved trajectory.

Careful observation of the object surface reveals some small wood wrenching on the edges which could correspond to impact damage due to its use as a projectile (See Figure 3). This damage can be compared to that on ethnological models (See Figure 3).

Mass to surface ratio is an important parameter for throwing sticks. A low mass to surface ratio throwing stick undergoes more aerodynamic lift and can cause it to follow a curved trajectory. For example, with a ratio under 0.7 g/cm2 it corresponds to a boomerang. Over this value a throwing stick has a curved but not returning trajectory.

The Urville Nacqueville artefacts mass to surface ratio without iron strips is between 0.55 to 0.7 g/cm2 and 0.69 to 1.03 g/cm2 depending on number of strips.

Useful Comparisons

Two archaeological throwing sticks found in Europe shed light on the Urville Nacqueville stick. The first is a boomerang-like object from Velsen, Netherlands (Hess, 1975), of the middle Iron Age period (300 BC). It was made of oak and is similar in shape to the Urville Nacqueville stick. However, its height to wingspan ratio is higher and it is lighter and finer.

The second is the Magdebourg throwing stick, found at Elbschottern, Germany, dated to 800 to 400 BC. Made of ash, its wingspan is 37 cm giving a height to wingspan ratio of 0.67. This projectile belongs to the 'very light' class and probably had returning capabilities.

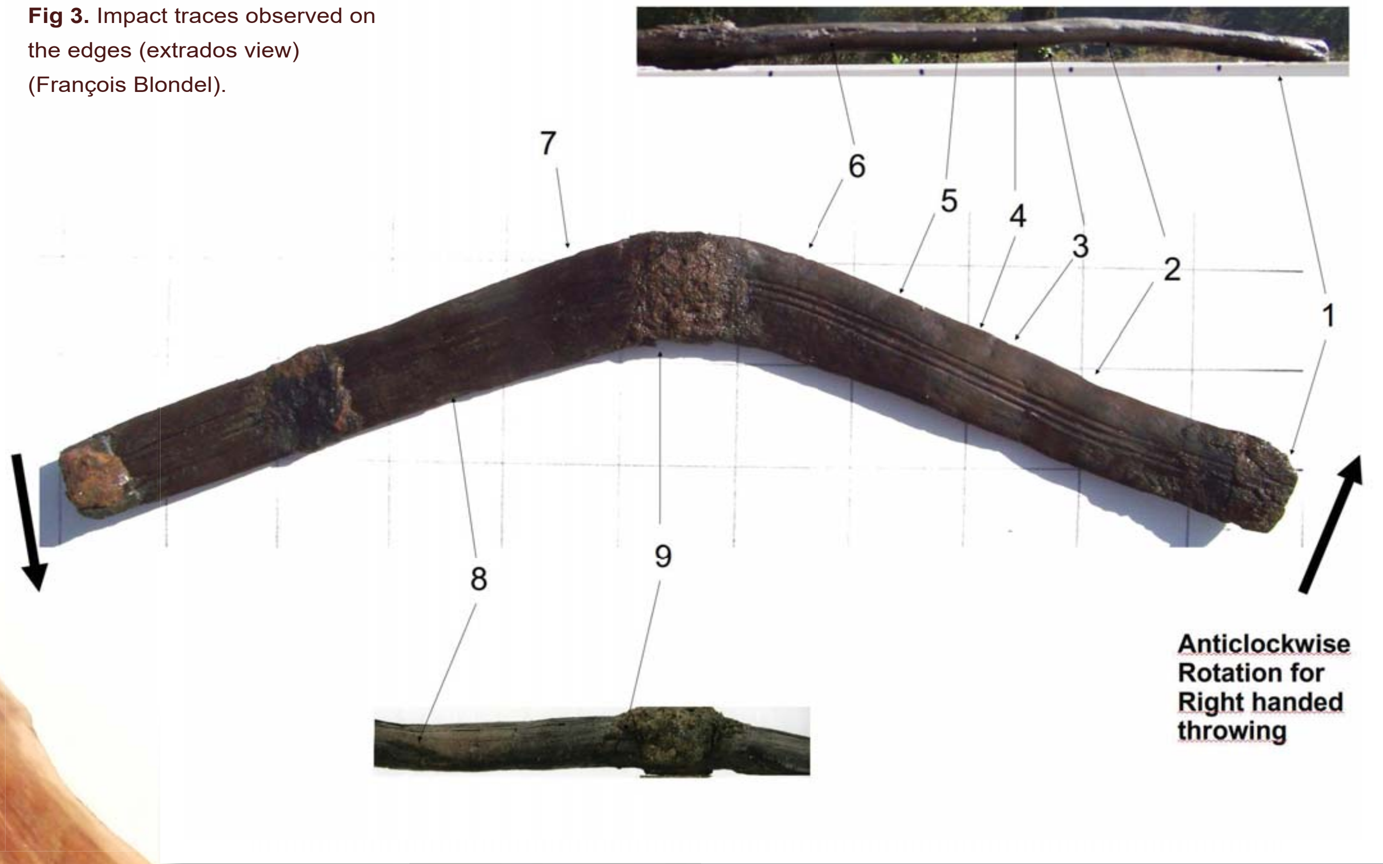

Fig 3. Impact traces observed on the edges (extrados view) (François Blondel).

Fig 1. (Left) Replica A with dihedral angle deformation, extrados (a) and intrados (b) views (Luc Bordes)

Ethnological comparisons are also useful. The Urville Nacqueville artefact has features in common with American pueblo throwing sticks (Heizer 1942). Tamil 'Valari' throwing sticks dating to the nineteenth and twentieth century used iron strips to reinforce and repair. 'Valari' bonded with iron strips were sometimes used in ritual and symbolic roles or exchanged during weddings. (See Figure 5a and 5b)

A third ethnological comparison can be made with throwing sticks and boomerangs from the Lake Alexandrina region of South Australia where they are used for bird hunting.

Arguments for the throwing stick hypothesis

If we compare the artefacts dimensions with ethnological examples it fits within their mean values. A rectangular cross section on the following blade is commonly encountered on American rabbit sticks while the biconvex attacking blade section is the most common airfoil used around the world. Among Aboriginal Australians, mixed types of airfoil on each blade are frequently observed.

Its height to wingspan ratio of 0.26 indicates that it would be stable in flight. Apple wood is compatible with and favourable for a light throwing stick. Iron strips are found on certain types of throwing sticks both for reinforcement and repair.

Fig 4. (Below) Replica A with dihedral angle deformation, extrados (a) and intrados (b) views (Luc Bordes)

Experimental replica crafting and throwing

The replicas were crafted with traditional hand tools as a deliberate choice. A drawback to this method is that it does not lead to exact replicas of the archaeological object but has the advantage of leaving natural irregularities which are a factor in slowing rotation in flight. These differences from the archaeological object were offset by the creation of three replicas (A, B, and C) which bracket the originals characteristics.

Replica A

The first replica was made by Luc Bordes using apple wood and was slightly thinner and lighter (See Figure 1 and 4).

Fig 5a (Top) and 5b (Right). Example of valari showing the two different types of iron strips encountered: a wide welded iron strip at the short following blade extremity and several narrower repair strips fixed with rings (Pitt Rivers Museum, Oxford UK)

The experimentations were done with both dihedral deformation extremities pointing both up and down and different angles to the wind. Throwing the object vertically with dihedral angle deformation pointing downward leads to an uncontrollable trajectory. Throwing horizontally leads to a straighter trajectory but is subject to flight instability. The trajectory obtained with dihedral angles pointing up is more stable, but because of rotation, small wingspan and the light weight of the object, the flight is S-shaped.

Different throwing inclinations were tested from a nearly vertical (typical for boomerangs) through to a more horizontal (typical for heavy throwing sticks). The best trajectory was found to be around 45°. Using a slight positive incidence tuning, done by heating, the throwing stick gained more distance and a more stable flight with a slight curve (See Figure 7). The maximum ranges observed were 35 m for a high trajectory and 45 m for a low trajectory (See Figure 7).

Experiments using ballast equal to the iron strips

1 mm thick lead ballast were attached with adhesive tape to simulate the iron strips but allow changes. Three tests were done with one, four, or five lead ballasts of eight grams each.

With a single eight-gram ballast at the elbow, the projectile's trajectory was a little shorter and higher. In this state the artefact remains efficient for bird hunting (trajectory type 3).

With four eight-gram lead ballasts, range was increased by ten meters. Adding other three lead ballasts dramatically changes the flight of the projectile so that the inaccurate trajectory is straight and low, describing an S figure due to clockwise rotation (trajectory type 1).

Restarting the same experiment with little or no dihedral positive deformations, it was possible to throw the replica with five lead ballasts (trajectory type 2). Indeed, without the deformations the projectile has faster rotation and superior aerodynamic lift leading to a more stable trajectory (See Figure 6).

Making of Second (B) and third (C) replicas

Two others replicas were made to bracket the original artefact's characteristics, specifically its thickness and mass. For the tests, replica B was equipped with four lead weights while replica C was equipped with four steel strips of identical mass to simulate the final state of the artefact.

These replicas, whose masses were closer to the original artefact, were thrown in the same way as replica A and in the same conditions. Trajectories obtained are almost all straight, low and follow an inaccurate S shaped flight (trajectory type 1, Figure 7). Replica B's flights were worst, probably because of its slightly different airfoil and wingspan. Even when all the ballast was removed from B, the same trajectories were observed when keeping the incidence tuning neutral. The flight obtained by a third set of tests after changing the incidence to positive on the attacking blade proved to be both stable and accurate.

Fig 6. Replica weighted with lead fixed by adhesive tape (prepared for four strip test).

The main observations about Replica B and C are that they do not reach enough rotation speed for efficient flight. This is because of their dihedral positive deformations and increased thickness. This lead us to wonder if these deformations really existed on the functional Gaulish object and so a last set of tests was carried with dihedral tuning removed. The results were convincing: Both showed very good flight, with a slight climb and curved terminal trajectory.

The Urville Nacqueville artefacts use as a throwing stick

To get an insight into the use of this artefact as a throwing stick, we need to take into consideration all of its characteristics and the experimental tests results:

Without iron strips, the artefact mass to surface ratio is between 0.52 and 0.66 g/cm², which categorises it as a very light throwing stick (Bordes et al. 2014). It is therefore not surprising to obtain a curved trajectory. On the other hand, adding five iron strips brings the ratio to between 0.66 and 0.8 g/cm², which makes it a light throwing stick, which is a projectile with a straight trajectory.

The artefact's dimensions and wood type show it would not be efficient for ground targets and would break easily. This allows us to infer that it was made as a weapon specialised for bird hunting. Two different trajectories are possible; a low flight to intercept birds on take off or a higher flight to hit them in flight. The strips show the artefact had several different stages and that it needed reinforcement due to damage. The additional mass of these strips tends to increase the range which confirms it use as a throwing stick.

After the addition of iron strips at both mid blade and tips the artefact became less functional as a projectile. Which mean the artefact was probably no longer used for real hunting, but more likely kept as a prestige item.

Conclusions

The Urville Nacqueville throwing stick is unique in the European Iron Age period. Its different stages reflect its transition from hunting projectile to a prestige item with a more symbolic function.

Its discovery shows a continuity of throwing stick usage from the Palaeolithic onwards, despite other projectile weapons being available. One of the main advantages of a throwing stick is its potential to hit multiple targets with a single throw. The Urville Nacqueville throwing stick was found in a coastal swamp area, which are favourable environment for bird hunting, as birds often live there in large numbers. Other such weapons were found in similar environments such as the Elbchottern object from the river Elbe (Evers 1994) and the Velsen object (Hess 1975) found on a coastal site in the Netherlands.

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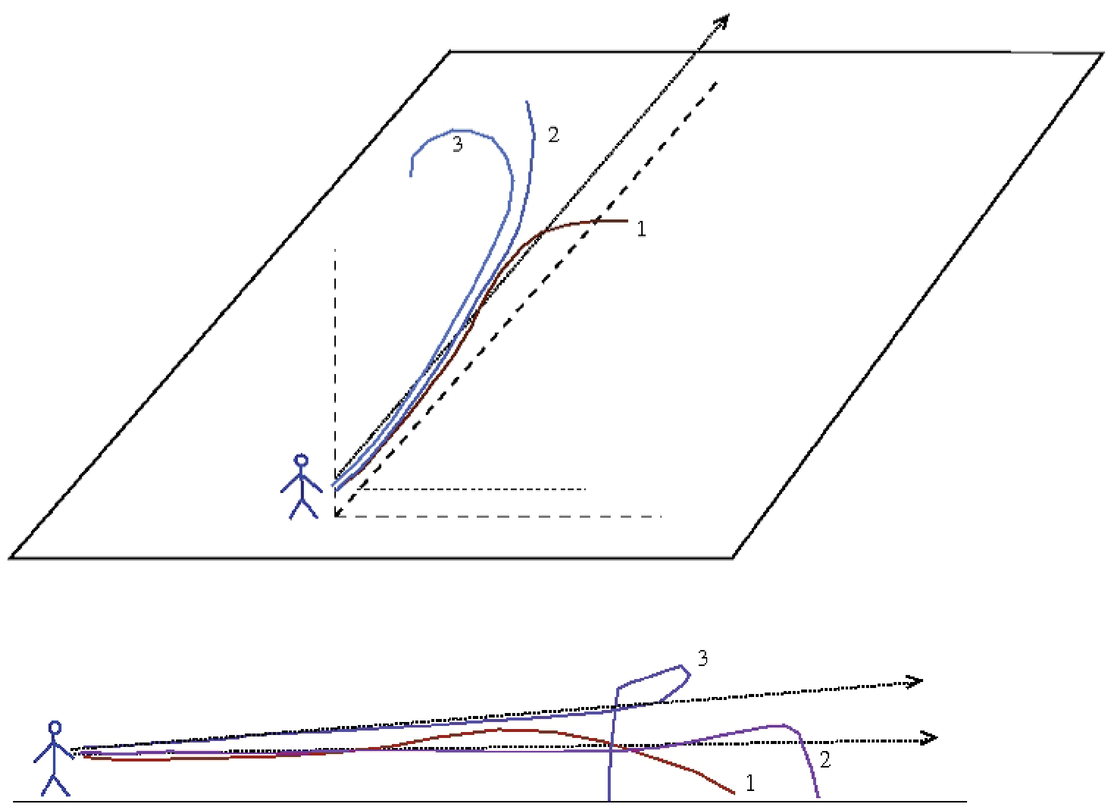

Fig 7. The different typical trajectories observed during the tests: (1) Inaccurate S shaped trajectory by throwing the object horizontally, without incidence or dihedral angle toward the ground: (2) Optimal low trajectory by throwing near vertical plane: (3) Optimal higher trajectory by throwing with a 45° angle from the vertical.