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Application of parabolic cracks in determining handedness in archaeological remains. The case study of the Axlor site (Bizkaia, Iberian Peninsula)

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ABSTRACT

Lithic artefacts are a potential source of information for the study of handedness in different human species. In flint flakes, a system of fractures is developed (parabolic cracks) around the point of percussion in connection with the cone of percussion and the conical fracture of the flint. The orientation of these fractures is linked to the direction of percussion, and therefore to the knapper's handedness. The archaeological remains from Levels III, IV, V and VI at Axlor (Bizkaia, Iberian Peninsula) are studied here in order to determine how well parabolic cracks are preserved in archaeological remains, and whether it is possible to study them if the remains are covered with a patina or damaged.

1. Introduction

Handedness is defined by Corey et al. (2001) as "the individual's preference to use one hand predominately for unimanual tasks and/or the ability to perform these tasks more efficiently with one hand" and is related to the laterality of cerebral functions. Brain functions are asymmetric within the brain (Bisazza et al., 1998) and laterality is one of the clearest etological manifestations of the presence of these asymmetries. Laterality is also clearly related to language, albeit in a complex way (Knecht et al., 2000a). Indeed, the brain functions of language were precisely some of the first brain asymmetries to be detected (Broca, 1861; Wernicke, 1874). The brain areas responsible for language are mostly found in the left hemisphere. However, for a small part of the population they are in the right hemisphere. This proportion of the population is not divided equally among left-handed and right-handed individuals; only 4% of right-handed people possess language in the right hemisphere, whereas for 27% of left-handed people it is in the right hemisphere (Knecht et al., 2000b). If we were able to establish the linguistic capabilities of our ancestors, we would be nearer understanding the origin of the human mind (Martinez and Arsuaga, 2009). In this respect, the study of laterality through the analysis of archaeological remains can provide information for research into language in our ancestors.

The first studies that addressed manual laterality through archaeological objects were undertaken by Semenov (Semenov, 1964), who carried out experiments on Palaeolithic tools that included aspects related to manual dominance. Afterwards, Toth (Toth, 1985) carried out a study of manual laterality through lithic remains. The conclusions of his research were based on the hypothesis that handedness influences the direction in which a core is turned during lithic reduction. According to Toth, a right-handed knapper would turn the core towards the right as the flakes were removed. This habit would tend to result in flakes with the cortex on their right hand side, whereas if the knapper was left-handed, the opposite effect would occur. Later experimental work (Patterson & Sollberger, 1986) established that the geometric shape of the core is more important than the direction of rotation of the core as regards the last flake that is removed, and consequently a left-handed knapper may produce a number of right-handed flakes, and vice versa. In their experimentation, Sollberger produced 56% of right-handed flakes (according to Toth's terminology) despite being left-handed. In the same year, Cornford (Cornford, 1986) published evidence of handedness in lithic resharpening techniques. In a study conducted by Pobiner (Pobiner, 1999) with seven right-handed students at Pennsylvania University, 284 flakes were produced in successive knapping sessions and it was determined that as the number of flakes increased, the ratio of right-handed:left-handed flakes approached 50:50. Therefore, Toth's method can only be applied in a specific reduction strategy, in which flakes are removed from the same platform following a specific

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sequence. It is thus necessary to find a method that is not based on knapping habits, but by proposing hypotheses based on elements directly related to percussion, such as the angle and direction of the hammerstone on the percussion platform. Precisely in this approach, Rugg and Mullane (Rugg & Mullane, 2001) studied the orientation of the cone of percussion on the flake, as it is conditioned by the direction and angle of percussion. In their experiment they studied 299 flakes, of which 75 were considered valid to determine the knapper's handedness. With this restricted collection, they claimed to be able to identify handedness correctly 75% of the time. In this way, the research of Rugg and Mullane (Rugg & Mullane, 2001) represented a significant advance in the study of lithic assemblages from the handedness point of view.

However, it was later demonstrated (Bargalló & Mosquera, 2013) that Rugg and Mullane's method alone is not enough to determine the knapper's handedness. They developed another method by analysing the cone of percussion and other characteristics of the flakes. To do this, they needed several flakes produced by the same person and in the archaeological record it is very difficult to know which flakes have been removed by any given individual. Consequently, this study was limited to refits, in accordance with the disputable premise that all the flakes that refit were knapped by the same person. As a result, this method is not applicable to each individual flake, and most lithic assemblages cannot be refitted. It is therefore important to find a method that can establish reasonably accurately a knapper's handedness even from a single flake. The systems that had been proposed required conditions that made it very difficult to obtain a large enough sample from any assemblage.

Several papers have compiled and discussed some of the methods mentioned above (Ruck et al., 2015, 2019; Uomini & Ruck, 2018). The most recent of these papers, published in 2019, includes comments on the method used in the present study (Dominguez-Ballesteros & Arrizabalaga, 2015). According to the authors, because of the size of the sample and the low percentage of parabolic cracks, the efficacy of the method could not be determined correctly (Ruck et al., 2019).

More recent publications study lithic tools from the perspective of the user and not their manufacturer (Rodriguez et al., 2020) and establish a method using indirect evidence (use traces, micro-scars in particular) of the hand holding the stone tool during use. This method, based on the study of the handedness of the user, is compatible with methods that determine the laterality of the creator of the implement and the same archaeological collections can be analysed from these two approaches.

In the present paper, the stratigraphic sequence at Axlor will be studied to test the application of one of those methods, based on the formation of small fractures we call parabolic cracks in the percussion platform of a flake (Dominguez-Ballesteros & Arrizabalaga, 2015), to archaeological remains as a way to determine the percentage of right-handers in the population that produced those artefacts. The aim of this research is to determine whether parabolic cracks are preserved in archaeological remains, and whether it is possible to study them if the remains are covered with a patina or damaged.

2. Methods

The method used to study the artefacts in the present research, as noted above, was published in 2015 (Dominguez-Ballesteros & Arrizabalaga, 2015) and is able to obtain extensive results by studying a series of fractures that appear in the platform or the butt of the flake made in flint and which are called "parabolic cracks" (Fig. 1A). To verify the archaeological application of these fractures, a blind test was designed in which four knappers (two right-handed and two left-handed, of which one was an expert and the other a novice in each case) produced 300 flakes in the course of several sessions. Later, without knowing the origin of the flakes, each one was classed as R, L or indeterminable (Dominguez-Ballesteros & Arrizabalaga, 2015). Of the 300 flakes extracted in the blind experiment, 198 (66%) were deemed indeterminable because they did not display a parabolic crack. The other 102 flakes (34%) were classified in either the L or R category. Of these flakes, 95 (93.1%) were correctly associated with the handedness of the knapper, as described in the original article (Dominguez-Ballesteros & Arrizabalaga, 2015). These fractures are present in 4.5% of the flakes from the site of Axlor: they acquire an overall parabolic shape and the axis of symmetry of the parabola indicates the direction of percussion (Fig. 1B).

In the development of this method, as described in the original article, a margin of error of 9.36° was established. For this reason, when applying this method, a shadow zone of 20° is established around the vertical axis of the butt of the flake (more than 9.36° on each side of the axis) to ensure that any difference in the measurement of this direction by two different experimenters can never cause the same flake to be classified as R instead of as L and vice versa.

The knapper's handedness can be determined from a single flake with this method, as long as it preserves the parabolic fractures in its butt. In this way, *a priori* the available sample is much larger. However, archaeological levels that have formed over a considerable span of time must be studied. Knapping workshop levels should be excluded as they will contain numerous flakes removed by the same knapper, which will invalidate any conclusion from the point of view of populational handedness. In contrast, in archaeological levels deposited over a long period of time and with a considerable number of remains, it is unlikely that a large proportion of flakes were produced by a single individual, also bearing in mind that only flakes with a parabolic crack are studied, which represents a small percentage.

When a flake is removed from a flint core, the hammerstone impacts the percussion platform violently. Approximately 88% of the flakes produced by direct percussion with a hard hammerstone (limestone) develop parabolic cracks around the percussion point, caused by the

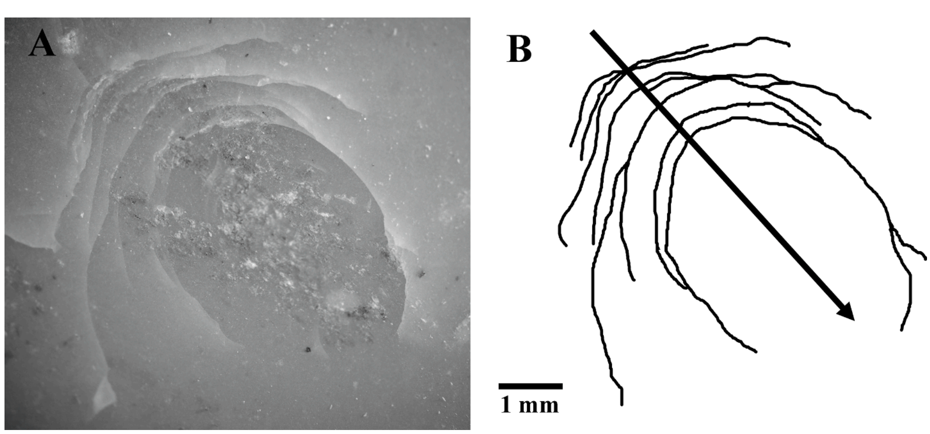

Fig. 1. Detail of parabolic cracks: (A) real photography, (B) scheme showing the direction and line of the parabolic crack vector.

impact of the hammerstone on the percussion platform (Dominguez-Ballesteros & Arrizabalaga, 2015). Nevertheless, in 66% of these cases, the parabolic crack is incomplete or not identifiable. In addition, in the case of flakes with linear, cortical and punctiform butts, and when the fragment of the percussion platform is not large enough for these fractures to be recorded, they simply do not appear, or are very weak, which reduces the number of flakes with parabolic cracks that can be studied in a complete collection.

We should therefore bear in mind that not all the flakes found in a deposit were produced by direct percussion with a hard hammer. Additionally, the butt of many pieces is broken or is simply too small to develop these fractures. Moreover, in most of the cases in which they are present, they are incomplete or illegible. Consequently, the flakes with well-preserved parabolic cracks represent 4.5% of the total number of pieces studied here, as will be explained below.

To understand how these fractures are formed and how they are oriented according to the direction of percussion, it should be considered that there is a certain angle of percussion when the core is hit. As the human arm pivots around the shoulder, elbow and wrist, many of the blows on the percussion platform with the hammerstone will not be vertical (Rein et al., 2013; Williams et al., 2010) and, therefore, the core is struck at an angle. In the usual knapping process the core is held in one hand and the hammerstone is held in the other. To obtain a flake from the same part of the core, left-handed and right-handed people hit the surface with an equivalent, but mirrored, angle and direction. The existence of this angle of percussion means that the direction of percussion is different for left-handed and right-handed people, and parabolic cracks are oriented according to this direction. Consequently, the parabolic cracks acquire an equivalent, but mirrored, orientation if the flake has been removed by striking the core with the hammerstone in the right or left hand. Depending on its orientation, a flake with this type of parabolic fracture in the butt can be classified classified into two categories, called R and L (Dominguez-Ballesteros & Arrizabalaga, 2015).

To classify the flakes, they are placed with their ventral face upwards and the butt is viewed by looking onto its vertical plane (Fig. 2 A). The line joining the ends of the intersection of the ventral face with the butt is established as the horizontal reference axis (Fig. 2 B); in most cases this line represents the maximum width of the butt. The next step is to draw the parabolic vector, whose direction is that of the axis of symmetry of the parabola formed by the fractures and its line towards the concave part of the parabola is established (Fig. 2 C). From that point, a vertical axis is determined perpendicular to the horizontal axis and the angle it forms with the parabolic vector is measured from the positive or upper part of the vertical axis (Fig. 2 D).

The flake is classed as Type R if this angle is on the right-hand side of the axis (positive), or as Type L if it is on the left-hand side (negative) (Fig. 3). Flakes are classed as indeterminable if this angle is less than 9.36° (according to the error determined experimentally), and if these cracks are undetectable (Dominguez-Ballesteros & Arrizabalaga, 2015).

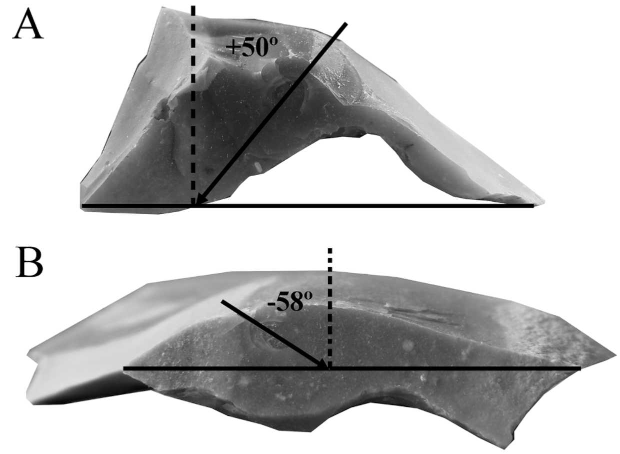

Fig. 3. Cracks produced in the butt by percussion in the case of flakes extracted by right-handed (A) and left-handed (B) knappers. The percussion directions and lines obtained by the parabolic axis of symmetry are shown.

2.1. *Margin of Error*

In order to study the percentage of right-handers in an ancient population through its flakes, first, we have to assume that each individual contributes a single flake to the record. Although we understand that certainly the same knapper can contribute several flakes to an archaeological assemblage, this would only become a real problem in the case of workshop levels that accumulated in a short time. Therefore, to avoid this issue, levels accumulated over long periods of time and with abundant flakes have been studied. This is because we suppose that in a level where a large number of flakes accumulated over a long time, the likelihood of finding two flakes knapped by the same person is very small, especially as in the end only about 4.5% of the flakes display parabolic cracks. Furthermore, they are examined to verify that they do not refit with one another. Second, when studying a population without access to all its individuals, in order to know the proportion of those who achieve a certain condition, a sample of this population has to be studied. The size of the sample studied in this work is 232 flakes, and we are interested in knowing the error that may exist between the percentages of left-handed and right-handed people obtained from this sample and the real percentages of the study population. This error can be calculated using the following equation:

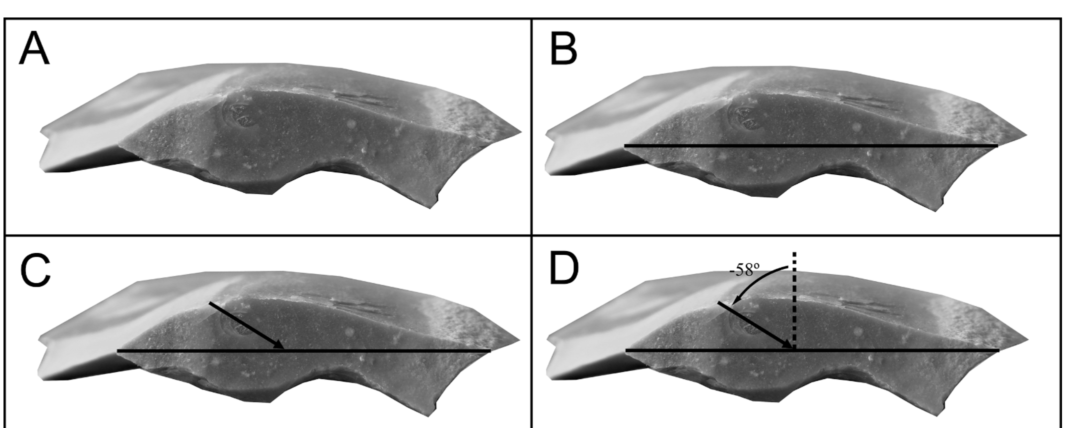

Fig. 2. Graphic representation of the application of the method in faur steps (A, B C, and D).

$$n = \frac{Z^2 pq}{e^2}$$

Where “n” is the size of the sample, “Z” is a value that represents the confidence interval, “p” is the estimated proportion, “q” is “1 - p” and “e” is the margin of error.

2.1.1. Estimated proportion

Normally in studies with access to the population being studied, an exploratory study is carried out to obtain preliminary data and calculate the required sample size. This is because the minimum size of a representative sample of a population to measure a quality that is present, for example, in 10% of the population, is smaller than the sample size required to measure a quality that is present in only 0.01%, for example. To calculate the appropriate sample size it is not necessary to know the exact proportion (obviously, if the exact proportion were known, the study would be unnecessary); a rough estimate is sufficient. In our case, we can make an estimate from studies that have been made in modern societies (Connolly and Bishop, 1992; Marchant et al., 1995; Raymond and Pontier, 2004; Faurie et al., 2005) (Table 1). First, obviously, no population can have a higher proportion of right-handed people than 100%. We also know that none of the populations studied currently has a larger number of left-handers than right-handers, so it is reasonable in principle to limit the expected ratio to between 50% and 100% of right-handers. In addition, we have some specific studies in non-industrialized societies, whose levels of handedness may resemble more closely those that might be found in non-industrialized prehistoric societies like those being studied here. These studies are detailed in the following table.

From the data in Table 1 we can set a proportion of right-handed people of between 73.1% and 89.8% for non-industrialized populations. The central value of this range is 81.5%, so we can suppose that the proportion of right-handed people in a prehistoric population will be around this value (p = 0,815).

2.1.2. Confidence intervals

This value is established by the researcher depending on the degree of confidence that he wishes to obtain. In this case we have chosen a 95% confidence level (Z = 1.96).

2.1.3. Margin of error

Applying the formula mentioned above and knowing the estimated proportion (p), the confidence interval (Z) and the size of our sample (n) we can say that the error (e) on the percentage of right-handers corresponding to the total number of flakes studied (n = 232) is ± 4.99%.

Table 1
Percentage of left-handed individuals obtained in handedness studies of different populations.

% left-handed	Country	Task	Method used to measure handedness	Reference
10.2	Gabon (Baka tribe)	Using a machete	Observing the task	Faurie et al. (2005)
15	Papua New Guinea	Hammering	Observing the task	Connolly and Bishop (1992)
15	Botswana (G /wi San tribe)	Using tools	With a video	Marchant et al. (1995)
16	Venezuela (Yanomami tribe)	Using tools	With a video	Marchant et al. (1995)
19.6	Papua New Guinea	Throwing	Observing the task	Raymond and Pontier (2004)
21	Namibia (Himba tribe)	Using tools	With a video	Marchant et al. (1995)
26.9	Indonesia (Eipo tribe)	Archery	With photographs	Faurie et al. (2005)

3. Materials and results

In the present study, remains from Levels III, IV, V and VI at the site of Axlor have been studied. These levels fulfil the conditions for a study of the handedness of the human groups that formed them following the method described above. First, they have yielded a large number of remains that preserve the butt: waste products, unretouched flakes and tools on flakes. Second, the good state of preservation of these flake butts allows the parabolic fractures to be observed appropriately. Third, the levels formed over long periods of time, so the probability of finding several flakes removed by the same individual is low. Finally, only about 4.5% (250 flakes) of the 5,512 flakes that have been studied display parabolic cracks, so the probability of including several flakes produced by the same knapper is even lower. In this way, we may assume that each flake corresponds to a different individual and each individual is represented by a single flake.

The cave of Axlor is in the municipality of Dima (Biscay) (Fig. 4). It is in an enclosed valley, with very rugged relief (Rios-Garaizar, 2005). The entrance of the cave is at 320 m above sea level and 20 m from a stream, and it faces north-northwest (Baldeón, 1999).

The deposit was discovered by J.M. de Barandiaran in 1932, when he found some archaeological remains that he published in the same year. However, Barandiaran did not commence the systematic excavation of the deposit until 1967. First, he opened a longitudinal trench along what he called Band 11, and this showed that the cave had been partly emptied as a consequence of livestock farming in the area (Baldeón, 1999; Barandiaran, 1980). As a result, Levels I and II are only present in a part of the cave that was protected by a block of limestone fallen from the roof, and Level III is the first to extend more generally and is more intact from the archaeological point of view (Baldeón, 1999).

Beginning in 2000, the site was again excavated by J. E. González-Urquijo, J. Ríos-Garaizar and J. E. Ibáñez-Estévez, who concentrated on the interior fill in the rock-shelter, where they excavated a total of 14 m^2 around Barandiaran’s original test pit, with the main aim of establishing the stratigraphic sequence with greater precision (Rios-Garaizar et al., 2003).

In this section, we have studied the remains found in Barandiaran’s excavation of Levels I, II, III, IV, V, VI, VII and VIII, which are equivalent to the levels detected in the excavations carried out since 2000. In both cases, a barren layer was detected in the stratigraphy. In the old excavations, this layer corresponds to Level I and Level II which yielded only 12 archaeological remains, whereas it was named Level A in the excavations after 2000. Similarly, the archaeological Levels III, IV and V excavated by Barandiaran correspond to Levels B, C and D in the recent fieldwork, although not exactly, because part of Level V and Level VI correspond to Levels F and M. Finally Levels VII and VIII correspond to

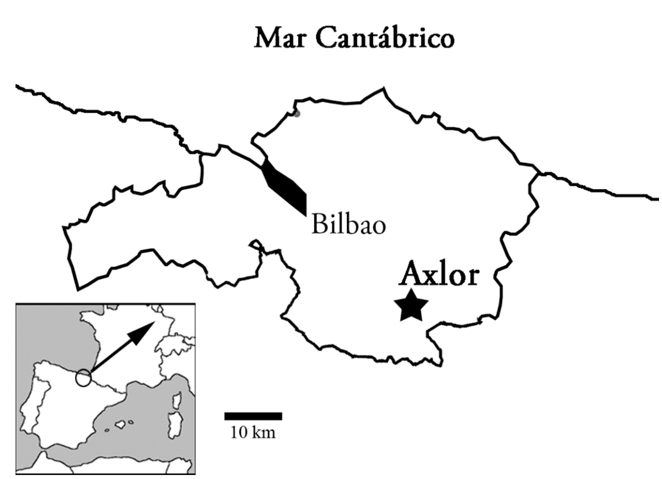

Fig. 4. Location of the Axlor site.

Levels M and N, and in both cases these are the last levels above the base of the known stratigraphy (Rios-Garaizar, 2005; Rios-Garaizar et al., 2003).

Levels 0, I and II are practically barren from the archaeological point of view and therefore have not been studied here. Similarly, Levels VII and VIII yielded few pieces with parabolic cracks (13 and 5 respectively). However, these levels are included in the calculation of a 4.5% percentage of flakes with parabolic cracks and in the total of 5,512 remains that have been studied in order to determine the total proportion of flakes with a parabolic crack. However, for the above reason, they are not included in the results given below. Therefore, the present study has examined the pieces from Levels III, IV, V and VI, as described below.

3.1. Level III

This level is 25 cm thick and reaches a depth of −255 cm below the surface level. It is a reddish sandy-clayey deposit with numerous cobbles and gravel. It contains an extraordinary abundance of osseous remains and lithic pieces (Baldeón, 1999). Moreover, three human molars, a premolar and a canine were found next to two sidescrapers and an arrowhead (Baldeón, 1999; Barandiaran, 1980). In the study of the parabolic fractures, 899 pieces from this level have been examined, of which 359 (39.9%) were discarded because they lacked a butt, the part in which those fractures form. The other 60.1% (n = 540) were considered susceptible of presenting a parabolic crack. Among these pieces with a butt, 92.2% did not possess such a fracture, while the other 8.1% (n = 44) did display a parabolic crack and were studied.

3.2. Level IV

This level consists of a clayey-sandy deposit that is harder at its base than at the top. It is about 50 cm thick, between the depths of −255 and −300 cm below the superficial Level 0. It is the richest level in the whole sequence, in terms of both the fauna and the lithic assemblage (Baldeón, 1999). To study the parabolic cracks, 3,989 pieces from this level were examined, of which 1,614 (40.5%) were discarded because they did not possess a butt. Of the remaining 59.5% (n = 2,375) were susceptible of displaying a parabolic fracture. Of these, 94.7% lacked such a fracture, while the other 5.3% (n = 127) did display a parabolic crack and were studied.

3.3. Level V

This level is a loose sandy deposit with numerous angular limestone pebbles and some pockets of more compact clay. It is 40 cm thick and reaches a depth of −340 cm below the superficial Level 0 (Baldeón, 1999). It contains numerous archaeological remains and as, *a priori*, these are susceptible to being studied from the viewpoint of handedness, this level has been included in the present study. A total of 884 pieces have been examined for parabolic fractures, of which 354 (40%) were discarded as they lacked a butt, the place where these fractures form. Of the other 60% (n = 530) with a butt, 94% did not display a parabolic crack, while the remaining 6% (n = 32) possessed these fractures and were studied.

3.4. Level VI

This level consists of stony compact earth which is ash-coloured in some parts and darker in others, with hearths on its east side and looser and sandier in the rest, according to Barandiaran (Baldeón, 1999; Barandiaran, 1980). This level is about 40 cm thick and therefore reaches a depth of −380 cm below the surface level (Baldeón, 1999). It also contained numerous remains, although in this case, only 6 m^2 were excavated (only in Band 11) and for this reason has also been included in the present study. A total of 441 remains have been examined, of which 165 (37.5%) were discarded because of the absence of a butt. The other 62.5% (n = 276) were considered susceptible of possessing a parabolic fracture. Of the pieces with a butt, 89.5% did not display such a fracture. The other 10.5% (n = 29) with a parabolic crack were analysed.

Of all the pieces that were studied, 44 flakes from Level III, 127 from Level IV, 32 from Level V and 29from Level VI contained well-preserved parabolic fractures that were studied from the viewpoint of handedness. They were all measured, photographed and classified based on the direction of the axis of symmetry of the parabolic crack. Table 2 gives the number of flakes that have been classified in each type.

Fig. 5 shows two of the flakes in the present study. In the detailed photograph of the butt, a horizontal axis has been marked as the point of reference to orientate the flake. The area with the parabolic cracks has been enlarged and accompanied by a diagram. The direction and line of the axis of symmetry of the parabolic cracks has been marked, as described in the methodology, and the angle that they form with the vertical axis has been shown. Those that are on the right are positive (A), signifying an R-type parabolic crack, while those that are on the left are negative, signifying an L-type crack.

An average of 4.5% of the flakes studied in each level display parabolic cracks. From the percentages of L and R flakes, the ratio of left-handed/right-handed knappers has been calculated for each level in the cave. Table 2 shows that this ratio varied between 3/7, in the case of the largest proportion of left-handers, and 2/8 with the most right-handers.

These should be considered preliminary results as the main objective of the present study was to explore whether the method described previously was applicable to archaeological assemblages. It will be necessary to study other archaeological levels in the future to corroborate, nuance or discard these results. However, the present investigation has shown that the methodology is applicable to archaeological materials and provided initial data about the degree of laterality that might be found in levels studied in the future.

4. Discussion

The methodology tested in this paper was developed in 2015 to study handedness in prehistoric populations through their archaeological remains. The method is based on the study of flakes and was tested experimentally with positive results. The artefacts from Axlor are the first archaeological materials to which the method has been applied. At first, it was not known whether parabolic cracks are preserved in archaeological remains, or whether it was possible to study them if the remains were covered with a patina or damaged. However, the study of the flakes from this site has shown that parabolic cracks are preserved satisfactorily. In the archaeological remains that have been studied the percentage of flakes with well-preserved parabolic cracks is only 4.5%, but this still permits the study of a significant sample and can be applied to large archaeological assemblages.

It is necessary to ensure that the handedness of the same knapper is not being studied repeatedly, examining several flakes removed by the same person as if each one had been knapped by a different individual. To achieve this, the levels must have been deposited over a long period of time, as the likelihood of finding several flakes preserving parabolic cracks (which make up only about 4.5% of the total number of flakes in the assemblage) removed by the same individual is reduced

Table 2
Results of the study of the flakes from Axlor.

		Type of parabolic crack		
	Total	L	R	L/R ratio
Level III	44	10 (22.7%)	34 (77.3%)	2/8
Level IV	127	37 (29.1%)	90 (70.9%)	3/7
Level V	32	7 (21.9%)	25 (78.1%)	2/8
Level VI	29	10 (34.5%)	19 (65.5%)	3/7
TOTAL	232	64 (27.6%)	168 (72,4%)	3/7

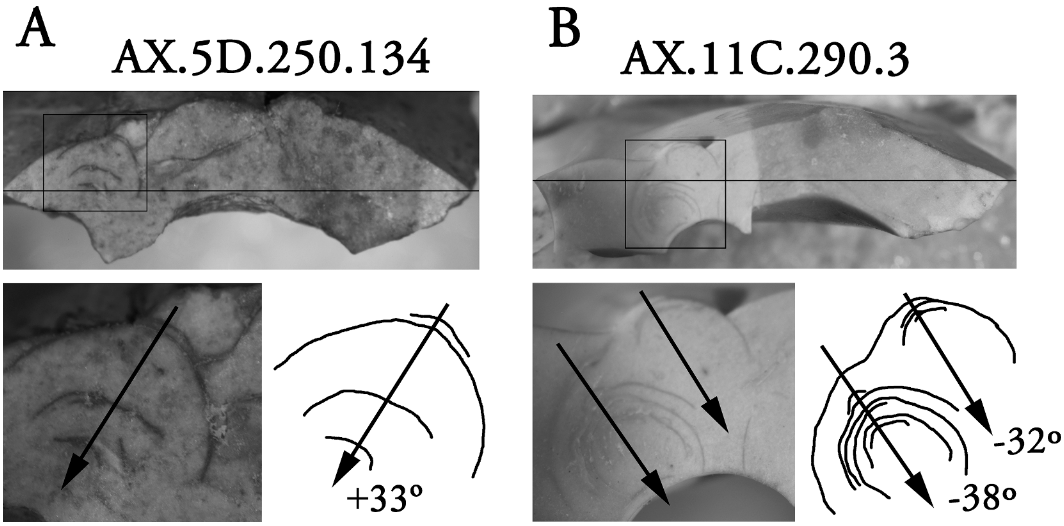

Fig. 5. Photography of two of the flakes from Axlor showing the direction and line of the parabolic vector.

considerably. Consequently, the study of workshops or other types of levels that have formed in short periods of time is not appropriate. In this regard, the levels studied here fulfil that condition.

If we compare the populational handedness obtained in this study of Neanderthal populations with the degree of handedness in modern societies, we can see that ratios of 22.7%, 29.1%, 21.9% and 34.5% respectively of left-handed individuals in each level, and 27.6% (±4.99%) on average for all the levels together (Table 2), differ significantly from the ratios in industrialised societies like Japan with 5% or USA with 7.1% (Raymond & Pontier, 2004), but are similar to the results obtained in non-industrialised societies like the Himba tribe of Namibia with 21% left-handed people (Marchant et al., 1995) or the Eipo tribe of Indonesia with 26.9% (Faurie et al., 2005).

5. Conclusions

Through the study of the archaeological remains from Axlor, it has been shown that this method can be applied satisfactorily in the case of 4.5% of the flakes preserving the butt. It has been shown that in the artefacts that were finally studied, the parabolic cracks can be observed appropriately and their axis of symmetry can be measured accurately. It is therefore feasible to calculate the direction of percussion and determine the handedness of the knapper.

The handedness ratios determined in this particular research are what might be expected. The levels of right-handedness are lower than recorded in studies of modern industrialised societies and are similar to those of non-industrialised societies. Even so, the conclusions referring to hand laterality presented in this paper are absolutely preliminary and above all demonstrate that our methods are applicable to the archaeological record. Future research and studies of more archaeological levels using this method will contribute further information that will help to refine an understanding of the phenomenon of laterality in prehistory.

CRediT authorship contribution statement

Eder Dominguez-Ballesteros: Conceptualization, Methodology, Investigation, Writing – original draft, Funding acquisition. **Alvaro Arrizabalaga:** Resources, Writing – review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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