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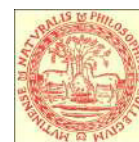


Image analysis technique for the identification of archaeological *Prunus* fruit-stones of Sardinia

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Introduction

Fruit remains from the genus *Prunus* L. are frequently recovered during excavations in archaeological waterlogged contexts since prehistoric times. The identification of *Prunus* based on traditional methods is difficult due to the morphological range variation within the different taxa, mainly due to hybridization problems (Woldring 2000). Despite this, some research shows that *Prunus* fruit-stones would be the most stable of the all diagnostic characters used for their identification (Depypere et al. 2007).

In the last two decades, to properly identify the remains found in archaeological contexts and to overcome the manual procedure for the classification of seeds, a morphometric approach based on the image analysis, was performed. Thanks to this technique it is possible to distinguish wild species from cultivated ones using automated system, replacing human visual assessments in a more accurate, reliable and repeatable way also in archaeobotany (e.g. Bouby et al. 2013; Orrù et al. 2013, 2015; Pagnoux et al. 2015; Ucchesu et al. 2014, 2016, 2017).

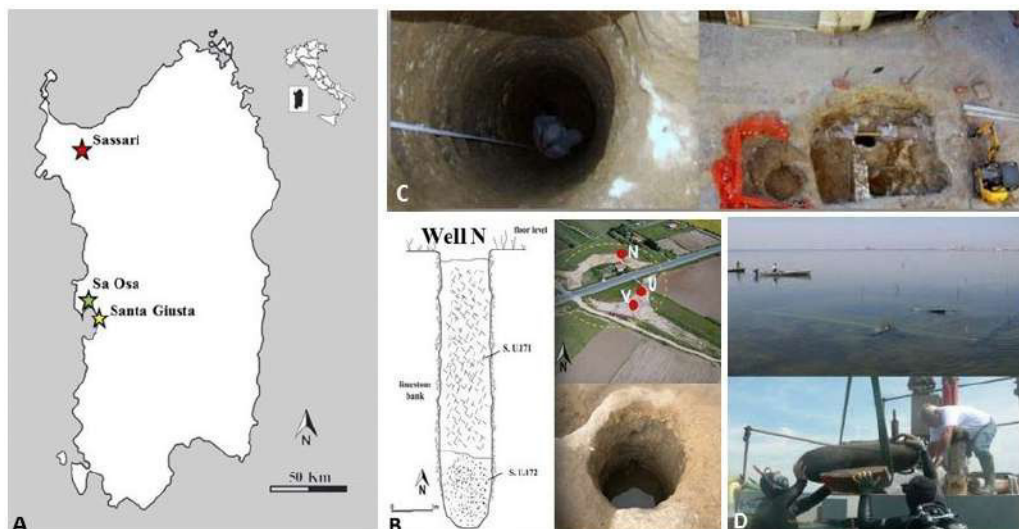


Figure 1 - A) Location of the investigated archaeological sites; B) Sa Osa context; C) Medieval site of Via Satta (SS); D) Santa Giusta lagoon context.

With this in mind, the main goal of this research is to compare Sardinia archaeological fruit-stones with modern one by image analysis system. The results obtained allow to increase knowledge about the origin and use of wild and cultivated *Prunus* fruits in the diet of human communities of the past and to investigate the relationships with traditional varieties still cultivated in Sardinia.

Materials and Methods

The waterlogged *Prunus* fruit-stones analysed in this study came from the archaeological sites of Sa Osa (1286-1115 BC), Santa Giusta (600-300 BC) and Via Satta-Sassari (1330-1360 AD) (Fig. 1). The archaeobotanical remains were extracted from the sediment, cleaned, kept in distilled water and stored at +5 °C in the Germplasm Bank of Sardinia (BG-SAR) (Porceddu et al. 2017). Modern samples consist of 2130 fruit-stones of *P. spinosa* collected in Sardinia and 1663 of *P. domestica* collected from the field catalogue of CNR-ISPA (OR, Sardinia).

Digital images were acquired with a flatbed scanner according to Bacchetta et al. (2008) and processed using the software ImageJ v. 1.49. The morphometric parameters were obtained through a specific plugin able to measure 26 morphometric features and 80 Elliptic Fourier Descriptors (EFDs). Applying the stepwise Linear Discriminant Analysis (LDA), using IBM SPSS software package release 16.0, a morphometrical comparison among the archaeological fruit-stones of *Prunus* and the modern one was performed.

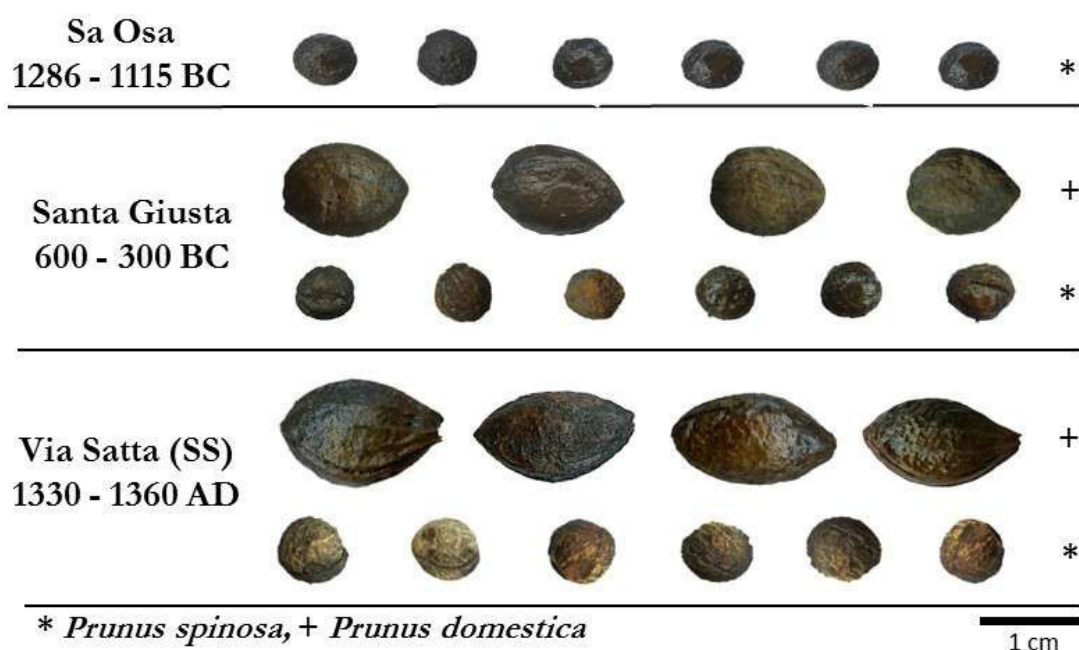


Figure 2 - The identified *Prunus* samples.

Results and Discussion

Thanks to the exceptional state of preservation of the fruit-stones remains it was possible to investigate and identify *Prunus* taxa found in the archaeological sites of Sardinia.

Prunus remains from Sa Osa have been identified as wild in the 100% of the case. The results suggest that since the Bronze Age, Nuragic people had knowledge about the use and consumption of *P. spinosa* proving to be an important complement to their diet.

The analyses conducted on the samples of Santa Giusta allowed identifying 53 archaeological fruit-stones as *P. spinosa*. In fact these specimens showed morphometric similarities in 92.5%

of the cases with the modern wild samples currently growing near to the archeological site (Fig. 2). Likewise, the 11 archaeological fruit-stones identified as *P. domestica* showed similarity with the modern varieties, in particular with a variety currently cultivated in the village of Bosa (OR, Sardinia) called Sanguigna di Bosa (Ucchesu et al. 2017). Furthermore, several modern varieties of *P. domestica*, with yellow drupes, showed similarities in the morphometry of the fruit-stones found in the medieval well of Via Satta (Sassari).

Conclusions

The results presented in this study represent new data about the application of image analysis technique for the identification and classification of the archaeological fruit-stones of *Prunus*. The discovery of several *Prunus* remains in waterlogged contexts of Sardinia allowed to investigate about the use and consumption of these fruits through time. Thanks to the image analysis technique it was possible to identify both wild and cultivated species of *Prunus* found in archaeological sites of Sardinia. These analyses indicated that the use and consumption of *P. domestica* was well established in Sardinia since the Phoenician and Punic period. Therefore, the use and consumption of *P. spinosa* was still a diffuse practice since the prehistory.

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