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## A Revised Sex Assessment of the Epigravettian Human Remains ST1 from San Teodoro Cave (Messina, Sicily)

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**PAROLE CHIAVE:** Paleolitico superiore, determinazione del sesso, San Teodoro, dimorfismo sessuale, cinto pelvico.

**RIASSUNTO** — La difficoltà di una corretta attribuzione di sesso ai resti scheletrici è una tra le principali problematiche bioantropologiche e dipende, principalmente, dalla completezza del campione disponibile.

Il presente studio, condotto sull'individuo epigravettiano proveniente dal sito di San Teodoro (ME) e conosciuto come ST1, applica due affidabili metodologie di diagnosi del sesso, il metodo di Bruzek e il metodo DSP (Probabilistic Sex Diagnosis) entrambi basati sull'analisi morfologica e metrica delle ossa pelviche.

Il reperto ST1, che era stato inizialmente attribuito al sesso maschile sulla base della morfologia cranica e della generale robustezza delle ossa postcraniali, venne in seguito assegnato al sesso femminile attraverso l'analisi della pelvi.

La nostra revisione indica senza ambiguità che ST1 è un maschio. Questo risultato ribadisce l'importanza dell'utilizzo di metodi aggiornati di diagnosi sessuale e evidenzia la necessità di procedere con una sistematica revisione dei reperti osteologici umani analizzati in studi ormai datati.

**KEY WORDS:** Upper Paleolithic, sex determination, San Teodoro, sexual dimorphism, pelvic girdle.

**SUMMARY** — Bias in skeletal sexing is well known and depends upon the completeness of the skeletal remains. The problem is very hard concerning prehistorical remains.

We applied 'Visual methods' and 'Probabilistic Sex Diagnosis' (DSP) on the coxal bones on the Epigravettian skeleton (ST1) from San Teodoro (Messina, Sicily).

On the basis of cranial characters and the overall robustness of the postcranial skeleton, it was suggested, since the time of the discovery, a male sex for ST1. This determination was later modified on the basis of the pelvic girdle morphology, and the skeleton was attributed the female sex for many years by large consensus.

Our results indicate without ambiguity that ST1 is a male and show the importance of applying update methods of sex determination to ancient remains.

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## INTRODUCTION

The majority of Paleolithic adults described in the literature have been sexed based on skull features and the general robustness of postcranial bones, but these methods are associated with problems that can bias a correct attribution (Villotte et al., 2011). Recently, methods for determining sex via cranial characteristics have been progressively abandoned and replaced with the method, when possible, of examining the pelvic bones. However, the need for precise sex identification in archaeological horizons, which has been strongly voiced since Leighton (1998), remains crucial.

The focus of this study is the nearly complete skeleton of the Epigravettian specimen 'ST1' (San Teodoro 1), which is in the custody of the G.G. Gemmellaro Museum of Paleontology in Palermo and was discovered by Graziosi (1947). Based on morphological and metrical characteristics of the skull, researchers deduced that ST1 was an adult male, whereas later research found that the individual was an adult female (Fabbri, 1993).

Because of a recent restyling of the G.G. Gemmellaro Museum of Paleontology, we performed new morphological and metrical analyses on ST1 with the aim of verifying the sex assessment and answering the highly discussed doubt regarding non-homogeneity of the exposed skeleton. The available literature on the human skeletal finds at San Teodoro suggests that the buried remains of ST1 were excavated and recovered directly. The grave appeared neither altered in its stratigraphy nor disturbed by grave robbers.

For the sex attribution, we applied two of the most recent and reliable methods for determining a skeleton's sex: the method of Bruzek (Bruzek, 2002), which entails a morphological approach and a semi-quantitative evaluation, and the method of Murail, known as DSP (i.e., Diagnose Sexuelle Probabiliste, Murail et al., 2005). The latter method relies on a global coxal bone metrical database; sex is determined by comparing the specimen's measurements to those from the database and by computing the individual probability of the remains being male or female from any combination of at least four out of ten variables. Following the advice of Pascal Murail, the DPS methodology was slightly revised to account for the preservation state of ST1.

This revision was necessary, following previous studies (Gambier et al., 2002, 2006), to generate objective evaluation parameters for reliable sex assessments in ancient *Homo sapiens*.

## THE S. TEODORO GROTTO – ARCHEOLOGICAL DATA

Embedded in the countryside of Acquedolci (Messina, Italy), the San Teodoro Grotto is one of the most relevant paleontological sites of the western Mediter-

ranean Pleistocene. In addition to important evidence of a Pleistocenic faunal complex, the San Teodoro-Pianetti (Bonfiglio et al., 2001), the site has revealed seven sepultures that are primarily attributed to the late Epigravettian period.

The first unearthed burial was excavated in 1937 and was referred to as ST1 (Maviglia, 1940). During the campaign, the archeologists discovered the remains of five other individuals in the identical stratigraphic horizon of ST1. After the initial identification in 1942, the site experienced a more systematic excavation (Graziosi, 1947). These excavations have clarified the stratigraphy of the deposits. The deposits were recognized as six layers, four of which showed evidence of human occupation in the cave. The human remains were discovered under a five-centimeter-thick deposit of red ochre, lying in a layer (C) that has been attributed to the Epigravettian period, at the base of associated lithic assemblages (Vigliardi, 1968).

Recent AMS radiocarbon dating was performed on bone collagen that was extracted from ST1 (Mannino et al., 2011). The dates were calibrated with Oxcal 4.1. (Bronk Ramsey, 2009) using the IntCal09 calibration curve (Reimer et al., 2009). The analysis indicated a calibrated calendar date of 15,232 – 14,126 BP ( $2\sigma$  95.4%).

Because the sample occurred chronologically during the warm, humid Bølling-Allerød interstadial, the San Teodoro site can be considered an example of an ancient settlement; beginning in the Younger Dryas, the site was likely used as a migration route from the Italian peninsula to Sicily (D'Amore et al., 2009).

Since their discovery, the human remains have been displayed in various Italian museums and universities. Thanks to the determination and perseverance of Enzo Burgio, a curator at the Gemellaro Museum in Palermo, two of the remains have been returned to Sicily. The first specimen is the nearly complete skeleton of ST1, and the second specimen is a skull labeled as ST2.

ST1 was buried with a necklace of perforated deer teeth (Graziosi, 1943). This find has never been interpreted with attention but may be a further diagnostic element for sex attribution; as Whitehouse (2001) notes, adult males were accompanied by grave goods in several Italian Upper Paleolithic burials, and the grave goods often included a deer tooth necklace.

### *Methods*

Sex assessment was performed on the pelvic bones using the morphological analysis described by Bruzek (2002) and the metric statistical method of Murail (Murail et al., 2005).

Both methods are based on compensation between sexual dimorphism and the morpho-functional aspects of the pelvis; the methods are designed to define the sexual characteristics of the symptomatic anatomical district.

Bruzek's visual determination uses an evaluation score that relies on five traits of the hip bone: 1. Aspects of the pre-auricular surface; 2. Aspects of the greater

sciatic notch; 3. The presence of a composite arch; 4. The morphology of the inferior pelvis; and 5. Ischiopubic proportions. For each characteristic, the observer assigns a score that corresponds to the sexual form with the symbols “f” for female, “i” for indeterminate, or “m” for male. Bruzek (2002) provides a detailed description of these characteristics. However, the method is observer-dependent, and a complete coxal bone is necessary for the method to be fully reliable. Sex determination may not be possible if female and male traits are equally represented.

To minimize the limitations, Murail and colleagues proposed a scoring system that relies on ten metric variables of the pelvis: 1. Acetabulo-symphyseal pubic length (PUM - Bräuer, 1988); 2. Cotylo-pubic width (SPU - Gaillard, 1960); 3. Innominate or coxal length (DCOX - Bräuer, 1988); 4. Greater sciatic notch height (IIMT - Bräuer, 1988); 5. Ischium post-acetabular length (ISMM - Schulter-Ellis et al., 1983); 6. Iliac or coxal breadth (SCOX - Bräuer, 1988); 7. Spino-sciatic length (SS - Gaillard, 1960); 8. Spino-auricular length (SA - Gaillard, 1960); 9. Cotylo-sciatic breadth (SIS - Bräuer, 1988); and 10. Vertical acetabular diameter (VEAC - Bräuer, 1988). Sex should be determined only if the posterior probability is greater than or equal to a 0.95 threshold.

The measurements of ST1 were performed by two of the authors (DDL and LS) using digital calipers.

## RESULTS

The results are presented separately for each method.

### *The Bruzek Visual Method for Sex Determination*

The pre-auricular surface of the left coxal (Fig. 1A) showed a deep depression (female character: f) with a closed circumference (f) that was associated with the presence of the piriform tubercle (masculine character: m). The pre-auricular surface of the right coxal (Fig. 1B) showed a slight negative relief (indeterminate: i) with open borders (m) and the presence of the piriform tubercle (m).

In both coxal bones, the ratio between segments AC and CB occupied a masculine form, as AC was smaller than CB (Fig. 1C and 1D). Regarding the maximum depth of the greater sciatic notch, the shape was asymmetrical (Fig. 1C and 1D).

On both the left and right sides, the composite arch was absent, which is a typical male form (Fig. 1E and 1F).

The left coxal revealed an external eversion of the ischiopubic ramus (Fig. 2), a female characteristic, whereas the *crista phallica* did not provide an adequate feature to determine sex.

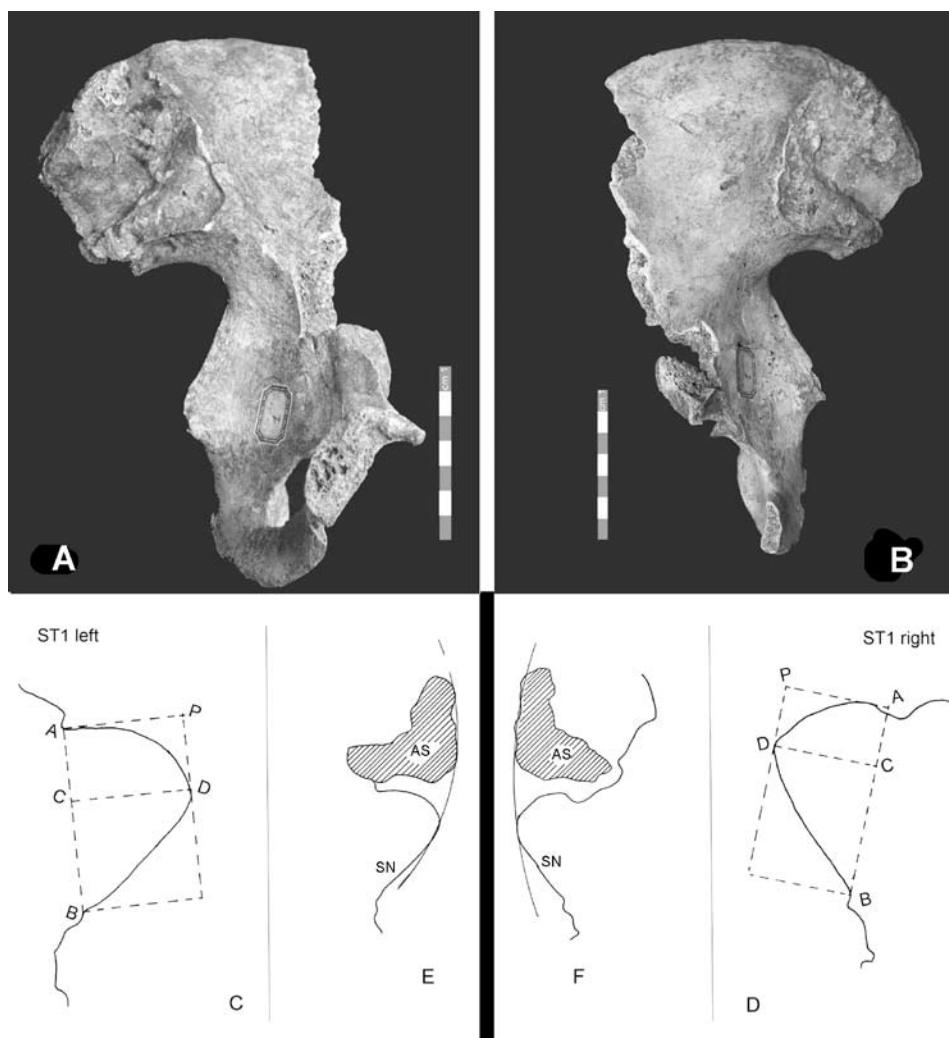


Fig. 1. The medial aspects of the left and right coxae (A and B), greater sciatic notch (C and D), and composite arch (E and F).

The left ischiopubic ramus was considered to be 'gracile'. However, the scoring of this characteristic is considered to be highly subjective, so we classified the characteristic as indeterminate (i).

The evaluation of the aspects of the ischiopubic proportion (Fig. 3) showed female traits.

However, when considering all five characteristics of the Bruzek approach, there was a discrepancy in the sexual determination, as the right coxal was male and the left was indeterminate.



Fig. 2. The anterior aspect of the inferior pelvis.

### The DSP Murail Method

We adopted the DSP method as described in the literature and followed additional suggestions from Murail (pers. comm.). Specifically, Murail suggested performing a slight modification in the composite evaluation to compensate for difficulties, because of poor preservation, in the proper detection of several landmarks. Following these indications, the two observers determined a male sex for the right coxa (with 99.78 and 99.75% probability) and the left coxa (with 97.81 and 97.83% probability) (Table 1).

In light of the above considerations, the measurements and morphological traits that were detected from the coxal bones strongly support the definitive male assignment for ST1.

Table 1. Sexual determination using the DSP method

Observer 1	PUM	SPU	DCOX	IIMT	ISMM	SCOX	SS	SA	SIS	VEAC	P(F)	P(M)	SEX
Left Side		26.00	235.00	40.50					40.00		0.1696	<b>0.9781</b>	Male
Right Side			235.00	39.51	121.11				41.27	55.22	0.0433	<b>0.9978</b>	Male
Observer 2	PUM	SPU	DCOX	IIMT	ISMM	SCOX	SS	SA	SIS	VEAC	P(F)	P(M)	SEX
Left Side		26.00	235.00	40.22					41.00		0.2316	<b>0.9783</b>	Male
Right Side			228.50	39.87	119.42				40.99	57.75	0.0002	<b>0.9975</b>	Male

P(F): probability of being female, P(M): probability of being male; P refers to posterior probabilities. Sex: sex determination using P(M) or P(F)  $\geq 0.95$ . Posterior probabilities  $\geq 0.95$  are indicated in bold type. For definitions of the variable abbreviations (PUM, SPU, DCOX, IIMT, ISMM, SCOX, SS, SA, SIS, and VEAC) see the 'Methods' section

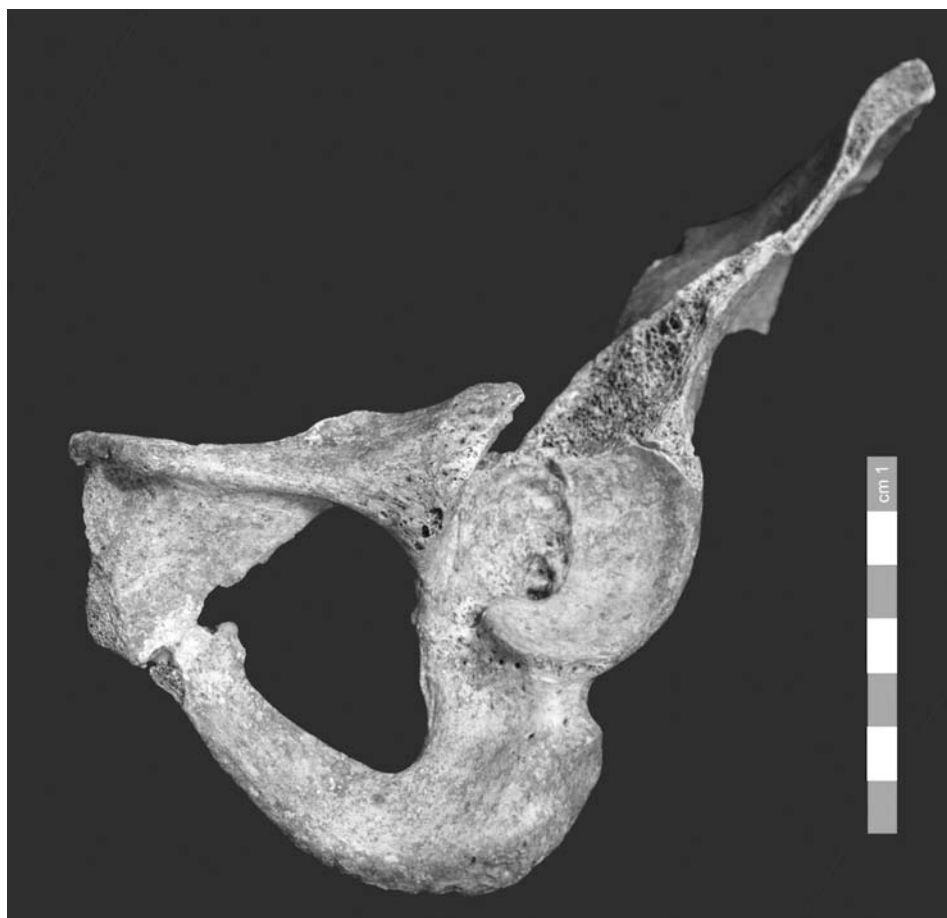


Fig. 3. *The antero-lateral aspects of the ischiopubic proportions.*

### DISCUSSION AND CONCLUSION

In paleoanthropological specimens, the correct attribution of sex is of vital importance and has a bearing on demographic and ecological evaluations (Hoppa & Vaupel, 2002). In the past, these attributions have been based on skull morphology and the robustness of the postcranial districts, with the assumption that males are more vigorous and heavier than their female counterparts. Other specific morphological markers have also been used, including considerations of generalized sexual dimorphism and social role separation (Walrath et al., 2004). However, when considering the phenomenon of intense selection, such as during the Upper Paleolithic, ancient populations, including females, may show greater robustness than modern populations (Holliday, 1997).

In spite of the state of preservation of the pelvis, which was damaged by time, we successfully attributed the sex of ST1 using the two updated methods of sex determination from Bruzek (2002) and Murail (Murail et al., 2005).

The indeterminate sex attribution that was obtained via the Bruzek method was most likely related to a slight dimorphism between the two coxae, which was resolved by the DSP determination.

Our initial impression was correct: ST1 is an adult male skeleton, and Graziosi's (1947) initial assessment was correct.

Based on this evidence and other results in the literature (Gambier et al., 2002, 2006; Villotte et al., 2011), the levels of skeletal sexual dimorphism in the Upper Paleolithic were appreciable, and inter-sexual differences should be considered on a case-by-case and geographical basis.

Our results suggest the need for a systematic revision of various Upper Paleolithic remains that may have been affected by similar problems related to interpretation.

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