



Amphibians and squamate reptiles from the stratigraphic unit Xb of El Salt (Middle Palaeolithic; Alcoy, Spain): palaeoenvironmental and palaeoclimatic implications

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ABSTRACT

The locality of El Salt (Middle Paleolithic, Alcoy, Spain) is mainly known by having one of the youngest Neanderthals records of the southeastern Iberian Peninsula. In this work, we have analysed the herpetofaunal fossils from the upper part of stratigraphic unit Xb, dated at 52.3 ± 4.6 ka (MIS 3). The faunal list is composed by three taxa of anurans (*Alytes obstetricans*, *Bufo bufo s.l.*, and *Epidalea calamita*), one taxon of blánid (*Blanus cinereus s.l.*), two taxa of lizards (*Chalcides bedriagai* and cf. *Acanthodactylus erythrurus*), and one taxon of snakes (cf. *Rhinechis scalaris*). All of them have a broad distribution range in the Mediterranean, with wide ecological preferences range. This association of amphibians and reptiles from the Unit Xb suggests a slightly warmer and more humid

RESUMEN

El yacimiento de El Salt (Paleolítico Medio, Alcoy, España) ha librado uno de los registros más recientes de neandertales del sudeste de la península Ibérica. En el presente trabajo se analiza los restos de herpetofauna de la parte superior de la unidad estratigráfica Xb del yacimiento, datada en 52.3 ± 4.6 ka. La lista faunística se compone de 7 taxones, incluyendo anuros (*Alytes obstetricans*, *Bufo bufo s.l.* y *Epidalea calamita*), blánidos (*Blanus cinereus s.l.*), lagartos (*Chalcides bedriagai* y cf. *Acanthodactylus erythrurus*) y serpientes (cf. *Rhinechis scalaris*). Todas las especies aquí descritas tienen un amplio rango de distribución en el Mediterráneo, presentando una amplia variedad de preferencias ecológicas. La asociación de anfibios y reptiles descrita en la Unidad Xb de El Salt

climate than the current one; with an annual temperature range less accused and a similar seasonality of the rainfall than it is recorded nowadays in Alcoy. These results may correspond to a warm period (Daansgard-Oeschger event) during the MIS 3. A landscape composed by bushland and forest patched in which some open areas were present, with presence of permanent water bodies in the nearby areas, would characterize the surroundings areas of El Salt.

Keywords: Amphibia, Squamata, Middle Palaeolithic, El Salt, Iberian Peninsula.

sugiere un clima más cálido y húmedo que el registrado en la actualidad en la zona, con un rango anual de temperaturas menos acusado y con una estacionalidad de las lluvias similar a la observada hoy día en Alcoy. Estos resultados se corresponderían con un periodo cálido (evento Daansgard-Oeschger) durante el MIS 3. El paisaje de los alrededores de El Salt estaría compuesto de formaciones boscosas intercalados con espacios abiertos, y con presencia de zonas de agua permanente en los alrededores.

Palabras clave: Anfibios, Escamosos, Paleolítico Medio, El Salt, Península Ibérica.

1. INTRODUCTION

Pleistocene was characterized by noticeable climatic oscillations and sea level fluctuations (Alley & Clark, 1999; Petit *et al.*, 1999). Marine Isotope Stage (MIS) 3 (ca. 60-30 ka BP) experienced abrupt climatic oscillations, alternating warm phases in which it is recorded the expansion of forests, with cold phases, related with the expansion of semi-arid areas (Fletcher & Sánchez-Goñi, 2008). Moreover MIS 3 is associated with the disappearance of Neanderthals (Wood *et al.*, 2013), the dispersion of *Homo sapiens* and the possible relation between both processes (Mallol *et al.*, 2012). Although large-scale reconstructions using, for example, marine sediments provide a valuable environmental context for hominin evolution, they must be complemented by smaller-scale, site-specific environmental investigations from close localities or where the hominin remains have been found (Holmes *et al.*, 2010). In this sense, herpetofauna (reptiles and amphibians) provide valuable palaeoclimatic and palaeoenvironmental approaches. Due to its ectothermic physiology, reptiles and amphibians are highly dependent of surrounding environment (Blain, 2009). Like vegetation, its distribution and species richness are related to climatic parameters such a reference evapotranspiration, solar radiation and mean annual temperature (Antúnez *et al.*, 1988). In last years, many works have used reptile and amphibian fossil assemblages as a new proxy for palaeoenvironmental reconstructions (Blain, 2005, 2009; Martínez-Solano & Sanchiz, 2005; among others). Lobo *et al.* (2016) corroborated the validity of using amphibians for this purpose.

The locality of El Salt contains a rich lithic and vertebrate faunal assemblage, with combustion structures and six Neanderthal teeth (Garralda *et al.*, 2014). The site was used recurrently by human populations, followed by sparse occupation and subsequent abandonment of the site (Garralda *et al.*, 2014; Galván *et al.*, 2014).

First archaeological excavations at El Salt took place in 1960 and 1961 by V. Pascual and R. Martín (Galván, 1992). Since 1986, El Salt has been studied systematically from an interdisciplinary perspective focused on the knowledge of the first human settlement of this region (Sistiaga *et al.*, 2014, and references therein). A scarce number of works on microvertebrates remains found in El Salt have been realized until now. The first data are from Guillem (1995), who cites the presence of *Microtus arvalis* (Pallas, 1778) and *Microtus duodecimcostatus* (de Selys-Longchamps, 1839) in the Unit XII. Twenty years later, Fagoaga *et al.* (2015a) provided the first micromammal and herpetological preliminary faunal list. Regarding the herpetofauna, Fagoaga *et al.* (2015a) reported the presence of remains of Lacertidae in Units XII, XI, Xa, VIII, VI and V, of Scincidae in Units XII, XI, Xb, Xa, VIII and VII, of Gekkonidae in Units XII, XI, VIII and VII, of Blanidae in the Unit XII and of Anguidae in the Units VII and VI. A posterior revision of this material discards the presence of Anguidae in El Salt. Moreover, the turtle *Testudo (Chersine) hermanni* (Gmelin, 1789) has been cited in the Unit X (Morales Pérez & Sanchis Serra, 2009). Finally, using the micromammal data found in Unit Xb Facies 11 Surface 3 (ST-F11-SUXb-S3), Fagoaga *et al.* (2015b) proposed the palaeoenvironmental conditions during the formation of these deposits.

In this work we identify the herpetofaunal species from the stratigraphic unit Xb, and then we reconstruct the climatic and environmental conditions of this unit to a small-scale (site-specific). Thus, and knowing the estimated absolute age data of deposits containing herpetofaunal remains in the El Salt locality (Unit Xb), we can correlate with the large-scale reconstructions of this period. The field campaign of 2013 in the El Salt focused in the stratigraphic unit Xb, having yielded a small sample of amphibian and reptile remains. Its study has allowed us to approach to climatic and environmental conditions from the Alcoy valleys when the Neanderthals inhabited this area.

2. GEOLOGICAL AND REGIONAL SETTING

Few Iberian localities show deposits with a stratigraphic continuity at the Middle-to-Upper Palaeolithic boundary (Mallol *et al.*, 2012), being the locality of El Salt (Alcoy) one of these sites. The stratigraphic column of El Salt consists of 6.3 m-thick of sediments formed on 38 m-high Paleocene limestone wall, at thrust fault and covered with tufa and travertine (Figs. 1-2). Fumanal (1994) divided this stratigraphic sequence into 13 lithostratigraphic units (XIII-I), which can be grouped into five different segments by their macroscopic textural appearance and archaeological content (Galván *et al.*, 2014) (Fig. 2). From the base to top, these Units are characterized by:

1. Unit XIII: subhorizontal travertine platform, which thickness is unknown, with only the first 50 cm exposed. This unit is archaeologically sterile. The top of this Unit has been dated with uranium-thorium (Th/U) to 81.5 ± 2.7 ka and 80.1 ± 4 ka (MIS 5a) (Fumanal, 1994).

2. Units XII-IX: 1.5 m-thick, horizontally bedded fine sand with abundant archaeological remains and combustion residues. At its base several large blocks are found. These units show a high presence of combustion features (Mallol *et al.*, 2012). These are commonly associated with rich archaeological assemblages comprising abundant vertebrate faunal remains, lithics elements and anthropogenically-modified cobbles. Numerous evidence for butchery, hide and wood work has been reported (Rodríguez *et al.*, 2002). This part of the sequence has been dated in 52.3 ± 4.6 ka

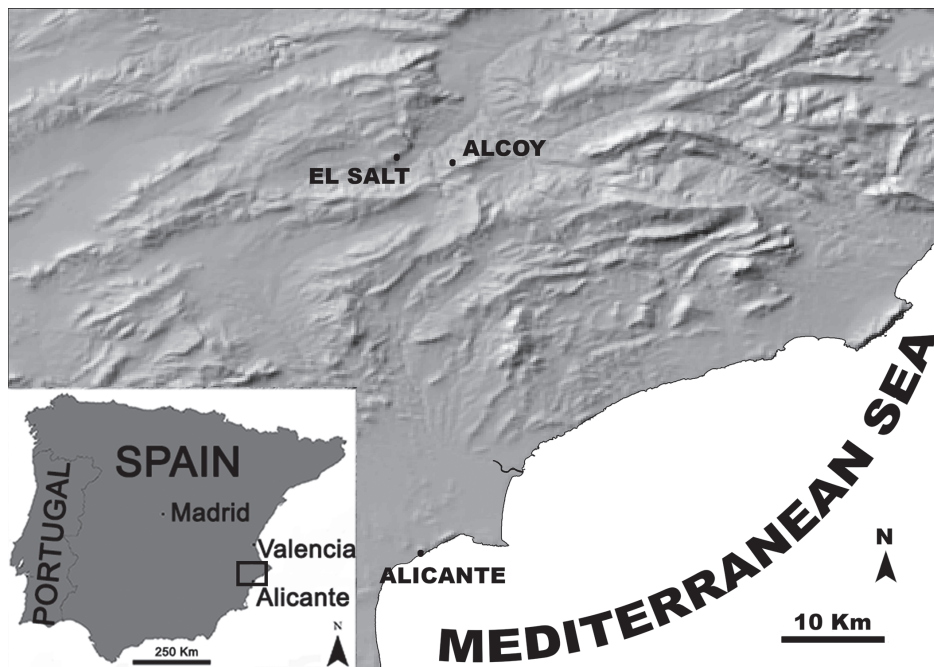


Figure 1. Geographic location of El Salt Middle Palaeolithic site in Iberian Peninsula and in the municipality of Alcoy in the Iberian Peninsula.

by thermoluminescence dating method (TL) (Galván *et al.*, 2014).

3. Unit VIII-middle of V: 1.5 - 2.8 m-thick horizontally bedded predominantly geogenic sand with decreasing and a spatially reduced evidence of human activity. Unit VI is covered by a significant accumulation of large blocks, produced by the collapse of roof of the travertine structure. Six teeth attributed to a *Homo neanderthalensis* King, 1864 were recovered from the base of Unit V (Garralda *et al.*, 2014). These remains could represent one of the last occurrences of Neanderthals in the region (Garralda *et al.*, 2014). The top of the Unit VI has been dated by TL between 52.3 ± 4.6 and 47.2 ± 4.4 ka, whereas the base has been dated by optically stimulated luminescence (OSL) to 45.2 ± 3.4 ka (Galván *et al.*, 2014).

4. Upper Unit V: 50 cm-thick, truncated, massive sandy silt with heterogeneous gravel in the top 20 cm. Most of this unit is archaeologically sterile (Garralda *et al.*, 2014), however in the gravelly segment at its top, some anthropic activity remains (two small undetermined flint blades, a few undifferentiated debitage flakes and a small combustion feature) were recovered. This section has been dated by optically stimulated luminescence (OSL) between 44.7 ± 3.2 (Galván *et al.*, 2014).

5. Units IV-I: 1.3 m-thick segment consisting of irregular beds of gravel and cobbles in a silty clayey matrix. In this deposit it has been recorded Neolithic pottery mixed with late Upper Palaeolithic, Epipalaeolithic and Mesolithic lithic remains, appointed a Holocene age for it.

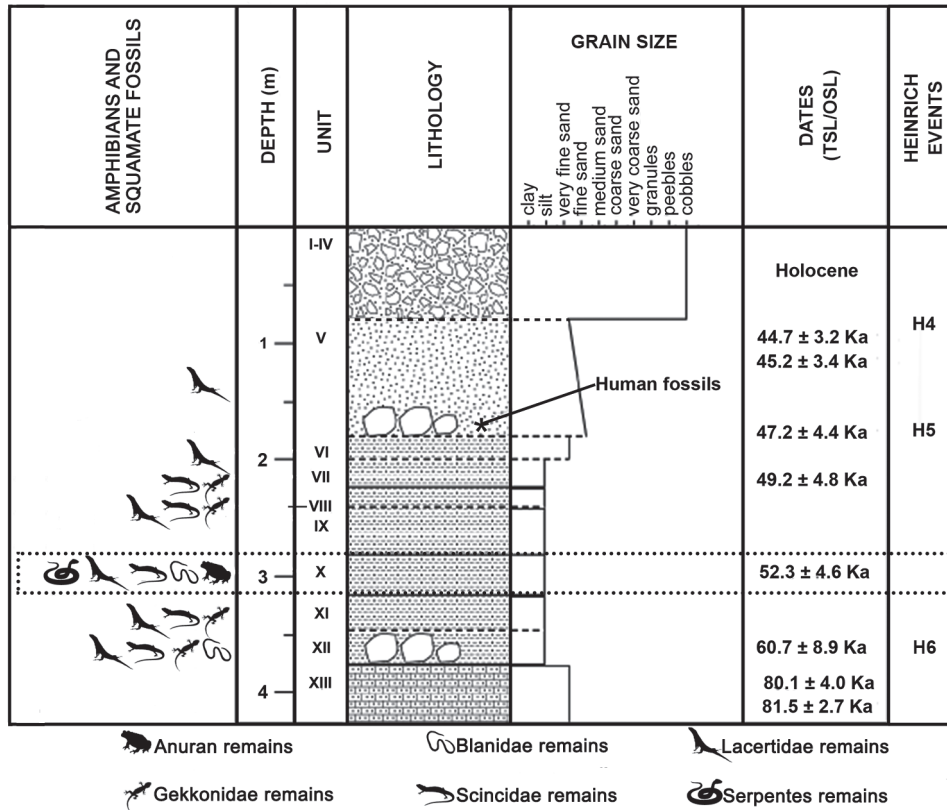


Figure 2. Stratigraphic column of El Salt showing the different lithostratigraphic units described by Fumanal (1994). Modified from Garralda *et al.* (2014).

3. MATERIAL AND METHODS

The material studied here consist on disarticulated elements collected from the water flotation from the joint work with the anthracology team during the 2013 excavation campaign at El Salt. The sediment was water-screened using superimposed 1.5 and 0.5 mm-mesh screens. The microfossils were processed, sorted and classified using a Leica MS5 binocular microscope. Measurements were taken on a Leica MZ75 binocular microscope, by means of displacement of a mechanical stage, connected to Sony Magnescale measuring equipment. Photographs were taken with a HITACHI 4800 scanning electron at the Servei Central de Suport a la Investigació Experimental (SCSIE) of the Universitat of València.

Herpetological bones remains were assigned to different taxa following the criteria given by Bailon (1991, 1999), and Blain (2009) for amphibian remains and Szyndlar (1984), Barbadillo (1989), Bailon (1991), Barahona (1996), Barahona & Barbadillo (1997), Szyndlar & Rage (1999), and Blain (2009) for Squamata. Comparisons were drawn using the collections of dry skeletons of the Museo Nacional de Ciencias Naturales (CSIC), Madrid (Spain); Muséum national d’Histoire naturelle, Paris (France); Gabinete de Fauna Cuaternària of the Museu de Prehistòria de València, Valencia (Spain); and Departament de Botànica i Geologia de la Universitat de València, Burjassot (Spain). The morphologic nomenclature follows Roček (1984), Szyndlar (1984) and Bailon (1991, 1999).

We follow the taxonomic nomenclature of Uetz & Hošek (2015) for reptiles and Frost (2015) for amphibians. All the measurements have been taken following Barahona (1996) and Barahona & Barbadillo (1997) for lacertids, and Blain (2009) for snakes.

In order to reconstruct the environment of ST-F11-SUXb-S3, we use the method of habitat weighting (Blain *et al.*, 2008). This method is based on distributing each amphibian and squamate taxon in the habitat(s) where it is possible to find them nowadays in the Iberian Peninsula. With the exception of few residual Early Pleistocene taxa (Bailon & Blain, 2007; Blain *et al.*, 2016a), Iberian Pleistocene amphibians and squamate reptiles are considered specifically identical to modern populations (Bailon, 1991; Barbadillo *et al.*, 1997; Blain, 2009). So, the current species habitat distribution may be used as an approach to calculate the habitat-weighting index of taxa described in ST-F11-SUXb-S3. In the original method, the habitats were sorted in five types (Blain *et al.*, 2008): (I) open-dry, (II) open-humid, (III) woodland, (IV) rocky areas and (V) water edges (areas surrounding to water areas).

Each species was given a maximum possible score of 1.00, which was broken down according to the habitat preference of that species; so that if an animal occurred in more than one habitat type, its score was proportional to its habitat preference. The distribution data are taken from different studies at Iberian level (Pleguezuelos & Martínez-Rica, 1997; Pleguezuelos *et al.*, 2002; Loureiro *et al.*, 2008), and from other works with a more specifically

geographic range (Velasco Marcos *et al.* (2005) and Diego-Rasilla & Ortiz-Saliestra (2009) for Castilla y León; Lacomba & Sancho (1999) and Jiménez *et al.* (2002) for Comunidad Valenciana; Barberá *et al.* (1999) for Cuenca province; and Pérez-Mellado (1983) for Salamanca province).

In the same way of Habitat Weighting Method, palaeoclimatic interpretations are based on the presence of amphibian and reptile species from ST-F11-SUXb-S3. The results obtained are supported by a simple quantitative climate reconstruction named originally Mutual Climate Range (MCR) by Blain *et al.* (2009). This technique is based in modern biogeographic co-occurrence of species described in a palaeontological site, unlike the classical MCR, which is based on overlap climatic range of different taxons. The MCR method was renamed as Universal Transverse Mercator-Mutual Climate Range (UTM-MCR, Lee Lyman, 2016) is known also as Mutual Ecogeographic Range (MER) (Blain *et al.*, 2016b).

The study of the distribution of the species, and therefore those derived from these, should be realized on areas with natural geographical limits (Real, 1991). The Southwestern Europe Mediterranean bioregion is a continuous area between Iberian Peninsula and East and South Italian Peninsula (Blondel & Aronson, 1999). Nevertheless, we limit our study area to Spain and Portugal due to the Iberian endemic character of some reptilian taxa (*Blanus cinereus s.l.* and *Chalcides bedriagai*) determined in the locality of El Salt. Following Real (1991), in this work we use UTM-MCR/MER according to the Iberian distribution of the analysed species (Loureiro *et al.* (2008) for Portugal, and Pleguezuelos *et al.* (2002) for Spain). Using free software GIS, the climatic parameters have been estimated overlapping the co-occurrence areas and the current climate layers with a resolution of 30 arcseconds resolution grid, from World Climate 1.4 (Hijmans *et al.*, 2005). Both set of data (co-occurrence areas and climate layers) are represented in the same spatial reference system (EPSG 25830). The bioclimatic parameters extracted from the cartography supplied by Hijmans *et al.* (2005) are: BIO 1 (annual mean temperature), BIO 5 (maximum temperature of warmest month), BIO 6 (minimum of coldest month), BIO 7 (temperature annual range), BIO 12 (annual precipitation), BIO 13 (precipitation of wettest month) and BIO 14 (precipitation of driest month). All layers have been projected at ETRS 1989 UTM datum-coordinate projection system.

On the other hand, it has been realised a preliminary study of the taphonomy of the reptiles and amphibians of ST-F11-SUXb-S3 to discern the agent/s responsible/s of the accumulation of the remains. Although taphonomical studies with micromammals are common, in the case of the herpetofauna are scarce (Lyman, 1994; Bailon, 2011). In this regard, papers with a topic exclusively centred in amphibian and/or reptilian taphonomy are extremely

rare (Pinto Llona & Andrews, 1999; Stoetzel *et al.*, 2011), and has usually been incidental to other studies (i. e., Castillo *et al.*, 2001). Our taphonomical approach is based mainly in Pinto Llona & Andrews (1999), who studied this topic in Anurans of Gran Dolina (Middle Pleistocene, Burgos, Spain). In this work, authors studied the skeletal representation, modification on bone surface and its fragmentation. Thus, in order to identify the grade of preservation of skeletal elements per carcass, it is calculated the ratio of NISP (the number of identifiable skeletal parts), matching with the minimum number of individuals for every taxon described here.

4. SYSTEMATIC PALAEOONTOLOGY

Class **AMPHIBIA** Linnaeus, 1758

Subclass **LISSAMPHIBIA** Haeckel, 1866

Order **ANURA** Duméril, 1806

Family **Alytidae** Fitzinger, 1843

Genus *Alytes* Wagler, 1830

Alytes obstetricans (Laurenti, 1768)

(Fig. 3a)

Material. 1 left humerus (ST-F11-200), 1 right humerus (ST-F11-233). NMI: 1.

Description. The humerus has a diaphysis that forms a curve in ventral view. The paraventral crest is short. The condyle is displaced to the radial side. The condyle and both epicondyles are robust and well developed.

Remarks. The overall morphology of the humerus does not differ with the genus *Alytes*. Nowadays, genus *Alytes* is composed by five species, with three of them presents in Iberian Peninsula: *A. obstetricans*, widely distributed in Western Europe, *Alytes cisternasii* Boscá, 1879, endemic to the Centre and Southwestern of the Iberian Peninsula, and *A. dickilleni* Arntzen & García-París, 1995, endemic to the Southeastern Iberian Peninsula (Pleguezuelos *et al.*, 2002; Loureiro *et al.*, 2008). Differentiation between these three species is based in the robustness of the appendicular bones, related with its different way of life (Sanchiz, 1984). In *Alytes dickilleni* the humerus is more elongated and slender than in *A. obstetricans* and *A. cisternasii* (Sanchiz, 1984). In *A. cisternasii* the distal region (the ensemble of epicondyles and condyle) is wider, showing a more pronounced curvature of the diaphysis of the humerus than in *A. obstetricans* (Sanchiz, 1977a).

Current ecology. Common midwife toad (*A. obstetricans*) occupies areas with high precipitation (< 1,000 mm) (Márquez & Rosa, 1997). In regions with lower precipitations (like the region of study nowadays), the species is located in mountain systems or in zones with impermeable substratum, and as relict populations in semiarid and arid regions (Bosch, 2014). Midwife toad inhabits a wide variety of habitats, independently of the type of soils, reaching from the sea level to 2,400 meters in the Pyrenees (see references in Bosch, 2014), being its present directly related with the existence of permanent water bodies.

Family **Bufonidae** Gray, 1825

Genus *Bufo* Laurenti, 1768

Bufo bufo s.l. (Linnaeus, 1758)
(Fig. 3b)

Material. 3 right humerus (females) (ST-F11-201, ST-F11-202, ST-F11-247), 2 left humerus (males) (ST-F11-203, ST-F11-204). NMI: 5.

Description. The humerus has a diaphysis that is straight in ventral view and without a paraventral crest. The condyle is located slightly moved outwardly relative to the diaphyseal axis. Epicondyles are relatively little developed. The diaphysis is strong. The medial or ulnar crest is short and transversal.

Remarks. Bufonids shows a noticeable sexual dimorphism in humerus. In females, the diaphysis is more incurved than males, whereas in the latter the medial or ulnar crest is more developed (Sanchiz, 1977a, 1977b; Bailon, 1999). The distal region of the humerus is wider in *B. bufo* than in *Epidalea calamita* (Laurenti, 1768), with an egg-shape of the condyle in the first, whereas it is rounded in the second. On the other hand, in ventral view, the distal border of the humerus is straight in *B. bufo* whereas in *E. calamita* it finishes with an inclination of 20° approximately respect to the horizontal. The overall morphology of the humerus found in El Salt is consistent with *Bufo bufo* s.l.

Current ecology. Recently, populations of common toad (*B. bufo*) from north Africa, Iberian Peninsula and southwest France have been considered a new species: *Bufo spinosus* Daudin, 1803 (Recuero *et al.*, 2012). Unfortunately, the osteological difference between both taxa had not been established yet. For this reason, we include the remains in the species group of *B. bufo*, which include all the western Palearctic populations traditionally known as common toad (Inger, 1972).

The species *Bufo bufo* occupies a wide variety of habitats in north Africa, throughout Europe, and western Asia (Pleguezuelos *et al.*, 2002; Loureiro *et al.*, 2008). Its only requirement seems to be, during its breeding season, the presence of quiet or low energy water preferably permanent with vegetation (Lizana, 1997).

Genus *Epidalea* Cope, 1864

Epidalea calamita (Laurenti, 1768)
(Figs. 3c-3d)

Material. 1 left ilium (ST-F11-205), 1 right scapula (ST-F11-206), 1 left scapula (ST-F11-207), 2 dorsal vertebrae (ST-F11-208). NMI: 2.

Description. The scapula is elongated dorsoventrally, with a sinuous anterior edge and a glenoid process that is strong and clearly separated from the bulk of the bone. The acromiale process is well defined, with straight edges. The supraglenoid fossa is present (Fig. 3c).

Dorsal vertebra (ST-F11-208) are procoelus with a short, wider than longer, neural arch. In dorsal view shows a well-defined neural spine. Two transverse processes (apophysis), located after the prezygapophysis are present. They are robust, cylindrical and directed transversally, typical trait of a middle trunk. Cotyle and condyle are dorso-ventrally compressed.

The ilium (Fig. 3d) does not have crista dorsalis. The tuber superior is low, with a pointed unilobed dorsal limit. This specimen shows a preacetabular lateral angle (PLA) (Fig. 3d) near to 90°. The ilium shows calamita ridge (a lateroventral excrescence) in inner lateral view.

Remarks. The overall morphology of dorsal vertebrae, radioulna and tibiofibula are consistent with bufonids genera *Bufo*, *Bufo*tes and *Epidalea* (Bailon, 1991, 1999). Nevertheless, the overall morphology of the 3th dorsal vertebra (apophysis with a rounded shape and width), ilium (absence of a crista dorsalis, tuber superior low and the presence of the calamita ridge) and the scapula (presence of supraglenoid fossa and straight edges of the acromiale process) is very similar from current osteological traits of *E. calamita* (Felix & Montori, 1986; Bailon, 1999).

Current ecology. *Epidalea calamita* is a palearctic species with great ecological plasticity, which is distributed from the Iberian Peninsula to the Belarus and the east of Ukraine (Pleguezuelos *et al.*, 2002; Loureiro *et al.*, 2008). In the Iberian Peninsula, it is thoroughly distributed, being absent only in large areas of the northern Eurosiberian zone (Pleguezuelos *et al.*, 2002). The altitudinal range of the species extends from sea level to 2,540 meters in

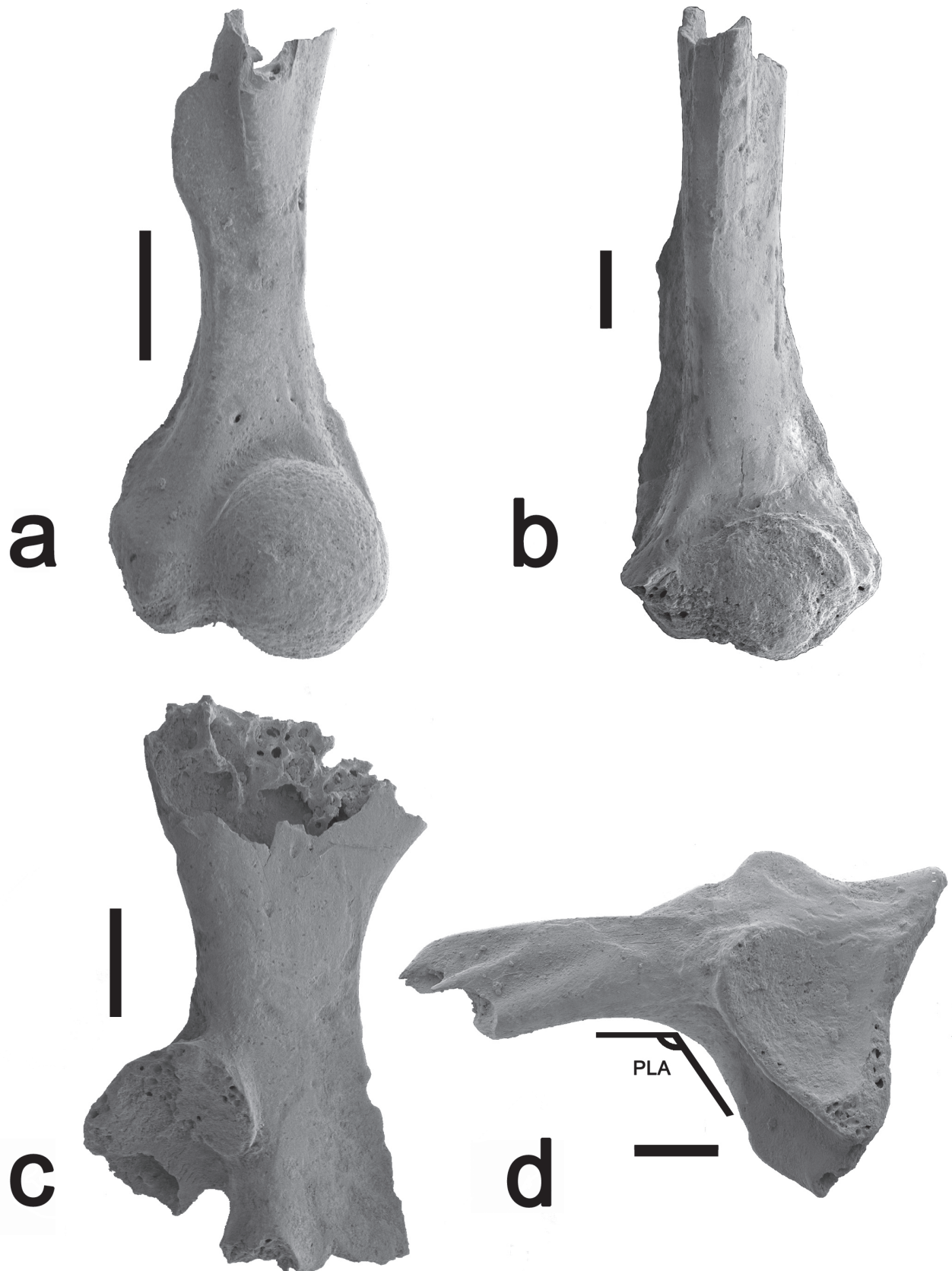


Figure 3. **a)** *Alytes obstetricans*, left humerus (ST-F11-200), ventral view. **b)** *Bufo bufo s.l.*, left humerus (ST-F11-204), ventral view. **c-d)** *Epidalea calamita*, right scapula (ST-F11-206), external view (**c**), left ilium (ST-F11-205), lateral view (**d**). Scale bars = 1 mm. PLA: preacetabular lateral angle.

Sierra Nevada (Benavides *et al.*, 2001), being its range delimited by an annual precipitation within 300 and 1,500 mm (Reques & Tejedo, 2002). *Epidalea calamita* inhabits a wide range of habitats, independently of antropogenic influence. Currently, the adult specimens prefer open areas with a strong sunshine. In this way, *E. calamita* supports high temperatures better than sympatric anuran species (Gómez-Mestre, 2014). *Epidalea calamita* is a pioneer species, which is able to colonise unstable biotope. Its breeding strategy is greatly influenced by the latitude of the area. Whereas in north Europe the species shows a prolonged reproductive behaviour, in the Mediterranean region *E. calamita* adjusts its breeding period to rainfall episodes (Richter-Boix *et al.*, 2006). The oldest fossil record of *E. calamita* is located in the Spanish localities of MN12 Conclud-Sierra de la Garita and Los Mansuetos, having been determined in both sites as *E. aff. calamita* (Sanchiz, 1977a).

Bufo sp. *s.l.*

Material. 4 dorsal vertebrae (ST-F11-209, ST-F11-210, ST-F11-211, ST-F11-212), 2 tibiofibulae (ST-F11-213, ST-F11-214), 2 radioulnae (ST-F11-215, ST-F11-216).

Description. In ST-F11-209 there are two procoelus dorsal vertebra with a short, wider than longer, neural arch. In dorsal view, it shows a well-defined neural spine. A pair of transverse processes (apophysis) is presents and is located after the prezygapophysis. These are robust, cylindrical and directed transversally, typical trait of a middle trunk. Cotyle and condyle are dorso-ventrally compressed. According to the arrangement of the apophysis, it is possible to differentiate two types of vertebra in basis of its position in vertebral column. In which apophysis projects downwards belongs to the 3th dorsal vertebra (ST-F11-209), whereas ST-F11-212 is the 4th dorsal vertebra, because the apophyses are directed backwards. Finally, ST-F11-210 and 211 belong to a 2nd dorsal vertebra due to the forward projection of the apophysis (Bailon, 1999).

The specimens ST-F11-215 and 216 are almost complete radioulnae, in which only the distal ends are lacking. Proximal extreme (olecrane) is concave, drawing an angle over 135°. Foramen nutritium is large and well developed; another large foramen is present near to the latter one, in close to the extreme of the ulna. In lateral view, radius is rounded and wider than ulna. These bones are only attributable at generic level (Bailon, 1999).

ST-F11-213 and ST-F11-214 are incomplete tibiofibulas without any of the extremes preserved. However, it is possible appreciates the difference in width between the central region and both ends of the bone. Foramen nutritium is slightly displaced to the proximal region of the bone.

Remarks. These remains show typical traits of family Bufonidae, but they do not have diagnostic value under generic level *Bufo s.l.*, which nowadays had split in different genus, like *Bufo s.s.*, *Epidalea* and *Bufotes*, among others (Frost, 2015).

Class **REPTILIA** McCartney, 1802

Order **SQUAMATA** Oppel, 1811

Suborder **Amphisbaenia** Gray, 1844

Family **Blanidae** Kearney, 2003

Genus *Blanus* Wagler, 1830

Blanus cinereus s.l. (Vandelli, 1797)
(Fig. 4a)

Material. 1 left dentary (ST-F11-217). NMI: 1.

Description. The specimen ST-F11-217 is a poor preserved left dentary. Its length is 2.68 mm, and presents 7 dental positions with only 4 teeth in life position. The teeth are subpleurodont and monocuspid. Anterior teeth are cylindrical and inclined anteriorly, whereas posterior teeth are cone-shaped, with a wide base and posteromedially directed apex. The third tooth is the highest. In labial view, dentary shows three large foramens. In lingual view, Meckelian groove is fully open and wide, forming a wide groove that runs parallel to ventral end of the dentary and it finishes close to the symphyseal articulation. As in the major part of amphisbaenians, an angle, close to 45°, at the symphysis of the dentary is present (Evans, 2008). At the level of the sixth tooth, in the ventral end of the dentary, a well-defined mark of the splenial is present. The posterior end of the dentary is broken.

Remarks. The overall morphology of ST-F11-217 is similar to current material of Blanidae. Due to its heterodonty, the dentary is clearly distinct from those of *Palaeoblanus tobieni* Schleich, 1988 and *Blanus antiquus* Schleich, 1985, both them displaying a homodont dentition (Schleich, 1985, 1988). Thus, some features of the dentition, such as the number of dental position and the well developed of the third tooth allow us to ascribe ST-F11-217 to the genus *Blanus* (Bailon, 1991).

Nowadays, *Blanus* is limited to the Mediterranean region of Europe and North Africa (Kearney & Stuart, 2004). The robustness of the teeth preserved in ST-F11-217 is comparable to the dentition of *Blanus* forms from the west Mediterranean, contrasting with the much slender dentition of Eastern taxa (Bolet *et al.*, 2014). The small size of this dentary remain discard that ST-F11-217 belongs to *Blanus mendezi* Bolet *et al.*, 2014, from the middle Miocene of Can Mata (Bolet *et al.*, 2014). Nowadays, in

the Iberian Peninsula inhabit two species of blinids: *B. cinereus*, widely distributed, except in north and northwest region, and the recently described *Blanus mariae* Albert & Fernández, 2009, species located in southwestern Iberia (Albert & Fernández, 2009). Thus, the lack of osteological studies of both current Iberian blinids seriously hinders the identification of late Neogene and Quaternary Iberian blinids at the species level. For this reason, we include the remains in the species group of *B. cinereus*, which includes both Iberian species of worm lizards.

Current ecology. *Blanus cinereus* is a thermophilus species, which is associated to warm areas with certain degree of humidity (López, 2015, and references therein). Iberian worm lizard occurs in all Mediterranean vegetal covers types, showing a markedly preference for sandy soils with dead leaves where is easier to excavate, avoiding soils with high concentration of clays (López *et al.*, 1998). It ranges extends practically from the seashore to the mesomediterranean bioclimatic level in the Iberian System (Gil, 1997).

Suborder **Lacertilia** Owen, 1842

Lacertilia indet.

Material. 499 vertebral centroms (ST-F11-232, ST-F11-246, ST-F11-248, ST-F11-249).

Description. Centroms are procoelous and slightly elongated. In ventral view, centroms show two foramina and a poorly defined haemal keel. Cotyle and condyle are dorsoventrally flattened.

Remarks. The overall morphology of the centroms does not differ from those of Scincidae and Lacertidae, however the state of the material do not allow us to allocate within one of the two groups.

Family **Scincidae** Oppel, 1811

Genus *Chalcides* Laurenti, 1768

Chalcides bedriagai Boscá, 1880
(Figs. 4b-4c)

Material. 14 premaxillae (ST-F11-221, ST-F11-222), 85 right dentaries (ST-F11-218, ST-F11-219, ST-F11-241), 74 left dentaries (ST-F11-220, ST-F11-240), 59 maxillae (ST-F11-223, ST-F11-242), 96 fragments of dental bones (ST-F11-243), 10 dorsal vertebrae (ST-F11-224, ST-F11-225), 1 caudal vertebra (ST-F11-226), 1 autotomic caudal vertebrae (ST-F11-237). NMI: 85.

Description. The premaxillae are unfused and bear 3-4 pleurodont, isodont, cylindrical and monocuspid teeth with blunt apex (Fig. 4b). Nasal process is spatulate shape and wide.

The most complete dentaries bear between 15 and 18 teeth (Fig. 4c), which are similar to described in premaxilla. In lingual view, in their apex, some of them show a more or less visible ornamentation, with delicate vertical striation limited ventrally by a transverse groove. Meckelian groove is open along its whole length and narrower anteriorly from the eighth or ninth dental position from the posterior end of the tooth row. In labial view, the dentary lacks the impression of the coronoid. Teeth show width/height ratio equal to 0.3 (σ : 0.1; n: 196).

The only maxilla remain is limited to its anterior end. It bears five dental positions, but only four teeth are present, showing the same morphology described above. In lingual view, the premaxillary process is low and projects anteromedially.

A total of 10 dorsal vertebrae have been recovered. They are procoelus, relatively elongated and presenting a few marked interzygophyseal constrictions. In dorsal view, neural arch shows in its anterior end a slightly marked notch. The dorsal vertebrae show a pseudozygosphene. Neural spine runs along the entire length of the neural arch, finishing in a point that overtakes the posterior end of the postzygapophysis. In lateral view, neural spine is low. Synapophysis are egg-shaped and projected anteroventrally. In ventral view, haemal keel is not well defined. Centroms show a pair of large foramina in the anterior region. In frontal and posterior view, condyle and cotyle are dorsoventrally flattened. The specimen ST-F11-226 is an anterior caudal vertebra by the presence of apophysis dorsolaterally compressed. Autotomic caudal vertebra (ST-F11-237) shows a Type E of plane of fracture (Etheridge, 1967).

Remarks. Fagoaga *et al.* (2015a) cited Scincidae indet. in the preliminary study of microfaunal content of El Salt. The presence of an unfused premaxilla, the overall morphology of the dentary (ventral end straight, absence of an impression of the coronoid and the lack of bi- or tricuspid teeth) and the vertebra (the end of the neural spine overtakes the posterior limit of the postzygapophysis) are consistent with the genus *Chalcides* (Barbadillo, 1989; Bailon, 1991; Blain, 2009). The morphology and width/high proportion of the teeth is similar to those of the modern species *Chalcides bedriagai*, which is characterized by the presence of 15 to 18 dental positions (Caputo, 2004) and by a width/height ratio equal to 0.3 (Barbadillo, 1989). The other skink present in Iberian Peninsula, *Chalcides striatus* Cuvier, 1829, is characterized by the presence of 18 to 21 dental positions (Caputo, 2004) and by a tooth width/height ratio equal to 0.22 (López-García *et al.*, 2011).

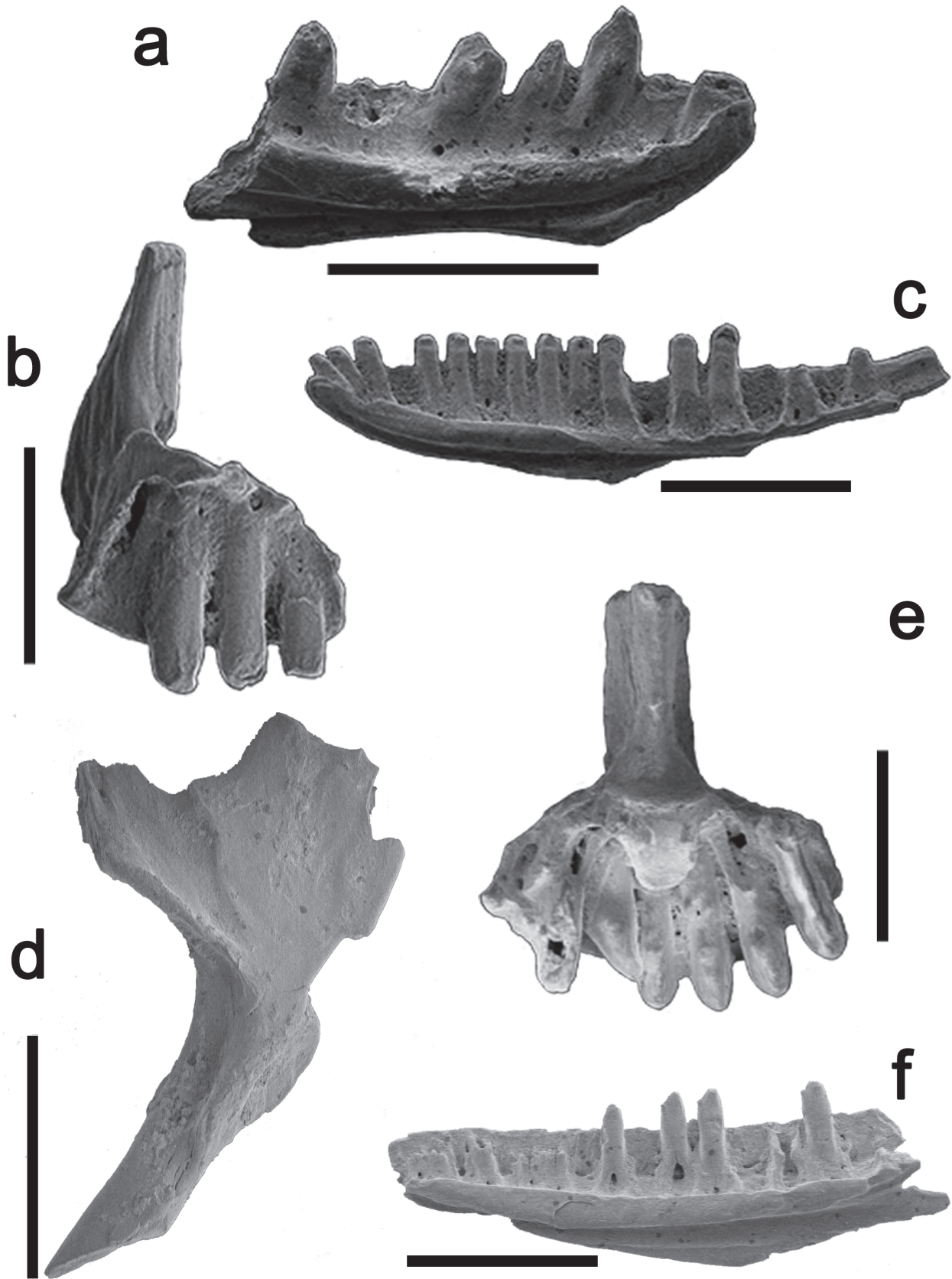


Figure 4. a) *Blanus cinereus*, s.l., left dentary ST-F11-217, lingual view. b-c) *Chalcides bedriagai*, right premaxilla ST-F11-221, lingual view (b); right dentary (ST-F11-218), lingual view (c). d-f) cf. *Acanthodactylus erythrurus*, right pterygoid (ST-F11-229), ventral view (d); premaxilla (ST-F11-227), lingual view (e); right dentary (ST-F11-234), lingual view (f). Scale bars = 1 mm, except for (b) and (e), in which scale bar is 0.5 mm.

Current ecology. The species *C. bedriagai* is an Iberian endemism that inhabits the greater part of the Iberian Peninsula, except its north end (Pollo, 2015). *Chalcides bedriagai* occupies a wide range of Mediterranean habitat with a sparse vegetation cover, characterized by sandy or muddy substrate with a large number of refuges, like stones, roots or dead leaves (Pollo, 2015). Pasteur (1981) divided the different species of genus *Chalcides* into 5 adaptative groups. *C. bedriagai* is included in “*Chalcides ocellatus* adaptative group”, which members do not show a great dependence of soil type or vegetal cover (Schleich *et al.*, 1996), showing besides some degree of semifossorial behaviour. Nevertheless, *C. bedriagai* also selects localities with low precipitations during annual warm periods and abundant solar exhibition (Maluquer-Margalef *et al.*, 2009).

Family **Lacertidae** Oppel, 1811

Genus *Acanthodactylus* Daudin, 1802

cf. *Acanthodactylus erythrurus* (Schinz, 1833)
(Figs. 4d-4f)

Material. 8 premaxillae (ST-F11-227, ST-F11-228), 2 pterygoids (ST-F11-229, ST-F11-230), 14 left maxillae (ST-F11-231, ST-F11-232), 10 right maxillae (ST-F11-233), 23 right dentaries (ST-F11-234, ST-F11-235), 20 left dentaries (ST-F11-236), 14 fragments of dental bones (ST-F11-239), 1 dorsal vertebra (ST-F11-238). NMI: 23.

Description. The premaxillae are wide, showing a well-developed nasal process, reported as “*proceso posterodorsal*” in Barahona (1996) and Barahona & Barbadillo (1997), and parallel lateral margins (Fig. 4d). In posterior view, premaxilla bears seven dental positions, being the teeth pleurodonts, isodonts and monoscupids with blunt apex. Medial crest is well defined, showing a pronounced widening in its base. In dorsal view, two nasal foramina are located in the base of the nasal process in the medial region. Length of the premaxilla shelf (X_{med}) is 1.29 mm (σ : 0.28; n: 6).

Two incomplete right pterygoids have been recovered from the level ST-Xb-F11-S3. These remains present three processes: palatine, transverse and quadrate (anterolateral, anteromedial and posterior in Barahona (1996), respectively) (Fig. 4e). In dorsal view, transverse process becomes less pronounced than palatine process, which is broken. Transverse process is triangular-shaped, without any expansion of its borders. Its posterior surface shows a well-defined fossa and insertion for the *pseudeotemporalis superficialis* muscle (Oelrich, 1956). Pterygoid recess, as “*escotadura pterigoidea*” in Barahona (1996), is not strong. Quadrate process is broken. Columellar fossa is well defined and egg-shaped. In ventral view, the remains do not show any teeth.

The most complete maxilla (ST-F11-234) bears 11 dental positions with only 4 teeth in life position. These teeth are pleurodont, isodont, cylindrical, mono and bicuspid and blunt apex. In general, maxillae are poorly-preserved with anterior and posterior processes broken. In labial view, the surface of the maxilla shows three foramina.

Dentaries are small (the most complete dentary has a length of dental shelf equal to 3.27 mm, with a total of 18 dental positions) (Fig. 4f). In lingual view, Meckelian groove is open along its whole length. Teeth show the same morphology than described above for the maxillae. Ventral end of the dentary is concave. In labial view, dentaries show six-seven labial foramina. The posterior end of the dentary is not preserved.

The vertebrae are procoelus, short and wide. In dorsal view, these have a long neural spine that occupies all the neural arch, not finishing in a point that overtakes the posterior end of the postzygapophysis, trait that distinguishes Lacertidae to Scincidae (Bailon, 1991). Interzygapophyseal constriction is little marked, which differs from Scincidae (Bailon, 1991). Prezygapophysis projects upward, whereas postzygapophysis is expanded in posterior direction. Synapophysis are oval-shape, elongated in postero-dorsal to anterior-ventral position, typical trait of the first cervical vertebra (Bailon, 1991). In ventral view, centrum has a convex surface and triangular-shape and shows a pair of foramina poorly defined. Haemal keel is poorly defined.

Remarks. The remains from El Salt show typical traits of Lacertidae: pterygoid slender and Y-shaped (Evans, 2008), teeth pleurodont, isodonts and mono or bicuspid, premaxillae fused, ventral end of the dentary concave, Meckelian groove of the dentary open along its whole length in lingual view and procoele vertebra with centrum convex and neural spine not exceeding the posterior limit of the postzygapophysis (Bailon, 1991). According to Barahona & Barbadillo (1997), the scarce development of the pterygoid recess allows us to reduce to *Acanthodactylus erythrurus* and *Timon lepidus* Daudin, 1802 the remains here examined. Comparing ST-F11-229 and 230 with pterygoids sketched in Barahona (1996) both species can be distinguished by the morphology of the transverse process and by the size of the bone, which is bigger in *T. lepidus* than in *A. erythrurus*. In *T. lepidus*, the external lateral margin of the process projects anteromedially and is well defined, whereas in *A. erythrurus* this limit does not show a markedly projection, being limited to a small protusion. Regarding the premaxillae, some traits of its morphology allow us to ascribe these remains to *A. erythrurus*. The number of seven teeth is typical of some species of *Podarcis* (*Podarcis muralis* (Laurenti, 1768), *Podarcis bocagei* (Seoane, 1885), and *Podarcis hispanicus* (Steindachner, 1870)), *Iberolacerta bonnali*

(Lantz, 1927), and *A. erythrurus* (Barahona & Barbadillo, 1997). Nevertheless, our taxonomic attribution is supported by the measurements of the premaxilla of *A. erythrurus*: width of the premaxillary shelf, X_{med} : 1.82 mm; σ : 0.28; X_{min} - X_{max} : 0.9-2.37; n: 30 (Barahona, 1996), being the size of our material included in this interval. On the other hand, the morphology of the lateral margins of the nasal process and the absence of teeth in the pterygoides are typical traits from juvenile specimens of *A. erythrurus* (Barahona, 1996; Barahona & Barbadillo, 1997). Unfortunately, teeth of the dentaries remains are incomplete, so it is impossible to check the diagnostic features described by Barbadillo (1989) for the species. According to the poorly-studied osteology of the lacertids, we prefer to adscribe these remains to cf. *Acanthodactylus erythrurus*.

Current ecology. *Acanthodactylus erythrurus* inhabits south and central Iberian Peninsula and northwestern Africa (Pleguezuelos *et al.*, 2002; Loureiro *et al.*, 2008). This species is generally found in open, loose sandy areas; smooth slopes with some sparse vegetation (see references in Belliure, 2015). In the Iberian Peninsula, *A. erythrurus* is located in coastal areas and some inner valleys (Belliure, 2015; Jiménez *et al.*, 2002). Its altitudinal range extends from sea level to 1,750 m, concretely in the sandy dolomites on slopes exceeding 50% in Betic Ranges (Fernández Cardenete *et al.*, 2000).

Suborder **SERPENTES** Linnaeus, 1758

Family **Colubridae** Oepel, 1811

Genus *Rhinechis* Michahelles in Wagler, 1833

cf. *Rhinechis scalaris* (Schinz, 1822)
(Fig. 5)

Material. 3 teeth (ST-F11-244), 1 trunk vertebra (ST-F11-245). NMI: 1.

Description. Teeth are small, conical and curved posteriorly, with sharp apex. This morphology is typical of snakes.

The trunk vertebra is small (LC: 0.78 mm.), procoelus and slightly longer than wider (Fig. 5). In dorsal view, neural spine finishes in the posterior half of the zygosphene. Prezygapophysis are individualized respect the rest of the neural arch. Prezygapophysis articular surface is oval-shaped, with its extreme rounded. Zygosphene is trilobulated, with a wide central lobule few developed. In lateral view, neural arch is high. Prezygapophysis projects anterolaterally, whereas postzygapophysis projects backward. Neural spine, diapophysis, parapophysis and condyle are broken. In the anterior part of the neural arch, ST-F11-245 presents a well defined and rounded

lateral foramen located in a deep depression behind the diapophysis. Centrum is convex, with well-defined lateral margins. In ventral view, centrum is triangular-shaped. Paracotylar foramens are small and not well defined. Haemal keel is spatulate-shaped and shows diffuse lateral margins. In frontal view, neural arch is slightly and laterally flattened. Zygosphene is slightly convex. Cotyle is small and rounded.

Remarks. Traditionally, palaeontologist distinguish two vertebral morphotypes within Colubridae: morphotype “natricinae” (with hypapophysis), and “colubrinae” (without it) (Szyndlar, 1984; Szyndlar & Rage, 1999). In this way, the remains from El Salt belong to a “colubrinae” colubrid. Due to its small size and the overall morphology of the vertebra (presence of a width zygosphene in dorsal view, narrow zygapophysis, posterior notch of the neural arch open and neural arch large), probably ST-F11-245 would belong to a juvenile of ladder snake (*Rhinechis scalaris*).

Current ecology. *Rhinechis scalaris* inhabits major part of the Iberian Peninsula (except Cantabrian coast), southwestern France and northwestern Italy (Pleguezuelos *et al.*, 2002; Loureiro *et al.*, 2008). This species occupies a wide range of habitats, always within in thermo, meso and supramediterranean bioclimatic range. This species inhabits Mediterranean bushes and forestry borders. In general, *R. scalaris* occupies wet and shaded spot areas in the south zone of its distribution area (Busack & Jaksić, 1982); whereas in the north, it is located in dry and northern-oriented areas (Bea, 1986). Regarding its altitudinal distribution, *R. scalaris* is scarce at sea level and abundant at medium high (400-1,000 amsl), reaching 2,200 amsl in the Betic Ranges (Pleguezuelos & Honrubia, 2002).

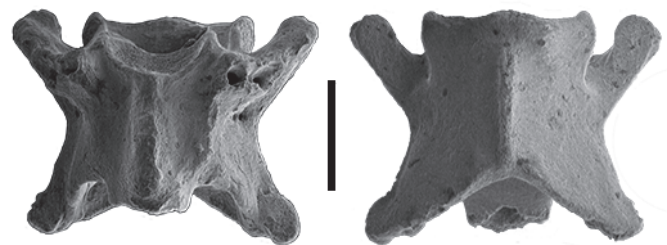


Figure 5. cf. *Rhinechis scalaris*, trunk vertebrae (ST-F11-235) in dorsal (right) and ventral (left) views. Scale bars: 0.5 mm.

5. DISCUSSION

A total of 961 remains of amphibians and reptiles have been recovered from the sediments of El Salt Unit Xb Facies 11 Surface 3. The paleoherpetofaunal community described at the site is composed by seven taxa: 3 amphibians (*Alytes obstetricans*, *Bufo bufo s.l.*, and *Epidalea calamita*) and 4 reptiles (*Blanus cinereus s.l.*, *Chalcides bedriagai*, cf. *Acanthodactylus erythrurus*, and cf. *Rhinechis scalaris*).

The most represented species is *C. bedriagai* with a MNI of 85 individuals. Following cf. *A. erythrurus* (23). With a smaller MNI are *B. bufo s. l.*, (5), *E. calamita* (2), and *A. obstetricans*, *B. cinereus, s. l.*, and cf. *Rhinechis scalaris* (1) (Table 1).

This herpetofaunal assemblage is composed by common species that currently are well distributed in the Iberian Peninsula (Pleguezuelos *et al.*, 2002; Loureiro *et al.*, 2008), and particularly in the central Mediterranean region (Jiménez *et al.*, 2002). Despite the amphibian species *A. obstetricans*, *E. calamita*, and *B. bufo s. l.* have, in a global context, populations outside of the Mediterranean bioregion, all taxa here described are included within Mediterranean chorotype of the Iberian herpetofauna (Sillero *et al.*, 2009). In the Iberian Peninsula, there are two major chorotypes (Atlantic and Mediterranean), which are extremely coincident with the geoclimatic and biogeography of the region. Thus, this equivalence emphasizes the important role of climate and

Table 1. Amphibians and reptiles from El Salt Facies 11 Subunit Xb Surface 3 (ST-F11-SUXb-S3), with the distribution of each taxon in the habitats where they are found in the Iberian Peninsula. NMI: minimum number of individuals.

	NMI	Open-dry	Open-humid	Woodland	Rocky	Water edge
<i>Alytes obstetricans</i>	1	0	0.60	0.20	0	0.20
<i>Bufo bufo s. l.</i>	5	0.10	0.30	0.40	0	0.20
<i>Epidalea calamita</i>	2	0.75	0	0	0.25	0
<i>Blanus cinereus s. l.</i>	1	0.45	0.10	0.45	0	0
<i>Chalcides bedriagai</i>	85	-	-	-	-	-
cf. <i>Acanthodactylus erythrurus</i>	23	-	-	-	-	-
cf. <i>Rhinechis scalaris</i>	1	-	-	-	-	-

vegetation on the distribution of the Iberian herpetofauna (Sillero *et al.*, 2009), thus, highlighting the important role of amphibians and reptiles as a tool for palaeoclimatic reconstruction.

The preliminary taphonomic results of the small mammals indicate that the accumulation of the fossils was originated by the predatory activity of nocturnal birds of prey. For its part, the results from the taphonomic analysis of the reptiles and amphibians show very few marks of digestion, whereas an important part of the remains exhibit slightly signs of the effect of weathering, marks of roots and chemical alteration (corrosion of the surface and manganese depositions). In this way, the origin of the reptiles and amphibians fossils is unclear. The assemblage seems to be not heterogeneous. The lack of strong intensity digestion marks on some remains suggests an accumulation due to, like micromammals, owls, whose gastric juice action on bones is smoother than carnivore mammals (Pinto Llona & Andrews, 1999). The fragmentation of the bones is high, being intact bones extremely rare. The fracturing plane is irregular in appearance and angular, consequence of a fragmentation *in situ* postdepositional. Root marks, black traces and corrosion of the surface are very common in the studied material. The color pattern

of the fossils is heterogeneous, from brown to black. All these modifications affected the remains once these had been buried.

Among the fossil material analysed, *C. bedriagai* is represented by 340 remains, accounting for 35.4% of the remains described here and 71.5% of the total NMI of the archaeological site. In this sense, *C. bedriagai* seems to be over-represented in the fossil assemblage, probably being due to greater *in situ* mortality during the formation of the site. The case of cf. *A. erythrurus* is similar to that of *C. bedriagai*. The lacertids represents the 9.7% of the remains and 19.3% of the total NMI of the herptiles described. For this reason, these species had to be removed from the quantitative palaeoenvironmental analysis. cf. *Rhinechis scalaris* has been removed too for the habitat reconstruction due to its uncertain taxonomical determination.

The application of Habitat Weighting Method for the different species recorded in ST-Xb-F11-S3 provides a slightly predominance of Forest habitats (Fig. 6). The presence of *B. bufo s. l.*, *A. obstetricans*, and *B. cinereus s. l.*, suggest the presence of bushland and forest patched (30%), in which some open areas were present (26% for Open-humid habitats and 27% for Open-dry). The presence

of cf. *Rhinechis scalaris* supports the existence of forests. Open-humid habitats are related to the presence of *B. bufo s. l.*, *A. obstetricans*, and cf. *Rhinechis scalaris*, whereas *E. calamita* (in addition to the presence, although not included in the study, of *C. bedriagai* and cf. *A. erythrurus*) suggests the presence of Dry-open habitats. Furthermore, the description of some burrowing taxa (*B. cinereus s. l.*, and *E. calamita*) or with semi-burrowing behaviour (*C. bedriagai*) indicates the existence of loose soils, which is corroborated by cf. *A. erythrurus*, which shows a clear preference for this kind of substrate (Seva *et al.*, 1982). Finally, *B. bufo s. l.* and *A. obstetricans* suggest the existence of a permanent water body in the vicinity of the cavity, possibly related with the water associated with the travertine complex system or a small river, probably linked with the current Barchell River.

These results are agreed with that provided by micromammal assemblage (Fagoaga *et al.*, 2015b). The palaeoenvironmental reconstruction from the small mammals remains points to a predominance of woodlands (60 %), followed by open humid (14.60 %) and open dry habitats (12.40 %). Rocky and water habitats show a marginal representation. Nevertheless, Galván *et al.* (2014) studied long-chained n-alkanes from the sediments of Level Xb, showing a landscape dominated by grassland. In the same way, preliminary results from an ongoing zooarchaeological study in El Salt indicate a prevalence of Equidae in the lower units of the site (Units X-VIII) (Garralda *et al.*, 2014), a typical group of organisms inhabiting open habitats.

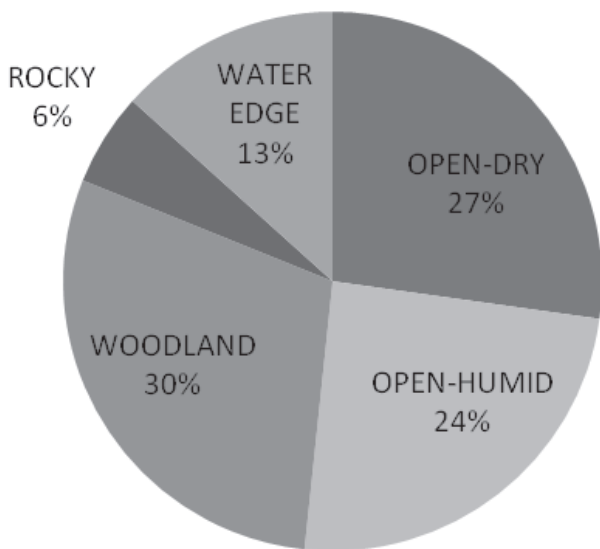


Figure 6. Reconstruction of landscape in ST-F11-SUXb-U3 by applying the Habitat Weighting Method on the amphibian and squamate reptile communities.

In the palaeoclimatological reconstruction, cf. *Acanthodactylus erythrurus* and cf. *Rhinechis scalaris* have not been included due its open taxonomical determination. The results from the UTM-MCR/MER analysis show that the potential area where all the taxa currently live corresponds to Mediterranean bioclimatic region, in the west and east of the Iberian Peninsula. In ST-F11-SUXb-S3, the overlap of the current distribution of all taxa described in the archaeological site gives a total 60 UTM squares (10 km x 10 km) (Fig. 7). This potential area is totally included in Mediterranean region, such as Castilla y León, Aragón and Comunitat Valenciana in Spain, and Districts of Porto, Vila Real, Bragança, Aveiro, Viseu, Guarda, Castelo Branco and Portalegre in Portugal. El Salt is located close to the southern squares of the potential area, but not included among them. Using the climatic layers of Word Climate 1.4 (Hijmans *et al.*, 2005), two sets of data, from the co-occurrence areas and from the municipality of Alcoy have been obtained and compared (Table 2).

Table 2. Estimated climatic parameters for ST-F11-SUXb-S3 using UTM MCR/MER method. Current climatic data are obtained from current global climatic data layers (Hijmans *et al.*, 2005), extending the mutual geographic range of the species represented in this locality over 8,852 pixels of 30 arcseconds (near of 1 km²) resolution grid. MAT: mean annual temperature; MTC: mean temperature of the coldest month; MTW: mean temperature of the warmest month; TAR: temperature annual range; MAP: mean annual precipitation; PWM: Precipitation of the wettest month; PDM: precipitation of the driest month; Δ: difference between the current values and the results obtained in the present work; ALCOY: current bioclimatic parameters of the municipality of Alcoy; SD: standard deviation; MIN: minimum; MAX: maximum.

	Mean	SD	Min.	Max.	Δ	Alcoy
MAT	14.0	2.4	4.1	18.3	+0.3	13.7
MTC	2.7	2.6	-6.7	7.0	+1.0	1.7
MTW	29.3	1.9	21.4	33.6	+0.8	28.5
TAR	26.6	1.9	19.0	30.6	-0.2	26.8
MAP	665.2	219.6	328.0	1,562.0	+122.8	542.3
PWM	93.9	32.4	42.0	233.0	+19.6	74.3
PDM	10.8	4.6	5.0	32.0	-4.4	15.2

This set of data suggests, for this zone of the Iberian Peninsula a mean annual temperature (MAT) slightly higher than at present (+0.26 °C; Table 2) during the period of MIS 3. Other climatic parameters show clear differences, mean temperature of the coldest month (MTC) and mean temperature of the warmest month (MTW) is higher (+0.99 °C



Figure 7. 10 x 10 km UTM squares in the Iberian Peninsula where all the species described in ST-F11-SUXb-S3 nowadays occur together. The white star indicates the location of El Salt. Data of recent distribution after Pleguezuelos *et al.* (2002) and Loureiro *et al.* (2008).

and $+0.80$ °C, respectively; Table 2). Nevertheless, the parameter of continentality, measured by temperature annual range (TAR), is lower (-0.20 °C; Table 2). This latter bioclimatic parameter shows the difference between the mean temperature of the warmest and coldest month of the year, taking monthly mean temperatures in each case. In the case of ST-F11-SUXb-S3 the differences between MTW and MTC was less accused than today.

Mean annual precipitation (MAP) is higher in the potential area than at present in Alcoy ($+122.85$ mm; Table 2). Whereas precipitation of the wettest month (PWM) is higher than today ($+19.64$ mm), precipitation of the driest month (PDM) is lower than today (-4.39 mm; Table 2).

In the same way, preliminary results from the palaeoclimatic reconstruction using micromammals remains from ST-F11-SUXb-S3 show a lower statistical range ($3.5 - 13.6$ °C, a range of 10.1 °C) than reptiles and amphibians, whose interval range is between 4.1 and 18.3 °C (ranging in 14.2 °C) for the MAT (Table 3). This result is clearly biased to cooler temperatures if it is compared with the palaeoclimatic conclusions obtained in the present work. This could be explained by the different distribution of the overlapping distribution of the mammal taxa regarding to the herpetofauna described in the site. Whereas in the case of micromammals most of the squares are located in the northwestern Castilla y León, a transitional area between Atlantic and Mediterranean bioregion, in the case of herpetofaunal remains, the majority of the overlapping distribution is situated in Comunidad Valenciana, in which higher temperatures are recorded. Regarding to MAP both faunal proxies (mammals and reptiles and amphibians) shows extremely similar results ($389-1,293$ mm and $328-1,562$ mm, respectively) (Table 3). That is, the study of both fauna agrees in describing the area of the site as more

humid than today; whereas regarding to temperature the conclusions is distinct. These differences are due to the cosmopolitan distribution of the reptiles and amphibian species present in the site, in which their distribution is limited by other factors different to temperature, such as the presence of permanent water bodies or of the substrate type. In addition, Mediterranean Iberian species show a low marginality and a high tolerance, mostly due to the large area occupied by the Mediterranean biogeographical region in the Iberian Peninsula (Sillero *et al.*, 2009). In this way, it is possible to distinguish two main populations in the potential area of where all the taxa currently live (Fig. 7). One is located in western Iberia. The second group is found in central Mediterranean coast. This latter is the responsible of higher temperatures recorded in the study. In this sense, in future researches it is necessary to focus in the study of the microvertebrates remains, especially those that belongs to amphibians and reptiles, of different surfaces of the stratigraphical unit Xb.

Our results (MAT and MAP) differ from those obtained applying the UTM-MCR/MER to the paleocommunity determined of micromammals and herptiles in other archaeological sites from eastern Spain with similar chronology (from north to south: L'Arbreda, Teixoneres, Abric Romaní, Cova del Gegant and Cova dels Xaragalls), being in general, warmer and drier than those of L'Arbreda (López-García *et al.*, 2015), Teixoneres (López-García *et al.*, 2012a), Abric Romaní (Burjachs *et al.*, 2012), Cova del Gegant (López-García *et al.*, 2014) and Xaragalls (López-García *et al.*, 2012b) (Table 3). However, the results from Unit Xb of El Salt are similar to those of levels J, K, L, M and N from the Abric Romaní and Cova dels Xaragalls C5 (Burjachs *et al.*, 2012; López-García *et al.*, 2012b), all them included in DO 14 event. In this way, the results

obtained through the study of herpetofauna in the present work are related to a warm period during MIS 3, in which the temperature and precipitation in the area were higher than today. The climatic data and datation from the Unit Xb of El Salt seem to match with those represented in DO 14 event.

Table 3. MAT (°C) and MAP (mm) values after applying UTM-MCR/MER method to the micromammals and herptiles of the sites of L'Arbreda (López-García *et al.*, 2015), Teixoneres (López-García *et al.*, 2012a), Abric Romani (Burjachs *et al.*, 2012), Cova del Gegant (López-García *et al.*, 2014), Xaragalls (López-García *et al.*, 2012b) and El Salt (Fagoaga, com. pers.) (only micromammals). AGE indicates chronology (Ky) of the sites which have been compared with ST-F11-SUXb-U3. ΔMAT (°C) and ΔMAP (mm) represent difference between values of a locality with respect to those of ST-F11-SUXb-S3 using herptiles remains.

Site	Level	Age	MAT	MAP	ΔMAT	ΔMAP
L'Arbreda	I	45.8 - 41.4	6.0	1,500.0	-8.0	-835.0
Teixoneres	II	50.0 - 30.0	7.6	1,008.0	-6.4	-343.0
	E	44.9 ± 2.5 - 49.0 ± 1.5	7.8	809.0	-6.2	-144.0
	J	50.0	9.8	719.0	-4.2	-53.8
	K	51.6 ± 0.3 - 50.6 ± 2.0	9.8	719.0	-4.2	-53.8
Abric Romani	L	50.6 ± 2.0 - 51.8 ± 1.4	9.8	719.0	-4.2	-53.8
	M	51.8 ± 1.4 - 55.8 ± 2.3	9.8	719.0	-4.2	-53.8
	N	55.8 ± 2.3 - 54.6 ± 0.4	10.7	734.0	-3.3	-68.8
	O	54.2 ± 4.2	7.8	1009.0	-6.2	-344.0
Cova del Gegant	IV	60 ± 3.8	10.0	1009.0	-4.0	-344.0
	C4	45.1 - 48.2	8.0	925.0	-6.0	-260.0
	C5	> 48.0	10.4	664.0	-3.7	+1.2
Xaragalls	C6	> 48.0	8.0	950.0	-6.0	-285.0
	C7	> 48.0	8.7	900.0	-5.4	-235.0
	C8	> 48.0	10.5	729.0	-3.6	-63.8
El Salt (micromammals)	Xb-S3	52.3 ± 4.6	10.1	656.8	-3.9	-8.4

The registered anurans (*Alytes obstetricans*, *Bufo bufo s.l.*, and *Epidalea calamita*) have a greater distribution area (10 x 10 km UTM squares) than those of reptiles of this locality (*Blanus cinereus s.l.* and *Chalcides bedriagai*) (Table 4). This gap in the recognized distribution area on both groups is directly related with an underestimate current distribution of *Blanus cinereus s.l.* and *Chalcides bedriagai*, due to its cryptical behaviour (Pleguezuelos *et al.*, 2002; Loureiro *et al.*, 2008). All the taxon described in ST-F11-SUXb-S3 occupies a high number of 10 x 10 km UTM squares in the Iberian Peninsula, areas representing

a diverse type of habitats (Pleguezuelos *et al.*, 2002; Loureiro *et al.*, 2008) and climates. Comparing with results provided by micromammal assemblage (Fagoaga *et al.*, 2015b), the high temperatures recorded in the present work could be explained by the presence of this few specialized faunal community, having a huge ecological range and an extensive distribution area in the Iberian Peninsula. Using this type of communities (wide distribution range and ecological specialization) for the study of the palaeoclimatology of archaeological sites provides results with a broad number of UTM squares that include territories with strongly differentiate climatic conditions. Moreover, 10 x 10 km UTM squares constitute an artificial division of the territory without a real ecological base, and therefore they can present quite heterogeneous conditions in altitude, temperature, humidity, etc. Thus, the climatic parameters are strongly biased by this environmental heterogeneity. In the present work, it leads to the inclusion of areas with elevated values for temperatures and low for rainfall (squares in eastern Iberian Peninsula), with others ones with opposite climatic conditions for precipitation (squares in the Atlantic coast of Portugal) and/or thermal reading (mountainous areas of central Iberian Peninsula).

Table 4. Percentage of 10 x 10 km UTM squares occupied by the differents species of reptiles and amphibians represented in ST-F11-SUXb-S3. TOT: number of 10 x 10 km UTM squares inhabited by each species in the Iberian Peninsula, in the Spanish territory (SPA), in Portugal (POR) and in Spain and Portugal (COM) after Pleguezuelos *et al.* (2002) (Spain) and Loureiro *et al.* (2008) (Portugal). %: percentage of UTM squares occuppies by each species respect to the total number in the Iberian Peninsula; ST: percentage of UTM squares occupied by each taxa considered in the UTM-MCR/MER method. Total number of 10 x 10 km UTM squares in the Iberian Peninsula are 5,928.

	TOT	SPA	POR	COM	%	ST
<i>Alytes obstetricans</i>	1,962	1,662	331	31	33.1	3.1
<i>Bufo bufo s.l.</i>	3,828	3,095	792	59	64.6	1.6
<i>Epidalea calamita</i>	3,272	2,772	556	56	55.2	1.8
<i>Blanus cinereus s.l.</i>	1,587	1,224	403	40	26.8	3.8
<i>Chalcides bedriagai</i>	753	562	191	0	12.7	8.0

6. CONCLUSIONS

The study of the fossil remains of reptiles and amphibians from unit ST-Xb-F11-S3 allow us to conclude that the faunal assemblage from this Unit is composed of three taxa of anurans (*Alytes obstetricans*, *Bufo bufo s.l.*, and *Epidalea calamita*), one taxon of blandid (*Blanus cinereus*

s.l.), two taxa of lizards (*Chalcides bedriagai* and cf. *Acanthodactylus erythrurus*) and one taxon of snake (cf. *Rhinechis scalaris*), all them typically Mediterranean species, still present in the area or very close to the place. During the formation of the fossiliferous layer, environment was dominated by open-dry vegetation, but also a mixture of bushland and forest patches was present. Permanent water bodies existed in the surrounding area of the site. The climatic conditions inferred for ST-Xb-F11-S3 from the locality of El Salt shows climate was a bit warmer and wetter than today.

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