

Pleistocene Birds of Gruta da Furninha (Peniche-Portugal): A Paleontological and Paleoenvironmental Approach

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Abstract: The cave-site of Gruta da Furninha is a coastal karstic cavity. In the late 19th century, excavation of the sedimentary infill of the cave allowed the identification of two lithostratigraphic units: a Holocene one dominated by sands, containing human bones and a Neolithic industry; and a Late Pleistocene one, containing a diverse set of fossils set and Paleolithic artifacts. This study mainly focuses on taphonomic and palaeoenvironmental data concerning the Pleistocene bird bones that were collected from six layers (at 11 m and 6.7 m asl). A main result of this study was the discovery of a left humerus fragment, with osteological features of the Alcidae family; from comparison with upper arms of distinct species of this family, it was concluded that this fossil belongs to *Penguin impennis*. The Pleistocene birds of the Furninha cave were also compared with the avifauna that currently occurs in the region of Peniche peninsula and a climate and environmental interpretation of the Pleistocene fossiliferous set is provided.

Key words: Birds, Pleistocene, marine caves, Portugal.

1. Introduction

The Furninha cave is a coastal karstic cavity in Lower Jurassic limestones, located ca. 850 m SE of Cape Carvoeiro, on the southern coast of the Peniche peninsula (western coast of central mainland Portugal), about 75 km north of Lisbon (39°21'23" lat. N and 9°26'14" long. W). This cave has an entrance of marine genesis located in the middle part of the coastal cliff, at ca. 15 m asl.

The sedimentary infilling of the cave was excavated in the late 19th century by Delgado, J. F. N. [1], which defined two main stratigraphic units: a Holocene unit and a Pleistocene unit. Later, Breuil, H. and

Zbyszewski, G. [2] identified at the base of the lower unit (at 6 m asl) a marine stratigraphic level, which they ascribed to the Riss-Wurm interglacial.

In the upper unit “Entulho Superior” (Upper Rubble), some of the bones collected are human. In the ca. 8 m-thick lower unit “Areias Quaternárias” (Quaternary Sands), with 7 main “níveis ossíferos” (bone-rich levels) I to VII, were recognized, several separated by a travertine and nine of them rich in well-preserved faunal bones [1]. A description of the sedimentary succession, including fossils and artifacts, can also be seen in Ref. [3].

Cunha, P. P., et al. [4] made a detailed characterization of this coastal area. Several wave-cut platforms and associated sedimentary deposits were mapped and located, respectively, at (asl): 33-36 m;

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24-27 m; 20-21 m; 15-17 m; 10-12 m and 6-8 m.

The first vertebrate inventory of fossils collected from the Pleistocene unit listed ca. three dozen mammalian taxa and showed the presence of birds, fish and chelonians [1]. Later, this Late Pleistocene fauna was more thoroughly studied by Harlé, E. [5]. In the case of birds, Harlé benefitted from the collaboration of Newton. Some other publications addressed the fossil remains of Furninha cave [6-8], but all of them just repeated the data already published by Harlé. During the 20th century and early 21st century, the mammals were revisited, and new analyses were provided [9, 10]. In the case of birds, until 2007, the bibliography only reproduced the results of the study made by Newton in Harlé [5]. Since 2008, there have been some new studies (paleontology, taxonomy, taphonomy and paleoenvironment) focused on fossil birds from Furninha cave [9-15].

Until now, the bibliography related to the Furninha cave avifauna had two gaps: (i) the downgrading of taxonomic nomenclature; and (ii) the lack of detailed study of the majority of the bird remains (only 20% of the total was previously studied).

2. Material and Methods

The present study is focused on the analysis of all the bird remains from Gruta da Furninha (436 bones), currently housed at the Geological Museum of LNEG (Laboratório Nacional de Energia e Geologia) in Lisbon. The analyzed avifauna remains of Furninha cave were complemented with literature search and through comparison with the reference osteological collections (Arqueosciences Laboratory of General

Direction of Cultural Heritage; Achaeozoology and Paleontology Laboratory of Portuguese Center of Geo-History and Prehistory). The association of taxonomic data with the environment of the species identified, according to the respective stratigraphic level of provenance, was also carried out.

3. Previous Studies

3.1 Geoarchaeology

Delgado, J. F. N. [1] published results in outstanding detail and the archaeological materials have been successively reviewed or acknowledged [2, 3, 5-7, 16-19]. The upper lithostratigraphic unit (“Entulho Superior”) encompasses an early to late Neolithic necropolis with abundant organic material, osteological human remains, personal adornments, bone tools and pottery along with polished and knapped stone tools [18] (Table 1).

The lower lithostratigraphic unit Quaternary Sands (“Areias Quaternárias”) comprises a sedimentary succession containing artifacts encompassing a sequence between the Middle and Upper Paleolithic, with assemblages pointing to the Acheulian, Mousterian, Gravettian, Solutrean and Magdalenian [3], most of them—especially the Mousterian industries—in association with abundant and diverse faunal remains [1, 5-15] (Tables 1 and 2 and Fig. 1).

Unfortunately, the site has very few absolute dates. Two radiocarbon AMS (Accelerator Mass Spectrometry) dates, one on human bone and another on a bone pin from the upper unit (Holocene) confirm that part, at least, of the necropolis identified from the upper unit dates from the Late Neolithic [18, 20, 21]. Another age,

Table 1 Stone-tool assemblage from Furninha cave, according to Delgado, J. F. N. [1]; Bicho, N. and Cardoso, J. L. [3]; Cardoso, J. L. and Carvalho, A. F. [18].

	Flint	Quartzite	Quartz	Limestone	Amphibole	Other	Total	Reference
Acheulean	1							1
Mousterian	25	2				4	31	3
Gravettian	24					1	25	3
Solutrean	9						9	3
Magdalenian	8						8	3
Indeterminate	46	1					47	3
Neolithic	70	1		1	26	4	102	3

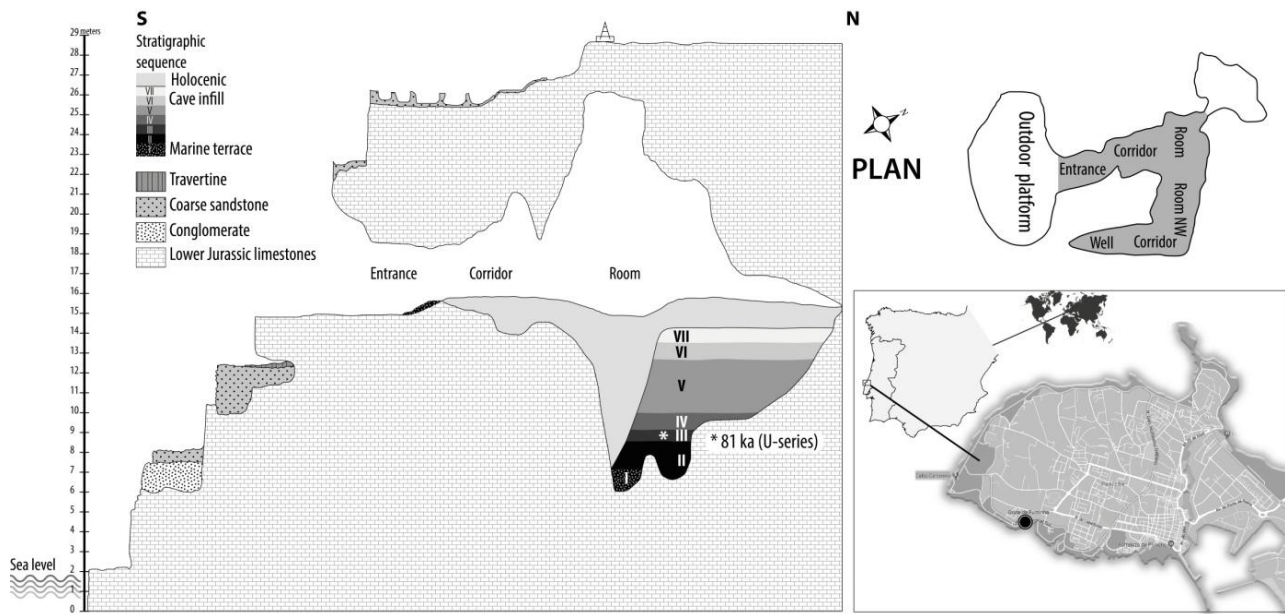


Fig. 1 Stratigraphy, plan and localization of the Furninha cave.

Table 2 Stratigraphic levels of the Pleistocene lithostratigraphic unit and correspondence of the different fauna groups for each of these levels, according to Delgado, J. F. N. [1].

Main subunits	VII	VI		V	IV	III			II		I	
Stratigraphic levels (m asl)	1 (13.5)	1 (13)	2 (12.8)	1 (10)	1 (9.2)	1 (9)	2 (8.7)	3 (8.5)	1 (7.2)	2 (7.1)	1 (6)	2 (5.7)
Mammals	*	*	*	*	*	*	*	*	*	*	*	*
Birds		*	*	*		*		*	*		*	*
Reptiles			*	*								
Amphibians				*		*		*				
Invertebrates											*	*
Artifacts	*	*	*		*	*		*	*	*		

resulting from Uranium-series dating of a bone collected from the 3th stratigraphic level (8.5-9 m asl), is $80,880 \pm 42,420 - 31,260$ years [22] (Fig. 1), but cannot be used as a reliable chronological marker due to the large standard deviation.

3.2 Paleontology

Previous studies [1, 5-10, 13-15] allowed the identification of the vertebrate taxa of the Furninha cave faunas and their distribution by the various stratigraphic levels (Figs. 1 and 3): carnivorous mammals (*Ursus arctos*, *Hyaenaprisca*, *Panthera pardus*, *Lynx pardina*, *Canis lupus*, *Vulpes vulpes*, *Melesmeles* and *Martessp*); herbivores (cervids, *Dicerorhinus hemitoechus*, *Bos primigenius*, *Equus caballus* and *Sus scrofa*); *Paleoloxodont antiquus*,

Oryctolagus, flying mammals (order Chiroptera); amphibians; turtles; lizards and birds.

4. Results

4.1 Osteological Data

A total of 436 bones of birds were identified (10% of the total number of vertebrate remains), collected from six of the seven Pleistocene stratigraphic levels of the Furninha Cave (Table 2). Most (95.4%) are bones of the appendicular skeleton. Of these, 36.2% are from hind limbs and 59.2% are from anterior limbs (Fig. 2). Of the remaining bones, 4.3% belong to the axial skeleton and only 0.3% to the cranial skeleton (a skull of *P. graculus*). The remaining variables have opposite signs, indicating positive contribution for ozone creation [10, 12].

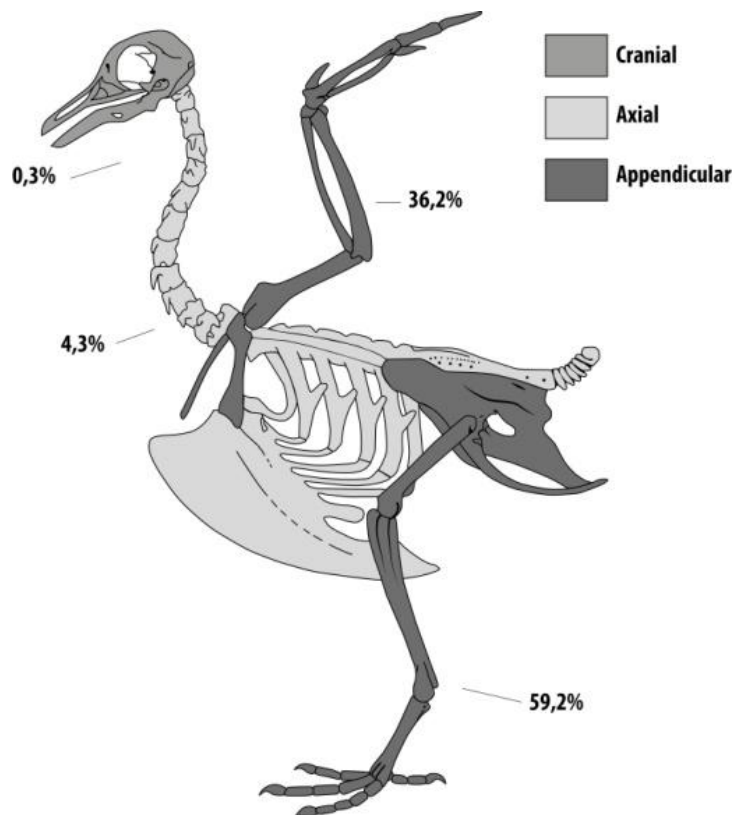


Fig. 2 Quantity and percentage of the skeleton parts represented by bird bones of the Furninha cave.

4.2 Taxonomy

Although the species *T. tadorna* predominates, with 149 bone specimens identified, Furninha cave has a large taxonomic diversity, when compared with other Portuguese Pleistocene sites. The predominant groups are the passerines and the anseriforms. Anseriforms are dominated by marine species (Table 3, Fig. 3), which is explained by the location of the cave.

4.3 Paleoenvironmental Interpretation

Except for the bone of *P. impennis*, which have a fracture that could be of anthropogenic origin, the bird bones from Furninha cave do not provide evidence of human activities (cut marks, effects of fire) [12, 14]. Damage from predation was also not identified. Although the species identified are not typical of caves, they are marine species and the Furninha cave is located on a sea cliff. It is believed that the accumulation of bird remains would have resulted from animals that died inside the cave, but also other

remains were brought by other animals and by the primitive humans using this cave. So, the biological remains also contributed to the sedimentary filling of the cave, which mainly consists of sand brought by wind and gravels provided by gravity processes, which would explain the large proportion of broken bones.

The Furninha cave avian assemblage is dominated by seabirds (anseriforms and peleceniforms). However, the presence of continental species (such as the grey partridge) indicates a connection with continental environments. Species associated with the following environments were identified: coastal habitats, forests, open fields, woods, wetlands and mountain areas.

The presence of birds as the *P. impennis*, *T. tadorna*, *C. olor* and *S. mollissima* point to a colder than present climate. Other bird species, such as *A. crecca* and *N. phaeopus*, as well as mammal species collected in stratigraphic association, suggest humid and hot to temperate climate conditions [9, 12, 13].

[illegible]

Table 3 continued

		Environments							Climates
		Bos	CA	Zh	LAD	Mont	ZR	Flo	
Procellariiforms	<i>Puffinus puffinus</i>								1 B
Pelicaniforms	<i>Phoenicopterus ruber</i>								1 A
Phoenicopteriforms	<i>Phalacrocorax aristotelis</i>								1 A
	<i>Tito alba</i>	0.5	0.5						D
Strigiforms	<i>Bubo bubo</i>						0.5	0.5	D
	<i>Asio flammeus</i>	0.33	0.33					0.33	D
	<i>Falco tinuculus</i>						0.5	0.5	C
Falconiforms	<i>Aquila chrysiatus</i>		0.33	0.33				0.33	C
	<i>Aquila sp</i>		0.33	0.33				0.33	C
	<i>Gyps fulvus</i>		0.5			0.5			C
	<i>Pyrrhoc. pyrrhocorax</i>					0.5			0.5 D
	<i>Pyrrhocorax graculus</i>					1			D
	<i>Corvus corone</i>	0.33	0.33	0.33					C
	<i>Corvus frugilegus</i>	0.5	0.5						C
	<i>Corvus monedula</i>	0.33	0.33						0.33 C
Passeriforms	<i>Turdus merula</i>	0.5	0.5						D
	<i>Turdus philomelos</i>	0.5	0.5						D
	<i>Turdus pilaris</i>	0.5	0.5						D
	<i>Turdus iliacus</i>	0.5	0.5						D
	<i>Turdus sp</i>	0.5	0.5						D
	<i>Pica pica</i>	0.33	0.33					0.33	C
	<i>Cuculus canorus</i>	0.33	0.33	0.33					C
Average		0.42	0.48	0.35	0.55	0.66	0.5	0.38	0.73 C/D

5. Discussion

A relevant highlight is the discovery of a left humerus fragment found in the middle of other bones not classified. This bone has osteological features of the Alcidae family: pronounced longitudinal flat of the diaphysis, lateral and ventral projection of proximal humeral articulation and slightly prominent pectoral crest, compared to dorsal margin. From these features, and from comparison of upper limbs of distinct species of the Alcidae family, it was concluded that this specimen belongs to *P. impennis* [11].

Most of the Pleistocene birds identified belong to taxa still living in Portugal, but only the following species have ceased to occur in the peninsula and its surroundings: *A. chrysaetos*, *C. frugilegus*, *G. fulvus*, *P. ruber*, *P. impennis*, *S. mollissima*, *P. perdix* and *P. graculus*. There are still a few reports of *S. mollissima* from the Minho estuary (upper North coast) to the

Algarve, although none in Peniche [23]. These reports must be checked by the PCRB (Portuguese Committee for Rare Birds). The same holds true for *C. olor*, which also occurs around Peniche, but most are probable escapees from captivity. *A. Chrysaetos* individuals prefer high inland mountains, but have occasionally been spotted in the Serra d'Aire e Candeeiros, not far away. *G. fulvus* also prefers inland habitats, but there are records of stray individuals spotted in the Tagus estuary and in an urban environment near Oporto. *C. frugilegus* has also become a rare species in Portugal, only recorded occasionally in the inner south and in the Algarve. It is nonetheless a bird that is common in colder climates. *P. graculus* is completely absent from Portugal, but is very common in several Portuguese Pleistocene assemblages. It is a bird that lives in high mountains above the 1,300 m, which makes the presence of its bones in Furninha remarkable, not because it is close to the coast, but because of the

latitude and the altitude as well as the modern-day mild climate of the place. *P. ruber*, an American bird from the Caribbean region, has been separated from the European species, and is about the same size as the *P. roseus*, which in his turn is quite common in the Ó bidos lagoon. Although Svensson, L., et al. [24] tell of its presence in Europe, he also claims they are of captive origin; no record from Portugal is known. As older guides [25-27] make no distinction between them, it is assumed that the bones found represent *P. roseus* instead, which is much more plausible.

The subunit III (8.5-9 m asl) has the highest number of faunal remains (mammals and birds) and has the presence of species associated with different climates (warm: *G. fulvus*, *A. rufa* or *D. hemitoechus* and *E. caballus*; cold: *P. impennis* or *P. graculus*) (Fig. 3), suggesting that this stratum was formed over a period of transition from an interstadial to a colder period.

The long period with successive faunal and human occupations of the cave occurred after the cave was above sea level, following the genesis of the marine platform at 15 m asl. The sedimentary filling of the lower lithostratigraphic unit (Pleistocene), which contains Middle Paleolithic to Upper Paleolithic industries (these only at the top) interspersed in aeolian sands, must encompass the period of ca. from 90 to 12 ka. This is supported, although without great precision, by the only absolute date available.

6. Conclusions

Building a bridge to the present-day avifauna hereabouts, it can be concluded that it has barely changed since the Pleistocene. From the analysis of a satellite map from Google Earth, including the Berlengas archipelago and the surroundings up to Caldas da Rainha and down to the São Domingos Dam, and having visited the region, the diversity of ecosystems can be attested, both terrestrial and marine: open sea, islands, coasts with both sand beaches and high cliffs, the harbor itself, and on the mainland agriculture fields both big and small gardens, with a

multitude of trees and bushes of several sizes, a few streams, the Ó bidos lagoon, the São Domingos Dam and the Paúl da Tornada, a biodiversity hotspot. It comes as no surprise then that from a search on the eBird database for only two of the hotspots in the Peninsula of Peniche (the Carvoeiro Cape and the harbor itself, thus on both sides of the Furninha cave), a total of 162 different species have been identified from the most diverse groups. From the Atlas of Breeding Birds, in its already somewhat outdated second edition of 2008, a total of 119 species are reported to nidify on the area. Both lists include pelagic birds, coastal birds, waders, raptors, and all sorts of smaller birds that are common in Europe.

The identification of *P. impennis* is important, because this is a species associated with a cold climate, and because this species is poorly known in the fossil record of Portugal: Until this identification, it was only known in Gruta da Figueira-Brava and in Porto Santo [28, 29].

The distribution of fauna (birds and mammals) in relation to sedimentary levels allows a study of corresponding paleoclimatic evolution [9, 10, 12, 13].

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References

- [1] Delgado, J. F. N. 1884. *La Grotte de Furninha à Peniche*. IX Congrès International d'Anthropologie et d'Archéologie Préhistoriques. Lisboa: Académie Royale des Sciences 1880: 207-78.
- [2] Breuil, H., and Zbyszewski, G. 1945. "Contribution à l'Etude des Industries Paléolithiques du Portugal et de Leurs Rapports avec la Géologie du Quaternaire." *Comunicações dos Serviços Geológicos de Portugal*. XXIV: 1-678.

- [3] Bicho, N., and Cardoso, J. L. 2010. "Paleolithic Occupations and Lithic Assemblages from Furninha Cave, Peniche (Portugal)." *Zephyrus* 65 (2): 17-38.
- [4] Cunha, P. P., Martins, A. A., Gouveia, M. P., Gomes, A. A., Figueiredo, S., Duarte, J., et al. 2017. "Registos Geomorfológicos e Sedimentares do Plio-Plistocénico de Peniche-Atouguia da Baleia. 8." In *Proceedings of Congresso Nacional de Geomorfologia*, 103-106.
- [5] Harlé, E. 1910-11. "Les Mammifères et Oiseaux Quaternaires Connus Jusqu'ici en Portugal. Mémoire Suivi d'une Liste Générale de Ceux de la Péninsule Ibérique." *Comunicações dos Serviços Geológicos de Portugal*, VIII: 22-86.
- [6] Ferreira, O. V. 1964. "Jazidas Quaternárias Com Fauna de Vertebrados Encontradas em Portugal." *Arqueologia e História*. 8 (11): 39-57.
- [7] Roche, J. 1970. "Le Climat et les Faunes du Paléolithique Moyen et Supérieur de la Province d'Estremadura." In *Proceedings of II National Congress of Archeology*, 39-48.
- [8] Roche, J. 1972. "Faunes du Pléistocène Supérieur et Final de l'Estremadura, Portugal." *Annales de Paléontologie (Vértebrés)* 58 (2): 229-242.
- [9] Cardoso, J. L. 1993. *Contribuição para o Conhecimento dos Grandes Mamíferos do Plistocénico Superior de Portugal*. Câmara Municipal de Oeiras. Oeiras.
- [10] Brugal, J. P., Argant, J., Crispim, J. A., Figueiredo, S., Serra, A. M., and Palmqvist, P. 2012. "The Complex Carnivore-rich Assemblages from Furninha (Peniche, Portugal): A Multidisciplinary Approach." *Journal of Taphonomy* 10: 417-138.
- [11] Pimenta, C., Figueiredo, S. and Moreno-Garcia, M. 2008. "Novo registro de Pinguim (*Pinguinus impennis*) no Plistocénico de Portugal." *Revista Portuguesa de Arqueologia* 11 (2): 361-70.
- [12] Figueiredo, S. 2010. *A Avifauna Plistocénica de Portugal: especificidades evolutivas, anatómicas e o seu contexto paleontológico, geológico e arqueológico*. Doctoral Dissertation, Universidad de Salamanca. Salamanca.
- [13] Figueiredo, S. 2012. "The Pleistocene Elephants of Portugal." In *Proceedings of the International Congress Ivory and Elephants in Iberian Peninsula and Occidental Mediterranean*, 37-44.
- [14] Figueiredo, S., and Rosa, M. A. 2014. "Indicadores Paleocológicos Resultantes do Estudo da Avifauna do Plistocénico Médio e Superior Português: Evolução Paleoclimática e Comparação com os Ambientes Atuais." *Arqueofauna e Paisagem* 37-41.
- [15] Figueiredo, S., Cunha, P. P., Martins, A. A., and Gouveia, M. 2017. "Aves Plistocénicas da Gruta da Furninha (Peniche): Abordagem Paleontológica e Paleoecológica." *Abstracts Book of IX Meeting of Iberian Quaternary*. Faro, 2017. Algarve University: 4-5.
- [16] Fontes, J. 1917. "Instruments Paléolithiques Dans la Collection de Préhistoire du Service Géologique. Études 2 à 5." *Comunicações dos Serviços Geológicos de Portugal* 12: 3-16.
- [17] Obermaier, H. 1925. *El Hombre Fósil*. Madrid: Comisión de Investigaciones Paleontológicas y Prehistóricas (Memoria número 9).
- [18] Cardoso, J. L., and Carvalho, A. F. 2011. "A Gruta da Furninha (Peniche). Estudo dos Espólios das Necrópoles Neolíticas." *Estudos Arqueológicos de Oeiras* 18: 333-92.
- [19] Zilhão, J. 1997. *O Paleolítico Superior da Estremadura Portuguesa*. Ed. Colibri, Lisboa.
- [20] Cardoso, J. L., and Soares, A. M. M. 1995. "Sobre a Cronologia Das Grutas Artificiais da Estremadura Portuguesa". *Al-madan*. Series II 4: 10-3.
- [21] Soares, A. M. 1999. "Megalitismo e Cronologia Absoluta." In *Proceedings of II Congress of Peninsular Archeology, III*. Zamora: Fundación Rei Afonso Henriques, 689-706.
- [22] Raposo, L. 1995. "Ambientes, Territorios y Subsistencia en el Paleolítico Medio de Portugal." *Complutum* 6: 57-77.
- [23] Catry, P., Costa, H., Elias, G. and Martins, R. 2010. *Aves de Portugal. Ornitologia do Território Continental*. Lisboa: Assírio & Alvim.
- [24] Svensson, L., Mullarney, K., and Zetterstrom, D. 2008. *Collins Bird Guide*. 2nd ed. London: Harper Collins Publishers.
- [25] Gooders, J. 1990. *Field Guide to the Birds of Britain & Europe*. London: Kingfisher.
- [26] Jonsson, L. 1993. *Vogels van Europa, Noord-Afrika en het Midden-Oosten*. 2nd ed. Baarn: Uitgeversmaatschappij. Tirion.
- [27] Harrison, C., and Greensmith, A. 1993. *Birds of the World*. London: Dorling Kindersley.
- [28] Mourer-Chauvire, C., and Antunes, M. T. 2000. "L'Avifaune Pléistocène et Holocene de Gruta da Figueira Brava." *Actas do colóquio Últimos Neandertais em Portugal, evidência, odontológica e outra*. Academia de Ciências de Lisboa, 129-62.
- [29] Pieper, H. 1985. "The Fossil Land Birds of Madeira and Porto Santo." *Bocagiana* 88:1-6.