

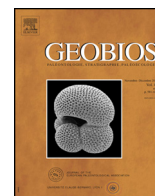


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Original article

The Upper Pleistocene-Holocene raptorial bird guild from Eivissa Island (Pityusic Archipelago, Western Mediterranean Sea)[☆]



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ABSTRACT

Predators are an essential component of past and present ecosystems and trophic networks. In addition, their role as bone bio-accumulators may at least partly determine the richness of fossil sites. Prior to human arrival, terrestrial mammals were absent from the Pityusic Archipelago (Eivissa and Formentera islands, Western Mediterranean Sea), a feature that represents an ecological singularity in the Mediterranean islands. The diurnal and nocturnal predatory bird guild from the Upper Pleistocene and Holocene of the Eivissa Island is approached here through the study of Accipitridae, Falconidae and Strigidae from Es Pouàs, an extraordinarily rich fossil site that provided more than two thousand bones of birds belonging to these three families. The importance of each species as bio-accumulator and a comparison with current fauna are outlined.

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1. Introduction

The fossil record usually consists of bone remains that document selected parts of ancient biotas (Winn Jones, 2006). The limited representativeness of the available fossil assemblages, combined with the presence of extinct species without unambiguous living ecological relatives, frequently impedes a detailed approach to the structure and functioning of ancient communities. Nevertheless, the study of paleo-food webs has been identified as a fruitful avenue for future ecological research on trophic networks (Ings et al., 2008: Table 2). Here we present an ancient guild of predator birds reasonably approached through the Accipitridae, Falconidae and Strigidae fossil record from the Upper Pleistocene and Holocene of the Pityusic Island of Eivissa (Western Mediterranean Sea). The relatively recent origin of this fauna precludes the presence of highly derived endemic species with uncertain ecological roles. The richness of the studied sample (probably the richest sample, in number of fossil specimens, of a predatory bird guild ever found in the Upper Pleistocene-Holocene on a Mediterranean island) allows us to assume that probably very few, if any predator species of this ancient guild escaped fossilization.

Indeed, the huge sample of raptorial fossil bones obtained offers a unique opportunity to test some biogeographic hypotheses. As

ecological by-products of the theory of island biogeography (MacArthur and Wilson, 1967), different authors have explored questions such as the patterns of body size evolution in insular raptorial birds (e.g., Blondel and Frochot, 1967; Blondel et al., 1988; Clegg and Owens, 2002). This study allows testing some proposals of these authors on the basis of the analysis of a raptorial community free of human influence and disturbance.

Eivissa is the largest of the Pityusic Islands, an archipelago situated 90 km off the Iberian mainland, and comprising two main islands (Eivissa, 541 km², and Formentera, 82 km²) and about 90 surrounding islets. These islands have acted as an isolated archipelago since the end of the Messinian (5.35 Ma), merging recurrently during glacial periods, and splitting during the interglacials. The faunal succession on these islands has already been described elsewhere (Bover et al., 2008). For the purposes of our research the most relevant point is the presence of a peculiar and highly disharmonious fauna that survives into (at least) the Upper Pleistocene and the Holocene (prior to human arrival). This fauna has been considered as the strongest faunal anomaly in the Mediterranean, the Pityusic Islands being the only non-desert territory larger than 500 km² in this region that was totally devoid of terrestrial mammals (Florit et al., 1989). Among vertebrates, only birds, one lizard species (*Podarcis pityusensis*), and several bats (Alcover, 2003) were present in the Pityusic Islands when humans first settled, probably around 4300–4200 years ago (Alcover, 2008).

Although the evidence of absence of terrestrial mammals in the Pleistocene and Holocene of the Pityusic Islands was presented *ca.*

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25 years ago (Florit et al., 1989; Alcover et al., 1994), the bird fauna still remains poorly known. Fossil sites are scarce in the Pityusic Islands—less than a dozen places have been described so far (Alcover, 2001). Nevertheless, one of the sites (Es Pouàs, Sta. Agnès de Corona, Ets Amunts, north of Eivissa; Florit et al., 1989) is extraordinarily rich, and has furnished numerous remains of extinct fauna. In this paper, a part of this fauna (consisting of the representatives of three families that include the main members of the predatory guild) is analysed and discussed. At least 279 different individual birds of prey have been recovered, represented by 2394 bones of Accipitridae, Falconidae and Strigidae.

Es Pouàs is a 19 m-deep and ~7 m in diameter sinkhole (Trias, 1983) that acted as a sedimentary trap at least during the last 30,000 years. More than 120,000 bone specimens were recovered during 6 months of fieldwork (1989–1994). This huge amount probably represents less than 10% of the material deposited at the site, according to the limited volume excavated. Among these remains, the record of predatory birds allows some comparisons with the extant Pityusic fauna (to evaluate its degree of disturbance), and also to compare it with other Upper Pleistocene and Holocene bird faunas of other Mediterranean islands. Additionally, some data on the structure of predatory guilds on islands will be discussed.

2. Material and methods

The material curated at the Institut Mediterrani d'Estudis Avançats (IMEDEA) has been studied. The sample consists of selected bones recovered at Es Pouàs (UTM-coordinates: 37222.92 m, 4321971.66 m). Skulls, jaws, long bones and bones of shoulder and pelvic girdle were determined using comparative material curated at IMEDEA, the Natural History Museum (London), the Natuurhistorisch Museum (Rotterdam), as well as with literature (Milne-Edwards, 1867–71; Langer, 1980; Otto, 1981; Schmidt-Burger, 1982; Solti, 1980, 1981a, 1981b, 1996). Ribs, vertebrae and phalanges were identified only in a few cases (e.g., those from *Haliaeetus albicilla*).

A summarized list of the studied material and an estimate of the minimal number of individuals (MNI) are presented for each taxon (see below; Table S1, Appendix A). Note that no differentiation between complete or fragmented bones has been made in this list, although the preservation state of the bones, as well as their stratigraphic position, have been considered for MNI estimates, leading in some cases to slight discrepancies between the MNI and the maximum number of bone remains. Relevant data on the known fossil record is summarized for each taxon, mainly following Tyrberg's catalogue and its addenda (Tyrberg, 1998, 2008), and additional literature.

Table 1

¹⁴C AMS-dates for different stratigraphic levels from Es Pouàs (Eivissa Island, Pityusic Archipelago, Western Mediterranean Sea). Radiocarbon ages are given in years BP (i.e., before 1950 AD) with a conventional 1σ standard error; calibration was calculated with the software OxCal v4.1, using the IntCal09 dataset; calibrated dates are expressed as 2σ-intervals (i.e., 95% confidence intervals) given in cal. yrs. BC.

Lab code	Species	Square and level	Radiocarbon Age (BP)	2σ Calibration interval (cal BC)	δ ¹³ C (‰)
KIA-29163	<i>Homo sapiens sapiens</i>	A4/B4 (–70 cm)	3785 ± 25	2290–2139 BC	–19.32
UtC-6516	Burnt bird bone	D4 (–60 to –80 cm)	5650 ± 60	4652–4354 BC	–25.00
Beta-162217	<i>Eliomys quercinus</i>	Wall section	3000 ± 50	1399–1057 BC	–24.00
Beta-162218	Caprinae indet.	A3 surface	3210 ± 50	1611–1406 BC	–20.30
CSIC-870	<i>Anser</i> sp.	D4 (–120 cm)	5770 ± 100	4844–4371 BC	–
UtC-6222	<i>Rallus eivissensis</i>	A3 (–60 to –80 cm)	6130 ± 80	5295–4848 BC	–25.00
CSIC-1002	Unidentified vegetal charcoal	H14 (0 cm)	7200 ± 50	6211–5991 BC	–
UtC-6673	<i>Grus grus</i>	A3 (level 6, upper part)	16,170 ± 90	17,589–16,969 BC	–16.70
UtC-6674	<i>Corvus corax</i>	A3 (level 7)	23,030 ± 150	26,492–25,036 BC	–18.60
UtC-2928	Bird bone	A3 (level 6)	26,200 – 300/+400	29,322–28,395 BC	–19.4
CSIC-1019	<i>Haliaeetus albicilla</i>	A4 (level 7, –280 to –300 cm)	26,420 ± 180	29,329–28,790 BC	–
UtC-2929	Bird bone	A3 (level 8)	30,700 ± 600	34,694–32,523 BC	–19.4

All the material presented here was recovered at Es Pouàs, at levels dated from the last glaciation up to the first arrival of humans. Information on the chronology of findings, mainly obtained in squares A3 and D4, is presented (Table 1). Currently, twelve ¹⁴C AMS-dates are available from Es Pouàs, nine of them concerning the palaeontological (pre-anthropogenic) deposit (Alcover, 2003), and three related to archaeological layers, documenting the earliest known human presence on the Pityusic Islands (Alcover, 2008). The palaeontological dates cover ca. 35 ka (square A3, level 8, at –320/–400 cm from reference level measured at the wall of the cave; Alcover, 2003) until ca. 6 ka (square A3, at –60/–80 cm, and square D4). From the Upper Pleistocene, the major part of the material comes from levels placed under level 3 of A3. The material from square D4 includes a higher representation of Holocene bones.

The sedimentary filling of Es Pouàs during the deposition time span is very homogeneous, which can be related to the absence of terrestrial mammals on the island. When present, terrestrial mammals compact the sediment, through trampling (e.g., Gé et al., 1993; Vallverdú, 2002), allowing an easier differentiation of stratigraphic units.

3. Systematic paleontology

Family ACCIPITRIDAE Vieillot, 1816

Genus *Haliaeetus* Savigny, 1809

Haliaeetus albicilla (Linnaeus, 1758)

Fig. 1

Material: 2 crania, 1 lacrimal, 1 praemaxilla, 6 mandibles, 3 quadrates (2 left, 1 right), 5 humeri (2 left, 2 right, 1 medial), 11 ulnae (6 left, 4 right, 1 medial), 7 radii (2 left, 4 right, 1 medial), 4 ossa carpi ulnare (3 left, 1 right), 3 ossa carpi radiale (1 left, 2 right), 4 carpometacarpi (2 left, 2 right), 12 coracoidea (4 left, 8 right), 6 scapulae (4 complete, 2 fragments), 4 fibulae (2 left, 2 right), 6 sterna, 2 synsacra, 15 ribs, 50 vertebrae, 4 pelvis, 8 femora (4 left, 4 right), 4 tibiotarsi (1 left, 3 right), 9 tarsometatarsi (7 left, 2 right), 3 metatarsi I, and 49 phalanges. Total: 219 bones; MNI: 8 (based on the coracoidea).

Stratigraphic range: Upper Pleistocene and Holocene (levels 4 and 8 of square A3, and one level of square D4).

Current Western Palaearctic distribution: the White-tailed Eagle is widespread as breeder in the northern part of the Palaearctic region, Iceland and coastal Greenland; a few pairs may still breed in Turkey, Greece and Croatia. It winters as south as India and Southeast Asia. Its populations are in decline (Snow and Perrins, 1998). Absent currently from Eivissa and vagrant (accidental) in Mallorca (AOB, 2011).

Fossil occurrence: common in the Palaearctic Late and Middle Pleistocene of Northern, Central and Eastern Europe (United

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