SHORT NOTES

HERPETOLOGICAL JOURNAL, Vol. 11, pp. 167-170 (2001)

A PRELIMINARY REPORT ON THE LATE PLEISTOCENE AMPHIBIANS AND REPTILES FROM GORHAM'S CAVE AND VANGUARD CAVE, GIBRALTAR

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Key words: subfossil herpetofauna, Late Pleistocene, refugium, Gibraltar

The Gibraltar Caves Project is a collaborative effort between the Natural History Museum, London (NHM), Oxford Brookes University and the Gibraltar Museum. Excavations of Late Pleistocene deposits took place at several caves in the south face of the Rock between 1994 and 1999, in search of neanderthal hominid remains and associated environmental evidence. Reports on the excavations and vertebrate remains are given by Barton *et al.* (1998), Stringer *et al.* (2000) and Cooper (2000). The following report results from a preliminary study by the author on the subfossil amphibian and reptile remains recovered from bulk sample analyses. A more or less random selection of eighty-six samples was chosen: fifty-six from Gorham's Cave and thirty from Vanguard Cave. Most samples are from the 1995 season, while the remainder are from the 1996 excavations. The overall species list contains at least twenty-eight amphibian and reptile species and probably more. As there are several thousand further samples to study, it is envisaged that this natural archive of subfossil remains will provide an invaluable record of herpetofaunal diversity and faunal change in a western Mediterranean refugium during the Late Pleistocene. No previous studies have examined such an abundant and species-rich herpetofaunal assemblage from a glacial refugium.

Identifications were made with reference to modern comparative material in the author's collection (at Coventry University), collections at the Museo Nacional de Ciencias Naturales, in Madrid (MNCN), and that of J. Barbadillo at the Universidad Autónoma, Madrid (UAM). Most of the remains (up to 90%) belong to *Pelobates cultripes* (western spadefoot toad) – a species with very distinctive cranial osteology (Fig. 1). Cranial and ilial remains were most commonly used to identify the other anurans: vertebrae were most useful for salamanders, shell and limb bones for tortoises, cranial bones and vertebrae for lizards (Figs 3-4), and vertebrae for snakes. Most species were present only sporadically, except for the Moorish gecko, *Tarentola mauritanica* (Fig. 3), which was present in about half the samples. Table 1 shows the list of amphibian and reptile species recovered so far from both caves studied. The snake identifications are incomplete (* signifies presence in an unknown number of samples), but *Elaphe scalaris* seems to be the most common snake. Vertebrae of undetermined viper species #1 belong to either the Iberian adder, *Vipera seoanei,* or northern adder, *Vipera berus*. The second undetermined species is either Lataste's viper, *Vipera latastei,* or asp viper, *Vipera aspis*.

The age of most (if not all) of the remains from Gorham's Cave is Oxygen Isotope Stage (OIS) 3 (A. Currant, pers. comm.), c.25-60 000 years ago (Lowe & Walker, 1997, pp.332-334). Nearly all of the Vanguard Cave material dates to OIS 5a/b (N. Barton, pers. comm.), c.75-95 000 years ago (Lowe & Walker, 1997, pp.334-340). Further lithostratigraphic analyses are awaited to determine the full temporal range of the assemblages. All of the herpetofaunal remains are held in the Department of Palaeontology at the NHM.

This preliminary study has produced surprisingly diverse herpetofaunal assemblages, especially as the Gorham's material dates from a period when global climate was heading towards the last glacial maximum c.20 000 years ago (OIS 2). The western Mediterranean climate was humid and significantly cooler than today during OIS 3 (Rose *et al.*, 1999), with sea level 75-85 m lower than today (van Andel & Tzedakis, 1998). The assemblages contain several Iberian endemics, and nearly all species have Iberian and Mediterranean ranges today (Gasc *et al.*, 1997; Pleguezuelos, 1997). They were probably accumulated in the caves by avian predators, and possibly also by humans, with most bones lacking the digestive damage characteristic of mustelids (cf. Pinto Llona & Andrews, 1999).

Excluding the North African ranges of some species, the European ranges of most species identified are either restricted to Iberia or have clearly originated postglacially from Iberian refugia. Gibraltar would have almost been the most southerly refuge possible in Iberia, with the Gibraltar Strait forming a constant marine barrier throughout the Pleistocene (Busack, 1986). This is a true refugium, at the extreme south of a continental peninsula. Climate would have become harsher, globally, during the ensuing glacial maximum of OIS 2, and the south-western coastal zone of Iberia is likely to have been crucial to the survival of many thermophilous species.

For them to have survived until today, the thermal requirements of all the subfossil species identified must have been met throughout the Late Pleistocene in southern Iberian refugia. Amphibians and reptiles are much more dependent on suitable climatic parameters than are other vertebrate groups, especially mammals.

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TABLE 1. Preliminary list of Late Pleistocene amphibian and reptile taxa recovered (and relative occurrence in samples) from OIS 3 sediments in Gorham's Cave and OIS 5a/b sediments in Vanguard Cave, Gibraltar. Some of the snake identifications are currently incomplete, hence their presence (in at least one sample) is denoted by "*".

	No. of samples	
	Gorham's (out of 56)	Vanguard (out of 30)
Sharp-ribbed salamander, *Pleurodeles waltl*	1	1
Pygmy marbled newt, *Triturus marmoratus pygmaeus*	4	1
Undeterminate newt, *Triturus* sp.	2	
A discoglossid frog, *Discoglossus* sp.	1	
Western spadefoot toad, *Pelobates cultripes*	55	26
Mediterranean common toad, *Bufo bufo spinosus*	1	2
Natterjack toad, *Bufo calamita*	1	1
Stripeless tree frog, *Hyla meridionalis*	13	17
A ranid frog, *Rana* sp.	2	1
Hermann's tortoise, *Testudo hermanni*	2	3
An emydid cf. stripe-necked terrapin, *Mauremys leprosa*	1	
Moorish gecko, *Tarentola mauritanica*	15	19
Spiny-footed lizard cf. *Acanthodactylus erythrurus*	3	2
Large Psammodromus, *Psammodromus* cf. *algirus*	8	5
Ocellated lizard, *Lacerta lepida*		1
Iberian wall lizard, *Podarcis* cf. *hispanica*	2	
A skink, *Chalcides* sp.	7	1
Undeterminate lizard no. 1		1
Undeterminate lizard no. 2		2
Amphisbaenian cf. *Blanus cinereus*		16
Montpellier snake, *Malpolon monspessulanus*	*	*
Horseshoe whip snake, *Coluber hippocrepis*	*	*
Ladder snake, *Elaphe scalaris*	>13	>3
Grass or ringed snake, *Natrix natrix*	1	1
Viperine snake, *Natrix* cf. *maura*	1	1
Southern smooth snake, *Coronella girondica*	*	*
Undeterminate viper no. 1 *Vipera* sp.	3	
Undeterminate viper no. 2 *Vipera* sp	5	1

Even if summer temperatures were not as dramatically reduced as in other parts of Europe, the mechanisms by which the most demanding thermophiles survived have yet to be adequately explained. Perhaps species which breed today during the winter/spring may have shifted their breeding season to the spring/summer in response to thermal deterioration during the Late Pleistocene. There is probably no direct way of determining whether this occurred during the Late Pleistocene, but it can be observed in many species today. *Bufo calamita* (natterjack toad) breeds during the spring and summer across most of its range, but in Iberia it breeds during the winter and spring. The glacial refugium for *B. calamita* was in Iberia, therefore one of the modern scenarios must have been an adaptation achieved after the end of the last glaciation. Clearly, climate-induced breeding season shifts can happen. If winter hibernation could replace summer aestivation, this mechanism might help to explain some species' survival during Pleistocene glacial periods. It is less easy to explain how the most thermally demanding reptiles could survive. Perhaps only rarely were breeding seasons successful, but this was just enough for a species to hold on.

As the effects of climatic deterioration were more severe on the Iberian Plateau, many upland species are likely to have been forced to lower altitudes. It seems probable that some coastal areas of southern Portugal and southwest Spain were subject to the moderating effects of the Gulf Stream during the Late Pleistocene (Zagwijn, 1992). Displaced southwards from its current position, the Gulf Stream may have maintained mild conditions in coastal refugia (at least in some years), allowing the survival of Iberia's most thermophilous species.

Arising from this study, there are several noteworthy taxonomic issues, which can be mentioned briefly. A very large partial skeleton of common toad from Vanguard Cave (estimated snout-vent length of 180 mm; Fig. 2) must belong to the Mediterranean subspecies *Bufo bufo spinosus*. The literature does not record *B. b. spinosus* subfossils any larger than this. Z. Szyndlar (pers. comm.), who examined a small amount of snake

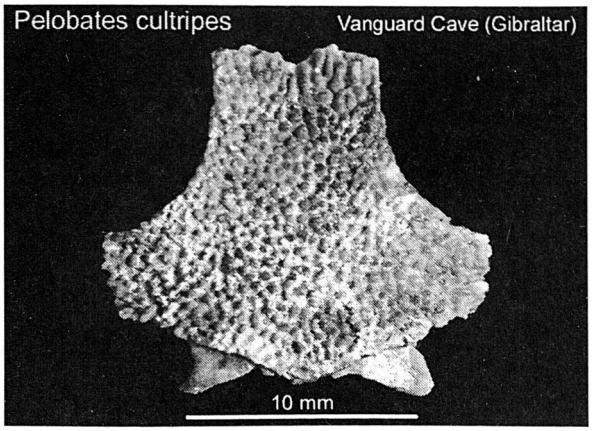

FIG. 1. Frontoparietal (dorsal view) of southern spadefoot toad *Pelobates cultripes* from Vanguard Cave, Gibraltar (sample VAN 95 105).

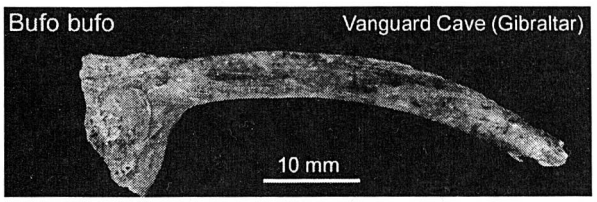

FIG. 2. Right ilium (lateral view) of Mediterranean common toad *Bufo bufo spinosus* from Vanguard Cave, Gibraltar (sample VAN 96 376).

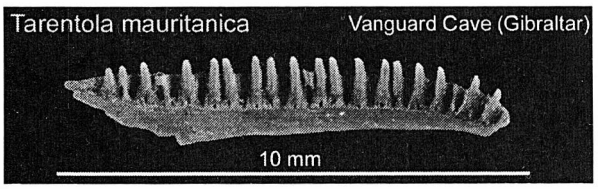

FIG. 3. Left dentary (lingual view) of Moorish gecko *Tarentola mauritanica* from Vanguard Cave, Gibraltar (sample VAN 95 172).

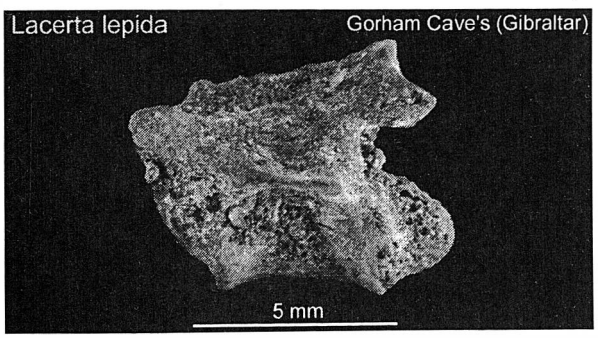

FIG. 4. Trunk vertebra (left lateral view) of ocellated lizard *Lacerta lepida* from Gorham's Cave, Gibraltar (sample GOR C 95 248).

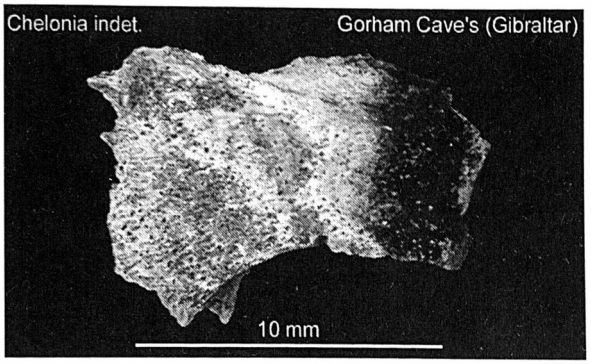

FIG. 5. Burnt fragment of chelonian shell from Gorham's Cave, Gibraltar (sample GOR C 95 408).

material, suggests that two vertebrae seen could not be matched with any Iberian species. They have some similarities with *Telescopus* – a genus not present in Iberia today but known from the Spanish uppermost Pliocene (Szyndlar, pers. comm.). The uncertain taxonomy of the viper remains would also merit further attention if more material were identified. As an Iberian endemic, *V. seoanei* is perhaps more likely during OIS 3 than *V. berus*, which is absent from Iberia today. The second viper species is most likely to be the Iberian endemic *V. latastei,* based on modern range characteristics, but the vertebrae resemble the largely non-Iberian *V. aspis* (Szyndlar, pers. comm.).

Several shell fragments of *Testudo hermanni* (Hermann's tortoise) are burnt (cf. Fig. 5), suggesting that tortoises were eaten by contemporary humans. Blackened bones of *P. cultripes* may also indicate that spadefoot toads were used as food. Little archaeozoological work has been carried out on the use of European herpetofauna as food by humans or hominids, although this would certainly have presented an easy-to-catch resource.

A large amount of fossil material (>5000 samples) from a range of Late Pleistocene ages at Gorham's and Vanguard Caves on Gibraltar, has still to be studied. Future study should fully identify these assemblages and investigate their palaeoenvironmental implications. The application of the Mutual Climatic Range method to provide quantified palaeoclimatic reconstructions is also intended.

Acknowledgments. This initial study was funded by the Gibraltar Caves Project, Natural History Museum, London and Gibraltar Museum. I extend my appreciation to Borja Sanchíz (amphibians), Javier Barbadillo (lizards) and Zbigniew Szyndlar (snakes) for their advice regarding identifications. Use of the comparative collections at the MNCN (CSIC) and UAM is gratefully acknowledged. I thank Nick Barton, Jo Cooper, Andy Currant, Clive Finlayson, Cath Price and Chris Stringer for helpful discussion and information relating to the excavations. Zbynek Rocek, Borja Sanchíz and Zbigniew Szyndlar are thanked for their helpful comments as referees.

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Accepted: 8.6.01