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HERPETOFAUNA OF PLEISTOCENE (IPSWICHIAN) DEPOSITS AT SELSEY, WEST SUSSEX:THE EARLIEST BRITISH RECORD OF *BUFO CALAMITA*

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ABSTRACT

Pleistocene deposits at Selsey, West Sussex, thought to represent Substage II of the Ipswichian Interglacial Age, have yielded five herpetological taxa: *Bufo bufo*, *Bufo calamita*, *Rana* sp., *Emys orbicularis*, and *Natrix natrix*. This is the earliest British record of *Bufo calamita* and extends its temporal range in Britain back about 105,000 years. The presence of *Emys orbicularis* indicates that mean July temperatures in Britain were probably at least two degrees Celsius warmer than today. The anurans and the pond tortoise indicate the presence of a lotic wetland situation The anurans (outside of the breeding season) and the grass snake could have lived in a grassy area near the wetland.

INTRODUCTION

The Pleistocene deposits at Selsey, West Sussex, (Fig. 1) are noteworthy because flint flakes from the site provide almost the only evidence of humans from the early part of the Ipswichian stage (Stuart, 1988), the last interglacial episode of the Pleistocene. Fossil mammals have been reported from the Selsey Site (West *et al.*, 1960), but herpetological remains (other than those of the European pond tortoise, *Emys orbicularis*, (Stuart, 1979) have never been recorded. Recent collections made by personnel of the Institute of Archaeology, London, have yielded remains of three taxa of anurans and a snake. Although this is a small herpetofauna, it is significant, because it has provided the earliest fossil record of the natterjack toad, *Bufo calamita*, from Britain. This record extends the knowledge of the natterjack in Britain back about 105,000 years. These herpetological remains form the subject of the present paper, along with comments about the ancient distribution of *Bufo calamita* in Britain and Europe.

THE SELSEY, WEST SUSSEX, SITE

At Selsey in West Sussex along the English Channel, Pleistocene sediments occur in a channel cut into the Eocene Bracklesham Beds. These deposits are located on the foreshore between the Lifeboat House and the Holiday Camp on Selsey Bill (West *et al.*, 1960). These landmarks are still depicted on ordnance Survey Landranger Series. Sheet 197, (1990). The area is at about SZ 859924 on this map.

Stuart (1982) has discussed the Selsey beds based on pollen spectra outlined in West *et al.* (1960). The earliest horizon covers the period of time from the late Wolstonian cold stage to Ipswichian subzone 1a (an early part of the Ipswichian interglacial stage). During this interval, birch woodland and pine replaced the late cold stage, herb-dominated vegetation. Horse remains (Equus ferus Boddaert) were taken from sediments within this interval, but the fossils were not assigned to any specific vegetational zone.

The later horizons, zones Ib to early IIb have yielded typical mid-Ipswichian taxa, plus the evidence of *Homo sapiens*. Vertebrates recorded from these zones by Stuart (1982) include pond tortoise (*Emys orbicularis* Linnaeus), humans (*Homo sapiens* Linnaeus represented by flint flakes), beaver (*Castor fiber* L.), extinct straight-tusked elephant (*Palaeoloxodon antiquus* Falconer & Cautley), and extinct (non-woolly) rhinoceros (*Dicerorhinus hemitoechus* (Falconer)).

The new amphibian and reptile fossils come from two collections, both equated with Ipswichian subzone II, and thus indicating mid-Ipswichian times. The first collection contains two species of *Bufo* and came from a peaty, organically-rich exposure which was referred to as the "Peat Bed" locality by the collectors. The second collection contains a *Rana* and a *Natrix* and came from an exposure of dark gray organic clayey silt. The principle collectors of this material were R. Fowler and S. Parfitt of the Institute of Archaeology, London.

SYSTEMATIC PALAEONTOLOGY

Abbreviations used in the numbering system used for the newly reported Selsey herpetological bones are as follows: IAL (Institute of Archaeology, London), SA (Selsey Amphibians), SR (Selsey Reptiles) - followed by individual specimen numbers.

Class Amphibia
Order Anura
Family Bufonidae

Two modern workers, Böhme (1977) and Sanchiz (1977) have studied the osteology of the European Bufonidae as it applies to the interpretation of fossil members of this family. Terminology for structures on individual bones follows these publications. The Family Bufonidae comprises a large anuran assemblage, but only one genus, *Bufo*, occurs in the Pleistocene and modern fauna of Britain and Europe.

Genus *Bufo* Laurenti

Three species of *Bufo*, *B. bufo*, *B. calamita*, and *B. viridis* occur in the Pleistocene and modern fauna of Britain and Europe. Two of these, *B. bufo* and *B. calamita* have been identified from the Selsey Site. Fossil *Bufo* mainly occur in the form of individual cranial and postcranial bones. I have

SITE	AGE	MINIMUM NUMBER OF INDIVIDUALS
Whitemoor Channel, Bosley, E. Cheshire. Holman and Stuart (1991)	Early Flandrian, ca 10,000 – 8,800 B.P.	2
Ightham Fissures, Sevenoaks, Kent. Holman (1985)	?Early Flandrian	12
Cow Cave, Chudleigh, Devon. Holman (1988)	?Early Flandrian	16
Selsey, West Sussex Holman (this paper)	Ipswichian II ca 115,000 B.P.	3

TABLE 1: Distribution of fossil *Bufo calamita* in Britain.

consistently found that the ilium is the the most reliable of all of the individual anuran bones upon which to make taxonomic identifications (vide Holman, 1985 for a discussion of this). Moreover, the ilium appears to be a very reliable bone for distinguishing the three modern and Pleistocene species of British and European *Bufo* (Sanchiz, 1977; Holman, 1989). Böhme (1977) and Sanchiz (1977) have found characters in other anuran postcranial elements that allow them to distinguish between different taxa of living and fossil British and European forms. Sanchiz (1977) has done an especially comprehensive study on the genus *Bufo* in the Tertiary of Europe in which he outlines differences in *Bufo* postcranial elements other than the ilium.

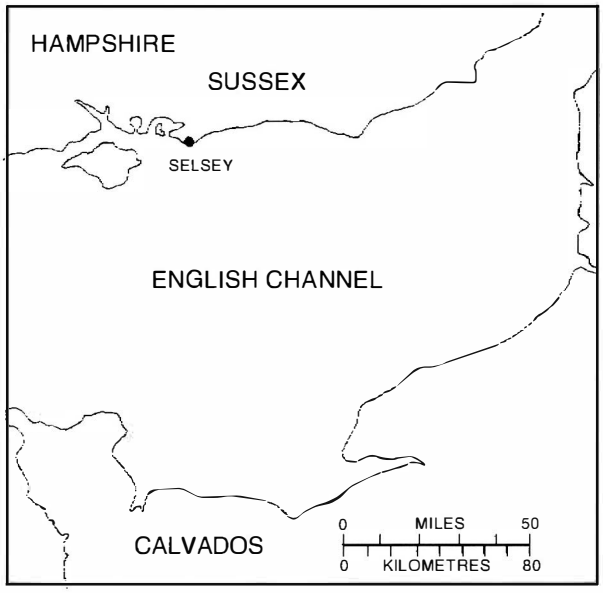

Fig. 1. General Location of the Selsey, West Sussex, site.

Bufo bufo (Linnaeus)

Material. Two left and three right humeri IALSA-1-5; three left and one right ilia IALSA-6-9 (Fig. 3b); three left and two right femora IALSA-10-14; three left and two right tibiofibulae IALSA-15-19; four calcania IALSA-20-23; one urostyle IALSA-24.

Remarks. This section will first deal with osteological criteria used herein to separate *B. bufo* Selsey site fossils from those of *B. calamita.* These criteria follow Sanchiz (1977) and Holman (1989) and have been confirmed as much as possible by comparison of the fossils with modern skeletons of both species. The terminology used for structures on individual bones also follows Sanchiz (1977) and Holman (1989).

Humerus. The humerus of *B. bufo* appears to lack a definable paraventral crest (Sanchiz, 1977, p. 81) whereas *B. calamita* has a rudimentary paraventral crest. In case this character is a reflection of sexual dimorphism, it should be pointed out that all of the Selsey fossils identified as *B. bufo* on the basis of this character appear to be males based on the enlarged distal flange, and that the one humerus identified as *B. calamita* appears to be a female based on the lack of a distal flange.

Ilia. Three characters are used to separate *B. bufo* from *B. calamita* (vide Fig. 3 and Holman, 1989, Fig. 1). The first character is that the ilial prominence of *B. bufo* is low and rounded; sometimes low and roughened; or sometimes even in the shape of a low, irregular, sharpened crest. The ilial prominence of *B. calamita* on the other hand is higher and is triangular in shape. The second character involves the lack of a ridge on the anteroventral part of the ilial shaft in *B. bufo* which is present as the so-called "*calamita* ridge" in *B. calamita* (Holman, 1989). It should be pointed out that a groove is present above the ridge in *B. calamita* (Fig. 3a and Holman, 1989, fig. 1) and that this groove might be as specifically diagnostic as the ridge itself. Finally, the third character is that the pars descendens is much less

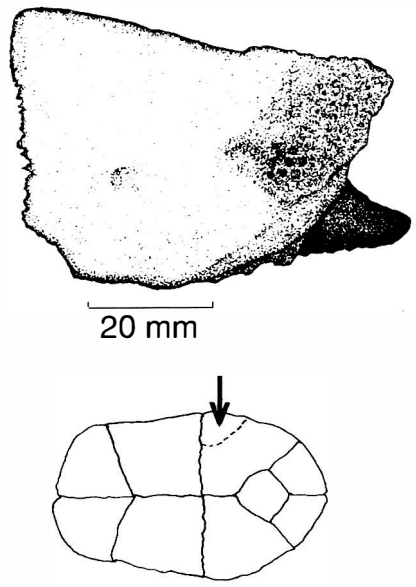

Fig. 2. Portion of a large right hyoplastron of *Emys orbicularis* Natural History Museum, London, Number BMR 9287, redrawn from Stuart (1979). The position of the fossil in life is indicated by an arrow on an outline drawing of a modern *E. orbicularis* plastron in ventral view.

extensive in *B. bufo* than in *B. calamita*, both anterior and ventral to the acetabular fossa. Quite probably, both of these characters relate to the different gaits of the two animals. *B. bufo* usually progresses by making a series of short hops, whereas *B. calamita* appears to be making "mouselike dashes".

Femora. In *B. bufo* the crista femoris is low and tends to be flattened proximally. In *B. calamita* and *B. viridis* this crest appears as a sharpened ridge. Another character pointed out by Sanchiz (1977) involves the the fact that the crista femoris of *B. bufo* is undivided rather than triangular in shape.

Tibiofibulae. The internal border of the tibiofibula in *B. bufo* has a sharp ridge on its internal border; this ridge is more roughened in *B. calamita* and *B. viridis* (Sanchiz, 1977, p. 81).

Calcanea. The calcanea of *B. bufo* are rounded rather than roughened and more flattened as in *B. calamita*. One might caution here that this might be a sexually variable character.

Urostyle. Sanchiz (1977) gives ratios based on measurements of the urostyle that he has found will separate the three species of British and European *Bufo*. These ratios are derived from dividing the height of the cotyles x 100 divided by the width of the cotyles. This ratio is given as 50.0 for *B. bufo*, 43.6 for *B.calamita*, and 41.3 for *B. viridis* (Sanchiz, 1977, table p. 78). The ratio reflects the fact that the cotyles of *B. bufo* are less wide and more high in *B. bufo* than in the other two species.

In the Selsey *B. bufo* urostyle the width of the cotyles is 3.0 mm, the height of the cotyle is 1.7, giving a Sanchiz ratio of 56.7. This appears to fall in line with *B. bufo* rather than the other two species, even though it exceeds the value of *B. bufo*.

Bufo calamita Laurenti

Material. Right humerus IALSA-25; two left and two right ilia IALSA-26-29 (Fig. 3a); two left and three right femora IALSA-30-34; two left tibiofibulae IALSA-35-36; one calcaneum IALSA-37.

Remarks. Characters for distinguishing the individual bones of *B. calamita* from *B. bufo* were given in the above section on *B. bufo*.

Bufo sp. indet.

Material. Presacral vertebra from region IV to VIII of Sanchiz (1977, p. 77) IALSA-38; two right radio-ulnae IALSA-39-40; three phalanges IALSA-41-43.

Remarks. These are elements that I am unable to identify to the specific level. They probably represent either *B. bufo* or *B. calamita*.

Family Ranidae
Genus *Rana*

The identification of individual skeletal elements of the genus *Rana* have been discussed by Böhme (1977)

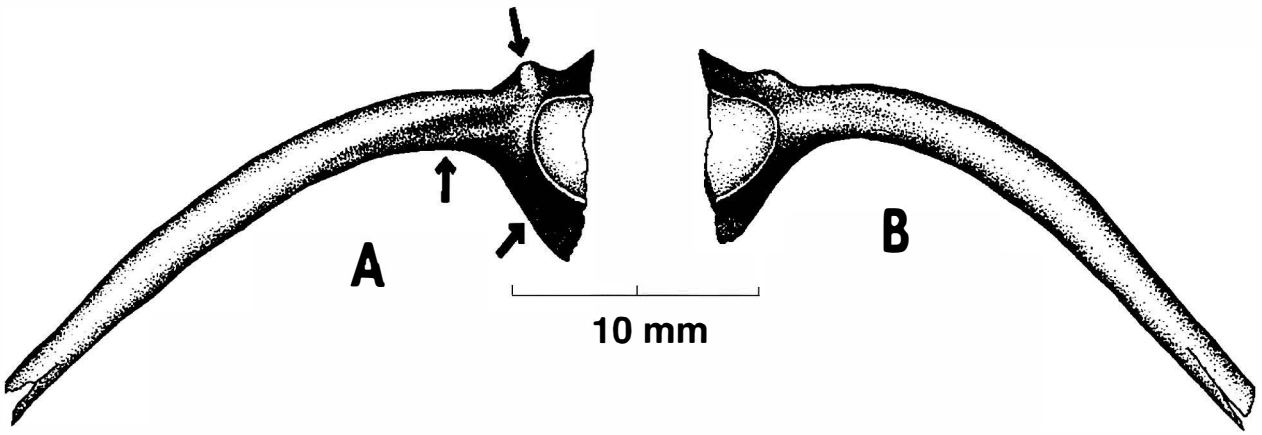

Fig. 3. A, Left ilium of *Bufo calamita* IALSA-29 from the Selsey, West Sussex, Site. B, Right ilium of *Bufo bufo* IALSA-O9 from the Selsey, West Sussex, Site.

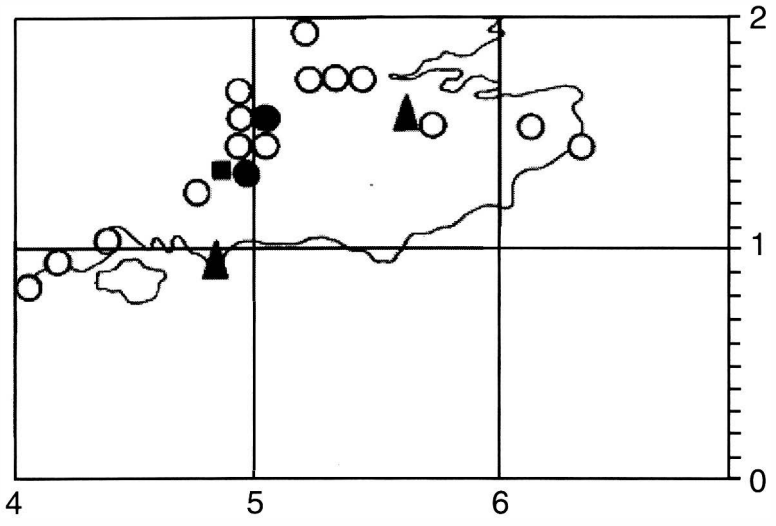

Fig. 4. Historic and fossil records of *Bufo calamita* in southeastern England redrawn and modified from Holman & Stuart (1991). Triangles indicate fossil records. Open circles indicate historic records up to and including 1959. Closed circles indicate records from 1960 through 1969. Squares indicate records from 1970 to 1983.

Rana sp. indet.

Material. Femur (with proximal and distal ends missing) IALSA-44.

Remarks. The femur of *Rana* is much larger and more curved than in species of European *Hyla* and longer and more gracile than in the three British and European species of *Bufo*. I am unable to identify this element to the specific level.

Class Reptilia
Order Testudinata
Family Emydidae
Emys orbicularis Linnaeus

Material. Part of a large right hyoplastron (Fig. 2); Natural History Museum, London, No. BMR 9287.

Remarks. This element was reported by Stuart (1979). It was found in 1961 in detritus mud which indicates zones Ib IIb of the Ipswichian.

Order Serpentes
Family Colubridae
Genus *Natrix* (Linnaeus)

Szyndlar (1984) has discussed the identification of British and European species of *Natrix* on the basis of individual vertebrae.

Natrix natrix (Linnaeus)

Material. Fragmentary anterior trunk vertebra IALSR 45.

Remarks. The vertebra has a more extensive and robust hypapophysis than in British and European *Vipera* and has the base of the parapophyseal process more massive than in *Natrix maura* and *tessellata* (Szyndlar, 1984, p. 26).

DISCUSSION AND SUMMARY

The Selsey, Sussex, Ipswichian strata have produced a small herpetological assemblage consisting of *Bufo bufo*, *Bufo calamita*, *Rana* sp, *Emys orbicularis*, and *Natrix natrix*. The most significant records are those of *B. calamita* and *Emys orbicularis*.

Bufo calamita, the natterjack toad, is one of the three most endangered herpetological species in Britain today. Since its first mention by Pennant in 1776 (Smith, 1973) the natterjack has been reported widely but locally in England and southwestern Scotland. Its habitat is now mainly coastal dune sites, but it was formerly also more common on inland heaths. It also occurs in southwestern Ireland. In the past few decades the natterjack has disappeared from many localities where it was formerly present (Holman & Stuart, 1991, fig. 5).

The present comprehensive range of *Bufo calamita* is from Iberia across to north-central Europe where it extends northward to about 55 degrees in Britain and to about 58 degrees in south Sweden and Estonia (Arnold & Burton, 1978). The natterjack lives in a wider range of habitats in the southwestern part of Europe where it is also more abundant than it is in northern areas. In northern and northeastern regions it lives in habitats with sandy soils that produce warmer microclimates (Beebee, 1983). According to Beebee, all of the habitats outside of the Iberian Peninsula are similar in that they have well-drained soil and low vegetation that facilitates insolation of the ground. Thus, *Bufo calamita* is considered primarily a species of southwestern Europe that has been able to extend its range northeastwards by exploiting locally warm habitats.

Sanchiz (1977) has discussed the fossil record of the Bufonidae in the Tertiary of Europe. He concludes that the family came to Europe as an Asiatic immigrant and arrived at about the boundary between the Oligocene and the Miocene. Of the

three modern European species, *B. viridis* is known in Europe since the middle Miocene and *Bufo bufo* and *Bufo calamita* since the upper Miocene. The fact that these three modern species were established by upper Miocene times is of considerable interest, but it is not surprising, considering the ancient origin of many species of anura in Europe (Sanchiz, in preparation for Handbuch Paläoherpetologie and pers. comm.).

There are no Tertiary records of any *Bufo* species in Britain, but this does not preclude their presence in the area during this geological period. In fact, since Britain was a peninsular appendage of Europe during most of the Cenozoic, it would seem possible that the two modern species of Britain could have extended westward into Britain by very late Miocene times.

Nevertheless, the Selsey, West Sussex. record of *Bufo calamita* represents the earliest fossil record of the natterjack in Britain, at about 115,000 years ago (Stuart, 1982, 1988).

Based on other vertebrate fossil remains in British Ipswichian Substage II faunas (Stuart, 1982) which include lion, hyaena, extinct (non-woolly) rhino, hippo, and European pond tortoise, one might expect a warmer climate than occurs in Britain today. Thus it might be suggested that *Bufo calamita* might have been able to exploit a wider variety of habitats in Britain during Ipswichian II times than they do at present. It is noted here that there are no historical records for *Bufo calamita* in the immediate vicinity of the fossil site (Fig. 4).

All of the other fossil records of *B. calamita* in Britain are from sites that are thought to represent the early Flandrian (Holocene) interglacial stage (Table 1). The author eagerly awaits more evidence of the fossil occurrence of this unique British amphibian.

The European pond tortoise, *Emys orbicularis*, is of considerable interest because its presence in fossil interglacial sites in Britain indicates that July temperatures were at least two degrees warmer than at present. *Emys orbicularis* is particularly characteristic of Ipswichian deposits in Britain (Stuart, 1979, 1982; Hallock, Holman & Warren, 1990; Holman & Clayden, 1990), and has been sparingly found at other interglacial sites including the Cromerian, Hoxnian, and early Flandrian (Stuart, 1979, 1982; Holman, Stuart & Clayden, 1990).

It is difficult to say much about the palaeoecological conditions indicated by the Selsey herpetofauna because only five taxa are known. Nevertheless, the presence of lotic wetland conditions are indicated by the three anuran species that would have needed such situations for breeding purposes (Frazer, 1983). Moreover, the European pond tortoise prefers still or slow-moving water with abundant aquatic vegetation (Arnold and Burton, 1978). The grass snake *Natrix natrix* and the anurans (outside of the breeding season) could have lived in nearby grassy areas.

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