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Frogs in pre-industrial Britain

Lee Raye

Swansea University, Singleton Park, Swansea, SA2 8PP, U.K.

This paper examines the pre-industrial historical record of Britain's anuran species. The records examined include especially the writings of naturalists and physicians, most notably Gerald of Wales (1188), John of Gaddesden (c.1314), Edward Wotton (1552), Timothie Bright (1580), Thomas Brown (1646), Robert Lovell (1660), Christopher Merrett (1667), Robert Sibbald (1684) and John Morton (1712). The common frog is attested as present throughout the period. Several reliable historical records are located that describe the presence or absence of a water frog species (*Pelodyphylax* spp.: two records of presence, two of absence) and the tree frog (*Hyla arborea*: five records of presence, three of absence). The moor frog (*Rana arvalis*) and agile frog (*Rana dalmatina*) are not described separately – if present in the time period, they may have been considered varieties of the common frog. The evidence of presence comes exclusively from England. The records taken together confirm the presence of populations of water frogs between (at least) the fifteenth and eighteenth century, and provide new evidence attesting to populations of tree frogs between the sixteenth century (when the species may have been introduced) and the eighteenth century (when the species seems to have become locally extinct/locally distributed).

Key words: pool frog, tree frog, native status, species history, historical analysis

INTRODUCTION

In the nineteenth century, there were six common research methods used to investigate species history. We can rank these through their use in Harting's (1880, pp.115–205) influential discussion of wolves in British animals extinct within historic times. These are, in order of importance: historical (the analysis of contemporary written sources), archaeological (which was called 'geological', and was seen as the only method that gave reliable evidence from the distant past), folkloric and linguistic (which could give evidence from pre-historical period), toponymic (place-name evidence), and art historical (generally only used to illustrate arguments). By the time Ritchie (1920, pp.3–4) wrote, some of these methods had already declined in importance. Ritchie considered historical, art historical and archaeological to be the proper methods of study for species historians. Species historians no longer considered folklore collected in modern times to be good evidence. We now recognise that folklore is not a repository of ancient wisdom, perfectly preserved by an ignorant peasantry, but a contemporary set of beliefs and practices received and adapted successively by each new generation of participant (Gazin-Schwartz & Holtorf 1999, pp.9–13). Linguistic evidence was also rejected because words change meaning unpredictably over time, and the existence of a word for a species in a language is often unrelated to that species' presence/absence in the local

area anyway (Dent 1974, pp.23–7). Place-name evidence was rejected by Ritchie, but has since been recovered by species historians, especially due to the efforts of Yalden and his co-authors (Aybes & Yalden, 1995; Yalden, 2007; Boisseau & Yalden 1998). The idea that we can draw conclusions about the presence/absence of species from naturalistic artwork has also since been criticised by some scholars (D'Aronco & Cameron, 1998, p.41; Backhouse, 1981, pp.165–174; Raye, 2013), although its use as championed by Yapp (1981) remains current.

At the same time, whilst historical source analysis has continued to be relevant, analysis of historical records has become much more complicated. The dates of some key sources have been challenged (e.g. Drout et al., 2014; Linnard 1984), 'forgeries' have been detected and separated from authentic historical source traditions (e.g. Morgan, 1983; Thomson, 1952) and historians now have a more sophisticated model of authorship as a process rather than as a single event; texts have authors, editors, scribes, translators and readers who all add additional layers of meaning (e.g. Charles-Edwards, 1978).

Perhaps because of these set-backs, the methods of species historians have become increasingly scientific. Modern zooarchaeological analysis has been developed scientifically, particularly by the use of absolute dating methods like carbon-14 dating (Bayliss, 2009) that allows archaeologists to be more confident about the context of organic remains, as well as the use of wet-sieving and flotation methods that allow the remains of much smaller species to be detected (McKenna et al., 1994).

Correspondence: Lee Raye (lee.raye@gmx.co.uk)

However, even scientific zooarchaeology has limitations. In the case of the pool frog, the archaeological record has been skilfully and carefully consulted (Gleed-Owen, 2000; Snell, 2015). However, in other cases, archaeological remains can be deceptive. The natterjack toad (*Bufo calamita*) is likely to be a native of Ireland, but natterjacks are not found in the archaeological record (Beebee, 2002), perhaps because the size of the bones mitigates against their survival and retrieval by archaeologists, and archaeological work is focused on human habitation (where natterjacks would be unlikely to occur). At the same time, the remains of a land tortoise have been found at Stafford Castle in Britain (Thomas, 2010), which clearly do not indicate the presence of a wild population of Testudinae. The presence of burrowing species can be especially complicated as they are capable of burrowing their way into the archaeological strata of older periods and either mixing the strata or leaving their remains in an anachronistic stratum (Bocek, 1986). In terms of species history therefore, where the historical and the archaeological methods can corroborate each other, this provides the most secure conclusions.

In modern times, species historians have also added an additional method of inquiry. Genetic satellite (phylogeographic) analysis provides historical evidence from the genetic material of modern species (Snell et al., 2005; Teacher et al., 2009). Genetic methods are especially exciting because they do not rely on the survival of contemporary material, and can therefore produce new data relatively quickly. This same advantage is also true of the call analysis methodology (Wycherley et al., 2002).

The methods of researching species history that remain frequently used today include genetic research, zooarchaeology, historical analysis, place-name evidence and art history. This paper is focused on historical analysis, and in the Conclusion, we will evaluate how useful the approach has been in answering questions of presence/absence, native status and introduction routes compared to zooarchaeology and genetic analysis in particular.

Amphibians in pre-industrial Britain

Over the last twenty-five years there has been a growing scholarly consensus that at least one species of amphibian became extinct in the historical period (i.e. the last two thousand years). Until the end of the twentieth century, it was commonly believed that Britain possessed six native amphibian species (Buckley & Foster, 2005): the common toad (*Bufo bufo*), natterjack toad (*B. calamita*), common frog (*Rana temporaria*), smooth newt (*Lissotriton vulgaris*), palmate newt (*Lissotriton helveticus*) and great crested newt (*Triturus cristatus*). We now commonly add at least the pool frog to this list (*Pelodyphyllax lessonae*), and sometimes also the moor frog (*Rana arvalis*), the agile frog (*Rana dalmatina*) and the European tree frog (*Hyla arborea*).

The evidence for these species being native is variable. The tree frog is considered to be possibly native on the basis of two previously long established populations and a study of the historical record (Snell, 2006; Snell, 1991), but this study provided only two sources from

before the twentieth century, and there are known to have been a series of introductions in the nineteenth and twentieth centuries (Lever, 2009, pp.217–8). The moor and agile frogs are thought to be native based on early medieval archaeological evidence, but the evidence comes from a single site (Gleed-Owen, 2000). The species that has been most investigated is the pool frog, which occurred in Britain in the twentieth century and was the subject of an interdisciplinary study by English Nature and others from 2000–2004. Scholars pursued several different avenues of research to investigate the species. Zooarchaeological surveys produced remains of the frog from late Saxon Gosberton, Lincolnshire (Gleed-Owen, 2000), and late Saxon Ely, Cambridgeshire (Beebee et al., 2005; Gleed-Owen, 2001, pp.5, 25–26). Genetic analysis (Snell et al., 2005) and call analysis (Wycherley et al., 2002) confirmed that the population present in 20th century Britain was closely related to populations found in Norway and Sweden, and therefore should be seen as part of the northern clade, with an introduction pathway via Scandinavia. Finally a search of historical and archival sources from the industrial period (Kelly, 2004) proved continuity of population from the eighteenth to the twentieth century. Based on this evidence, conspecific northern clade pool frogs have been reintroduced to the wild and are currently being introduced to a second site in East Anglia (Buckley & Foster, 2005; ARC, 2015).

Previously the pool frog reintroduction project was subjected to criticism (Burton & Langton, 2005; Langton & Burton, 2005). From the perspective of a critic of the introduction, an undocumented introduction from Norway or Sweden prior to 1750 would produce a population of British pool frogs that might also be consistent with the genetic data, call analysis data and archival records (although see contra: Buckley & Foster, 2005, p.5). This possibility is especially concerning because water frogs are invasive in some areas, and have, for example been known to displace common midwife toads and yellow bellied toads in central Europe (Roth et al., 2016). From the perspective of Anthropocene scholarship, the native fauna of a country constitutes a safe operating zone for biodiversity (Rockström et al., 2009), and removing and adding species is potentially disruptive.

However, the archaeological evidence argues against this possibility. In addition to the two late Saxon sites (Gleed-Owen, 2000; Gleed-Owen, 2001), further archaeological remains of water frogs have been identified, proving that the pool frog was also present at a religious site in late medieval London (Snell, 2015). This evidence came midway through the thousand-year gap between Gleed-Owen's (2000) study of the archaeological record from the end of the first millennium and Kelly's (2004) study of the archival records from the end of the second millennium. Based on this evidence the conclusion that the pool frog is a native is a secure one.

METHODS

This paper describes a directed search for references to frog species other than the common frog in the pre-

industrial historical record of Britain.

It is not possible to explore every pre-industrial reference to the frog in a paper of this length. Therefore, for the purposes of our study, I have identified two promising genres of evidence from the pre-industrial period:

1. The earliest British natural histories from before Linnaeus (1735) as described at the time by Scheuchzer (1716), in Miall (1912), and with respect to herpetologists in particular, in Adler (1989). The natural history genre was selected because naturalists are expected to be the most reliable surviving witnesses of the presence/absence and native status of various frog species in their area within their lifetimes.

2. The work of British physicians describing *materia medica* (natural pharmaceutical ingredients), where they mention frogs. These have been indexed by Early English Books Online, and The Malaga Corpus of Late Middle English Scientific Prose. This genre was chosen because physicians are also likely to be comparatively reliable informants. Before the popularisation of chemical medicine, physicians were considered to be students of the natural world (*physis*) and particularly the plants and animals harvested for medicine (Cooper, 2007, pp.88–90).

Supplementary references were also found by recourse to the available searchable national corpus projects (i.e. The Oxford English Dictionary, The Middle English Dictionary, The Dictionary of Old English, Geiriadur Prifysgol Cymru, The Dictionary of the Scots Language, The Dictionary of Latin from British Sources, Welsh Prose 1300-1425). Corpora in Anglo-Norman, Norse and Gaelic have been considered outside of the scope of this study, since with these languages it is difficult to separate out material that geographically describes the native British fauna rather than an Irish or continental fauna.

Most of these sources have been either scanned with Optical Character Recognition (OCR) or have been edited into facsimiles and editions. These can generally be searched through online database-specific search engines. Most of the databases collect orthographical variations of words together, but where necessary I searched for a range of terms (e.g. ‘rana’, ‘rane’ ‘ranuncul*’, ‘padock’, ‘pudoke’, ‘pode’). The natural history texts (1) were also searched manually. The resulting references were then sorted with the aim of producing references to the presence/absence of frog species other than *Rana temporaria* in pre-industrial Britain.

RESULTS

Medieval naturalists

We begin with references from the pre-industrial naturalists since these are generally clearer and more in-depth than the medical references and will allow us to identify the most common terminology in use.

Medieval scholarship generally emphasised by-rote learning of a set corpus of material. Medieval naturalists also generally excluded the local knowledge that ordinary people must have possessed about their local environments (Etheridge, 2007; Holmes, 1936). There are, nevertheless, two medieval British naturalists’ accounts

that we might consider. The first is *De Proprietatibus Rerum* by Bartholomeus Anglicus (c.1240 CE). This was translated in 1397 by John Trevisa into English. Book 18 of these texts discusses animals, and the frog is discussed in chapter 91 of this book (Anglicus, 1492; the frog section is not included in Steele, 1905). Both author and translator distinguish five species of frog: *Rana aquaticae* (water frogs); *Rana palustris* (Trevisa: ‘moor & mire frogs’, moor frogs); *Rana rubete* (common toad); *Rana calamite* (natterjack toad); and *Rana agredule* (common frog?). This text is significant as the only pre-industrial historical text I have found to mention the moor frog.

Unfortunately, this work needs to be rejected for our purposes. *De Proprietatibus Rerum* is a complete encyclopaedia, and Book 18 is not dedicated solely to native species. The very next entry after *Rana* (the frog) is a semi-mythical account of *Salamandra* (the salamander), and there are also sections on exotic species like elephants (*Loxodonta africana*) and lions (*Panthera leo*). The work is therefore of very limited use for establishing the presence/absence of British anuran species. It draws heavily on the international bestiary tradition (compare placement in: Barber, 2006, p.116; see: Steele, 1905, p.138). The bestiary tradition is obviously not considered for the same reason (see: George, 1981).

By contrast, Gerald of Wales is generally one of the few medieval authors to make reliable observations of local fauna (Holmes, 1936). In Gerald’s (1188) *Topography of Ireland*, it is noted:

In France and Spain, frogs are loud and talkative, in Britain they are mute, in Ireland there are none. (Dimock 1867, p.62 (l:28))

As Beebee et al. (2005) have noted, the mating call of the common frog is low frequency, and not usually heard any distance from the breeding pool. This is not the case for the pool frog or the tree frog, meaning that the calls can serve as species indicators (see also: Beebee & Griffiths, 2000, p.87; Dutt 1906, pp.165–174). This evidence suggests that twelfth century Britain lacked water and tree frogs, and the Ireland lacked all frogs. But it is not clear how far we can trust Gerald’s remarks. Other pre-industrial naturalists agreed with Gerald that Ireland did not have a native population of frogs. The most reliable are Bartholomew of England’s *De Proprietibus Rerum* (XV:80) and George Owen’s *Description of Pembrokeshire* (Miles, 1994, pp.225–6). The claim is also made by O’Sullivan in *The Natural History of Ireland*, written in 1626. One of O’Sullivan’s main reasons for writing was to correct and criticise Gerald of Wales (O’Sullivan, 2009, pp.19–20), and this would have presented an ideal opportunity, but in fact O’Sullivan exactly follows Gerald:

[Ireland] does not produce the frog, the scorpion, the toad, the viper, the serpent or any poisonous animal or insect. (O’Sullivan 2009, pp.166–7)

However, it is clear from the historical evidence that common frogs were known in Ireland before the best known introduction to Dublin in 1699 (Scharff, 1893), and the genetic evidence suggests that whilst a good number of Irish frogs are descended from the standard western European stock (and were probably introduced) some seem to have been present throughout the last Glacial

Period (and are native) (Teacher et al., 2009).

Further, Gerald's note was also only added to later versions of the Topography of Ireland. In these versions, Gerald concentrates on adding material of classical and religious allegorical significance and quotations from earlier authorities rather than naturalistic observations (Bartlett, 1982, pp.143–4). The idea that Ireland lacked poisonous creatures (especially snakes) was central to Gerald's claim of its holiness as the most western isle, and the Isle of the Saints. The claim is of course not original to Gerald, and can be found in Bede's Ecclesiastical History of the English People, written in 731 CE (Sherley-Price et al., 1955, p.46 (I.1)). This comment therefore might need to be understood as a moral and religious one (as suggested in Scharff 1893) rather than one based on naturalistic observation.

It is worth noting the large amount of corroborating but generally unreliable evidence that pre-industrial Britain was known to have loud-calling frogs. One of Aldhelm of Sherborne's letters uses the metaphor of a loud pool of frogs croaking (Lapidge & Herren, 1979, p.154), but the use of metaphor is not a reliable indicator of species presence (Raye, 2016). Additionally, the earliest Old English glossaries give frog as a translation for the Latin word *luscinius* (nightingale). This might be a reference to the calling of the water frog, just like Kelly noted a thousand years later in archival references to East Anglian water frogs (Kelly, 2004) but is more likely evidence of the earlier confusion between *acredula* (small bird) and *agredula* (frog) (see: Dictionary of Old English). The loud calling of 'water frogs in fenlands', is also noted as a model of lack of discretion in early eleventh century expanded Old English Rule of Chrodegang, (Napier 1916, pp.94–6) but this example is translated directly from the ninth century continental European Latin version, so does not provide evidence of native status. From the early modern period we might also cite Lupton's Thousand Notable Things of Sundry Sortes, which suggests leaving candles burning on the banks of the pond to stop frogs calling at night (1579, p.130). Like the other thousand things, this remedy is almost certainly borrowed by Lupton from elsewhere, although presumably Lupton including the remedy might suggest it was considered to be useful for Britain as well. An early modern Welsh almanac style manuscript called Llyfr Ffortun Bangor (NLW Film 1067 (Bangor 4)) from 1685–8 in the National Library of Wales contains amongst its signs foretelling rain: 'when frogs call, this foretells rain in a short time' (Williams, 1927, p.107). Frogs croaking before rain is mentioned by naturalists as the particular property of the tree frog (Topsell, 1658, p.724; Gesner, 1554, p.61), although the reference here is probably originally based on the observations of Aratus of Soli in the third century BCE (Pochigian 2010, l.991). There is a reference in John Evelyn's (1664, p.297) *Sylva* to frogs wailing in the leaves of alder and willow trees beside rivers, but this is part of a direct translation from René Rapin's (1665, pp.47–48) French *Hortorum*. This association appears to be folkloric. A modern study of the tree frogs in Zurich found the probability of calling activity is not usually affected by rainfall (Blankenhorn, 1972). Kelly's (2004) clearer evidence that frogs in the fens were

known to call loudly, and were known as nightingales comes from the eighteenth century, especially Morton (1712, pp.440–2).

Renaissance naturalists

Among the renaissance natural histories, the most useful sources for those interested in biodiversity and native status are those that are exclusively interested in species found locally or nationally. Therefore, I do not include naturalists' encyclopaedias that fail to distinguish native and non-native species, (Topsell, 1658; Ray, 1693; Wilkins, 1668; Walton, 1653). The most reliable accounts are: Wotton (1552) *De differentiis animalium libri decem*, Merrett (1666) *Pinax rerum naturalium Britannica*, Sibbald (1684) *Scotia Illustrata*, Morton (1712) *The Natural History of Northampton-shire* and Pennant (1776) *British Zoology* vol. 3: Reptiles and Fish. To these accounts we can add two further sources that discuss native frogs (Harrison (1577) *The Chronicles of England, Scotland and Ireland*, and Brown (1646) *Pseudodoxia Epidemica*). These authors are not naturalists, and therefore their opinions are less reliable, but they are scholars and their opinions seem informed by observation of the natural world.

There is some difficulty in identifying the species intended by these authors. Among the early naturalists between Gessner (1551) and Linnaeus (1735), binomial taxonomy was the standard, but the terms themselves were not yet standardised (Cooper, 2007, p.169). Some species had several terms, and authors might make up their own. However, we can generally be confident attributing modern species to each piece of terminology for four reasons: (i) the naturalists were aware their terminology was vague and often gave detailed descriptions of the species they included, (ii) although the terminology was not standardised, the most popular terms are used in multiple texts, and differentiated from each other, (iii) this is the era when naturalistic scientific illustration began (see: Etheridge, 2007), and some contemporary European authors provide useful pictures when they described these species (see Fig. 1 & 2), (iv) Linnaeus made a collection of species described in *Systema Naturae*. Specimens of the species of herpetofauna named by Linnaeus have been examined and identified by Dundee (1994). Table 1 gives the results.

Two of these identifications may surprise readers. (i) The term green frog in this period refers to the tree frog (*Hyla arborea*) not to the water frogs (*Pelophylax* spp.), while (ii) the term water frog becomes ambiguous after 1700. I will discuss the evidence for these identifications in the section below. As explained above, these identifications are as secure as possible, based on where the authors differentiate between species, where they identify multiple names together, where there are pictures available of the species, and where a Linnaean specimen survives. However, when reading this table, it should be cautioned that historical evidence can be difficult to interpret with a high degree of confidence and it is important to read this table alongside the relevant text so that the limitations of each source is understood.

It is also important to note that I have only included here names used multiple times, as most authors in this

Table 1. Linnaean identification of Latin terms used by renaissance naturalists.

Term	Attributed by	Probable species
<i>Rana aquatilis</i>	Brown	<i>Pelophylax</i> spp. & (later)
<i>Rana aquatica</i>	Walton	<i>Rana temporaria</i>
<i>Rana aquatica innoxia</i>	Merrett	
Water frog	Pennant	
<i>Rana</i>	Harrison	<i>Rana temporaria?</i>
Frog	Merrett	<i>Rana</i> spp.
	Sibbald	
	Pennant	
<i>Rana viridis</i>	Brown	<i>Hyla arborea</i>
<i>Ranunculus viridis</i>	Walton	
Green frog	Merrett	
<i>Rana temporariae</i>	Brown	<i>Rana temporaria</i>
<i>Rana temporaria</i>	Pennant	
'Short-lived frog'		
<i>Rana arborea</i>	Brown	<i>Hyla arborea</i>
<i>Ranunculus arboreus</i>	Merrett	
Dryopetes		
Tree frog		
<i>Rana fluviatilis</i>	Wotton	<i>Rana temporaria?</i>
<i>Rana fluviarium</i>	Pennant	<i>Rana</i> sp.?
River frog		
<i>Rana terrestris</i>	Walton	<i>Hyla arborea</i> &
Land frog	Merrett	<i>Rana temporaria?</i>

period invent or use a wide variety of names. For example, only including the Latin names, Pennant gives:

Rana fluviarium

Rana aquatica innoxia

Rana aquatica

Rana temporaria

Rana (Pennant 1776, p.9)

All these names are attributed to the common frog, to try and make it as clear as possible which frog Pennant is referring to.

Altogether, of the authorities presented here, Harrison (1577), Sibbald (1684) and Morton (1712) describe only the common frog as a native; Wotton (1552) describes the common frog and tree frog as native; Brown (1646) and Merrett (1666) describe the common frog, tree frog and water frog, and Pennant (1776) describes the common frog, water frog and the 'great frog' (Pennant, 1776, p.20), which is only found in a single Scottish loch and therefore sounds like either a piece of folklore or an introduced species. There is clearly some disagreement between our sources here.

Much of this dispute can be cleared up by examination of the scope of the authors. Harrison, Sibbald and Morton are significant not only in distinguishing only a single native species of frog, but also in considering only part of Britain. Harrison and Sibbald are both describing the fauna of Scotland and Morton is describing the fauna of Northamptonshire. The records can thus be reconciled by the suggestion that the water frog and tree frog were not widely distributed in these parts of Britain when the authors wrote, although Northamptonshire's situation on the edge of the fens, where the pool frog was known to exist in later times (Kelly, 2004) makes this suggestion more difficult. Despite Morton's talents as a county naturalist, it is difficult to take him seriously as an authority on anurans. He admits he "never yet had the hardiness of

meddling with them [toads] so far" (i.e. he never studied them in the field) and even indulges the theory that toads are just dried up frogs (1712, p.440). However, it is only fair to suggest that, given Morton's late date of writing, it is equally possible that any water and tree frogs that may have been formerly present had become locally distributed and uncommon. When he wrote, John Jonston (1657, p.185), usually one of the most reliable continental naturalists, gives a confused statement in his section on water frogs that '*Rana viridis*' ('the green frog' - a term he otherwise reserves for the tree frog, meaning that it is not entirely clear which species the term is being used for here) is not found in England. Later, Gilbert White, an English author also attests that absence of the tree frog in a letter to Pennant in *The Natural History of Selborne* (Mabey, 1977, p.50). Pennant appears to have been convinced by White's testimony (presumably it agreed with his own experience) and he leaves the tree frog out of his account of the British species (Snell, 2006). White's view on the subject continued to be the established one in the twentieth century (Mabey, 1977, p.273).

The overall pattern here is that every renaissance British account interested in native species across the whole of Britain before 1700 identifies at least two and sometimes three species of frog as native but accounts from Scotland, and from southern Britain after 1700 only distinguish one species. None of the accounts record the moor frog (*Rana arvalis*) or agile frog (*Rana dalmatina*). It is possible that the naturalists could not distinguish them from the common frog (*Rana temporaria*).

Terminology used for the tree frog and water frog

As explained above, there are two instances on our list of names changing in meaning. The first is a simple one. Although we often call the water frogs (i.e. the pool frog, edible frog (*Pelophylax* kl. *esculentus*), and marsh frog (*Pelophylax* *ribundus*)) 'green frogs' today, in the sixteenth and seventeenth century the terms *Rana viridis* and green frog originally described the tree frog. We can be certain about this from contemporary labelled specimens of the species (Dundee, 1994), and from pictures. We have a British authority for this. Topsell calls the tree frog the 'green frog' in his translation of Gessner. He distinguishes it from the common frog and the water frog and depicts it on a leaf as we see in Fig. 1.



Figure 1. Illustration of a tree frog on an Acer leaf from Topsell (1658, p.724), where it was copied from Gessner (1554, p.60). Heading moved into the frame from higher on the page. Image is in the public domain.

We can also be clear about the identity of the green frog based on other contemporary textual accounts (Aldrovandus 1637, pp.589–624). An example from Britain is in Ray:

Rana arborea or *Rannunculus viridis*; The small Tree-frog or Green frog. It is very small, with a green colour which bathes it on all sides. It is easily distinguished because it settles in the leaves of trees. (Ray 1693, p.251)

An example from our texts is in Merrett:

Ranunculus viridis {the green frog} or *Dryopetes* {the tree frog}, see Gessner *Historia Animalium*, vol. 2, p.60. (Merrett, 1666, p.169)

The second instance of a name change is that of *Rana aquatica*, the water frog. This term is not used by Linnaeus or Gessner, but there is an excellent picture of the species by the later German naturalist Roesel von Rosenhof (1758), see Fig. 2. Von Rosenhof calls the frog *Rana viridis aquaticae*, and depicts what we would call in modern times a water frog, and distinguishes it from the *Rana fuscae terrestris* (common frog) and *Rana arborea* (the tree frog).

The term is also distinguished from the common frog by two of our authors, most clearly by Brown:

By Frogs I understand not such as arising from putrefaction, are bred without copulation, and because they subsist not long, are called *Temporariæ*; nor do I mean the little Frog of an excellent Parrat green, that usually sits on Trees and Bushes, and is therefore called *Ranunculus viridis*, or *arboreus*; but hereby I understand the aquatile or Water-Frog, whereof in ditches and standing plashes we may behold many millions every Spring in England... (Brown 1646, pp.172–3)

Note: in medieval and early modern Europe, common frogs were thought to be produced spontaneously from mould and rot (as in Gerald of Wales: O'Meara, 1982, p.52 (l:25); Topsell, 1658, p.720; Walton, 1653, chap.8; Seymour, 1975, p.130). This was also believed of most small invertebrates. Species that were produced spontaneously rather than through sexual reproduction were thought to be demonic rather than divine. Common frogs in particular were supposed to live a short time (hence: *temporariae*) before returning into mud (see: Sleigh 2012b; Sleigh 2012a, pp.67–8).

The distinction of the term water frog also exactly follows Merrett:

Rana, a frog (J. 187, plate 75; A. 591). This is either a *Rana terrestris* {the land frog}, which is bigger and yellow, or smaller and black. The second is called by ordinary people *Rana aquatica* {the water frog}, or *Rana maculata* {the spotted frog}. (Merrett 1666, p.169)

As Merrett notes in the quotation above, this distinction between water frogs and land frogs is also followed by two of the most influential continental authors, Aldrovandus (1637, p.591) and Jonston (1657, p.187). The term 'land frog' later comes to refer to the toad, but Merrett describes 'Bufo, a toad' separately on the same page.

However, by around 1700 the term becomes generic,



Figure 2. High quality scanned illustration page showing a water frog at rest, and two water frogs in amplexus from von Rosenhof (1758, fig.13). This scan licensed for publication by Heidelberg University Library under CC-BY-SA 3.0.

and *Rana aquatica* is one of the nine synonyms listed for the common frog by Pennant (1776, p.9), possibly following Ray (1693, p.251) or Topsell (1658, p.718), who use the term as the main Latin name for the common frog.

Medieval Physicians

In addition to the naturalists accounts, accounts by physicians and particularly pharmaceutical texts often contain references to amphibians. (Getz 1992). The toad is ubiquitous throughout medical history, its use inspired by the strange properties of the bufotoxins found in its parotoid glands and other chemical compounds (DeGraaff, 1991, pp.71–76), but the medicinal use of frogs in Britain seems to have lasted 500 years, c.1200-1700 CE. In this period, frogs, especially tree frogs, were commonly prescribed as medicine. They were useful for their moist and cooling properties under the Galenic humour system (see for example: Etmüller 1699, pp.73, 299; Lovell, 1660, pp.52–3), but also prescribed based on experience of symptom alleviation.

An early example is found in Gilbertus Anglicus' *Compendium of Medicine*, (ed. 1510, fol.205v), one of the first medical handbooks, originally compiled in c.1240. Here, the treatment is for anal fistulas. Gilbertus Anglicus, the compiler, suggests taking the heart of *ranunculus parvus et viridis* [i.e. a tree frog] washed in wine with juice extracted from wormwood, and feeding it to the patient with morsels of bread. This treatment is not translated in the Middle English version of *Compendium Medicinae*,

System of Physic. There is however, a reference to using the fat of 'grene froggis, bat lyuen among trees' to treat deafness in the Middle English version of Lanfrank's 'Science of Cirurgie' (see: von Fleischhacker 1894, p.257). These medical references are of questionable value. Gilbertus Anglicus should be seen as a compiler of medicinal recipes rather than an author in his own right (Esteban-Segura 2013, p.19; 23), and Lanfrank was born on the continent, meaning that there was no reason that either should be discussing specifically British cures. Our texts do suggest that tree frogs were sometimes thought to have medicinal properties, however, we are not justified in suggesting they were universally lauded. The general perception of frogs in the period was negative, and some physicians even believed they could be internal parasites like worms (Hunt & Benskin 2001, pp.120, 174).

The most original discussion of tree frogs as a remedy from the medieval period can be found in the *Rosa Anglica*, a medical handbook from c.1314. The author, Iohannis Anglicus, or John of Gaddesden once again compiles descriptions of diseases and symptoms from elsewhere, but the treatments advised here are unique. John's work is unusual in that he created many original (perhaps dubious) medicines, and sold his 'secrets' at high price to rich patrons. These are shared freely for the use of other doctors in the handbook (Capener, 1972). One such is a recipe using tree frog fat as an ointment to help rotten teeth fall out. The description of the frog is very specific.

This is the secret cure for which I have received good money from the Barbers. Take a green frog which is arboreal in its habitat. It climbs from tree to tree, and many of them may be found in Provence. Take its fat and anoint the tooth with it. The tooth will fall out straight away. (trans. of: Anglicus 1502, p.120)

The text here seems like an introduction to the tree frog, as if John does not believe that his readers will be aware of the species. As well as being described like this, they are also mentioned as native to Provence, in modern day south-east France -- the text I am translating gives *Puincia*, which is an ambiguous shortening, but an earlier version of the text gives *Provincia* (Cholmeley, 1912, p.40). On balance, this reference implicitly suggests John of Gaddesden did not believe the tree frog to be native to Britain, since he introduces the species as a novelty, and suggests its ordinary home is abroad. The popularity of these medical recipe books stems from the increasing demand for fast-acting pharmaceutical cures over medical regimens in the second half of the medieval period. The apothecaries at the time were incorporated in the Company of Grocers, and commonly imported popular and exotic remedies to meet demands (Getz, 1992).

Renaissance Physicians

Tree frogs continue to be popular medicinal simples in the sixteenth and seventeenth centuries. The most common use of the species is for putting out teeth as in the *Rosa Anglica*, there are references to this use in *Levens' Pathway to Health* (1596, p.20). A mixed medicine of tree frog and water frog together is recommended in the *Treasure of pore men* (Anonymous 1526, fol.16 v.) and in *Moulton's Compleat Bone-Setter* (1657, p.120). Medicine from tree

frog and water frog is also suggested for the ague and for hair-loss in *The Treasury of Health* (Lloyde, 1553), and for hair loss in the *Homish apothecarye* (Hollybush 1561, fol.2 r.). These references must all be treated with caution for our purposes since they might still just reflect the importation of exotic references.

However, this reservation cannot be made of the *Treatise on English medicines* attributed to Timothie Bright. In the early modern period a debate arose between physicians who advocated the use of the most successful and exotic remedies as the best (although these were often imported in at great cost, and sometimes adulterated) and those who advocated local medicines to be mystically more effective for the people living in an area (see esp. Cooper, 2007, pp.29–45). Bright was firmly on the side of indigenous medicine, and drew up a list of native ingredients to assist. 'Greene frogges' (=tree frogs, see above) were included near the top of the list:

And heerein (gentle reader) thou art not to looke I should set downe all medicines which our natiue soyle is knowne to bestow vpon vs for cure of these diseases... And first to begin with Cankers, which being not exulcerated but remaying humors, are cured (if with any medicine) by the iuyce of Nightshade, all the sortes of Endiue and Succorie, with Agrimonie, with Saint Iohns wort, wilde Clarie, called Oculus Christi, the flesh of Snayles boyled, Crayfishes, greene Frogges, and to conclude, with all kinde of metall and mineralls; and among them Leade, how so euer it be vsed, is most souereigne (Bright 1580, pp.44–45).

Bright was hostile to exotic remedies, so the inclusion of tree frogs on this list is possible evidence of the species' presence. However, since Bright was not a naturalist, this evidence may not be reliable.

From the seventeenth century there is a reference in *A Friend to the Sick* to the use of tree frogs against plague carbuncles (Sermon, 1673, p.223) and an introduction to the use of 'green frogs' in Pechey's (1697, p.213) *Plain Introduction*. They continue to be referred to in direct translations of foreign texts (e.g. *Barbette*, 1687, p.99; *Ettmüller* 1699, p.69; *Surflet & Markham* 1616, pp.39, 614). The last of these references also refers to the use of water frogs in medicine, which is also introduced in considerable detail in *Schröder's Zoologia* (1659, pp. 127–130). However, this century also sees the end of the use of frogs in British medicine. Neither species is mentioned in the official national dispensatories and pharmacopoeias.

The strongest medical reference from this century comes from another British author, Robert Lovell, and his (1660, p.53) *Panzooryktologia*. This medical text discusses all natural simples commonly in use, including a series of exotic species like the crocodile and chameleon. At the beginning of every species' account are three bullet points on P[lace found], M[eat/Diet], and N[ames]. The Place found is usually specific, e.g. the chameleon is found 'in Asia, Africa, and India, or the Indies' (1660, p.30). The green frog is said to be found 'Almost everywhere, in woods, and among reeds'. This makes it likely that the species was present in Britain, but since Lovell is not explicit, the evidence is not certain.

Table 2. Evidence for water frogs and tree frogs from Britain. “Pres.” = Attested present, “Ab.”= Attested absent, “-“= Not mentioned) This table also lists pre-Linnaean names given in the historical sources.

Text	Date	<i>Rana temporaria</i>	<i>Pelodyphyllax</i> spp.	<i>Hyla arborea</i>
Ely archaeological remains (Beebee et al. 2005)	850-1050	Pres.	Pres.	-
Gosberton archaeological remains (Gleed-Owen 2000)	880-1040	Pres.	Pres.	-
Topography of Ireland (Dimock 1867)	1188	Pres. ‘Rana’	Ab. Ranae in Gallia et Italia clamosae et garrulae	
Rosa Anglica (Anglicus 1502)	1314	-	-	Ab. ‘Rana viridis’
Greyfriars archaeological remains (Snell 2015)	15th c.	Pres.	Pres.	-
De differentialis animalium libri decem (Wotton 1552)	1552	Pres. ‘Rana fluviatilis’	-	Pres. ‘Rana parva’
A Treatise... (Bright 1580)	1580	-	-	Pres. ‘greene Frogges’
Pseudodoxia Epidemica (Brown 1646)	1646	Pres. ‘Rana temporariae’	Pres. Rana aquatile	Pres. ‘Ranunculus viridis’ / ‘Rana arborea’
De Quadrupedibus (Jonston 1657)	1657	-	Ab. Rana viridis	
Panzooryktologia (Lovell 1660)	1660	Pres. ‘Those belonging to rivers’	-	Pres. ‘Ranunculus vir.’ / ‘Frog of the land’ / ‘green frog’
Pinax rerum naturalium Britannica (Merrett 1666)	1667	Pres. ‘Rana terrestris’	Pres. ‘Rana aquatica’	Pres. ‘Ranunculus viridis’ / ‘Dropetes’
The Natural History of Selbourne (Mabey 1977)	1788	Pres. ‘frog’	-	
Records from East Anglia (Kelly 2004)	1770-1995	Pres.	Pres.	-

CONCLUSIONS

Table 2 lists the most reliable historical evidence for the presence/absence of water frogs and tree frogs in the pre-industrial period. It does not include the agile frog or moor frog, since these are not mentioned by any reliable historical source. If these species were still present in Britain at the time (as Gleed-Owen (2000) suspects for the moor frog) they may have not been distinguished from the common frog.

For each of the contemporary sources, I have given the terms used by the author. Generally, the common frog is called the ‘temporary’, or ‘river’ frog. The tree frog is called the ‘tree’, ‘little’, or ‘green’ frog (the last term only comes to refer to the water frog later on). The water frog is generally the water frog, except in the ambiguous reference by Jonston. Prior to this paper, there were three main temporal points of evidence for the existence of water frogs in Britain. Gleed-Owen (2000) found remains from the late-Saxon period; Snell (2015) found remains from the fifteenth century, and Kelly (2004) found continuous historical evidence dating from the end of the eighteenth century to the twentieth, when the pool frog became extinct. There are gaps of four centuries between Kelly’s evidence and Snell’s and five centuries between Snell’s evidence and Gleed-Owen’s. There is also of course no evidence for the presence of water frogs in Britain before the late-Saxon remains, but there is very little evidence for the history of small species before this, so the lack of evidence there need not surprise us. Our study has been able to contribute two additional pieces of

reliable evidence to fill the gap between the fifteenth and eighteenth century. Our findings therefore confirm that pool frogs were formerly present in Britain’s wetlands for at least five centuries. This strongly suggests that reintroduction of the species will do no harm, even if its native species were not certain. Unfortunately, this study has not been able to fill the gap between the eleventh and fifteenth century, except for a single piece of less reliable evidence suggesting that pool frogs were not present. The testimony of Gerald of Wales is most probably to be understood as moralistic rather than naturalistic, and is not enough to overturn our understanding of the species as a native (as represented in: Beebee et al., 2005), but further research on this species is recommended to explain the historical evidence.

Our paper has been able to provide more useful evidence on the presence of the tree frog in the historical period. It is clear that the tree frog was present in Britain from at least the sixteenth century, when it is attested by an early renaissance naturalist and a localist physician, Timothie Bright. Bright, like other early modern localist physicians was interested in locally-occurring materia medica, but not exclusively native ones (Wear, 2000, pp.74–5). There are two earlier sources that suggest that the tree frog may not be a native, most importantly John of Gaddesden’s assertion that the tree frog should be sought in Provence (implying it cannot be found locally). The simplest explanation of this evidence is to suggest that the tree frog was imported in the sixteenth century, and live populations were purposefully or accidentally established. Species were commonly introduced to

new habitats in the pre-modern period. For example, carp were commonly transported in wet rushes, straw or barrels of water and were introduced across Europe to be bred in fish ponds (Hoffmann, 1996; Landsberg, 2003, pp.68–9). Various species of plant and animal were shipped internationally, most commonly dead and preserved as medical simples for pharmaceutical science (Getz, 1992). This probably included tree frogs as we have seen. Monastery physic gardens imported living herbs to grow for use in medicine, possibly including aquatic plants (Landsberg, 2003, pp.38–9; Harvey, 1992). Frogs were also frequently transported for use as fish food (Currie, 1988, p.274; Amherst, 1896, p.39). Before 1660, most gardens had still-water ponds (servatoria), and apparently frogs were commonly seen in them, since Francis Bacon praises the popularisation of fountains for the new lack of annoying flies and frogs (Montagu, 1844, p.52). Species can also be introduced unintentionally (McDevitt, 2016), and Gerald of Wales (I.22) records one example of the inadvertent transportation of common toads to Ireland (O'Meara, 1982, p.51). At the other end of our time period, we also have the testimony of one of Britain's foremost naturalists, Gilbert White, that the tree frog was no longer present in the eighteenth century, by which point populations may have become extinct, or purely localised, if we accept Snell's (2006) suggestion of a historical relict population in the New Forest. The reason for decline is difficult to ascertain. Since there was clearly a great demand for medicine made of the species, we might speculate that the tree frog became extinct from Britain due to overexploitation for medical purposes, just like the medicinal leech (*Hirudo medicinalis*) that declined around the same period (Elliott & Kutschera, 2011).

From the perspective of our wider study, it is possible to make some observations about the analysis of historical sources from our findings. In this case, the historical record seems to more useful than the archaeological record for discussions of the early modern presence/absence of the tree frog at least, and possibly also the pool frog. This is because archaeological evidence is not presented with an explanation. For example, there are several ways that the remains of a frog might end up in the archaeological record, whereas in the historical record we occasionally have existing range data included alongside species records. However, the historical record in this case was less useful than the archaeological record in ascertaining native status, because of the failure of renaissance naturalists to distinguish between 'local' and 'native' (Cooper, 2007, pp.32–3). The archaeological record also gives earlier records, from a period when very few texts provide useful information about natural history. Finally, it is worth noting that both the historical and the archaeological records provide only a few hints for us to speculate about possible introduction pathways. This issue can be much better answered by genetic analysis and, in the case of frog species, call-analysis studies.

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REFERENCES

- Adler, D., 1981. *Imaginary Toads in Real Gardens*. English Literary Renaissance, 11(3), pp.235–260.
- Adler, K., 1989. *Contributions to the History of Herpetology*. Vancouver: Society for the Study of Amphibians and Reptiles.
- Aldrovandus, U., 1637. *De Quadrupedibus Digitatis Viviparis & De Quadrupedibus Digitatis Oviparis*, Bonon: Nicolam Tebaldinum.
- Amherst, A., 1896. *A History of Gardening in England*, London: Bernard Quaritch.
- Anglicus, B., 1492. *De Proprietatibus Rerum*, Nuremberg: A. Koberger. Available at: <http://www.cmog.org/library/de-proprietatibus-rerum-bartholomeusanglicus>.
- Anglicus, G., 1510. *Compendium medicinae*, Lyon.
- Anglicus, I., 1502. *Rosa Anglica*, Venice.
- Anonymous, 1526. *Treasure of pore men*, London: [J. Rastell for] Rycherd Bankes.
- ARC, 2015. *Breaking New Ground – Pool Frog Reintroduction Project*. Amphibian and Reptile Conservation Website. Available at: <http://www.arc-trust.org/breaking-new-ground> [Accessed December 18, 2016].
- Aybes, C. & Yalden, D.W., 1995. Place-name evidence for the former distribution and status of Wolves and Beavers in Britain. *Mammal Review* 25(4), pp.201–227.
- Backhouse, J., 1981. *The Lindisfarne Gospels*, Phaidon Oxford.
- Barber, R., 2006. *Bestiary*, Woodbridge: Boydell Press.
- Barbette, P., 1687. *Thesaurus chirurgiae*, London: Printed for Henry Rhodes.
- Bartlett, R., 1982. *Gerald of Wales (1146–1223)*. Oxford: Clarendon Press.
- Bayliss, A., 2009. Rolling out revolution: using radiocarbon dating in archaeology. *Radiocarbon* 51(1), pp.123–147.
- Beebee, T.J.C. et al., 2005. Neglected native or undesirable alien? Resolution of a conservation dilemma concerning the pool frog *Rana lessonae*. *Biodiversity & Conservation* 14(7), pp.1607–1626.
- Beebee, T.J.C., 2002. *The Natterjack toad Bufo calamita in Ireland: current status and conservation requirements*, Dublin: Dúchas.
- Beebee, T.J.C. & Griffiths, R., 2000. *Amphibians and reptiles*, London: Collins.
- Blankenhorn, H.J., 1972. Meteorological variables affecting onset and duration of calling in *Hyla arborea* L. and *Bufo calamita* Laur. *Oecologia* 9(3), 223–234.
- Bocek, B., 1986. Rodent ecology and burrowing behavior: predicted effects on archaeological site formation. *American Antiquity*, 589–603.

- Boisseau, S. & Yalden, D.W., 1998. The former status of the Crane *Grus grus* in Britain. *Ibis* 140(3), 482–500.
- Bright, T., 1580. *A treatise, vvherein is declared the sufficiencye of English medicines, for cure of all diseases, cured with medicine*, London: Henrie Middleton for Thomas Man.
- Brown, T., 1646. *Pseudodoxia Epidemica*, London: Printed for Edward Dod.
- Buckley, J. & Foster, J., 2005. *Reintroduction strategy for the pool frog *Rana lessonae* in England*, Peterborough.
- Burton, J.A. & Langton, T.E.S., 2005. *On the approach to investigating the historic status of the Green/Water frog *Rana lessonae* in England using archive material, with particular reference to English Nature funded Research Reports and proposals to release Pool frogs in the wild in England.*, Halesworth.
- Capener, N., 1972. Chaucer and Doctor John of Gaddesden. *Annals of the Royal College of Surgeons of England* 50(5), 283.
- Chambley, A.D., 2000. *The leaper between: an historical study of the toad bone amulet*, Three Hands Press.
- Charles-Edwards, T.M., 1978. The authenticity of the Gododdin: an historian's view. In R. Bromwich & R. B. Jones, eds. *Astudiaethau ar yr Hengerdd: Studies in Old Welsh Poetry*. Cardiff: University of Wales Press, pp. 44–71.
- Cholmeley, H.P., 1912. *John of Gaddesden and the Rosa medicinae*, Oxford: Clarendon Press.
- Cooper, A., 2007. *Inventing the indigenous: Local knowledge and natural history in early modern Europe*, Cambridge: Cambridge University Press.
- Crump, M., 2015. *Eye of Newt and Toe of Frog, Adder's Fork and Lizard's Leg: The Lore and Mythology of Amphibians and Reptiles*, Chicago: University of Chicago Press.
- Currie, C.K., 1988. Medieval Fishponds in Hampshire. In M. Aston, ed. *Medieval Fish, Fisheries and Fishponds in England*. Oxford: British Archaeological Reports 182, pp. 367–389.
- D'Aronco, M.A. & Cameron, M.L., 1998. *The Old English Illustrated Pharmacopoeia: British Library Cotton Vitellius C. iii*, Rosenkilde and Bagger.
- DeGraaff, R.M., 1991. *The Book of the Toad: A Natural and Magical History of Toad-human Relations*, Park Street Press.
- Dent, A., 1974. *Lost beasts of Britain*, London: Harrap.
- Dimock, J.F., 1867. *Giraldi Cambrensis Opera: Topographica Hibernia et Expugnatio Hibernica*, Longman, Greed, Reader & Dyer.
- Drout, M.D.C., Boyd, P. & Bowman, E., 2014. "Give the people what they want": Historiography and rhetorical history of the dating of Beowulf controversy. In L. Neidorf, ed. *The dating of Beowulf: A reassessment*. Cambridge: D.S. Brewer, pp. 157–177.
- Dundee, H.A., 1994. Current Names for Linnaeus's Herpetological Species in Systema Naturae X. In *A trilogy on the herpetology of Linnaeus's Systema Natura X*. Washington DC: Smithsonian Herpetological Information Service no. 100.
- Dutt, W.A., 1906. *Wild Life in East Anglia*, London: Methuen & Company.
- Elliott, J.M. & Kutschera, U., 2011. Medicinal leeches: historical use, ecology, genetics and conservation. *Freshwater Reviews* 4(1), 21–41.
- Esteban-Segura, L., 2013. *System of Physic (GUL MS Hunter 509, Ff: A Compendium of Mediaeval Medicine Including the Middle English Gilbertus Anglicus*, Peter Lang AG, Internationaler Verlag der Wissenschaften.
- Etheridge, K., 2007. Loathsome Beasts: Images of Reptiles and Amphibians in Art and Science. In S. L. French & K. Etheridge, eds. *Origins of Scientific Learning: Essays on Culture and Knowledge in Early Modern Europe*. Lewiston: Edwin Mellen Press, pp. 63–88.
- Ettmüller, M., 1699. *Etmullerus abridg'd*, London: Printed for E. Harris.
- Evelyn, J., 1664. *Silva: or, a discourse of forest-trees* vol. 2., London: Royal Society.
- von Fleischhacker, R., 1894. *Lanfrank's "Science of Chirurgie,"* London: Early English Text Society 102.
- Gazin-Schwartz, A. & Holtorf, C., 1999. "As long as ever I've known it..." On Folklore and Archaeology. In A. Gazin-Schwartz & C. Holtorf, eds. *Archaeology and Folklore*. London: Routledge, pp. 2–23.
- George, W., 1981. The bestiary: a handbook of the local fauna. *Archives of Natural History* 10(2), 187–203.
- Gesner, K., 1554. *Historia Animalium* vol. 2., Frankfurt: Ioannis Wecheli.
- Getz, F.M., 1992. The pharmaceutical writings of Gilbertus Anglicus. *Pharmacy in history* 34(1), 17–25.
- Gleed-Owen, C., 2001. *Further archaeozoological work for the pool frog species recovery programme*, Peterborough.
- Gleed-Owen, C.P., 2000. Subfossil records of *Rana* cf. *lessonae*, *Rana arvalis* and *Rana* cf. *dalmatina* from Middle Saxon (c. 600-950 AD) deposits in eastern England: evidence for native status. *Amphibia Reptilia* 21(1), 57–66.
- Harting, J.E., 1880. *British animals extinct within historic times: with some account of British wild white cattle*, Trübner and Company.
- Harvey, J.H., 1992. Westminster Abbey: the infirmerer's garden. *Garden History* 20(2), 97–115.
- Hoffmann, R.C., 1996. Economic Development and Aquatic Ecosystems in Medieval Europe. *The American Historical Review* 101(3), 631–669.
- Hollybush, I., 1561. *A most excellent and perfecte homish apothecarye or homely physick booke/ for all the grefes and diseases of the bodye [Hieronymus Braunschweig]*, Cologne: Arnold Birckman.
- Holmes, U.T., 1936. Gerald the naturalist. *Speculum* 11(1), 110–121.
- Hunt, T. & Benskin, M., 2001. *Three Receptaria from Medieval England Medium Ævu.*, Oxford: The Society for the Study of Medieval Languages and Literature.
- Jonston, J., 1657. *Historiae naturalis de quadrupedibus libri*, Amsterdam: J. J. Schipperri.
- Kelly, G., 2004. *Literature/archive search for information relating to pool frogs *Rana lessonae* in East Anglia.*, Peterborough.
- Landsberg, S., 2003. *The Medieval Garden*, Toronto: University of Toronto Press.
- Langton, T.E.S. & Burton, J.A., 2005. *Pool frog *Rana lessonae* in Britain: past nativeness unresolved: On the verification of sub-fossil bone identification.*, Halesworth.
- Lapidge, M. & Herren, M.W., 1979. *Aldhelm, the prose works*, Cambridge: DS Brewer.
- Lenders, H.J. & Janssen, I.A.W., 2014. The grass snake and the basilisk: from pre-Christian protective house god to the antichrist. *Environment and History* 20(3), 319–346.
- Levens, P., 1596. *The pathway to health*, London: Edward White.
- Lever, C., 2009. *The Naturalized Animals of Britain and Ireland*, London: New Holland.
- Linnard, W., 1984. The Nine Huntings: A Re-examination of Y Naw Helwriaeth. *Bulletin of the Board of Celtic Studies* 31, 119–132.
- Lloyde, H., 1553. *The Treasury of healthe conteyning many profitable medycines gathered out of Hypocrates, Galen and Auycen, by one Petrus Hispanus*, London: Wyllyam Coplande.

- Lovell, R., 1660. *Panzooryktologia*, Oxford: Henry Hall for Joseph Godwin.
- Lupton, T., 1579. *A thousand notable things*, London: By Iohn Charlewood for Hughe Spooner.
- Mabey, R., 1977. *Gilbert White: The Natural History of Selborne*, London: Penguin.
- McDevitt, A., 2016. Shrew invasion of Ireland. *Mammal News* 176, 16–17.
- McKenna, M.C., Bleefeld, A.R. & Mellett, J.S., 1994. Microvertebrate collecting: large-scale wet sieving for fossil microvertebrates in the field. In P. Leiggi & P. May, eds. *Vertebrate paleontological techniques*. Cambridge: Cambridge University Press, pp. 93–111.
- Merrett, C., 1666. *Pinax Rerum Naturalium Britannicarum*, London: T. Warren.
- Miall, L.C., 1912. *The early naturalists: their lives and work (1530-1789)*, London: Macmillan.
- Miles, D., 1994. *The description of Pembrokeshire by George Owen of Henllys*, Llandysul: Gomer Press.
- Montagu, B., 1844. *The works of Francis Bacon* vol. 1., Philadelphia: Carey & Hart.
- Morgan, P., 1983. From a death to a view: the hunt for the Welsh past in the Romantic period. In E. Hobsbawm & T. Ranger, eds. *The invention of tradition*. Cambridge: Cambridge University Press, pp. 43–100.
- Morton, J., 1712. *The Natural History of Northampton-shire*, London: R. Knaplock.
- Moulton, T., 1657. *The compleat bone-setter*, London: Martha Harison.
- Napier, A.S., 1916. *The Old English Version of the "Enlarged Rule of Chrodegang", Together with the Latin Original*, London: Early English Text Society, vol. 150.
- O'Meara, J., 1982. *The History and Topography of Ireland*, London: Penguin.
- O'Suillivan, D., 2009. *The Natural History of Ireland* by Philip O'Sullivan Beare, Cork: Cork University Press.
- Pechey, J., 1697. *A plain introduction to the art of physick*, London: Henry Bonwicke.
- Pennant, T., 1776. *British Zoology, vol. 3: Reptiles & Fish*, London: Warrington.
- Poochigian, A., 2010. *Aratus: Phaenomena*, Baltimore: Johns Hopkins University Press.
- Rapin, R., 1665. *Hortorum Libri IV*, Paris: Typographia Regia.
- Ray, J., 1693. *Synopsis Methodica*, London: Robert Southwell.
- Raye, L., 2016. "Blue skies, green grass": Is The Redemption of Althalus a reliable biological record? *Fafnir* 3(2), 25–38.
- Raye, L., 2013. Lions in Insular British Artwork, 650-1000 AD. *Journal of Late Antique Religion and Culture* 7, 72–89.
- Ritchie, J., 1920. *The Influence of Man on Animal Life in Scotland*, Cambridge: Cambridge University Press.
- Rockström, J. et al., 2009. A safe operating space for humanity. *Nature*, 461(7263) 472–475.
- von Rosenhof, A.I.R., 1758. *Historia Natvralis Ranarvm*, Nuremberg: Joseph Fleischmann.
- Roth, T., Bühler, C. & Amrhein, V., 2016. Estimating Effects of Species Interactions on Populations of Endangered Species. *The American naturalist* 187(4), 457–67.
- Scharff, R.F., 1893. The Frog a Native of Ireland. *The Irish Naturalist* 2(1), 1–6.
- Scheuchzer, J.J., 1716. *Bibliotheca scriptorum Historiæ naturali omnium terræ*, Zurich: Henric Bodmer.
- Schröder, J., 1659. *Zoologia*, London: E. Cotes, for R. Royston.
- Sermon, W., 1673. *A friend to the sick*, London: Printed by W. Downing for Edward Thomas.
- Seymour, M.C. et al., 1975. *On the Properties of Things: John Trevisa's Translation of Bartholomaeus Anglicus* volume 2., Oxford: Oxford University Press.
- Sherley-Price, L., Latham, R.E. & Farmer, D.H., 1955. *Bede: Ecclesiastical History of the English People*, London: Penguin.
- Sibbald, R., 1684. *Scotia Illustrata*, Edinburgh: Jacobi Kniblo, Joshuae Solingensis, Johannis Colmarii.
- Sleigh, C., 2012a. *Frog*, London: Reaktion Books.
- Sleigh, C., 2012b. Jan Swammerdam's frogs. *Notes and Records: The Royal Society Journal of the History of Science*, 66(4), pp.373–392.
- Snell, C., 2006. Status of the Common tree frog in Britain. *British Wildlife* 17(3), 153–160.
- Snell, C.A., 1991. Disappearance of Britain's tree frog (*Hyla arborea*) colonies. *Bulletin of the British Herpetological Society* 38, p.40.
- Snell, C.A., 2015. Identifying *Ranid urostyle*, ilial and anomalous bones from a 15th century London well. *The Herpetological Journal* 25(4), 245–255.
- Snell, C., Tetteh, J. & Evans, I.H., 2005. Phylogeography of the pool frog (*Rana lessonae* Camerano) in Europe: evidence for native status in Great Britain and for an unusual postglacial colonization route. *Biological journal of the Linnean Society* 85(1), 41–51.
- Steele, R., 1905. *Medieaval Lore from Bartholomew Anglicus*, London: De La More Press.
- Surflet, R. & Markham, G., 1616. *Maison rustique, or The countrey farme*, London: Adam Islip for Iohn Bill.
- Teacher, A.G.F., Garner, T.W.J. & Nichols, R.A., 2009. European phylogeography of the common frog (*Rana temporaria*): routes of postglacial colonization into the British Isles, and evidence for an Irish glacial refugium. *Heredity* 102(5), 490–496.
- The Holinshed Project, 2013. Holinshed's Chronicles of England, Scotland and Ireland, 1577 ed. Available at: <http://www.cems.ox.ac.uk/holinshed> [Accessed January 10, 2016].
- Thomas, R., 2010. Translocated Testudinidae: the earliest archaeological evidence for land tortoise in Britain. *Post-medieval archaeology* 44(1), 165–171.
- Thomson, D.S., 1952. *The Gaelic Sources of Macpherson's Ossian*, Published for the University of Aberdeen [by] Oliver and Boyd.
- Topsell, E., 1658. *The History of Four-Footed Beasts, Serpents and Insects*, London: E. Cotes.
- Walton, I., 1653. *The Compleat Angler or the Contemplative Man's Recreation*, London: Rich Marriot.
- Wear, A., 2000. *Knowledge and practice in English medicine, 1550-1680*, Cambridge: Cambridge University Press.
- Wilkins, J., 1668. *An essay towards a real character, and a philosophical language*, London: Royal Society.
- Williams, I., 1927. Llfyr Ffortun Bangor. *Bulletin of the Board of Celtic Studies* 3(2), 90–119.
- Wotton, E., 1552. *De Differentiis Animalium*, Paris.
- Wycherley, J., Doran, S. & Beebee, T.J.C., 2002. Frog calls echo microsatellite phylogeography in the European pool frog (*Rana lessonae*). *Journal of Zoology* 258(4), 479–484.
- Yalden, D.W., 2007. *The older history of the White-tailed Eagle in Britain*. *British Birds*, 100(8), p.471.
- Yapp, W.B., 1981. *Birds in medieval manuscripts*, New York: Schocken Books.

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