peptide have been largely unnoticed or ignored.

Lauressergues and colleagues identified short open reading frames (ORFs) — sequences that can potentially encode proteins — in many different pri-miRs of two plant species. For five of them, they predicted the corresponding amino-acid sequences of the ORFs, synthesized the corresponding peptides and made specific antibodies against them. Using these antibodies, the authors showed that the ORFs are naturally translated in plants into peptides that they call miPEPs.

In the cases examined, the miPEPs had the same tissue distribution as their associated mature miRNAs and enhanced the expression and effectiveness of these miRNAs. Moreover, the miPEPs promoted the transcription of their corresponding pri-miR, rather than enhancing miRNA stability. This discovery reveals an unexpected function for at least part of the non-foldback pri-miR sequences and highlights yet another layer of gene regulation. It also raises questions about the existence and functions of other peptides potentially encoded by such short ORFs.

Genomic sequences with the potential to encode pri-miRs are constantly evolving in plants. They seem to arise from inverted duplications of whole or fragmented genes that lead to the production of hairpin-like RNAs[8]. If such RNAs produce useful miRNAs for gene regulation, they are refined into pri-miRs; if not, they erode away. This has led to the concept of ancient and recent miRNAs. Ancient miRNAs have sequences and functions that are conserved across many species, have survived for hundreds of millions of years, and seem destined to be essential for future plant evolution. Recent miRNAs are more species-specific and have much less assured functions and futures.

The miPEPs discovered in the present paper are associated with several families of miRNAs. If we put miR165 into the miR166 family (the two miRNAs differ by only one nucleotide), all seven of the miPEPs discovered in the present paper are associated with ancient miRNA families that are conserved across all flowering plants. Thus, they have all had the evolutionary time to create ORFs encoding functionally useful peptides. From this, it seems likely that yet-to-be-discovered miPEPs will be more prevalent in ancient miRNA families and that miPEPs in younger miRNA families may be detectably co-evolving with their associated miRNAs. It also seems possible that miPEPs are encoded in some animal pri-miRs.

The identification of further miPEPs, using bioinformatics alone, might not be easy. Five of the seven miPEPs identified by Lauressergues *et al.* are encoded in ORFs of fewer than 100 nucleotides. Sequences encoding potential peptides from ORFs of this size are often ignored or filtered out by automated genome-annotation programs, because the probability of their occurring by chance alone increases exponentially as they get shorter.

Short yet functional peptide-encoding ORFs are also beginning to be discovered upstream of larger conventional protein-coding ORFs[9], and many of these defy convention by having unusual start codons (sequences that initiate protein synthesis)[10]. The experimental discovery of miPEPs and other small peptides such as these raises an inconvenient question: are we missing a vast library of biologically important peptide signals because our bioinformatic analyses are not yet well enough designed to detect them? ■

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This article was published online on 25 March 2015.

ZOOLOGY

Here be dragons

Emerging evidence indicates that dragons can no longer be dismissed as creatures of legend and fantasy, and that anthropogenic effects on the world's climate may inadvertently be paving the way for the resurgence of these beasts.

ANDREW J. HAMILTON, ROBERT M. MAY & EDWARD K. WATERS

Long considered to be the stuff of legend, dragons cross cultures and continents. Until recently, however, scant attention had been paid to the fact that the commonality in cultural representations of such creatures indicates something more sinister. From depictions in Ancient Greek literature and Slavic myth, to the dragons of the East or allusions in Zoroastrian scripture, the descriptions resonate. What if these legends were rooted in truth? The differences in appearance — some lack wings, some have multiple heads and some seem not to breathe fire — once thought to reflect local traditions, can also readily be explained by speciation.

The 800th anniversary of the signing of *Magna Carta* in 1215 has sparked an unprecedented investigation of literary resources from the early medieval period. One such document, uncovered by chance under a pile of rusty candlesticks in a locked cupboard marked "loste propertie" in the depths of the University of Oxford's Bodleian Library, provides strong evidence that the field of fantastical beasts requires urgent re-evaluation.

ANDERSON, WAYNE/PRIVATE COLLECTION/BRIDGEMAN IMAGES

Figure 1 | Lizards of legend. Dragons have somehow wormed their way into the realm of fantasy, which belies the threat posed by them in the twenty-first century.

Attributed to the monk Godfrey of Exmouth, the treatise discusses many verified aspects of English history but, crucially, proffers evidence that for millennia dragons have periodically been a scourge to civilizations (Fig. 1).

Further work has revealed that the early medieval period was a veritable paradise for dragons. This can be attributed to the period's unusually warm temperatures (Fig. 2) and an abundance of knights, the beasts' favourite combatant and food. It was also a time when wealth and status were measured in terms of gold and silver — the preferred nesting material for Western dragons. As result, the major needs for living, feeding and, crucially, relaxation were readily available to dragons, allowing populations to flourish. The roasting of flesh and the indiscriminate demolition of hovels and castles became commonplace.

As Godfrey of Exmouth attests, this was an era when humanity as a whole was fully aware of the existence of dragons and all other magical beings. It is likely that the persistent antisocial behaviour of dragons, and the failure of seemingly powerful magical beings to combat the scourge effectively, led to a deep-seated antipathy: witches became kindling, wizards who dared to imagine a heliocentric Universe suffered the indignity of trial and ridicule.

The combination of decreasing temperatures and a sharp decline in the number of knights saw the onset among dragons of The Great Sleep around the start of the fifteenth century. Such a phenomenon is well recognized: many ectothermic beasts enter a period of brumation (analogous to hibernation in endotherms) under adverse food and climatic conditions. The Great Sleep coincided with what is generally referred to as the Little Ice Age (Fig. 2). Historical records demonstrate that this period was a time of relative peace, at least with regard to dragon attacks. Many believed that dragons — the fire-breathing species, at any rate — had become extinct by the thirteenth or fourteenth century[1]. This belief has further been extended to a perplexing level, whereby conventional opinion now holds that dragons, and indeed all other magical beings, are mere fantasy. Such a creed has been a blessing for dragons, because it spelt an end to the persecutions. Witches are now seen as crazy but harmless women, and wizards as senile old men with nothing better to do than wander around folk festivals in funny hats.

The calm was shaken briefly from 1586 to 1597 with The First Stir. Dragons behave no differently from other ectotherms in their brumation protocols, and they will periodically awaken from their slumber and check to see whether outside conditions justify ending the torpor. With their need to maintain extremely high temperatures in their buccal and nasal furnaces, it is crucially important for the fire-breathing species to ensure that the environmental conditions are energetically favourable before breaking their dormancy: there must be warmth and food. Fortunately, The First Stir coincided with the depths of the Little Ice Age and a bewildering lack of knights. Thus, the decision to return to slumber was made without hesitation. Although very few witnessed the awakenings, those who did (including some highly respected philosophers) were quick to record their astonishment in text (Fig. 2), but were immediately ridiculed by their peers and their writings relegated to the disrespected genre of fiction.

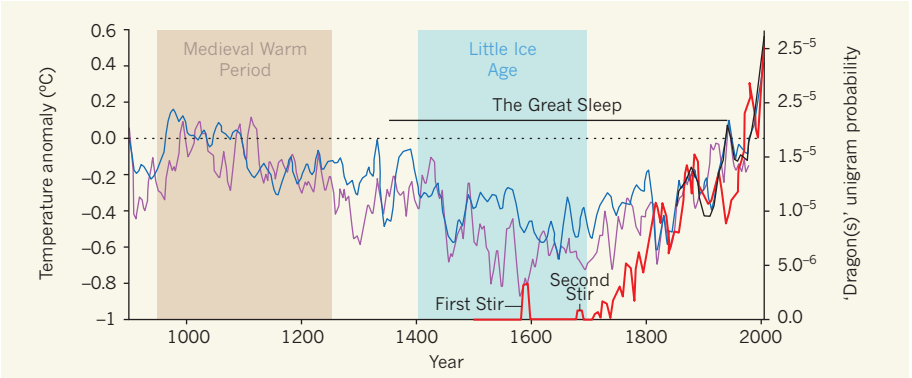

Figure 2 | The rise and fall and rise again of dragons. The relative frequency of 'dragons' in fictional literature (thick red line), as determined as a unigram probability[4], with two historical reconstructions of Northern Hemisphere temperature (decadal smoothing) shown in blue[5] and purple[6]. Global temperatures have been measured since 1855 (thick black line[5]). Temperature anomalies represent deviations from the 1961–90 reference period. The rising incidence of dragons in the literature correlates with rising temperatures, and suggests that these fire-breathing lizards are being sighted more frequently. As a result, the large-scale 'Third Stir' is deemed to be imminent.

The Second Stir, 1680–90, although generally considered smaller than the first, produced similar results. Belief in dragons was virtually restricted to youngsters — who are readily ignored — and a handful of believing philosophers (scientists), who were acutely aware of how their predecessors had been ostracized a century earlier and so chose to remain mostly silent on sightings. This is reflected in the lower frequency of dragons in the literature in this stir compared with the first (Fig. 2).

The shift in societal views of dragons from reality to fantasy has been described by some as a kind of bewitchment. Newt Scamander[2] suggests that there was a deliberate policy among those of a 'magical' persuasion to hide the creatures. This is thought to have taken the form of casting a neurotransfer spell that translocates all information on magical phenomena held in the brain to a small lobe of the neocortex exclusively reserved for imaginative thought. As a result, any reported sightings are almost always done under the unconscious protection of fictitious communication. (This view has been challenged in the light of other cryptozoological phenomena such as the yeti or the Loch Ness monster, although the evidence remains inconclusive and proponents have largely been dismissed as unsuitable for responsible positions.)

It would have been expected that humanity's ignorance of the dragon situation would have been maintained were it not for a combination of events in the past few decades. First, the global economic downturn has led to a rise in the search for 'buried' treasure, and hoards that serve as homes to resting dragons are an ideal way to bolster a failing economic policy. This strategy of 'quantitative thieving' is highly likely to provoke reprisals from slumbering dragons who awake to discover that their nests have been stripped bare.

To make matters worse, it seems that the 'block' on human awareness is occasionally failing, as evidenced in 1976 when a scientist (ironically, a knight and baron) published a non-fiction manuscript on dragons in *Nature*[3]. Sluggish action on global warming is set to compound the problem, and policies such as the restoration of knighthoods in Australia are likely to exacerbate the predicament yet further by providing a sustained and delicious food supply. It is now only a matter of time before The Third Stir takes place, and this, to borrow a phrase from Godfrey of Exmouth, will be the "bigge one". Climatic conditions are rapidly reaching an optimum for breeding dragons, and it is only a matter of time before the neurotransfer spell loses its efficacy completely. Further research into fireproof protective clothing is highly recommended — as is an avoidance of honorific titles. ■

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This article first appeared online on 1 April 2015; some its content may merit a degree of scepticism.