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Paleospecies as cognitive construct: The meme of "Homo floresiensis"

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ABSTRACT: Creation and subsequent abandonment of a number of earlier species considered human ancestors: *Eoanthropus dawsoni, Hesperopithecus haroldcooki, Homo gardarensis* and *Ramapithecus punjabicus* is presented using cases from the history of science. This review indicates that the fossil evidence for these species has been questionable from the beginning but that mental images – memes – they invoked were attractive to students of human evolution and as such persisted even if not confirmed by further finds, with new research still being disputed. Against this background the status of the recent construction of the hominin species "Homo floresiensis" is discussed showing that despite dubious interpretations of the objective data and a relatively long time of non-confirmation due to paucity of newly discovered skeletal remains, the "species" still exists in minds of scholars and in the scientific literature extending into textbooks.

KEY WORDS: meme, "Homo floresiensis", Flores, species

Lost ancestors of the past

Many papers have been written since 2004 in an attempt to make the case that "Homo floresiensis" is not only a valid hominin taxon, but indeed a species that is so quintessentially unique that one Nova "documentary" characterized it as an "Alien From Earth" with biological and material cultural characteristics that reportedly contradict a great many patterns and principles of the phylogenetic framework built upon multiple fossil and material culture finds over the last two centuries. The previously accepted broad pattern of human evolution includes transition to obligate upright posture and bipedal locomotion, a greater than

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threefold increase in endocranial volume over roughly four million years, and a broadly parallel increase in the complexity and sophistication of material culture. How can a small sample of bones – now known to have been mismeasured and initially misdated (but even after more recent revisions the Liang Bua bones still continue to lie within the known span of existence of *Homo sapiens*) – be held to overturn so completely a pattern that has been pieced together from thousands of finds, spanning six million years of evolution, distributed across several continents? And if it could, what would that singular contradiction mean for credibility of the disciplines of archeology and paleoanthropology that constructed the patterns now supposedly falsified by remains from one site?

In response, here we make the point that "H. floresiensis" is not a valid hominin species at all (and thus not a paradigm-destroyer), but instead a meme: A mental construct, "an imitated thing" propagated by written and spoken repetition of an idea by people who do not themselves independently analyze – or even think much about -- the underlying physical evidence. The term "meme" was popularized by the evolutionary biologist Richard Dawkins in his book, *The Selfish Gene* (Dawkins 2016) as a mental parallel for the concept of the physical particle termed a "gene" that is propagated by descent through germline cells. By characterizing "H. floresiensis" as a meme we do not imply that the Latin binomial applied to it has no physical referent. The small sample of bones and teeth found at an archeological site, Liang Bua (Cold Cave), on the island of Flores, Indonesia, and first described in the scientific literature in 2004 (Brown et al. 2004) undeniably are real; it is their taxonomic status and phylogenetic significance that is questionable. We maintain that the "Homo floresiensis" Latin binomial or its "Hobbit" nickname has taken on a reality – unreality, really – as a meme that vastly exceeds and misrepresents its basis in physical evidence (100 mostly fragmented bones and teeth in all, including a single developmentally abnormal skull). Although the Flores "Hobbit" may mark the most extreme case of its sort, it is not the first case of mistaken phylogenetic identity in the study of human evolution.

It is not possible within the scope of this paper to review the extensive record of human ancestry that is based on new finds that appear to be valid, i.e., that have *not* been called into question or actually disproved by subsequent discoveries. That record stands on its own very great merits. It comprises multiple discoveries, hypotheses based on that evidence, and the syntheses resulting from the repeated testing of those hypotheses through time (often with minor modifications of some details that do not change the substance, e.g., the numerous additions and removals of certain specimens from the taxon *Homo habilis*). Among the familiar positive examples here are members of our own species narrowly defined as *Homo sapiens* as documented in Paleolithic contexts, then in turn neandertals, pithecanthropines (*Homo erectus*), and australopithecines. Unsurprisingly, acceptance of evidence that built the framework of human evolution has proceeded from more familiar early humans to those less familiar (Eckhardt 2000), from specimens of *Homo sapiens* found unexpectedly but indisputably in a fossil context, such as Paviland in 1823, to *Orrorin* and *Ardipithecus*, which combine some unanticipated features along with incipient erect bipedality marking the point of departure of our lineage from that of other hominoid primates six million or more years in the past.

The academic history of hominin taxa that were successful, in the sense of enduring past opposition or skepticism, is in many regards the mirror image of those that have been dropped from the record. That is, human ancestors who have remained as part of the evolutionary record generally were not one-off finds but rather harbingers of more abundant specimens to come. Thus, the Taung child (Dart 1925) had its confirmation in Broom's discovery of an adult australopithecine skull a dozen years later. The first "Pithecanthropus" (*Homo erectus*) find made by Dubois in 1890 was followed by a tooth and skull fragment in 1891, and a femur in 1892. The reality of this evolutionary grade was broadly confirmed by the somewhat later but phyletically comparable Chinese pithecanthropines. The contentiously received neandertal find from Feldhofer Grotte in Germany actually had been preceded by similar finds at Engis in Belgium (1829/1830) and Forbes Quarry on Gibraltar in 1848, then a subsequent stream of finds followed from the 1880s onward. For valid hominin ancestors, a fairly consistent pattern of reinforcement and recognition usually follows the first discovery within a few years, with the longest gap being that in South Africa, probably explained largely by the fact that Dart and Broom were working with most limited financial and physical resources and the field being distracted by firm rejection of the original discovery described in Nature in 1925 (Dart 1925) but fortunately no shortage of energy and determination. Another part of the pattern shown by enduring ancestral taxa is that specimens that support original discoveries quite commonly are found elsewhere. For the australopithecines, these subsequent confirming finds occurred at other South African sites (about 500 km distant from Taung) and subsequently East African sites. Early Javan erectus finds were followed by the others in China and elsewhere. Fossils representing populations similar to neandertals have been recovered from many western and eastern European countries, and others similar in morphology (Maba) from China. After all, biological species share phenotypic and genetic characteristics as populations, not isolated, "unique" individuals.

As with most other areas of science, however, along the way to our present understanding, not all of the milestones set up along the way remain standing. Chemistry dispensed with the fire-like pseudo-element phlogiston, and physics realized that the universal ether was not required as an explanatory device for transmission of radio signals. In paleoanthropology, some widely-accepted previous hominin taxa – and their type specimens – survive now only as historical curiosities that should serve as cautions for enthusiasts of the newest new thing at face value, however widely promoted and believed. This history is worth reviewing because of its lessons for correspondingly credulous enthusiasms of the present.

Perhaps the best-known fossil exemplar of a failed human ancestor: "Eoanthropus dawsoni" (most widely known by the name of the site at which its remains were discovered, Piltdown), is remembered as a conscious fraud on the part of some perpetrator, but outright fraud is exceedingly rare in science. Also unusual is the way in which Piltdown was removed from the roster of iconic hominins, in part by the application of a new technology that exposed a glaring flaw in the evidence that previously had been overlooked. As detailed below, the more common situation is one in which corroborative evidence for the hominin candidate either is lacking after some time has passed (non-confirmation) or later evidence shows a pattern that is different from the one originally perceived on the basis of limited finds because the later, more abundant and more complete specimens show a clearly different pattern (disconfirmation).

Eoanthropus dawsoni (Piltdown)

The Piltdown find was announced in 1912 (summary in Eckhardt et al. 2014). Piltdown was not exposed as a clumsy fraud until 1953, but in the interim period it distorted not only evolutionary science but also the lives of competent and dedicated scientists such as Raymond Dart. Sir Arthur Keith, whose name and parts of whose career are linked to Piltdown, evidently had no hand in manufacture of the bones, accompanied by cultural artifacts, that collectively came to be seen as evidence for "Eoanthropus dawsoni." However, his endorsement virtually was assured by the wondrous fit of the cranial characteristics of some parts to his theoretical speculations about the brain leading the way in human evolution, and that endorsement in turn lent unwarranted credibility to the invalid ancestor.

For those parts of the specimen that were incomplete, Keith's reconstruction gave the skull an extremely modern appearance, to the extent of drawing upon his imagination to model a cranium that appeared capacious, above a chin that projected ahead of the incisors. In contrast, Arthur Smith Woodward's more apelike reconstruction showed a smaller vault and absence of a chin. Since the vault bones were incomplete and the chin region was entirely missing in the area of the anterior teeth (incisors through premolars), both features involved subjective elements on the part of the two scientists, with their directional biases being reflected in what each portrayed (Thomson 1991).

Keith's support as one of the most respected (and self-assured) anatomists of his day lent great credibility to the find. This was sufficient to sideline the informed skepticism of the foremost medically-trained human biologist of the era, Franz Weidenreich, who identified the "Eoanthropus dawsoni" type specimen as a chimera combining an ape mandible with *Homo sapiens* vault fragments. While credit for the final disproof of Piltdown as a valid human ancestor usually is given to Kenneth Oakley's application of the fluorine test for dating, it is less widely known that as late as 1950 the fluorine test seemingly *confirmed* the contemporaneity of the orangutan mandible and associated thick vault bones of *Homo*. Ultimately it was the persistent questioning and experimentation by the South African human biologist Joseph Weiner that caused re-examination of the Piltdown bones, and thus exposure of the fraud.

Limited access to the original Piltdown specimens seems to have played an important role in preventing earlier discovery of the deception. Just before his death in 1972, Louis Leakey noted "*As I write this book and ask myself how it was that the forgery remained unmasked for so many years, I turned my mind back to 1933…. I was taken into the basement [of the British Museum] to be shown the specimens, which were lifted out of a safe and laid on a table. Next to each fos-*

sil was an excellent cast. I was not allowed to handle the originals in any way, but merely to look at them and satisfy myself that the casts were really good replicas. Then abruptly, the originals were removed and locked up again, and I was left for the rest of the morning with only the casts to study" (Gould 1980).

The more important lessons concerning "Eoanthropus" include not only the powerful role that can be played by new technology in correcting previous misconceptions, but also the necessity of having the original specimens available for study by a broad array of outside scholars who might be more skeptical than discoverers who have the most to lose by independent critical analysis. Above all is the lesson that widespread acceptance of a specimen's interpretation – its existence as a meme -- is no guarantee of the objective validity of that mental construct. In fact, widespread acceptance – popularity – in the face of contrary or even imagined evidence is one of the hallmarks of a meme.

Hesperopithecus haroldcooki

Piltdown was followed soon after, in 1922, by "Hesperopithecus haroldcooki," promoted as the *"first anthropoid ape of America,"* by the eminent paleontologist Henry Fairfield Osborn (1922 [with his italics]). A week later Osborn reported to the discoverer of the original tooth *"we believe we have found another one of the teeth, very much worn, of the same animal, which, as far as it goes, is confirmatory. The animal certainly is a new genus of anthropoid ape, probably an animal which wandered over here from Asia with the large south Asiatic element which has recently been discovered in our fauna by Merriam, Gidley and others. It is one of the great surprises in the history of American paleontology..."*.

Osborn's belief in the validity of the molar tooth as evidence was echoed by such highly-qualified and experienced paleontologists as William D. Matthew, William King Gregory, and Milo Hellman. After a detailed examination Gregory and Hellman noted unusual wear patterns, but reported "*On the whole, we think its nearest resemblances are with 'Pithecanthropus' and with men rather than apes.*" The comparisons yielded further correspondences. *"Thus the proportions of the molar crown of the Hesperopithecus type are about the same as those in the Homo sapiens mongoloideus type....But the Hesperopithecus molar cannot be said to resemble any known type of human molar very closely....The disposition of the roots in Hesperopithecus, in Homo, in Pithecanthropus, is shown to be very broadly similar.... The Hesperopithecus molar is three-fanged, the postero-external fang having been broken off of the type; the internal fang shows a median internal groove and a tendency to a deep external groove on the outer side."* The overall impression is unmistakable: a new find, confirmation by a second example (in this case already in the Museum's collections), study and endorsement by highly experienced and eminently qualified experts, accompanied by detailed descriptions and comparisons.

Five years later *Hesperopithecus haroldcookyi* was dropped summarily from the roster of human-like American anthropoids (Gregory 1927).

From Gregory's account of the resolution, the difference from the 1920s to a present example such as "H. floresiensis" is notable. Following the initial enthusiasm, which generated reconstructions of an enigmatically-bipedal, club-carrying male and his spouse crouching at her labor (artistically heroic work from just two teeth), Gregory reported the more critical responses: *"The scientific world, however, was far from accepting without further evidence the validity of Professor Osborn's enthusiasm that the fossil tooth from Nebraska represented either a human or an anthropoid tooth. Many authorities made the objection 'Not proven,' which is raised to nearly every striking new discovery or theory, and in the course of time nine suggestions were put forward by responsible critics as to what the type specimen of 'Hesperopithecus' might represent other than any kind of ape or man. Accordingly, Professor Osborn requested Drs. Gregory and Hellman to consider these suggestions and to present a more detailed report on the already famous specimens."* A second report was published by Gregory and Hellman in 1923. In that publication Gregory still leaned toward anthropoid affinities while Hellman continued to stress the human resemblances. Both agreed that an exact generic diagnosis should await more discoveries.

Additional field research was carried out in the summers of 1925 and 1926. The further specimens that were discovered led Gregory to suspect that the "Hesperopithecus" type specimen might be an upper molar of a species of *Prosthennops*, an extinct genus related to modern peccaries. Despite some non-correspondences in root morphology, nearly every important characteristic of the type specimen was matched by one or another among *Prosthennops* teeth. These matches had been confirmed by more specimens discovered the next year (Gregory 1927). Gregory concluded *"Thus it seems to me far more probable that we were formerly deceived by the resemblances of the much worn type to equally worn chimpanzee molars than that the type is really a unique token of the presence of anthropoids in North America."*

The original hypothesis had been questioned from the first by some qualified scientists who were not unanimous in their own hypothetical explanations (and thus, of course, not all were correct in detail on resolution of the problem). But their general skepticism led to further investigations over the span of about five years, which included three rounds of additional field research. Eventually this work produced additional specimens to test and disprove the original hypothesis (thus a disconfirmation). Less than a century ago skeptics had access to key specimens, and their questions were tabulated as the basis for further research. The original hypothesis was tested with new evidence sought and recovered from the field, not supported by common acclaim.

Homo gardarensis

Between the announcement of "the first anthropoid primate found in America" and its relegation to peccary ancestry, another taxon briefly joined it on the spotlighted stage of prominent early humans. Frederick C. C. Hansen, professor of anatomy at the University of Copenhagen and a member of the Danish Government Committee for Research in Greenland, announced the discovery of a new, previously undescribed skull of a hitherto unknown type of human that was given the formal taxonomic designation *Homo gardarensis*. The partial cranium and mandible of the specimen were excavated from the cemetery of an abandoned medieval Christian settlement on the south coast of Greenland. Found in 1926 among a sample of about fifty skeletons, many of them "strongly built" was an unusually robust specimen that came to be accepted as the type specimen of *Homo gardarensis*. Its characteristics were compared with the Kabwe (Rhodesian) skull from South Africa and the neandertal skull from La Chapelle-aux-Saints in France. The Greenland find was given serious attention by Sir Arthur Keith, who at one point wrote that "*the chief interest of the discovery of Gardar lies in the fact that a human skull, manifestly of modern date, should reproduce so many resemblances to skulls of ancient palaeolithic man*" (Kjærgaard 2014). Keith's later diagnosis of acromegaly for the Gardar skull was dismissed by some "*because some diagnostic characteristics were missing*" [our emphasis for the parallel to criticisms of our Down syndrome (DS) hypothesis by Baab and colleagues (Baab et al. 2015) because some variably-expressed DS signs were not present in LB1]. But for "Homo gardarensis" as for "Homo floresiensis" the "missing diagnostic characteristics" were overwhelmed by critically important signs that were *not* missing: the weight of Keith's arguments from all of the evidence, anatomical and contextual (in a sense archeological since after all this was a specimen excavated from a cemetery), that the characteristics of the skull indeed were the result of a pathological affliction and not a deep evolutionary trait that suddenly had revealed itself. In the end, Hansen's conclusions were rejected definitively because his results were characterized as having been based on "*almost without exception hypothetical measurements*" (Bröste 1944) with the diagnosis of endocrine disorder enduring longer than the taxon based on its previously discounted diagnosis. With no further comparable specimens forthcoming, this case was a non-confirmation of the original speculations about a new human species, and in a short time "Homo gardarensis" disappeared from discussions of human phylogeny.

Ramapithecus punjabicus

Nearly half a century after Gardar man first was hailed as a very recent but morphologically primitive ancestor and then dwindled from scientific and popular interest, some specimens assigned to the genus *Ramapithecus* spent several decades being discussed as an important early human; see also (Eckhardt et al. 2014). Originally based on two isolated maxillae collected in 1932 by G. Edward Lewis, these were diagnosed by him in 1934 as hominid (for which we now would use the term hominin), based on a suite of characteristics, some observed and some that were more extrapolated or imagined (small canine, absence of diastema, orthognathous face, vertically implanted upper incisors, parabolic dental arch, and other homomorphic dental features). The next year Hrdlicka (1935) expressed profound skepticism of the supposed hominin features. Several decades later, however, Elwyn Simons (1961) argued anew for its hominin taxonomic status, and a few years later was joined by David Pilbeam in creating the taxon *Ramapithecus punjabicus,* which became widely accepted as the earliest human ancestor, dated to about 14 million years ago, with erect bipedality and tool use inferred from gnathic and dental remains alone.

These inferences first came into serious question from several quarters in the early 1970s. The African Fort Ternan mandible of *Ramapithecus* (*Kenyapithecus*) *wickeri* was associated with a lower jaw that previously had been described as a fossil ape due to its possession of a sectorial lower third premolar and a simian shelf in the mandible, both of which had been hypothesized not to occur in *Ramapithecus* (Andrews 1971). Around the same time questions were raised about the accuracy of the supposedly human features, not only on the basis of gnathic morphology, but also more broadly on molecular as well as morphological grounds, Eckhardt (1972a, 1972b, 1973) pointed out that the dental dimensions that widely were stated to be small and gracile, consistent with the inferred orthognathic and hence human-like face, simply were statistical abstractions, non-representative samples derived from the lower end of the range of variation in the total sample of dryopithecine teeth in each geographical and temporal range where *Ramapithecus* had been identified. He also noted that the 14 to 15 Ma dates postulated for the ape-human separation were nearly twice those inferred from the molecular evidence, while his work favored a divergence time in the range of 6 to 8 Ma.

This skepticism about the hominin status of *Ramapithecus* was confirmed more strongly several years later (Frayer 1976, Greenfield 1975) and ultimately further finds showed that the characteristics of newly-discovered specimens seemed to make *Ramapithecus* a better candidate for ancestry of orangutans than humans, though this case is less a classic disconfirmation than it is a shift in focus from the original problem to a resolution based on a different sample. Years later it was noted with bland understatement that "*Ramapithecus has often been included in the Hominidae, while species of the other genera [Sivapithecus, Gigantopithecus] usually have been considered pongids. This arrangement has not been accepted universally*" (Pilbeam et al. 1977). But indeed, it had been nearly universally accepted for years until challenged by a small group of scientists who realized the importance of variation over typology.

Eventually the non-hominin status of *Ramapithecus* became accepted, and also, on independent grounds, the shorter divergence time predicted by Eckhardt (1972 b) when with his colleagues the group established (Galik et al. 2004) on the basis of internal bone distribution in the neck of the femur, that the 6 Ma Kenyan fossil fragments referred to as *Orrorin tugenensis* were from a bipedal hominoid.

Overview and summary of past rejected hominid and hominin type specimens

The finds at Piltdown hold the record for reputational longevity, having been accepted for about 40 years before being disconfirmed spectacularly. As noted, however, "Eoanthropus dawsoni" had several unusual supports for its endurance as a type specimen, including not only the underlying outright fraud but also notable sponsorship and limited accessibility of the primary material.

The Gardar hominid had a shorter span of acceptance, about five years from discovery to nonconfirmation and abandonment, in good part because no further similar unusual specimens were discovered, but also because its primary supporter was open about his data and inferences. Professor Hansen shared his findings with Keith, who on studying them shifted from openly expressed interest to strongly critical rejection within a year or two.

"Hesperopithecus" also lasted as a hominid for about five years, during which there was a focused search for more evidence. The result was successful materially but devastating comparatively by making it clear that the anthropoid-like, or hominoid-like, or even hominin-like features of its molars were due to a combination of convergent evolution across different mammalian families and the accident of the initial specimens being isolated and heavily worn. This was another disconfirmation.

Ramapithecus (for which the taxonomic designation was retained for remains that still are accepted as hominoids, though no longer as hominins) was based on fossil evidence that had existed for about six decades, during which time it was suggested as hominin several times and dismissed about as often by knowledgeable scientists, until strongly advocated once again on typological grounds in 1967. It was eliminated finally on the basis of strong skepticism based on comprehensive analysis of all the evidence bearing on the question (the entire spectrum of dryopithecine teeth existing over wide ranges of time and space), not just a few selected, atypical, specimens (Eckhardt 1975) . These suspicions were borne out several years later as new, different specimens were found and assigned to the taxon. Depending on the event on which one focuses, the near-universal acceptance of *Ramapithecus* as a hominin endured four to ten years. The anniversaries of scientific discoveries, positive or negative, can be marked disparately (see the unsigned editorial in Nature, 5 October 2017, noting the various dates for the discovery of continental drift).

The pattern that marks all of the negative examples reviewed here is that, in the absence of outright, recurrent fraud (Piltdown), disproof of extreme claims for the importance of particular bones and fossils came from determined, independent skepticism (sometimes ignored, often deplored). In the long run what has not proved to be important scientifically is widespread endorsement by people who have not examined the primary evidence on which importance of the purported important taxa is claimed. "Eoanthropus" (Piltdown) and *Ramapithecus* (as a hominin) literally were "textbook" cases, in the sense that those two spurious hominins were propagated by the majority of textbook authors responsible for educating undergraduate students in the study of human evolution. Seeds planted early grow deep roots, even if they do not yield sustainable harvests. Unsurprisingly, "Homo floresiensis" also is now a "textbook case" that is endorsed by many instructors who are unfamiliar with the primary evidence or critical analyses based on it.

Of particular note here is the fact that all of the ultimately rejected ancestors reviewed here can be seen – as vividly as creative artistic efforts can manage -- as imagined in the minds of their supporters, in the form of full reconstructions not only of what the living beings are supposed to have looked like, but typically in representations of family groups going about their daily lives. All are there, from "Eoanthropus" through "Hesperopithecus" and "Homo gardarensis" and *Ramapithecus* (as a hominin), as fully and imaginatively reconstructed in words and pictures as "Homo floresiensis" is now. The case of "Homo floresiensis" is particularly interesting in this regard, since its multiple flesh reconstructions scarcely resemble each other at all. Fascinatingly these contradictions draw no comment; each contradicts the others, but all are taken collectively as "evidence" that buttresses the "reality" of "Homo floresiensis" as a genuine taxon. That such a situation goes unremarked is remarkable, and suggests "willing suspension of disbelief" in the sense of Samuel Taylor Coleridge, but with the mental process being less desirable in science than in literature.

Disconfirming finds must not only be made, but accepted, as ultimately occurred in the cases for the hominin statuses of “Hesperopithecus” and *Ramapithecus*. Taung was the decisive disconfirmatory find for Piltdown, but it was misperceived and misrepresented for far longer than seems plausible in retrospect, until Robert Broom found the first fossils of adult australopithecines.

The case that “Homo floresiensis” is a meme, not a valid hominin species

The main reason for recognizing “Homo floresiensis” as a meme rather than a species is the fact that although the data offered in support of it have changed profoundly, the conception transferred from mind to mind as meme has not. The image of a diminutive but large-footed “Hobbit” with a tiny brain that evolved in isolation on a Pacific Island, steadily shrinking over nearly a million years, remains unchanged as the evidence on all of these points has been disproved. However, while disproof of a hypothesis is part of science, casual acceptance in the absence of sustaining evidence is the stuff of which memes are made.

Eroding primary data

The abstract of the first paper describing “Homo floresiensis” (Brown et al. 2004) reported remains of “*…an adult hominin with stature and endocranial volume approximating 1 m and 380 cm^3, respectively – equal to the smallest-known australopithecines*.” These “facts” clearly were attention-getting, but unfortunately have not proved to be sustainable. The correct endocranial volume, obtained by the same method as that used by Peter Brown (filling the skull vault with mustard seed), was published two years later by our group as 430 ml (13% greater) (Jacob 2006). After a period in which various other methods were used to determine intermediate values, our measurement was confirmed independently as 426 ml, ±0.9% different from ours by MRI (Kubo 2013). Similarly, Jacob and colleagues (Jacob et al. 2006) provided a first alternative estimate of taller stature (by about 15%), which again was sustained in several further publications later supported independently (DeKlerk 2013). The original values used to define the type specimen (LB1) could not be confirmed. Details of these events of non-replication of “Homo floresiensis” species-defining data are readily available in previous publications (Eckhardt et al. 2014, Henneberg et al. 2014) and are updated later in this paper.

Invalidity of the LB1 type specimen

More damaging to the original claim were data that the LB1 skull was abnormal, which should preclude its being used as a type specimen. The first evidence for this problem (Henneberg, Thorne 2004) used published data to show that the neurocranium (braincase) was unusually small in relation to the splanchnocranium (facial skeleton). This inference was largely ignored. Subsequently, Jacob and colleagues (Jacob et al. 2006) demonstrated that the skull was measurably asymmetrical in several ways, showing in facial view left-right deviations from the midline that were exceeding clinical standards for abnormality as seen in patients with numerous developmental disorders, as well having a palate that was rotated from the midline of the skull base. These results again were ignored, then temporized, but the key findings have not been disproved, and some such as the palatal deviation have been confirmed (Kubo et al. 2013) though without giving appropriate credit to our prior work. In the course of further research additional abnormalities of the LB1 type specimen have accumulated from independent sources. Since the International Code of Zoological Nomenclature bars as types for species specimens that are teratological (developmentally abnormal), in formal terms "Homo floresiensis" is without a valid type specimen. This scientific anomaly has not lessened acceptance of the "new species" in the derivative scientific literature, press releases, comments by journalists, and other forms of meme propagation.

Contradictory data and inferences

Cavalier treatment of data pertaining to "Homo floresiensis" has been evident from the first publication, in which the legend for Figure 7 described "Anterior and posterior views for the LB1 right femur and tibia" (Brown et al. 2004) although the left antimeres were shown. Attempts to bring this and other errors to the attention of Nature's editors were rejected by them. The point is material because the left femur that was not illustrated is asymmetrical relative to the right, providing collateral evidence to that of the skull for developmental abnormality of LB1 (see Henneberg et al. (2014) for further discussion).

Supporters of the Liang Bua skeletal remains as representing a new, unique hominin species are far more strongly in agreement about their conclusions than about the evidence on which those inferences are based. Stark contradictions abound. In the initial species definition and description (Brown et al. 2004) LB1 was said to be "megadont" relative to *Homo sapiens*, although that characterization was contradicted by Figure 5 of the same paper and by reported tooth dimensions, which are within the range of extant humans. Confusions about the appropriate relationships between evidence and inference continue more than a decade later. For example, in actual dimensions of cranial vault thickness, LB1 is about at the midpoint for modern *Homo sapiens* populations and lower than might be expected for the Australomelanesian region (Eckhardt et al. 2014). Nonetheless, in some papers stressing the uniqueness of the "H. floresiensis" species, the LB1 vault is represented as relatively thick (Baab et al. 2009, 2015). Yet other papers emphasizing the same morphological-based species uniqueness (Larick et al. 2015) state the reverse: "*LB1 exhibits a marked reductive trend in its facial skeleton, with extremely low overall cranial size, a primitive low and anteriorly narrow vault shape with* <u>*thin cranial bones*</u> [our emphasis], *a relatively prognathic face, and* <u>*small teeth*</u> [again our emphasis]." Fact checking is in order at this point. The creators and advocates of "Homo floresiensis" are in agreement about the uniqueness of the taxon. But some of those supporters maintain that this belief is supported by the expression in LB1 of cranial vault bones that are relatively thick, while other advocates find their support rooted in the belief that the same vault bones (of the only existing skull) are relatively thin. Similarly, some believers in the unique nature of "H. floresiensis" do so on the basis of the taxon's relatively large (megadont) teeth, and others on its relatively small teeth. In relation to the taxon *Homo sapiens* the dimensions of the LB1 cranial vault and teeth cannot at the same time respectively be both thicker and thinner or larger and smaller. The underlying dimensions exist as data determined by objective measurement to be used for comparative purposes. It follows that if the taxonomic and phylogenetic inferences about the "Homo floresiensis" based on the Liang Bua sample of bones and teeth (overwhelmingly those of LB1) are affirmed regardless of the objective data (e.g., that the same bones of the vault of the only skull, that of LB1, are by some supporters of the taxon to be thick, but others thin, with both interpretations supposedly supporting the unique new taxon and the teeth being "megadont" but within the range of comparable extant human samples, i.e., both unusually large and not unusually large not being seen as contradictory), then the phylogenetic inference does not follow from the data but rather exists independent of the data; indeed, the conceptions shape interpretation of the data rather than the reverse.

There is an abundance of other examples showing that demonstrably erroneous "data" do not provide support for the alleged "reality" of the new taxon. For example, the following qualitatively descriptive material is from the web site of the Australian National Museum (see "Homo floresiensis: Key specimens: "LB6 – a partial skeleton belonging to a shorter individual than LB1. It has a more V-shaped jaw and is assumed to be a child, possibly only 5 years old." (https://australian.museum/learn/science/human-evolution/homo-floresiensis/). This official statement about the developmental age of LB6, available on that site since before 2016, is verifiably incorrect simply by inspection of available photographs of the specimen, which can be seen to contain a full adult dentition. Even worse are the quantitative "data" concerning numbers of specimens. Recall our earlier point that among the more important factors involved in confirmation or failure of a hominin species candidate to be retained in the corpus of evidence for human evolution is the presence or absence of additional specimens discovered later. For Piltdown these were provided, but turned out also to have been fabricated.

In the case of "Hesperopithecus" the first additional specimens seemed to be corroborative but more abundant and complete later ones offered persuasive disproof. "Homo garderensis" was based on a single abnormal specimen backed by no more than imaginative rhetoric and those "almost without exception hypothetical measurements" that should ring a warning bell in the present case explicitly because the original key defining measurements for "Homo floresiensis" brain and body size proved to be both inaccurate and biased downward; "hypothetical" fits nicely. The "Ramapithecus" situation was more complex, but the "human like" (at the time hominid, subsequently hominin) features proved to characterize a few, fragmentary specimens that, in the context of the enormously abundant generic dryopithecine sample, were no more than a statistical abstraction of sorts. In the case of "Homo floresiensis" attempts to enlarge the body of supporting evidence are of three types: first, ambiguous statements of a sort that convey misleading impressions about the number of individuals represented by the numbers of specimens; second, by inventions or fictions about sample sizes of "Homo floresiensis" specimens that seem to arise from the ambiguous statements (both noted immediately below); and third, by additional new specimens (promoted as further specimens supporting the "reality of "Homo floresiensis") that really are not at all confirmatory of the "Homo floresiensis" taxon because the anatomical parts found lack the diagnostic attributes of the "new species" (discussed in a later section).

Ambiguous statements about numbers of "Homo floresiensis" specimens.

This important point would best be documented by a listing of all of the journal articles and books that discuss "Homo floresiensis" and its importance in human evolution and that do so while giving a clear or definite idea about the extent of evidence on which the discussions are based, particularly numbers of bones and inferred individuals. As an exercise this would produce something along the lines written so amusingly by the poet T. S. Eliot about "Macavity: The Mystery Cat":

"*You may seek him in the basement, you may look up in the air–But I tell you once and once again,* Macavity's not there!"

Against this background, in which a great many papers discuss "Homo floresiensis" but virtually none discuss explicitly the sparse data, one example will suffice to support the point that most discussions of "Homo floresiensis" simply avoid giving accurate numbers of individuals and the specific bones attributed to them: Henry Gee, a senior editor at Nature and an avowed advocate of the evolutionary importance of "H. floresiensis" for human phylogeny, focused much of a book, The Accidental Species (2013) on the Liang Bua sample. Although that book appeared four years after a published enumeration of the number of separate bones and inferred individuals (Morwood, Jungers 2009), Gee's basic statement about the body of evidence begins "Further work at Liang Bua showed that the first skull and skeleton were no flukes…" but provides no further enumeration. Supplying the relevant numbers (although always subject to revision) is not difficult now and would not have been then. Here it is: The total sample of Liang Bua human bones was 100, of which 62 bones (including the only skull) were assigned to LB1. The remaining 38 bones were distributed among about 13 additional individuals, with 19 allocated to LB6, 3 to LB11, and the remaining 11 individuals represented by 1 or 2 bones each. Those two preceding sentences easily could have been accommodated in Gee's 203 page book (at the end of which are seven blank pages). One wonders whether Gee felt that the data were unimportant or would have spoiled the narrative that he presented.

Fictional sample sizes of "Homo floresiensis"

The first example of imaginary bones and bodies declares "*This find has proven to be among the most compelling human specimens since the discovery of 'Lucy', an iconic early australopithecine…. The researchers have recovered at least nine individuals, all exhibiting the same small bodies and crania*" [sic; there is only one cranium as the LB1 Homo floresiensis holotype specimen] (Minteer 2013). A second, similar reference, states "*Scientists have found many near-whole skeletons of this species* ["H. floresiensis"] *on the island* [*Flores*]" (Alarie 2012). Not even the supporters of Piltdown or the other discarded earlier taxa invented imaginary skulls; the internet age greatly facilitates meme propagation, and not all "facts" are checked.

Specimens attributed to "Homo floresiensis" that lack species-diagnostic attributes.

We previously have covered in great detail the matter of numbers of specimens and their attributes (Eckhardt et al. 2014), the main point being the critically important one that from the very beginning of this memetic simulacrum of science there has been discovered only a single skull, that of LB1: It is demonstrably aberrant, and yet has been the focus of a concerted attempt to define a new species that is thoroughly anomalous in terms of cranial proportions, craniofacial size disparity, asymmetry, and multiple dental and other signs of developmental abnormality . The other notable physical attribute mentioned repeatedly is small body size. But small body size simply is known to be routine for many extant human populations living in Australo-Melanesian region as well as their predecessors for tens to hundreds of thousands of years. And, of course, body size is labile to a variety of environmental conditions including but not limited to "island isolation" (which is simply a description of what happens under certain conditions and not a mechanism unto itself).

Evidently, once belief exists, contradictory data do not matter. Memes are adopted by fashion and propagated by consensus. Conforming to this pattern, "Homo floresiensis" is logically better considered as a meme than a real hominin species.

Subsequent discoveries do NOT support existence of the "Homo floresiensis" taxon

Much-needed informative context for understanding the ancient webs of contact and dispersion among continental, island, and ocean Australomelanesian populations going back through the time range that includes *Homo erectus, s.l.* populations in the broad sense, and their phyletically successive species, *Homo sapiens*, has been provided in *The First Mariners* by Robert Bednarik (2015), the scholar who suggested to Mike Morwood that Flores presented promising sites for the study of human ancestry in this region. Here we discuss additional evidence from a few pertinent sites, Mata Menge on Flores and Callao Cave in Northern Luzon, the Philippines. However, these sites long have been known, and attempts to use specimens from them discovered since 2004 (the year in which the limited sample of bones of small humans were recovered from Liang Bua) to buttress a claim for legitimate taxonomic status for "H. floresiensis" resembles far more the *ex post facto* justification of a meme than the empirical expansion of a valid species hypodigm. In fact, all of these specimens provide data that are far more problematical than supportive of the new taxon originally invented on the basis of the sparse Liang Bua remains, which cannot be considered in isolation.

Mata Menge

The Mata Menge site was mentioned at the beginning of our first paper in 2006 on the Liang Bua specimens [ref 7,8 in Jacob et al. 2006] as providing evidence in the form of Middle Pleistocene stone tools that were claimed by the original investigators to establish that populations of the widely dispersed taxon *Homo erectus* had reached the island of Flores by about 840,000 years ago, very probably as one among multiple human arrivals there possibly before and certainly multiple times since.

In assessing the diagnostic meaning of the Mata Menge specimens it is useful to begin with a key sentence in the abstract of the 2004 paper in Nature (Brown et al., 2004) that first proposed the existence of the taxon referred to as “Homo floresiensis”: “*Here we report the discovery, from the late Pleistocene of Flores, Indonesia, of an adult hominin with stature and endocranial volume approximating 1 m and 380 cm3, respectively*.” Our group’s research, published in 2006 and subsequently, has shown that both of the above values are substantial underestimates. The best current value for the endocranial volume of LB1 (the only known skull attributed to “Homo floresiensis” from the Liang Bua site or any other) is 430 ml (cm^3). More appropriate stature estimates for LB1 (the only individual for which femora are known) are approximately 1.25 to 1.30 m, which overlap the statures of some living *Homo sapiens* on Flores and elsewhere. Our estimates of endocranial volume and stature have been confirmed independently. The formal diagnostic elements of the proposed species “Homo floresiensis” from Liang Bua (LB) are listed here (in left column) in order originally presented). Notes in the right column assess whether the LB1 (and LB2) characteristics can be observed in the Mata Menge material (van den Bergh et al. 2016) (Table 1).

From the above comparisons it should be noted that the overlaps of the Mata Menge gnathic remains with those reported from Liang Bua are minimal. The most pertinent Liang Bua elements are the LB1 and LB6 mandibles, plus several isolated teeth. Sizes of Mata Menge teeth and the mandibular fragments are comparable (within ranges of individual variation) with various Pleistocene hominins. The molar crown SOA-MM1, that is small even in comparison to LB teeth, may be that of the second deciduous molar because its wear is slight. It shows proximal wear on the distal surface, but this does not argue against it being a deciduous tooth because permanent M1 lying just behind it erupts (now at age 6–7 years) while the second deciduous molar is still in place, and the second deciduous molar is lost only when replaced by a second premolar that erupts later (in extant humans at 10 years or a bit later).

The features shared in common between Liang Bua and Mata Menge are principally overall body sizes loosely inferred from the mandibles at the two sites. Reportedly, SOA-MM4 is smaller than LB1 and LB6. Size variation among humans in the Australomelanesian and surrounding regions should be considered in the context provided by the thesis of Dr. Bonita De Klerk (2012): Variably small stature is the norm for many populations in the region.

Curiously, the cranial fragment (SOA MM3) mentioned by Brumm et al. (2016) and listed in the Extended Data Table 1 by van den Berg et al. (2016) was neither pictured nor described in their original paper. Since endocranial volume initially was a critical defining feature of “Homo floresiensis” and is disputed as being abnormally low due to developmental disruption, this omission is puzzling. The cranial vault bone of LB1 also has been stated incorrectly to be unusually thick since the initial description (Brown et al. 2004), with this error repeated persistently since (e;g. Balzeau, Charlier, 2015). Consequently, even a small bone fragment might help correct this error as noted (Eckhardt et al. 2014).

Overall, the Mata Menge fossils do not help to resolve some of the most endur-

Table 1. Comparison of Liang Bua and Mata Menge Remains

Morphological characteristics listed in Brown et al., 2004 (based on LB1 partial skeleton and LB2 isolated left P_3	Mata Menge gnathic remains Mandible SOA-MM4 Left I^1, right P^3, $I_{1/2}$, left $M_{1/2}$ Deciduous teeth (l and r d_c)
small-bodied hominin	yes
Bipedal	unobservable (but see “Note” below)
stature (body height) similar to, or smaller than, *Australopithecus africanus*	unobservable
endocranial volume similar to, or smaller than, *Australopithecus africanus*	unobservable
lacks masticatory adaptations present in *Australopithecus* and *Paranthropus*	probable
substantially reduced facial height and prognathism	unobservable
smaller postcanine teeth	probable
posteriorly oriented infraorbital region	unobservable
cranial base flexed	unobservable
prominent maxillary canine juga form prominent pillars, laterally separated from nasal aperture	unobservable
petrous pyramid smooth and with low relief	unobservable
styloid process absent	unobservable
without vaginal crest	unobservable
superior cranial vault bone thicker than *Australopithecus* and similar to *H. sapiens*	unobservable
supraorbital torus arches over each orbit and does not form a flat bar as in Javan *H. erectus*	unobservable
mandibular P3 with relatively large occlusal surface area, with prominent protoconid and broad talonid	unobservable
mandibular P3 with either bifurcated roots or a mesiodistally compressed Tomes’ root	unobservable
mandibular P4 also with Tomes root	yes, bifurcated root (but a polymorphic trait)
first and second molar teeth of similar size	unobservable
mandibular coronoid process higher than condyle	unobservable
ramus [of mandible] has a posterior orientation	unobservable
mandible without chin	unobservable
posterior inclination of [mandibular] symphysial axis	unobservable
posteriorly inclined alveolar planum with superior and inferior transverse tori	unobservable
ilium with marked lateral flare	unobservable
femur neck long relative to head diameter	unobservable
femur shaft circular and without pilaster	unobservable
high bicondylar angle	unobservable
long axis of tibia curved and the midshaft has an oval cross-section	unobservable

ing questions that remain for bones from the LB site: endocranial volume, stature and limb proportions, taxonomic significance of chin presence or absence, and – perhaps still most important — whether the only relatively complete specimen, LB1 (which includes the only skull in the 62 bones it comprises from the site's total of about 100 bones) is normal or abnormal. The most informative publications here include: Jacob et al. (2006); Eckhardt et al. (2014); Henneberg et al. (2014); Eckhardt et al. (2015).

The Mata Menge gnathic remains refute the widely repeated, simplistic idea (part of the "Homo floresienis" meme) that early human populations probably at the *Homo erectus* level reached Flores only once and then progressively shrank, since by reasonable inference from known remains hominins at Mata Menge were smaller than body sizes from Liang Bua, which in turn were smaller than those of extant Rampasasa. The suggestion that comparisons among the Mata Menge and Liang Bua gnathic remains, with reference to previously-known *Homo erectus* fossils, represent an "evolutionary reversal" from larger to smaller species-specific body statures and masses overlooks an enormous body of work on size fluctuations not only in living human populations but also overall in mammalian populations, wild and domestic. Similarly, there now is an existing body of knowledge about *Homo erectus, s.l.* populations. Many of these (Dmanisi) manifest small body sizes and extensive within-population variation; between-population comparisons of Dmanisi and other hominins with those from sites in other geographic regions (e.g. Nariokotome, Africa) show that, more than a million years ago, within and between-population differences approach some of those now found in our own species.

As they themselves have recognized, van den Bergh et al. (2016) provide data that are useful in countering the contention (by Argue and others) that the Liang Bua hominins may be derived from unknown African early hominin ancestors at the australopithecine or habiline levels). However, the case for such an African early hominin ancestor to the Liang Bua population never was plausible to begin with, and had been countered strongly by the extensive fossils discovered by Berger, Hawks, and their many colleagues in Dinaledi Chamber, South Africa (Eckhardt et al. 2016).

Callao Cave, Luzon, Philippines

Documentation of the pattern of human occupation on the island of Luzon in the Philippines is broadly reminiscent of the situation on Flores. That is, in 2018 an early human presence was demonstrated on the island in the range of 631,000 to 771,000 years ago by lithic evidence (two hammerstones, six cores, and 49 various lithic flakes) associated with the nearly complete butchered skeleton of what was described as an extinct large mammal (*Rhinoceros philippensis*) at a site in the Cagayan Valley, northern Luzon (Ingicco et al. 2018). Previous publication in a disciplinary journal during 2010 already had documented minimal human remains in the form of a third metatarsal dated to much later, about 67,000 years ago (Mijares et al. 2010). The specimen had a gracile structure similar to small-bodied humans (*Homo sapiens*) living on the island. Twelve new specimens were discovered in 2019 (Detroit et al. 2019). The holotype, CCH6, comprises the upper right premolars and molars.

Paratypes include CCH1, a right third metatarsal bone of the foot; CCH2 and CCH5, two phalanges; CCH3 and CCH4, two foot phalanges; CCH4, a left premolar; and CCH9, a right third molar; and CCH7, a juvenile femoral shaft. These represent at least three individuals. Although these modestly more abundant bones were dated to within the last 50,000 years, within the temporal range of our own species, minor anatomical details were used as justification for creation of a new species, *Homo luzonensis*, the specific name deriving from the name of the island. That Linnaean taxonomic "upgrade" is in keeping with the pattern of systematic hyperbole endemic to Nature, with the overall promotional pattern being deeply reminiscent of that journal's treatment of the Flores evidence.

What's in a Name? Maybe Nothing

Nearly two decades now have elapsed since discovery of the original human bones in Liang Bua Cave. Despite the widespread attention that they have attracted, as well as the greater human, financial, and technical resources available in the 21st century (including for archeological research on Flores) than in the early 20th century that provided the examples used as context here, the scientific basis in evidence for "Homo floresiensis" has grown no more abundant, despite strained attempts to assimilate small-bodied remains from sites more distant in time and space (Mata Menge, Luzon) to the corpus of evidence for this "unique new species" that grows ever more popular as a subject, making its way into actual fiction as well as the sort that sometimes passes as science. Against this background, research based on our own visit to the Liang Bua site and detailed personal study of the bones themselves as well as some 17 years of detailed scholarship leads us to maintain that the place of "Homo floresiensis" as a valid taxon is insupportable. However, the many derivative scientific papers published on it have given rise to enormous popular infatuation with the Flores "Hobbit" myth, assuring that "Homo floresiensis" has achieved true meme status: one need know little or nothing about the dubious evidence to invoke the image and the reassuring in-group status that familiarity with it conveys.

There is, however, a deeper scholarly context for understanding phenomena of this sort. Alcuin of York (c. 735–804 C.E.) left an impressive legacy of scholarship, including some riddles. Here is one (Alcuin 790):

"Quid est quod est et non est? – Nihil."
"Quomodo potest esse et non esse? – Nomine
Est et re non est;"

"What is it that is and is not? – Nothing.
How can it be and not be? – It exists in name and not in actuality."

"Homo floresiensis" still lives in name and probably will do so for a time, perhaps as long as the taxon "*Eoanthropus dawsoni*" but finally evoking an aura of uneasy disenchantment rather than dishonesty, science fiction rather than scientific fraud. In any case, despite its status as a meme, the body of evidence for the existence of "Homo floresiensis" is so much less in quality and quantity than generally is supposed that the reality of the taxon must remain dubious.

The Authors' contribution

Each of the authors contributed equally to production of the paper.

Conflict of interest

The authors declare that there is no conflict of interest.

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