“Hobbits” of Flores: Implications for the pattern of human evolution

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Recent developments in research regarding the so-called "hobbits" of Flores, Indonesia, may lend support to the multilineal or "branching" view of human evolution. The weight of evidence being accumulated increasingly tends to validate *Homo floresiensis*, the taxonomic designation given to these specimens by their discoverers, as a distinct species of hominin rather than as deformed modern humans.* A summary of these new developments has been presented in a recent Nova program on PBS. However, not all researchers in the field of paleoanthropology have accepted this view. Alternate interpretations continue to be proposed.

The controversy over the taxonomic and evolutionary status of the Flores hobbits provides a good example of the dialectical process whereby advances in scientific knowledge are achieved. Both major camps in this controversy (i.e., those who view the hobbits as a new species and those who think they are deformed modern humans) base themselves on modern evolutionary theory. The debate is not over whether other hominin species have existed, but how these particular specimens should be interpreted within the framework of human evolution.

While individual researchers' viewpoints may be motivated by a variety of factors, one important component in the division between the two camps is their differing underlying assumptions regarding whether hominin evolution has tended toward a unilineal or multilineal pattern. The significance of the hobbit controversy is that if these individuals were indeed members of a previously unknown species, it would imply that hominin evolution has followed the multilineal pattern to an even greater degree than has generally been thought by its proponents. Resolution of the "hobbit question" is likely to significantly influence how the majority of researchers in the field conceptualize human evolution and, therefore, impact the direction of investigations for decades to come.

The new data

If the recent research results are correct, it may be that *H. floresiensis* represents a very ancient split among hominins, possibly dating back more than a million years, substantially earlier than the separation between the lineage that ultimately gave rise to modern humans and that which developed into Neanderthals. Perhaps even more interesting are indications that the apparent ability of *H. floresiensis* to produce relatively sophisticated stone tools was based on the evolution of their brains independently and in a manner different from the main *Homo* lineage (i.e., the one that led to *Homo erectus*, Neanderthals, and modern humans). And yet they were capable of supporting a technology at least equivalent to that of *H. erectus*. If so, this would provide powerful support for the view that not only is intelligence subject to evolutionary processes just as much as other aspects of biology but also that there are multiple ways in which intelligence can evolve.

Following the announcement of the discovery of the small (about 3.5 feet or just over 1 meter tall), human-like skeletal remains on Flores (an island in Indonesia) back in 2003, reaction in the scientific community essentially fell into two camps. One included those who accepted the discoverers' interpretation that this was a new species of hominin that had coexisted with modern humans on the island until at least as recently as about 12,000 years ago. The other camp consisted of those who expressed varying degrees of skepticism regarding this claim. The major competing interpretation was that the bones (note: they are not lithified [i.e., turned to stone] and are, therefore, not technically fossils) were the remains of an individual (initially only one, largely complete individual was identified, plus one tooth of a second) who had suffered some sort of disease or deformity, such as microcephaly (a genetic disorder which results in a substantial underdevelopment of the brain as well as general stunting).

The basis for the microcephaly hypothesis was that the Flores hobbit (named LB1, because it was the first specimen found in the Liang Bua cave) not only had a very small body compared to modern humans, but a highly reduced brain size. The body size range of normal (i.e., healthy) modern humans varies widely. The best known of those at the small end of the body size spectrum are those people popularly known as "pygmies" who inhabit certain tropical forest areas of Africa. Other populations of "small" people exist in similar environmental settings in Asia and Melanesia. Small size in humans is thought to be, at least in part, an evolutionary adaptation for thermo-regulation (i.e., control of body temperature) in forests with hot, humid climates where heat dissipation by sweating is not effective. However, "pygmies" have brain sizes within the normal range for modern humans, though at the low end, and are in all respects *Homo sapiens*. The brain sizes of pygmy populations are, in fact, relatively larger in proportion to their body sizes than the brain to body size ratios of larger modern humans, indicating that an adaptive reduction in body size has not resulted in a commensurate brain-size reduction).

By contrast, the Flores "hobbit" has a brain size approximately equal to that of chimpanzees and australopithecines. Modern humans' cranial capacity (space inside the skull) is approximately 1,150-1,750 cubic centimeters (mean 1,325 cc) and that of chimps 285-500 cc (mean 395 cc). The cranial capacity of the single known Flores hobbit skull is approximately 417 cc, just slightly larger than the mean for chimps. The hobbit's brain size is at the low end of known sizes of australopithecines (410-530 cc), such as the famous Lucy fossil (*Australopithecus afarensis*), which has a cranial capacity of 438 cc and dates to 3.2 million years ago. These early hominins became extinct more than a million years ago. The essential observation is that all healthy modern humans, regardless of their body size, have brains that fall within a specific size range. The Flores skull is definitely outside of that range.

Over the course of hominin evolution there has been a general, though not necessarily steady increase in brain size. This trend toward encephalization is most especially pronounced in modern humans. Partly, this has been due to increases in body size. However, the growth in brain size has been proportionally greater than that of body size. The difference is thought to represent the increase in capacity needed to support higher

intelligence. It is also important to note that not only has there been a disproportionate increase in brain size, but there have also been changes in brain architecture (i.e., some parts of the brain have grown more than others). Again, this is most probably associated with increases in mental capacity.

The abnormally small brain size of the Flores hobbit, if it were simply a downsized modern human, would imply a greatly diminished mental capacity. The hypothesis of microcephaly is at least plausible if the first known hobbit specimen represents a single, diseased individual which belonged to a population of otherwise normal modern humans, even if small in stature. However, evidence has been developed to counter the microcephaly hypothesis.

One of these lines of evidence consists of detailed studies of brain morphology, comparing the gross structure (i.e., the relative sizes and shapes of various parts of the brain) of the hobbit brain with that of normal modern humans, modern humans afflicted with microcephaly, various apes, and a series of fossil hominins going all the way back to australopithecines. Although brains normally do not fossilize, if at least a good portion of the skull is recovered it is possible to create an endocast by filling the inside of the skull with plastic. The plastic conforms to the skull's interior and, since the external configuration of the brain closely matches the inside surface of the skull, a detailed cast of the brain can be created. Since the hobbit remains are not fossilized, and are therefore rather fragile, a "virtual" endocast was created by use of CT scans of the skull.

A major result of the study of the hobbit brain endocast is to indicate significant differences between it and the morphology of the brains of modern humans with microcephaly. If true, the hobbit is unlikely to have been a modern human suffering from that disease. This research further found that, although it bears some similarities with the brain of *Homo erectus*, there are differences as well, indicating that LB1 is not simply a downsized member of that species. This interpretation, if upheld by examination of additional hobbit skulls yet to be found, will force researchers to try to find a new place for the Flores hobbits somewhere in the pattern of hominin evolution. However, there remains fierce debate in the scientific community regarding the nature of the hobbit brain and body.

Other genetic deformities have now been proposed as explanations for the small brain as well as other skeletal characteristics. Some have claimed that the hobbits represent a combination of endemic genetic deformities in a pygmy-like population caused by the phenomenon of island dwarfism.

Island dwarfism is a phenomenon that has been observed in a number of species, including the dwarf elephants (*Stegadon*, now extinct) on Flores. Such dwarfism is thought to result from a variety of factors, including restricted nutrient availability on small islands (smaller individuals need less to eat) and lack of predators (larger size is a defense against predators). These factors, and the previously cited thermodynamic advantage of small bodies in tropical rainforest environments, may all have contributed to further reducing the body size of the ancestors of the hobbits who, if they were indeed very early members of the genus *Homo*, such as the early *Homo erectus* specimens from Dmanisi, Georgia, dating to 1.7 million years ago, or even a form of australopithecine, would have been small to begin with.

Stone tools have been found on Flores in contexts dating to 840,000 years ago. However, no hominin skeletal remains of any kind have yet been found on Flores dating back to that time. The earliest hobbit remains recovered so far date to 95,000 years ago. Therefore, there is currently no direct paleontological data to indicate the sort of hominin the hobbits may have descended from.

The apparent association of fairly sophisticated stone tools with the hobbits, along with butchered animal bone and evidence of the use of fire would seem to argue against the microcephaly argument, since individuals suffering such a disability are unlikely to have been able to make and use stone tools. Therefore, the unique characteristics of hobbit brain morphology mean either that they had evolved sufficient mental capacity for such technological accomplishments in a manner different from that of the main line of human evolution or that the tools were made by another, as yet undiscovered hominin that coexisted with the hobbits on Flores.

Remains of small hominins have recently been found on the Palau islands of Micronesia. In contrast to the Flores specimens, however, initial reports indicate that although those on Palau exhibit some "primitive" anatomical characteristics, the preponderance of data supports the interpretation that these are dwarfed modern humans, but smaller than contemporary pygmies. If true, this would support the interpretation that the Flores individuals' small size may have been at least in part due to the size-reducing factors cited above, regardless of whether they were ancient or modern humans. The claim that the Palau specimens are dwarfed has been disputed, however.

One very important line of evidence that could help to sort out the controversy over the evolutionary status of the Flores hobbits would be the comparison of their DNA with that of fossil and modern humans, as is being done with Neanderthals and modern humans. Unfortunately, given the warm and wet conditions of Flores, which are not conducive to the preservation of DNA, no samples have yet been recovered. Therefore, for the time being at least, researchers must look to anatomy and archaeology for the necessary data.

Proponents of hobbits as a new species have marshaled a number of additional lines of evidence. One is that the characteristics of hobbit carpals (wrist bones) resemble those of the great apes and australopithecines rather than those of more recent hominins—Neanderthals and modern humans. Based on this finding, the ancestors of the Flores hobbits would have had to split from the line leading to the latter groups before the evolution of this new configuration of wrist bones, probably more than 1 million years ago. This difference would likely have implications regarding the hobbits' dexterity of manipulation, particularly with respect to the human "precision grip," perhaps indicating that they were more limited than *Homo erectus* and later hominins with regard to delicate manual work. The researchers believe that the hobbit wrist morphology could not be the result of genetic deformity or disease.

Beyond the specifics of the debate over whether the Flores hobbit remains represent evidence of a new, previously unknown form of hominin or of a deformed modern human, this controversy illustrates the process by which scientific knowledge is advanced.

Both the unilineal and multilineal models of human evolution have been constructed within the overall paradigm of modern evolutionary theory. However, the two place different emphases on the degree to which culture (i.e., non-biological adaptation) modified the selective pressures of the natural environment on hominin populations and, therefore, on the course of evolutionary development. The conflict between these two interpretations, and there are certainly variations within each camp, acts to continually test the "fit" between predictions made on the basis of each model and the results of discovery and experimentation. The adherents of one camp are ever ready to attempt to poke holes in the interpretations of the other. This drives research to examine specific questions in ever-greater detail, questions that might otherwise not have been considered worthy of investigation or even have been formulated at all.

For example, the back-and-forth dialogue over whether hobbit morphology could be explained as due to microcephaly has prompted detailed research into the brain morphology of a variety of fossil hominins as well as modern individuals with this affliction. New data is being sought concerning the actual range of variation in particular morphological structures of the brain between various populations and

what those variations may mean regarding the behaviors controlled by those structures. Furthermore, previously unanticipated complications are being identified regarding how the existence of genetic abnormalities, such as microcephaly, among small, isolated populations may have combined with the effects of island dwarfism to create unexpected biological manifestations that could mimic certain characteristics of early hominins. Researchers are forced to identify and demonstrate the validity of experimental criteria that differentiate between the predicted outcomes of various interpretations.

Pursuit of such topics can lead to unexpected results that may either enrich the understanding of current formulations or identify significant flaws, bringing into question higher-level theoretical constructs. It is this constant dialectic involving the individual researchers, schools of thought, and experimental results that drives progress in scientific research. None of these opposites exists by themselves. Each to some degree both determines and is determined by the others. However, ultimately, it is the reality of the material world, the "ground truth" that determines the shape of scientific knowledge.

At some point, the majority of researchers in human evolution will reach a consensus regarding the status of the Flores hobbits, probably supported by the discovery and analysis of additional specimens. One interpretation will be seen to be more effective in explaining the available data and to have successfully weathered a sufficient number of attacks by proponents of other viewpoints so that it is adopted as the correct resolution of the controversy. This will then be seen as "settled science" and its implications for the larger model of human evolution will have to be worked out.

One of these implications may be that differences between fossil specimens that were previously considered to represent the normal range of variation within a species may have to be reexamined to evaluate the possibility that this variation is in fact evidence of the existence of distinct species. Another consequence could be that the focus of field investigations may shift or grow to encompass locations not previously thought of as likely to yield relevant data.

The discovery of the Flores hominins has already brought to a higher level a simmering debate regarding the "out of Africa" paradigm, which views Africa as the center of evolution and dispersal of successive waves of human ancestors.

The relatively neat and tidy formulation, which had become the consensus view among at least a substantial proportion of paleoanthropologists in recent decades, received its first significant blow with the discovery of the hominin fossils at Dmanisi, Georgia. These specimens were substantially older, 1.7 million years, and more primitive than the existing formulation had predicted for the earliest ventures out of Africa. The Flores discoveries may support the new interpretation that the earliest hominin dispersal from Africa took place significantly earlier, both chronologically and in terms of evolutionary development, than had previously been thought. Furthermore, these discoveries raise the possibility that important developments in human evolution may have taken place in Asia as well as in Africa.

The discoveries on the island of Flores were not expected within the frameworks of either the unilineal or multilineal models of human evolution. The survival of australopithecine or very early *Homo* descendants down to nearly the present challenges the existing view, held to varying degrees by supporters of both models, that through time more-progressive forms successively replaced older, less-advanced ones, whether by genetic flow or extinction. Nevertheless, the new discovery is more easily encompassed by the multilineal model. It merely means that the multilineality of human evolution has been even more extreme than had been thought and that there have been many evolutionary experiments in how to be an intelligent, technologically based species.

In science, the validity of a theory rests on its ability to more accurately and comprehensively explain and predict patterns observed in the material world than can its competitors. In this sense, the Flores discoveries tend to support the superiority of the multilineal model. This, in turn, reinforces our understanding of the active and complex dialectic between culture and nature that has shaped human evolution for millions of years.

* The term hominin reflects a recent change in taxonomic nomenclature. Essentially, it is equivalent to the previous term "hominid," including modern humans and all their predecessors and collateral lines back to the split with chimpanzees, at least 6-7 million years ago. A more detailed explanation can be found here.