SCIENTIFIC REASONING AND DISCOVERY:
HONR 1033 FALL 2020
'YOUR PLACE IN NATURE'

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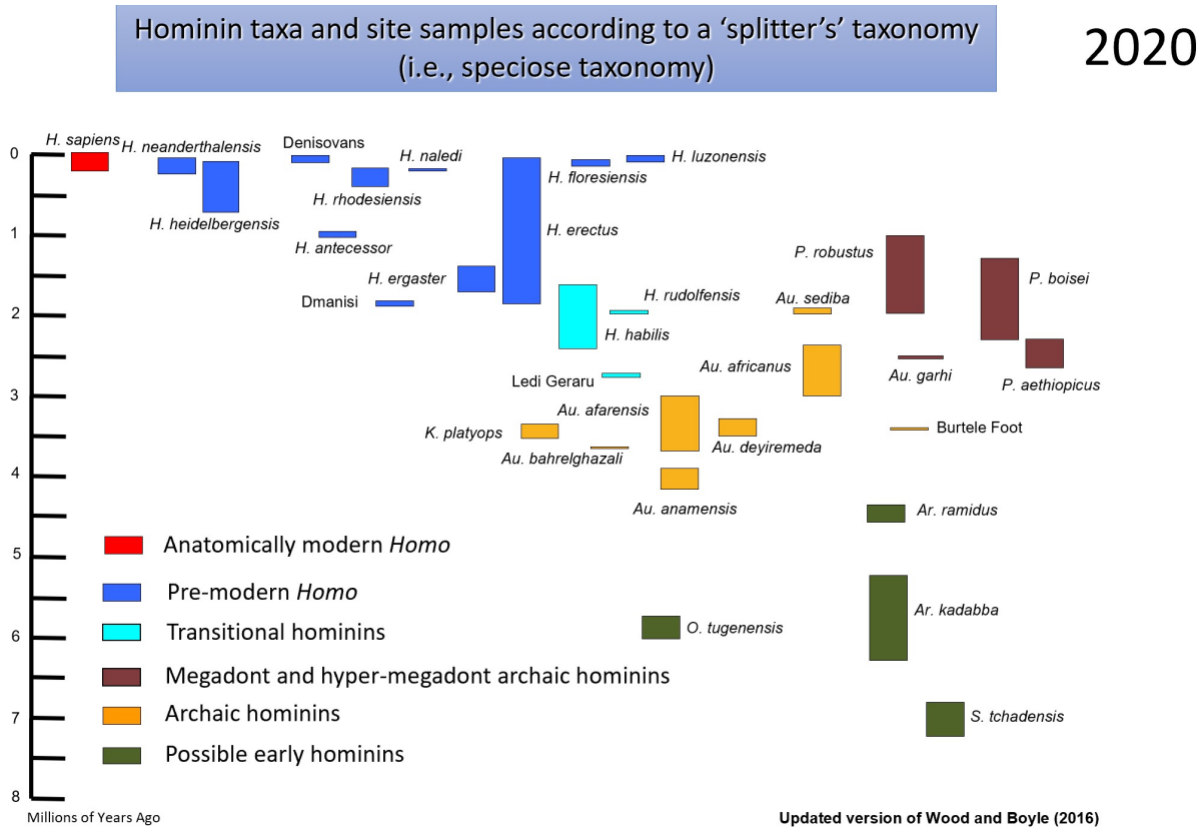
On-line Access: This syllabus and introduction, other resources and any notes for the classes and some of the readings will be available on Blackboard at http://blackboard.gwu.edu.



I. Introduction

The title of this class—which is part of the 'Scientific Reasoning and Understanding' sequence—is adapted from the title of a book published in London in 1863. Thomas Henry Huxley's (1825-1895) *Evidence as to Man's Place in Nature* was one of two books about human origins published that year—Charles Lyell's *Antiquity of Man* was the other— but because Huxley's book is more wide-ranging than the latter, *Evidence as to Man's Place in Nature* probably qualifies as the first scientific account of human origins. It is a collection of three essays. The first reviews the history of discovery of the great apes and what was known about them in 1863. The second considers how "Man" (i.e., modern humans) is related to the rest of the animal kingdom, and the third reviews what little was known in 1863 about the fossil evidence for human evolution.

The class will compare and contrast what was known about human origins in 1863, with what we think we know now. It covers the history of ideas about our relationship with the rest of the natural world, how we work out who our closest living relatives are, how animals are related, the fossil record for human evolution, and the growth of the sciences involved in the interpretation of that fossil record. It explores the social and intellectual context of relevant discoveries as well as the biographies of the people who made major contributions to working out the relationships among the great apes and to the recovery and interpretation of the fossil evidence for human evolution.

This class uses the topic of human origin research as an exemplar of a historical science, and emphasizes how the scientific process in historical sciences differs from that used in the experimental sciences.

Today, unlike in 1863, there is sound evidence that modern humans are more closely related to chimpanzees and bonobos than they are to any other living primate—they and we are each other's nearest neighbors on the surface of the Tree of Life (TOL). This means that modern humans and extant chimpanzees/bonobos must have evolved from a common ancestor exclusive to themselves. The molecular differences between modern humans and chimpanzees/bonobos can be calibrated in various ways, and most evidence points to that common ancestor occurring between *c*.8 and 5 million years ago (Ma) and probably between *c*.7-6 Ma.

The study of human evolution involves:

- understanding the evolutionary context and the circumstances surrounding the origin of the branch (aka clade) of the TOL that includes modern humans, but not chimpanzees and bonobos;
- recognizing the extinct species that are likely to be more closely related to modern humans than to chimpanzees/bonobos;
- reconstructing the morphology and behavior of those species;
- determining how they are related to each other and to modern humans;
- investigating the factors and influences that shaped their evolution, and
- reconstructing the origin(s) of modern human anatomy and behavior.

The study of the fossil evidence for human evolution is traditionally referred to as hominid paleontology. The word 'hominid' comes from Hominidae the name of the Linnaean family within which modern humans (and the other fossil-only species included within the human branch were traditionally placed.

However, because nearly all of the molecular data support a particularly close relationship between *Homo sapiens* (the formal Linnaean name for modern humans) and the species of living chimpanzees and bonobos included within the genus *Pan*, this traditional terminology needed to be changed. Most researchers agree that the term Hominidae, and its informal version hominid, should be made more inclusive and be extended to embrace the clades containing the living great apes (i.e., the *Gorilla* (lowland and mountain gorillas), *Pan* (chimpanzees and bonobos), and *Pongo* (Bornean and Sumatran orangutans) plus the *Homo* clade. Thus, another name needs to be found for modern humans and the fossil species more closely related to modern humans than to chimpanzees and bonobos. In this class, I suggest we recognize this grouping as a tribe (this is a taxonomic category below the level of the family and above the level of the genus) called the Hominini, with the informal name 'hominin.' Thus, if researchers are confident a species is in the clade whose only living representatives are modern humans, then it should be referred to as a 'hominin,' not as a 'hominid.' Therefore, according to this revised terminology (see Table 1 for the 'old' and 'new' taxonomies) this course concentrates on 'hominin paleontology.' The study of the artifacts (e.g., stone and bone tools, drawn and carved images, early structures, evidence of decoration, etc.) made in prehistoric times is called prehistoric archeology. In the US the combined study of hominin paleontology and prehistoric archaeology is called paleoanthropology (outside the US the spelling is palaeoanthropology), human prehistory, or just prehistory.

This course concentrates on the fossil and the molecular evidence; it will refer to the archeological record only when the latter can provide insights into hominin behavior. Because it will emphasize the importance of trying to reconstruct as much biology as possible from the fossil record it is most aptly described as a course in 'hominin paleobiology' (HPb).

Aims

The class aims to:

- provide an understanding of the scientific process (aka scientific method), and how it operates in the context of a historical science such as paleontology;
- trace how the scientific enterprise has helped us understand where modern humans come from and how they relate to other living creatures;
- set out the scope of HPb (see the paragraph above);
- introduce scientific logic, and its importance for framing scientifically tractable questions relevant to HPb;
- introduce the main analytical and research methods used in HPb;
- introduce the relevant fossil evidence and set out, as appropriate, its context (e.g., its geological age, paleoenvironmental context, etc.);
- review interpretations of the hominin fossil record including discussing their strengths and weaknesses;
- provide a sound foundation for more advanced study and independent research within the area of HPb.

Objectives

Through attendance at classes, participation in discussions, combined with appropriate reading and independent study, diligent students should:

- become familiar with the scientific method;
- become familiar with the classes of evidence available to hominin paleobiologists;
- understand the limitations and inherent uncertainties of a historical science such as HPb;
- be able to discriminate between evidence and the interpretations placed on that evidence;
- be familiar with the important research questions within HPb;
- be sufficiently familiar with the anatomy of modern humans, and with anatomical terminology, to be able to understand and comprehend descriptions of hominin fossil evidence;
- be sufficiently familiar with the paleontological evidence and the relevant research methods to follow the arguments set out in reviews of the primary research literature, and
- be aware of the strengths and limitations of the main methods used in HPb research.

II. Information

A. Class Notes

BW has written a commentary on most classes. These are relatively detailed. You will not be expected to be familiar with all of the detail, but it is there if you want to explore topics outside of the class. These notes, along with PowerPoint (Ppt) presentations used for each class, plus any suggested reading(s), will be available on Blackboard.

B. Required Texts

The only required books are ***Evidence as to Man's Place in Nature*** **(1863)** and ***A Very Short Introduction to Human Evolution*** **(2019)**.

- A facsimile of the *Evidence as to Man's Place in Nature* is available in the 'Cambridge Library Collection' series; it was published in 2009 – ISBN 978-1-108-00457-2. You can also get a version from Barnes and Noble (2006) - ISBN-10: 0760783381 and ISBN-13: 978-0760783382. Both versions are available on Amazon, or you can access it here (https://archive.org/details/evidenceastomans1879huxl).
- The VSI to Human Evolution (https://www.veryshortintroductions.com/view/10.1093/actrade/9780198831747.001.0001/actrade-9780198831747) is available on Amazon. Be sure to get the second edition published in 2019, not the first, published in 2006.

Before coming to class, you should acquaint yourself with *both* of these publications.

As we go through the semester we will also explore a relevant seminal publication by Edward Tyson (https://cashp.columbian.gwu.edu/pioneer-who-deserves-more-recognition). You can access it at (https://archive.org/details/orangoutangsiveh00tyso).

C. Recommended Texts

- Depending on how much you know about evolution, fossils, paleoanthropology and prehistory you might also look at the relevant titles in the OUP VSI series (http://ukcatalogue.oup.com/category/academic/series/general/vsi.do).
- If you are new to evolution and Darwin, try the short book discussed here (https://cashp.columbian.gwu.edu/fruits-browsing-no-3-small-perfectly-formed).

You might consider looking at the following**.** All three provide a history of paleoanthropology and are well written. Gee's is especially accessible.

- ***Missing Links: In Search of Human Origins*** by John Reader (2011, Oxford University Press: New York) (ISBN-10: 0199276854/ISBN-13: 978-0199276851)
- ***The Fossil Trail: How we know what we think we know about human evolution*** by Ian Tattersall (2008, Oxford University Press: New York) (ISBN-13: 978-0195367669)
- ***The Accidental Species*** by Henry Gee (2013, Chicago University Press, Chicago) (ISBN-13: 978-022627120).

BW has recently revised the Human Evolution entry in the Oxford Bibliography series. This annotated bibliography is another way to get your head around the questions addressed, and the material covered, in the course. The updated version will be in Blackboard.

III. Requirements

A. Readings

For some classes, students will be directed to specific reading assignments. These have been carefully selected so as not to burden you with impossibly long reading lists. However, you will be expected to have read, and be familiar with, the few readings that are suggested.

- **Wiley-Blackwell Encyclopedia of Human Evolution (W-BEHE)** This should be available on-line in the Gelman Library.

B. Assessment

Multiple-Choice/Short Answers

There will be two MCQ/SAs examinations. The first one is designed to help students judge whether they are making progress with the goals of the class, and to give them examples of the types of factual information they will be expected to be familiar with. It will cover Classes 1-8 and will be held in Class time. The second concentrates on Classes 10-25 but may also include material from Classes 1-8.

Writing/Presentations

Early in the semester we will seek *your* advice about what sorts of additional assessments would be most useful.

Possibilities include A) drafting a new, or revising an existing, human evolution-related Wikipedia entry; B) using the primary literature to trace attempts to use tree diagrams to summarize human evolution. See if you can beg, borrow, or steal David Archibald's book (https://cup.columbia.edu/book/aristotles-ladder-darwins-tree/9780231164122) for some context. The plan would be to select a particular author (e.g., John Robinson, Wilfrid Le Gros Clark, etc.) and document how their ideas evolved during their career or responded to the discovery of new evidence.

Students can work on agreed topics individually, or they can work in a group. If you choose that route, you will need to specify in advance what each member's contribution will be.

Any writing assignments should be submitted as a Word document, using Times 12 font with one and a half spacing.

Each submission must be labelled as follows:

'HONR_1033_2020_NAME OF ASSIGMENT_YOURNAME_DATE'. References should follow the style in the notes for the classes.

C. Labs

The arrangements for the labs will be finalized once the arrangements for the fall term have been confirmed. They will either be all on-line, or a mix of on-line and in-person.

D. Effort

Be advised that, whatever final form the assessments take, each week we expect students to spend *c.*150 minutes on in-class instruction, and *at least twice that time* (>*c.*300 minutes) on independent learning.

E. Grading*

The four formal components of the Class grade are summarized below: -

First MCQ/SA Assessment	**25%**
Second MCQ/SA Assessment	**45%**
Writing assignments	**30%**

Grading Scale:

89.5-100	**A**
79.5-89.4	**B**
69.5-79.5	**C**
59.5-69.4	**D**
0-59.4	**F**

***BW, in consultation with RM, reserves the right to moderate the overall grade on the basis of each student's contributions to discussions during class and the lab exercises. Usually this will be used to increase a student's grade. Only in exceptional circumstances will it be used to reduce a grade.**

IV: Organization

Class 1: 'Introduction and outline of the course' (VSIHE.2: pp. 1-17) *

This class looks at the context and the contents of *Evidence as to Man's Place in Nature* and compares and contrasts the investigation of human evolution in 1863 and today. It will explain how fossil evidence is 'interrogated' so that it yields as much information as possible, consider examples of how new fossil finds are published, and explain the role that scientific journals of various categories play in hominin paleobiology.

*Please come to the first class having done some background research on T.H. Huxley, and having read 'The principles and practice of human evolution research: Are we asking questions that can be answered?' Smith, Richard J. and Wood, Bernard (2017) Comptes Rendus-Palevol., **16**: 670-679.
DOI: 10.1016/j.crpv.2016.11.005

Section 1: Man's place in Nature

Class 2: 'Evolutionary context of the hominin clade' (VSIHE.2: pp. 18-23)

What evidence is available to determine which, if any, of the living primates is more closely related to modern humans than any other? This class will review the classes of evidence that can be used to explore the relationships among living organisms, and it will suggest that the majority of that evidence points to modern humans being more closely related to chimpanzees and bonobos than to any other living primate. What implications does the close relationship between modern humans and chimpanzees and bonobos have for using morphology as an indicator of phylogenetic relationships within the hominin clade?

Class 3: 'Names and what they mean: I. Taxonomy and systematics' (VSIHE.2: pp. 38-51)

Systems and conventions are essential for everyday life and for science. Think of how difficult physics and chemistry would be if there were no conventions about notation and there was no periodic table, or how difficult it would be if your local supermarket had no system for displaying the goods for sale, so corn flour was next to grapefruit juice, and wine next to kitchen cleaners.

The convention we use to classify living things is the one devised by Linnaeus. However, when he devised the scheme the only organisms he had in mind were living ones. How easily can it be applied to extinct animals, when all we know about them comes from the sparse fossil record? Can a fossil species be recognized and defined in the same way as a living species? How well, if at all, can criteria such as reproductive isolation be inferred from the fossil record? What criteria should be used to identify species in the fossil record?

Class 4: 'Names and what they mean: II. Terminology of human evolutionary anatomy'

In order to study human evolution students must acquire a working knowledge of both anatomical terminology and the landmarks that are used in studies that involve measuring fossils and comparative collections. This class will review the history of anatomical research and explain the origin of the terms used in anatomy and hominin paleobiology. Learning human evolutionary anatomy requires one to be able to recognize anatomical elements and understand, and be able to use, a precise anatomical vocabulary.

Section 2: Hominins: reconstructing the past

Class 5: 'Overview of the hominin fossil record'

The hominin fossil record can be broken up finely into many exclusive categories, or more coarsely into inclusive taxa or even more inclusive grades. This class sets out the case for recognizing six grades around and within the hominin clade.

Class 6: 'Reconstructing the past: I. Time and context' (VSIHE.2: pp. 24-37)

Many aspects of the context of the hominin fossil record are important for its interpretation. How are fossils dated? What can be inferred about the habitats the early hominins lived in? What roles, if any, did changes in global and regional climates play in determining the course of hominin evolution? How do scientists obtain information about past climates? What other animal groups co-existed with fossil hominins? Can the changes and trends observed in their evolution help interpret the hominin fossil record?

Class 7: 'Reconstructing the past: II. Phylogeny' (VSIHE.2: pp. 51-56)

Once the fossil record has been resolved into species the next task is to understand how those species are related. Was there just a single hominin lineage, or did it break up into several lineages, each with its own particular morphological signature? This problem has been addressed, apparently successfully, at higher taxonomic levels (i.e., the relationships between major groupings such as birds and reptiles) by a method called cladistics, or phylogenetic analysis. But how successful is cladistics at determining the phylogenetic significance of the relatively subtle differences between hominin species, especially when the sparse early hominin fossil record is dominated by skulls and teeth?

Class 8: 'Fossils and their analysis' (VSIHE.2: pp. 57-59)

What do fossils consist of? Why are some parts of the skeleton better represented in the fossil record than others? Are fossils an unbiased, or a biased, sample of past populations and faunas? How can an irregular object, such as a tooth or a skull, be converted into qualitative or quantitative data suitable for subsequent analysis?

Class 9: Assessment

Section 3: Hominins: fossil and molecular evidence

Class 10: 'Contenders for the title of earliest hominin' (VSIHE.2: pp. 60-72)

When the principles of neutral mutation are applied to the molecular differences between modern humans and chimpanzees/bonobos, they suggest that the common ancestor of these two groups would have been living between about 12 and 5 Ma, with most estimates tending to be closer to the younger end of the range (i.e., 8-5 Ma). The common ancestor of later hominins was almost certainly more ape-like than modern human-like, but it was unlikely to have been like modern apes. Discoveries made at Aramis in Ethiopia in the 1990s that are *c*.4.4 Ma and which display an intriguing mixture of features that formerly had been regarded as peculiar to *Australopithecus* or as ape-like, were allocated to a novel species in a novel genus as *Ardipithecus ramidus*. Subsequent discoveries at localities older than Aramis in Ethiopia were referred to a second species of *Ardipithecus*, as *Ardipithecus kadabba* (*c*.5.7 Ma), and at the Kenyan site of Lukeino hominin-like fossils dated to *c*.6 Ma were placed into yet another new species in a different genus as *Orrorin tugenensis*. Fossils dating to *c*.7 Ma discovered at a site called Toros-Menalla in central Africa were assigned to yet another new species and genus as *Sahelanthropus tchadensis*. All of these taxa have at one time or another been put forward as the likely ancestor of all later hominins. But, how certain can we be that *any* of these discoveries sample taxa that are more closely related to modern humans than to chimpanzees and bonobos? Could they belong to an archaic 'proto-hominin' group with no direct link with to living chimpanzees/bonobos or modern humans? Have recent additional discoveries and analyses of these taxa provided any clarification?

Class 11: 'Archaic hominins: early evidence from eastern and central Africa' (VSIHE.2: pp. 73-77)

Discoveries in eastern Africa, most made over the past two decades, together with a few fossils from a site in central Africa, make up the evidence for at least one, and perhaps several, species of *Australopithecus*. The best known of these is *Australopithecus afarensis*. There is as good a fossil record for this species as there is for any early hominin, so it provides an opportunity to use the principles and methods set out earlier in the course to investigate it. How well is it dated? How well can it be characterized in terms of its functional capabilities? How different are males and females? Does it display any evolutionary trends through time? Can its paleohabitat be determined with any precision?

How do the other eastern and central African archaic hominins, *Australopithecus anamensis* and *Australopithecus garhi*, and *Australopithecus bahrelghazali* respectively, differ from *Au. afarensis*? Why did researchers decide to erect a new genus, *Kenyanthropus*, to accommodate recent discoveries from Kenya? How does the new taxon differ from taxa included in *Australopithecus*? What are the relationships of *Au. garhi*?

Class 12: 'Archaic hominins: evidence from southern Africa' (VSIHE.2: pp. 77-80)

The first archaic hominin was not discovered in eastern Africa, but at the Taungs (now called Taung) Limeworks, 75 miles north of Kimberley, in what is now part of South Africa, in 1924. In a letter to the journal *Nature* Raymond Dart attributed the child's skull from Taung to a new species and genus, *Australopithecus africanus.* Comparable finds at Sterkfontein and at Makapansgat were initially attributed to different genera and species, but they were later included within *Au. africanus,* as were hominins more recently recovered from Gladysvale Cave. Fossils with slightly larger postcanine (i.e., the premolar and molar teeth), more robust jaws, and with flatter faces, were found at Kromdraai and Swartkrans, and more recently in other caves, Drimolen, Gondolin and Coopers, in the Blaauwbank Valley near Johannesburg. These more megadont (i.e., large toothed) fossils were assigned to a second genus, *Paranthropus*, as *Paranthropus robustus*, and that is how we treat them in this course. The *Paranthropus* remains are sometimes referred to as the 'robust' australopiths because of their large faces and jaws, but in this class they will be referred to as paranthrops. Some researchers believe that fossil hominin remains from a relatively unexplored lower part of the Sterkfontein cave complex (Member 2 and the Jacovec Cavern) push the southern African fossil record back to 4 Ma, and perhaps beyond, but this early date has been challenged and is probably wrong. It has been claimed that the Jacovec fossils sample a more primitive hominin species than *Au. africanus.* Fossils from another cave, Malapa, have been assigned to a separate species, *Australopithecus sediba*, that researchers interpret as linking *Au. africanus* with *Homo*. But the Jacovec and Malapa fossil are more likely to be variants of *Au. africanus.* How are these hominin taxa recovered in southern Africa related to the evidence recovered from eastern African sites?

Class 13: 'Hyper-megadont archaic hominins: evidence from eastern Africa' (VSIHE.2: pp. 80-82)

The OH 5 cranium was discovered by Mary Leakey at Olduvai Gorge in 1959. It was designated as the type specimen of *Zinjanthropus*, later to be called *Australopithecus (Zinjanthropus) boisei*. Subsequent discoveries at Olduvai and other sites, notably from Omo-Shungura, Koobi Fora and West Turkana, all located in the Turkana Basin, and Konso in Ethiopia, have confirmed the existence of a species that was distinct from, and more derived than, *Paranthropus robustus* (e.g., its postcanine teeth are even larger than those of *P. robustus*). Some researchers consider the eastern African evidence belongs to the same clade as *P. robustus*, and we will refer to this eastern African archaic hominin as *Paranthropus boisei*. Its massive, wide, flat face, large mandible, diminutive anterior and very large-crowned (hyper-megadont) and thick-enameled premolar and molar teeth are among its diagnostic features. Similar, but morphologically distinctive and temporally earlier

(>2.3 Ma) material from West Turkana has been assigned to a separate species, *P. aethiopicus*.

Class 14: 'Hyper-megadont and megadont archaic hominins: the case for a *Paranthropus* clade'

The morphological similarities shared by the southern African megadont, and the eastern African hyper-megadont forms, may either be the result of similar adaptations affecting separate, regionally-distinct, hominin lineages (i.e., convergent evolution), making the grouping polyphyletic), or they may reflect the fact that the two regional variants shared a recent common ancestor not shared with *Au. africanus*, and thus form a morphologically coherent and distinctive monophyletic group (i.e., they are a grade and clade of fossil hominins). If there is support for the latter proposition (i.e., they are a clade) then this would provide further justification for the reintroduction of the genus *Paranthropus.* This class will use *Paranthropus* species as an example of how to determine whether a group of species comprises a clade or a polyphyletic group.

Class 15: 'Transitional hominins: the discovery of *Homo habilis*' (VSIHE.2: pp. 82-85)

In the early 1960s, Louis and Mary Leakey made a series of discoveries at Olduvai Gorge of a type of hominin that was clearly distinct from *P. boisei*. In 1964, Louis Leakey, Phillip Tobias and John Napier proposed that the fossils sampled a new, more primitive, species of the genus *Homo*, which they named *Homo habilis* (literally 'handy man'). Some critics claimed the new material was indistinguishable from *Au. africanus*, while others regarded it as being more closely related to *Homo erectus* (see below). *Homo habilis* was the subject of intense discussion and debate in the 1960s, and the debate continues today. This class will review the history of the early discoveries of *H. habilis*, summarize the debate about the justification of the new species, review the fossils attributed to *H. habilis* since 1964, and present the background to contemporary interpretations of this taxon.

Class 16: 'Transitional hominins: how many species and which genus?'

Since 1964, *Homo*-like fossil material found at Olduvai Gorge has been added to the *H. habilis* hypodigm, but it was discoveries at Koobi Fora that proved to be decisive in prompting researchers to reassess the informal taxonomic group called 'early *Homo.*' Some researchers claimed that the extent and nature of the variation in this catch-all grouping was excessive for a single species, and they proposed the fossil evidence included in early *Homo* should be allocated to two species. One widely adopted scheme recognizes *Homo habilis sensu stricto*, with OH 7 as its type specimen. It is known from both Olduvai Gorge and the Omo region and perhaps from sites elsewhere. The other early *Homo* species, *Homo rudolfensis*, with KNM-ER 1470 as its type specimen, is currently only known from sites in the Omo region. Recently, researchers have gone even further and questioned whether it is appropriate to include these taxa in *Homo*. What criteria should be used to decide whether taxa deserve their own genus? When these criteria are applied to early *Homo* species, what is the outcome? How do recent discoveries in the Omo region and Dmanisi (Georgia) affect these discussions?

Class 17: 'Pre-modern *Homo*: *Homo ergaster* – origins and dispersal beyond Africa' (VSIHE.2: pp. 86-93)

By perhaps 2.0 Ma, and certainly by 1.7 Ma, the remains of a new form of hominin, *Homo ergaster* or early African *Homo erectus*, appear in sites in the Omo region of eastern Africa. What distinguishes it from all the hominin taxa that have been referred to in earlier classes is a reduction in the relative and absolute size of the face, jaws and chewing teeth, perhaps a reduction in sexual dimorphism (but the discovery of small-brained *H. erectus* challenges this hypothesis) together with a postcranial skeleton that clearly demonstrates it is an obligate biped. Cranial specimens similar to those of *Homo erectus* from the Far East (see below) are also found in eastern Africa, but these (e.g., OH 9) postdate the remains attributed to *H. ergaster*. Similar fossils have been recovered from a *c*.1.8 Ma site in Georgia called Dmanisi. Some researchers imply, the latter remains bridge the morphological gap between *H. habilis* and *H. ergaster*/early African *H. erectus*.

Classes 18: 'Pre-modern *Homo*: *Homo erectus sensu stricto*' (VSIHE.2: pp. 93-97)

Despite early claims that archaic hominins were among the hominin fossils recovered from Indonesia there has never been any convincing evidence that hominins belonging to *Au. africanus* or *Au. afarensis* have been recovered from sites beyond Africa. The earliest hominin fossil evidence outside of Africa is from Indonesia, where absolute dates of *c*.1.8 Ma have been claimed for *H. erectus* remains, and from Dmanisi, Georgia, where *c*.1.8 Ma crania that are in some ways resemble *H. ergaster*, and in others, *H. habilis*, have been recovered. There is archeological evidence from China that is earlier than this, but no fossil evidence. Were the first hominins to leave Africa *H. ergaster*-like, or were they more primitive, *H. habilis*-like hominins? There is evidence that *H. erectus* persisted in Asia for well over a million years (*c.*1.8 - *c*.0.1 Ma), so *H. erectus* in Asia overlapped temporally with *Homo sapiens* in Africa (see below). Did *H. erectus sensu stricto* ever penetrate Europe? Where does the *c*.300 ka *Homo naledi* and the *c*.90-18 ka *Homo floresiensis*, fit into all this?

Class 19: 'Pre-modern *Homo*: later archaic *Homo*' (VSIHE.2: pp. 94)

The distinctive morphology of *H. erectus* gives way to hominins with a less specialized but still quite 'robust' (i.e., relatively wide mandibular body and ectocranial features in the skull, and thick cortex and relatively thick long-bone shafts in the postcranial skeleton) skull and postcranial skeleton. There is an ongoing debate about the degree of regional distinctiveness of these remains, which include fossil crania from sites such as Kabwe in Africa, Petralona and Mauer in Europe and Jinnuishan in China. There is no consensus about the most appropriate taxonomy for this material. Some researchers support species-level distinctions (e.g., *H. heidelbergensis*, *H. rhodesiensis, H. antecessor*), while others are content to recognize the variability as no more than an expression of polytypic, intraspecific, variation within an interpretation of *Homo sapiens* that would see it subsume all of *Homo* post-*H. erectus*.

Class 20: 'Pre-modern *Homo*: Neanderthals - the fossil evidence' (VSIHE.2: pp. 97-100, 103-104)

Homo neanderthalensis (aka Neanderthals) is a group of pre-modern *Homo* that has what many, but not all, researchers interpret as a particularly distinctive morphology. The group is found in sites which are spread across Europe, the Near East and western Asia, and the remains date from *c*.>200-30 ka (this date would be earlier if the Sima de los Huesos material is included). Their distinctive facial shape, robust long-bones and large joints have been interpreted as being a phenotypic consequence of their occupying cold and 'marginal' environments armed with relatively unrefined tools. However, this simplistic interpretation has been challenged.

Class 21: 'Pre-modern *Homo*: Neanderthals - the molecular evidence' (VSIHE.2: pp. 100-103)

This class reviews evidence from Neanderthal DNA. These data provide important new evidence about whether Neanderthals are a separate species, and thus about the relationship between Neanderthals and modern humans.

Class 22: 'Pre-modern *Homo*: Denisovans – molecular & fossil evidence' (VSIHE.2: pp. 102-103)

In 2008 part of the distal phalanx of the fifth digit (aka pinky finger) of a hominin hand (Denisova 3) was recovered from Denisova Cave in the Altai Mountains in Russia. The expectation was that it belonged to a Neanderthal, whose archeology was known to be preserved at Denisova. But the DNA was distinct from that of Neanderthals. Aside from isolated teeth and a few fossil bone fragments (see above), the only other fossil linked with the Denisovans is a 160 ka mandible recovered in 1980 from Xiahe in Chinese Tibet. Analysis of its ancient proteome suggests that it belongs to the Denisovans. It is more primitive than *H.* sapiens and *H. neanderthalensis* and closest to Chinese *H. erectus* and *H. heidelbergensis.* What role, if any, did the Denisovans play in the evolution of modern humans?

Class 23: 'Modern human origins: the anatomy of the debate and the molecular evidence' (VSIHE.2: pp. 105-115)

The origin of modern humans is a topic that has dominated human evolutionary studies for the past decade or more. The crux of the debate is whether, or not, anatomically modern humans originate from a series of migrations of hominins 'Out of Africa.' The successive migrations each took their gene pools with them so that modern humans everywhere have a genome that is mainly made up of genes that originated in Africa at different times. The competing hypothesis is that modern humans arose by a series of regional transitions from archaic to anatomically modern humans with, or without, significant admixture with immigrants from Africa. The latter hypothesis allows for genes to be transferred *between* regions (by either migration of interbreeding), but it also implies there was substantial

morphological continuity *within* each major region through time. The evidence is consistent with the 'Out of Africa' hypothesis, with limited interbreeding between modern humans and Neanderthals and Denisovans.

Class 24: 'Modern human origins: the fossil evidence' (VSIHE.2: pp. 115-119)

This class will also focus on the implications of the *c*.170 ka modern human-like crania from Herto, in the Middle Awash, Ethiopia, the *c*.190 ka crania from the Omo, Ethiopia, and recently announced discoveries from Jebel Irhoud, Morocco, that may be in excess of *c*.300 ka-old. We examine whether, and in what ways, the paleontological and archeological evidence can be reconciled with the molecular evidence from individuals sampled from modern human populations. We will discuss Each of the three lines of evidence, molecular, anatomical and behavioral, has its strengths and weaknesses, and these will be discussed.

Class 25: Overview

Class 26: Presentations

Class 27: Presentations

Class 28: Presentations

Class 29: Review for Final Exam

The second assessment will be scheduled in the exam period

V: Additional Information

Diversity

One of the consequences of the scientific investigation of human evolution is the realization that modern humanity is biologically homogeneous, yet its members have, for a variety of reasons, been exposed to very different circumstances and experiences. Because of this, we, and our families, have not all had the same opportunities, nor have we been faced with the same societal and personal challenges. This class will always try to acknowledge and celebrate our homogeneity and our cultural diversity. If you feel we are failing to do that, and are advertently, or inadvertently, excluding, alienating or devaluing you, or one of your colleagues, I encourage you to reach out individually or collectively, by email, through Blackboard, or by phone.

Use of electronic devices (laptops, cellphones) during class

Many people now read online or take notes on laptops or tablets. However, electronics are a major distraction in the classroom. If you are interested in reading about this topic, please consult the literature on the impact of electronics (e.g., Fried, C.B. 2008. "In Class Laptop Use" in *Computers & Education*, 50: 906-914). The study found that "students who used laptops in class spent considerable time multitasking and that laptop use posed a significant distraction to both users and fellow students." See also, Fana, S. 2013. "Laptop Multitasking" in Computers & Education, 62: 24-31 and Patterson, R.W. 2017. "Computers and Productivity." *Economics of Education Review,* 57: 66-79. The latter study found that use of computers in the classroom had the most negative impact on achievement among students with a record of lower academic performance.

Students may **not** use electronic devices (e.g., laptops, cell phones, tablets) in the classroom without BW's written consent. If you have special needs for which use of electronics is an appropriate accommodation you must either 1) deliver a request from Disability Support Services or 2) send me a 100-word explanation justifying the request.

Students learning remotely are encouraged to keep phones and other distractions away from their workstation during class times.

Compliance with Academic Integrity

Academic Integrity: We expect students to follow the GW Code of Academic Integrity. It states: "Academic dishonesty is defined as cheating of any kind, including misrepresenting one's own work, taking credit for the work of others without crediting them and without appropriate authorization, and the fabrication of information." For the remainder of the code, see: https://studentconduct.gwu.edu/code-student-conduct

Support For Students Outside The Classroom:

DISABILITY SUPPORT SERVICES (DSS): Any student who may need an accommodation based on the potential impact of a disability should contact the Disability Support Services office at 202-994-8250 in the Marvin Center, Suite 242, to establish eligibility and to coordinate reasonable accommodations. For additional information please refer to: https://disabilitysupport.gwu.edu
MENTAL HEALTH SERVICES (MHS): Mental Health Services (MHS) (202-994-5300) offers 24/7 assistance and referral to address students' personal, social, career, and study skills problems.
Services for students include:
- crisis and emergency mental health consultations
- confidential assessment, counseling services (individual and small group), and referrals
https://healthcenter.gwu.edu/mental-health

Table 1: 'Old' and 'New' Taxonomies

A traditional pre-molecular taxonomy of higher primates. Extinct only taxa are in bold.

Superfamily Hominoidea (hominoids)
Family Hylobatidae (hylobatids)
Genus *Hylobates*
Family Pongidae (pongids)
Genus *Pongo*
Genus *Gorilla*
Genus *Pan*
Family Hominidae (hominids)
Subfamily Australopithecinae (possible and archaic hominins)
Genus *Ardipithecus*
Genus *Australopithecus*
Genus *Kenyanthropus*
Genus *Orrorin*
Genus *Paranthropus*
Genus *Sahelanthropus*
Subfamily Homininae (hominines)
Genus *Homo*

A taxonomy of higher primates that recognizes the close genetic links between *Pan* and *Homo*. Extinct only taxa are in bold type.

Superfamily Hominoidea (hominoids)

Family Hylobatidae (hylobatids)

Genus *Hylobates*

Family Hominidae (hominids)

Subfamily Ponginae

Genus *Pongo* (pongines)

Subfamily Gorillinae

Genus *Gorilla* (gorillines)

Subfamily Homininae (hominines)

Tribe Panini

Genus *Pan* (panins)

Tribe Hominini (hominins)

Subtribe Australopithecina (possible and archaic hominins)

Genus *Ardipithecus*

Ardipithecus ramidus (White et al., 1994) White et al., 1995

Ardipithecus kaddaba HaileSelassie, 2001

Genus *Australopithecus*

Australopithecus africanus Dart, 1925

Australopithecus afarensis Johanson, 1978

Australopithecus anamensis Leakey et al., 1995

Australopithecus bahrelghazali Brunet et al., 1996

Australopithecus garhi Asfaw *et al*., 1999

Australopithecus sediba Berger *et al.,* 2010

Genus *Kenyanthropus*

Kenyanthropus platyops Leakey et al., 2001

Genus *Orrorin*

Orrorin tugenensis Senut et al., 2001

Genus *Paranthropus*

Paranthropus robustus Broom, 1938

Paranthropus boisei (Leakey, 1959) Robinson, 1960

Paranthropus aethiopicus (Arambourg, 1968)

Genus *Sahelanthropus*

Sahelanthropus tchadensis Brunet et al., 2002

Subtribe Hominina (hominans)

Genus *Homo*

Homo sapiens Linnaeus, 1758

Homo neanderthalensis King, 1864

Homo erectus (Dubois, 1893) Weidenreich, 1940

Homo heidelbergensis Schoetensack, 1908

Homo habilis Leakey, Tobias and Napier, 1964

Homo luzonensis Détroit, *et al*. 2019

Homo rudolfensis (Alexeev, 1986) *sensu* Wood, 1992

Homo antecessor Bermúdez de Castro *et al*., 1997

Homo floresiensis Brown *et al*., 2004

Homo naledi Berger *et al*., 2015