ocean explorer
www.oceanexplorer.noaa.gov

Exploring the Submerged New World 2009

By Land or By Sea…or Both?

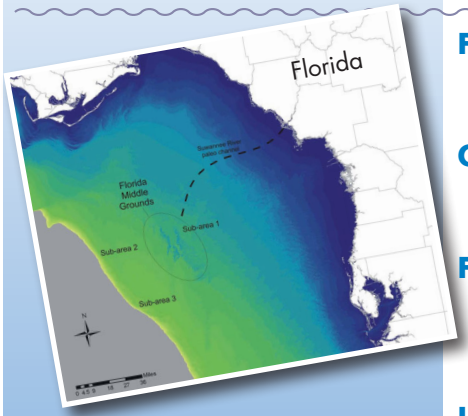

Image captions/credits on Page 2.

lesson plan

Focus
Watercraft in paleoamerican migrations

Grade Level
9-12 (Archaeology/Anthropology)

Focus Question
What kind of watercraft might have been used in paleoamerican migrations?

Learning Objectives
- Students will be able to describe evidence that supports the idea that the ingress of humans into North and South America involved watercraft.
- Students will be able to discuss types of watercraft that might have been involved in paleoamerican migrations.
- Students will explain at least three advantages and three disadvantages of coastal settlements compared to inland settlements.

Materials
- ❑ Copies of *Paleoamerican Watercraft Inquiry Guide*, one copy for each student or student group

Audio-Visual Materials
- ❑ None

Teaching Time
One or two 45-minute class periods

Seating Arrangement
Classroom style, or groups of 2-4 students

Maximum Number of Students
30

Key Words
Paleoamerican
Pleistocene Epoch

Watercraft
Arlington Springs Woman
Luzia skull
Homo erectus

Background Information

NOTE: Explanations and procedures in this lesson are written at a level appropriate to professional educators. In presenting and discussing this material with students, educators may need to adapt the language and instructional approach to styles that are best suited to specific student groups.

Recent archaeological and molecular genetic evidence (Goebel, *et al.*, 2008) indicates that the first humans to inhabit North America migrated from Siberia around 15,000 years ago, near the end of the Pleistocene Epoch. These migrants are believed to have crossed a land bridge to the Pacific coast of North America, and continued southward, possibly using boats. Some of their descendants spread across what is today the United States, while others continued southward into South America. An important characteristic of these first Americans is that they used thrusting spears tipped with specialized stone points, and were very successful hunters. At this time, North America was inhabited by many large mammals that are now extinct, including mammoths, bison, short-faced bears, giant sloths, and sabre-toothed cats.

Some of the oldest archaeological sites discovered in North America are in the eastern United States, and there are numerous quarry-campsites in the southeastern states. Quarries are locations where raw rock material was mined and processed to make tools. If a reliable source of water is nearby (or was nearby during late Pleistocene times), residential sites are often found near the quarry. When the first humans arrived in Florida, sea level was much lower and there was more than twice as much dry land as exists today. The climate was considerably drier, and water was scarce. Not surprisingly, early American settlements that have been discovered in the state are almost always associated with a reliable water supply such as rivers and springs. These areas would also have been attractive to animals, increasing the likelihood that human hunters would be able to find food.

Limestone bedrock that underlies the Florida peninsula strongly influences the state's landscape. Limestone dissolves in acidic solutions, and over time has been sculpted by rainwater which is weakly acidic. This sculpting includes the formation of underground caves. When the roof of a cave becomes unstable, it collapses to form a hole in the ground called a sinkhole. Florida has hundreds of sinkholes, some of which became natural reservoirs for fresh water. Not surprisingly, some of the most artifact-rich paleoamerican sites are located near sinkholes.

Images from Page 1 top to bottom:
The eastern Gulf of Mexico showing the three sub-areas examined in 2008, the Florida Middle Grounds, and the Suwanee River paleo channel.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/plan/media/fmg_surveyareas.html

During the Late Pleistocene Florida's shoreline extended much farther offshore than the present coast. The Florida Middle Grounds were part of the exposed coastal margin.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/climatechange/media/pleistocene.html

Map of the Bering land bridge during the late Wisconsin glaciation, when global sea level dropped to about 120 meters or more below its present position.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/occupation/media/beringia_late_wisconsin.html

This image portrays a more accurate reconstruction of Ice Age human behavior with a focus on small familial groups and the processing and use of plants as opposed to athletically fit young men attacking large, dangerous animals.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/beliefs/media/correctpaleobehavior.html

All images courtesy NOAA.

Coastal areas inhabited by early Americans are difficult to explore because the coastlines of 15,000 years ago are now under more than 300 feet of water! As the last ice age drew to a close, melting ice sheets caused a rapid rise in sea level just as the first Americans were entering the New World. Drowned settlements may contain well-preserved artifacts that can provide important new information about how the first Americans lived and when they arrived at various locations in North and South America. The eastern Gulf of Mexico in the vicinity of the Ocala Uplift Zone (Florida) is particularly promising as a potential location for drowned coastal settlements because:

- There are numerous onshore archaeological sites along the same zone that are more than 13,000 years old;
- Clusters of similar sites have been identified along drowned shorelines in the northern Gulf of Mexico;
- Rivers that discharge into this part of the Gulf do not carry large quantities of sediment, so sites should not be deeply buried;
- The coastal shelf is gently sloped which would reduce the impact of waves and storms; and
- Rapid sea level rise would have reduced the impact of waves as coastal settlements were inundated.

The Northeastern Gulf of Mexico 2008 Expedition focused on ancient river channels in the vicinity of the Florida Middle Grounds, which are now several hundred feet below the Gulf's surface. Major accomplishments included:

- Locating and high resolution mapping of a large, essentially intact, and infilled ancient river channel several kilometers long, east of the Florida Middle Grounds;
- Identifying additional stream and river channels, some with clearly visible deposits along the banks;
- Locating and identifying more than 100 sinkhole features filled with material in stratified layers that may contain human artifacts as well as plant and animal material from early American times; and
- Mapping nearly 10 square kilometers of intact, shallow-water, nearshore sand ripples/ridges adjacent to an area that would have been Florida's shoreline when sea level was at its lowest point during the last glacial period.

The latter achievement is particularly important because it shows that the oldest shoreline is extraordinarily well preserved. Most interesting, though, are the infilled sinkholes with multiple layers of distinct strata. These sinkholes are a potential treasure trove of new information about the late Pleistocene landscape and environment, as well as about the humans who lived there.

Key questions for the Exploring the Submerged New World 2009 expedition included:

- Is there evidence of human activity at sites identified in 2008 that is

visible to diver and/or video examination?
- Does the previously identified ancient river channel form a "T" intersection with another river channel (three modern terrestrial sites where rivers form a "T" junction have extensive paleoamerican settlements with hundreds of thousands of artifacts)?
- Is the previously identified ancient river channel the former course of the modern Suwannee River?
- Are several "channel-like" features identified in 2008 tributaries of the ancient river channel (areas where major and minor tributaries converge also have a high potential as locations for paleoamerican settlement sites)?

This lesson guides a student inquiry into how watercraft might have been involved in paleoamerican migrations.

Learning Procedure

1. To prepare for this lesson:
   (a) Review introductory essays for the Exploring the Submerged New World 2009 Expedition at http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html; and
   (b) Review procedures and questions on the *Paleoamerican Watercraft Inquiry Guide*; and
   (c) Review the video clips titled *Who Was Arlington Springs Woman?* and By Land or By Sea (http://www.pbs.org/saf/1406/video/watchonline.htm), which were aired in 2004 as part of a *Scientific American Frontiers* program about paleoamericans titled *Coming into America*.

2. Briefly review the background and mission of the Exploring the Submerged New World 2009 expedition. Point out that investigations of early human settlements face a serious problem of artifact preservation, since weather, animals, natural decomposition, and many other factors tend to deteriorate and scatter artifacts so that the information they once contained is lost. When we are dealing with people who lived more than 10,000 years ago, only very durable artifacts (such as those made of stone) or those that have been preserved (by freezing or other processes that slow natural decomposition) will survive to provide clues about the people with whom they were once associated.

3. Give each student group a copy of the *Paleoamerican Watercraft Inquiry Guide*. Suggest that they begin their research by watching the *Scientific American Frontiers* program, *Coming into America* (http://www.pbs.org/saf/1406/video/watchonline.htm), or at least the video clips titled *Who Was Arlington Springs Woman?* and *By Land or By Sea*. Caution students to pay attention to the dates of their research sources. The *Coming into America* program was aired in 2004, and more recent information may conflict with some of the

discussion presented in the program. You may also want to provide some of the sources cited in Step 4, and/or in the Other Resources section below.

4. Lead a discussion of students' research results. You may want to begin by discussing Arlington Springs Woman, the Solutrean hypothesis, the Luzia skull, and *Homo erectus* on Flores Island.

- Arlington Springs Woman refers to the 13,000 - 13,100 year-old human remains discovered on Santa Rosa island off the California coast. Since Santa Rosa Island was an island during the late Pleistocene, this discovery supports the idea that some of the first Americans may have traveled by sea.

- The Solutrean hypothesis (described in the *Scientific American Frontiers* program) suggests that the first Americans arrived in North America from the Iberian Peninsula via a route that crossed the North Atlantic on the edge of Arctic glaciers. Molecular genetic evidence does not support this hypothesis, since DNA from early American skeletal remains resembles that of humans living in Asia but not of humans living in Europe.

- The Luzia skull was discovered in 1974 by a French-Brazilian archaeological expedition working in Brazil. The skull was not studied until 1999, when it was examined along with many other bones recovered from the same area. Based on detailed measurements (e.g., Neves and Hubbe, 2005), some investigators have concluded that the skulls are similar to present-day sub-Saharan Africans and/or Australians traits and were part of a human population that lived in Brazil about 12,500 years ago.

- Once again, the obvious questions arise: Where did these people come from, and how did they arrive in South America? Several possibilities have been suggested, including:
  – Trans-Atlantic migration from Africa;
  – Migration via Siberia and the coastal corridor;
  – Trans-Pacific migration from Australia or Indonesia; and
  – Migration from Australia or New Zealand southward, along an extended Antarctic ice sheet to Tierra del Fuego.

- There is no direct evidence to support any of these hypotheses. One explanation (Bonnichsen and Gruhn, 2001) of the Antarctic route is that during the late Pleistocene Epoch, the ice of Antarctica extended north to about 55° south latitude, near the coast of Tierra del Fuego. At the same time, Tasmania was still attached to Australia at a latitude of about 45° south. Migrants in boats might have island-hopped from Tasmania to the edge of the Antarctic ice, and then followed the coastline to South America.

- Archeological evidence indicates that *Homo erectus* was present on the island of Flores (one of the Lesser Sunda Islands east of Java in Indonesia) 840,000 years ago. Even during periods when sea level was lowest, the nearest land was 30 km away. This implies that some type of watercraft was used to reach the island. The most likely type of boat is some form of raft built from logs lashed together with plant fiber cordage. Bamboo was plentiful in the area and possesses natural buoyancy.

- In addition to Arlington Springs Woman, other lines of evidence supporting the idea that watercraft were used by the first humans to enter North and South America include:
  - The coastal route from Siberia to North America was open about 1,500 years before inland routes, and the inferred timing of migrations using the coastal route is more consistent with the age of paleoamerican artifacts in North America than the timing of migrations using inland routes.
  - The existence of a 14,600 year-old paleoamerican settlement in Chile (Monte Verde) suggests that migration occurred before inland routes were passable.
  - The presence of late Pleistocene human populations with African and/or Australian traits in South America and Baja California has led some investigators to propose a migratory route from Australia via Japan and the Aleutian Islands that would have required watercraft (Epstein, 2005).

- The *Scientific American Frontiers* video clip *By Land or By Sea* describes one type of watercraft that might have been used in paleoamerican migrations. Rafts inferred as having been used by *Homo erectus* are another possibility. The oldest known dugout canoe (from the Netherlands) is dated to about 10,600 years ago, but similar vessels might have been available as well. Archaeological evidence in Australia shows that the first humans reached there around 50,000 years ago; almost certainly in some type of boat. The point is that watercraft of various kinds were very likely in use by some humans long before the earliest migrations into North and South America.

- Some advantages of coastal settlements include:
  - A frequently abundant and diverse food supply;
  - Easier travel via water routes than over land; and
  - Generally, more moderate climates in coastal areas than inland areas.

- Possible disadvantages of coastal settlements include:
  - Exposure to severe weather;
  - Vulnerability to sea level changes; and
  - Limited supply of fresh water in some areas.

The BRIDGE Connection

www.vims.edu/bridge/archeology.html

The "Me" Connection

Have students write a brief essay describing how understanding the history of human settlement and occupation in North and South America might be of personal benefit.

Connections to Other Subjects

English/Language Arts, Geography, Earth Science, Life Science

Evaluation

Students' research reports and class discussions provide opportunities for assessment.

Extensions

1. Visit http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html for more about the Submerged New World 2009 Expedition.

2. Visit http://www.pbs.org/wgbh/nova/first/ for information and resources about the discovery and controversy surrounding a well-preserved, 9,000-year-old human skeleton called Kennewick Man.

3. Visit http://www.andaman.org/ for resources and discussions about a living human population that has been largely isolated from contact with other human groups for at least 30,000 years, who represent the least-changed survivors of the first migration of *homo sapiens* into Asia, and who have the most ancient surviving way of life on earth today.

Other Relevant Lesson Plans from NOAA's Ocean Exploration Program

(The following Lesson Plans are targeted toward grades 9-12)

My Wet Robot
(9 pages, 300kb) (from the Bonaire 2008: Exploring Coral Reef Sustainability with New Technologies Expedition)
http://www.oceanexplorer.noaa.gov/explorations/08bonaire/background/edu/media/wetrobot.pdf

Focus: Underwater Robotic Vehicles (Physical Science)

In this activity, students will be able to discuss the advantages and disadvantages of using underwater robots in scientific explorations, identify key design requirements for a robotic vehicle that is capable of carrying out specific exploration tasks, describe practical approaches

to meet identified design requirements, and (optionally) construct a robotic vehicle capable of carrying out an assigned task.

Do You Have a Sinking Feeling?
(9 pages, 764k) (from the 2003 Steamship Portland Expedition)
http://oceanexplorer.noaa.gov/explorations/03portland/background/edu/media/portlandsinking.pdf

Focus: Marine Archaeology (Earth Science/Mathematics)

In this activity, students plot the position of a vessel given two bearings on appropriate landmarks, draw inferences about a shipwreck given information on the location and characteristics of artifacts from the wreck, and explain how the debris field associated with a shipwreck gives clues about the circumstances of the sinking ship.

Where's My 'Bot?
(17 pages, 492kb) (from the Bonaire 2008: Exploring Coral Reef Sustainability with New Technologies Expedition)
http://oceanexplorer.noaa.gov/explorations/08bonaire/background/edu/media/wheresbot.pdf

Focus: Marine Navigation (Earth Science/Mathematics)

In this activity, students will estimate geographic position based on speed and direction of travel, and integrate these calculations with GPS data to estimate the set and drift of currents.

Designing Tools for Ocean Exploration
(13 pages, 496k) (from the Galapagos Rift 2002 Expedition)
http://oceanexplorer.noaa.gov/explorations/02galapagos/background/education/media/gal_gr9_12_l1.pdf

Focus: Ocean Exploration (Earth Science)

In this activity, students will understand the complexity of ocean exploration; students will learn about the technological applications and capabilities required for ocean exploration; students will discover the importance of teamwork in scientific research projects; and students will develop the abilities necessary for scientific inquiry.

Where Am I?
(4 pages, 344k) (from the 2003 Steamship Portland Expedition)
http://oceanexplorer.noaa.gov/explorations/03portland/background/edu/media/portlandwhereami.pdf

Focus: Marine Navigation and Position Finding (Earth Science)

In this activity, students identify and explain at least seven different techniques used for marine navigation and position finding, explain the purpose of a marine sextant, and use an astrolabe to solve practical trigonometric problems.

Other Resources

The Web links below are provided for informational purposes only. Links outside of Ocean Explorer have been checked at the time of this page's publication, but the linking sites may become outdated or non-operational over time.

http://oceanexplorer.noaa.gov – NOAA's Ocean Explorer Web site

http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html – Web site for the Submerged New World 2009 Expedition

http://celebrating200years.noaa.gov/edufun/book/welcome.html#book – A free printable book for home and school use introduced in 2004 to celebrate the 200th anniversary of NOAA; nearly 200 pages of lessons focusing on the exploration, understanding, and protection of Earth as a whole system

http://centerfirstamericans.org/index.php – Web site for the Center for the Study of the First Americans

http://www.jqjacobs.net/anthro/paleoamericans.html – Online article on issues and evidence relating to peopling of the New World

http://www.pbs.org/wgbh/nova/first/ – Web site to accompany the NOVA presentation, "Mystery of the First Americans" (originally broadcast on February 15, 2000) documenting the discovery and controversy surrounding a well-preserved, 9,000-year-old human skeleton called Kennewick Man; includes "Does Race Exist?," "Meet Kennewick Man," "Claims for the Remains," "The Dating Game" (about carbon-14 analysis), and links to resources

http://www.nps.gov/history/aad/eam/index.htm – National Park Service Archaeology and Ethnography Program's Web site, The Earliest Americans

http://www.andaman.org/index.htm – Web site about the Negrito People and the out-of-Africa story of the human race; includes extensive essays, maps, and illustrations about human migrations, especially in the South Pacific and Americas

Goebel, T., M. R. Waters, and D. H. O'Rourke. 2008. The Late Pleistocene Dispersal of Modern Humans in the Americas. *Science* 319:1497-1502. http://centerfirstamericans.org/cfsa-publications/Science2008.pdf

Bonnichsen, R. and R. Gruhn. 2001. The First Americans: Were They Australians? Mammoth Trumpet 16(2):4-6. http://centerfirstamericans.org/mammoth/issues/Volume-16/vol16_num2.pdf

Epstein, D. 2005. First Americans May Have Come From Australia; http://discovermagazine.com/2005/jan/first-americans-from-australia

Neves, W. and M. Hubbe. 2005. Cranial morphology of early Americans from Lagoa Santa, Brazil: Implications for the settlement of the New World. Proc Natl Acad Sci. 102(51):18309-18314.

National Science Education Standards

Content Standard A: Science As Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C: Life Science

- Interdependence of organisms

Content Standard D: Earth and Space Science

- Origin and evolution of the Earth system

Content Standard E: Science and Technology

- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- Natural resources
- Environmental quality
- Natural and human-induced hazards

Content Standard G: History and Nature of Science

- Science as a human endeavor
- Nature of scientific knowledge

Ocean Literacy Essential Principles and Fundamental Concepts

Essential Principle 1.

The Earth has one big ocean with many features.

Fundamental Concept d. Sea level is the average height of the ocean relative to the land, taking into account the differences caused by tides. Sea level changes as plate tectonics cause the volume of ocean basins and the height of the land to change. It changes as ice caps on land melt or grow. It also changes as sea water expands and contracts when ocean water warms and cools.

Essential Principle 2.
The ocean and life in the ocean shape the features of the Earth.
Fundamental Concept b. Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas, and shaped the surface of land.

Essential Principle 6.
The ocean and humans are inextricably interconnected.
Fundamental Concept c. The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.
Fundamental Concept f. Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).

Essential Principle 7.
The ocean is largely unexplored.
Fundamental Concept a. The ocean is the last and largest unexplored place on Earth—less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation.
Fundamental Concept d. New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.
Fundamental Concept f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, and physicists, and new ways of thinking.

Send Us Your Feedback

We value your feedback on this lesson.
Please send your comments to:
oceanexeducation@noaa.gov

For More Information

Paula Keener-Chavis, Director, Education Programs
NOAA Ocean Exploration and Research Program
Hollings Marine Laboratory
331 Fort Johnson Road, Charleston SC 29412
843.762.8818 843.762.8737 (fax) paula.keener-chavis@noaa.gov

Acknowledgements

This lesson plan was produced by Mel Goodwin, PhD, The Harmony Project, Charleson, SC for NOAA's Office of Ocean Exploration and Research. If reproducing this lesson, please cite NOAA as the source, and provide the following URL: http://oceanexplorer.noaa.gov

By Land or By Sea…or Both?
Paleoamerican Watercraft Inquiry Guide

Background Reading

[The following text is adapted from Goebel et al., (2008), and *Who were the First Americans?*, a Web page from the Center for the Study of the First Americans (http://centerfirstamericans.org/who.php).]

Molecular genetics studies indicate that all Native Americans came from Asia. Ancient DNA from early American skeletal remains and human coprolites (fossilized fecal material) also point to an Asian origin. The earliest evidence of humans in central Asia is dated to about 40,000 years ago. So it is unlikely that people entered North America before that time. Archeological evidence of 32,000 year-old human settlements in Siberia shows that people were able to live in the extreme environment of the ice-age Siberian Arctic, and made tools from stone and bones of various animals that included rhinoceros and mammoths.

Periods of cold temperatures during the last ice-age alternated with warmer intervals. During these warmer periods, the huge ice sheets that covered much of Canada melted enough to create ice-free corridors along the Pacific coast and in the plains east of the Canadian Rockies. These corridors were the pathways on which the first humans migrated from Siberia to North and South America. The corridors were open 32,000 years ago, but had closed by 24,000 years ago. The Pacific coastal corridor was open again by at least 15,000 years ago, but the interior corridor may not have opened until after 13,500 years ago.

In 1927, archaeologists working near Folsom, New Mexico discovered a stone spearpoint embedded in the rib cage of an extinct bison. Several years later, distinctive long spearpoints were discovered at an archaeological site near Clovis, New Mexico, along with bones of prey dated to about 11,200 years ago. These discoveries provided the basis for a theory that the first humans to enter North America were a small group of hunters that migrated across a land bridge between Asia and North America about 13,500 years ago, and then passed through an inland ice-free corridor in western Canada. A key element of this theory is that these "Clovis people" were the first human inhabitants of North and South America; hence this theory has come to be known as the Clovis First model.

Radiocarbon dates from Clovis sites across North America indicate ages ranging from 13,200 to 12,900 years ago. Studies of other sites show evidence of earlier occupation by humans. These include Monte Verde in Chile (occupied 14,600 years ago), the Schaefer and Hebior sites in Wisconsin where humans hunted mammoths and mastodons between 14,200 and 14,800 years ago, Meadowcroft Rockshelter, Pennsylvania with artifacts in sediments that may be as old as 18,000 to 22,000 years, the Page-Ladson sinkhole in Florida with evidence of

By Land or By Sea…or Both?
Paleoamerican Watercraft Inquiry Guide – 2

mastodon hunting about 14,400 years ago, and Paisley Cave, Oregon, which contained human coprolites dated to about 14,100 years ago.

These observations indicate that humans probably colonized the Americas around 15,000 years ago, as soon as the Pacific coastal corridor re-opened. Once they reached the Pacific Northwest, humans could have continued their spread southward along the coast to Chile, as well as eastward along the southern margin of the continental ice sheets, possibly following traces of mammoth and mastodon to Wisconsin.

Inquiry Questions

1. Some archaeologists believe that at least some of the first humans to enter North and South America used some type of watercraft. What are three lines of evidence for this idea?

By Land or By Sea…or Both?
Paleoamerican Watercraft Inquiry Guide – 3

2. What types of boats might have been used by humans during the late Pleistocene Epoch (20,000 to 10,000 years ago)?

3. What are advantages and disadvantages of living in coastal areas?

Be sure to include the following in your discussion of these questions:

- Arlington Springs Woman
- The Solutrean hypothesis
- The Luzia skull
- *Homo erectus* on Flores Island