

Ice Ages and Human Occupation



A bird's-eye view of the globe, showing the connections between the continents at times of low sea level during the Ice Ages, and the general directions of human migrations from East Africa over millions of years.

of the Continental Shelf

by Nicholas C. Flemming

While the earliest continental ice sheets were gradually engulfing the mountainous landmass of Antarctica, in Africa an undistinguished species of ape was evolving into the species that we now call man. Examination of oceanographic cores and the dating of sediments from around Antarctica show that the ice began to form about 5 million years ago. Later, ice sheets up to 3 kilometers thick also covered Greenland, Canada, and Scandinavia, and extensive glaciers formed in the valleys of all the mountain ranges of the world. During the last 2 million years such vast accumulations of ice have covered the land and melted again about 20 times, each Ice Age lasting about 100,000 years.

Discoveries of fossil bones, footprints, remains of tools, and food materials show that types of early men known as *Australopithecus* and *Homo erectus* had evolved in East Africa by 1.5 million years ago. The cultural and tool-making attributes of man are later found over a wider and wider area, encompassing Africa, most of Asia, and Europe, by about 1 million to 500,000 years B.P.*

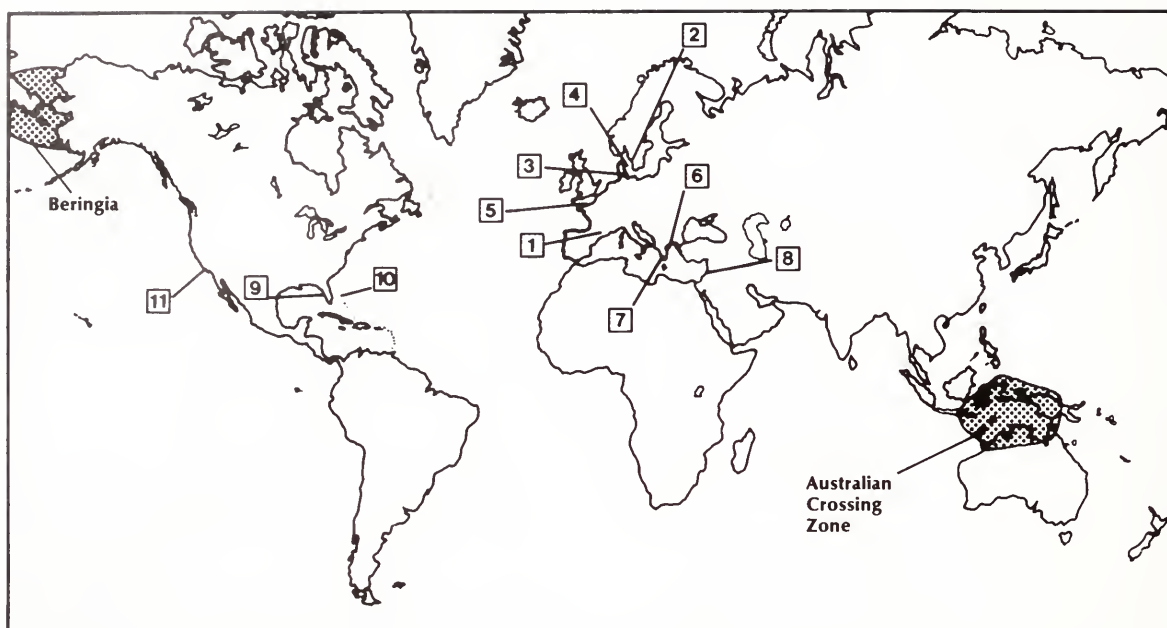
During the long time span from 1 million years B.P. to 10,000 B.P., the human race colonized all the continents of the earth (with the exception of Antarctica) and most of the major islands. The dates of these colonizing migrations are not known, even approximately, although some of them involve crossing channels that are now wide sea straits, such as the Timor Sea and Celebes Sea between Indonesia and Papua New Guinea-Australia (which were one continent during the glaciations) or the Bering Strait between Siberia and Alaska. This spread of the human race across the globe is poorly understood, though it must be counted one of the most important processes in human history.

To illustrate the spread one can note traces of huts made of bone and pebble tools found in Siberia by Nikolai Dikov (of the U.S.S.R. Academy of Sciences at Magadan, Siberia), dating from



A diver making a survey of the shallowest part of Cootamundra Shoals, Australia, examines a coral. (Photo courtesy of Sirius Expedition)

*Before present, calculated from 1950 by scientific convention



Submerged sites that contained the remains of cultures older than 6,000 years before present. Site numbers and names are as follows: 1) Etang de Leucate; 2) Landskrona, Sweden; 3) Danish Archipelago; 4) Tybrind Vig; 5) Brittany coast; 6) Aghios Petros; 7) Franchthi Cave; 8) Mediterranean coast of Israel; 9) Little Salt Springs and Warm Mineral Springs, Florida; 10) Cape Canaveral; 11) La Jolla, California. The key inter-continental passages from Siberia to Alaska and Asia to Australia also are marked.

20,000 B.P., and rather similar remains in Alaska from later dates. In South America, human remains and tools are found dating from 13,000 B.P. Hearths, food remains, tools, and human remains have been found at widely separated locations in Australia dating from as early as 30,000 B.P. Japan was occupied well before 20,000 B.P.

There is controversy about the precise origins of the modern species of human, *Homo sapiens*, and the relations between the various preceding species or sub-species identified in Africa and Asia. Although this process of differentiation, evolution, and survival is a worthy subject for study, I do not wish to devote time to it here. For the purposes of this article we can view the human race as a single species, which evolves and spreads throughout the dryland surface of the globe in the course of about 1 million years. I wish to examine the mechanism and routes of that expansion, and the limits of the area which was inhabited.

Ice Age Sea Levels

Each time that the ice sheets reached their maximum extent, the additional volume of water extracted from the ocean was about 40 million cubic kilometers. This resulted in a drop of sea level of about 100 meters. The precise magnitude of sea-level drop relative to the land at each location is complicated by several side effects. In brief, the weight of ice itself depresses the earth's crust by about 1 kilometer in the immediate neighborhood of the ice, and the crust subsequently rises again

when the ice melts. Conversely, the weight of water removed from all the oceans of the world causes the ocean floor to rise slightly, and it is depressed again when the water returns to the ocean. Since the crust and the underlying mantle are not perfectly uniform, the magnitude of these responses is not easily calculated. Additionally, the coast at all places in the world is subject to changes in altitude, relative to the center of the earth, as a result of the addition or removal of loads of sediment, and because of earthquakes or earth movements caused by forces arising within the earth, so-called tectonic movements.

Although we know that the sea fell and rose again with a periodicity of about 100,000 years, and through a range of about 100 meters, the variations locally are so great that the exact area of the continental shelf exposed at each place is difficult to calculate. For example, close to the ice sheet, the earth is forced down by more than the drop of sea level, so that the land floods as the sea level drops. Consequently, we have only approximate knowledge of what land was dry and at what time.

The Archaeological Problem

Archaeologists have been aware for several decades that the low sea levels created a larger living space for Stone Age tribes of the Paleolithic period (older than 10,000 years B.P.), and that migrations between continents and islands were promoted by the creation of land bridges or the narrowing of straits. To show how widely these ideas

Archaeological Periods

Geological Time	Geological Sub-division	Archaeological Period	Stone Tool Type	Years Before Present
HOLOCENE				3,000
		Bronze Age		5,000
		Neolithic		8,000
		Mesolithic	Microliths	10,000
PLEISTOCENE	Upper Pleistocene	Upper Paleolithic	Magdalenian	25,000
			Aurignacian	35,000
		Middle Paleolithic	Levolloiso-Mousterian	50,000
			Acheullian Flake tools	100,000
	Middle Pleistocene		Handaxe	250,000
				500,000
	Lower Pleistocene	Lower Paleolithic	Chopper tools first tools	3 million

Approximate beginning and end dates for the archaeological periods mentioned in the text. The terms refer to different styles and technologies for making flint tools. The transitions from one style to the next took place at different dates in different parts of the world. These dates are generally accepted for Europe and the Middle East.

are accepted I quote from Grahame Clark's *World Prehistory*, published in 1969: "The radiocarbon dating suggests that the Japanese islands were settled already during the Late Pleistocene, and this after all agrees very well with the fact that at the peak of glaciation (about 20,000 years B.P.) the main islands were joined to one another and to the mainland of east Asia by way both of Korea and of Sakhalin and the Amur Basin."

And again: "The territory of Siberia . . . owes its interest largely to its position in relation to the New World. . . . through this region the first immigrants must have passed on their way to America, presumably at a time when the land-connection was still intact."

And again: "There were periods during the Pleistocene when man could occupy most of Indonesia west of the Wallace line* without having to traverse open water. . . . Having once got to Australia by the use of some kind of boats or floats . . . which at the time of low sea level would have been joined to New Guinea on a broad front by the Sahul Shelf, there was nothing to prevent overland crossing to Tasmania, which was likewise joined to the mainland. The mere fact that sea passages were so narrow during the late glacial period makes it more likely that man first got into Australia at this time."

So if everybody agrees with this view, what is the problem? Let me quote Clark once again: "Mesolithic (about 10,000-6,000 B.P.) man could compensate for the reduction in animal grazing ground caused by the spread of forests, and that was by the development of fishing. Much of the evidence for this lies submerged by the rise of the ocean levels due to the continued melting of the ice-sheets."

*The Wallace line, first described by Alfred Wallace, marks the evolutionary break between Asia on one side and eastern Indonesia and Australia on the other.

In short, all competent archaeologists agree that the continental shelf must have been exploited in a general way for hunting and fishing, and in an explicit way to facilitate continent-to-continent migrations, but we have no direct evidence at all to support this, except that people arrived on the other side! It is implicit that they made the crossing by walking or use of simple craft at times of low sea level, but they could have made the crossing by use of more sophisticated craft over greater extents of water. Everybody agrees that the explanation is obvious, but we do not actually have any proof. This is rather unscientific; in fact, it is the Medieval view of knowledge. As Hilaire Belloc, a turn-of-the-century British humorist, said in his delightfully ironic poem about the microbe: "Let us never never doubt what nobody is sure about. Scientists, who ought to know, assure us that it must be so."

So everybody agrees what the answer ought to be, and everybody agrees that all the relevant data are buried beneath the sea. To continue my unscientific quotations, Mark Twain said (in reference to the weather), "Everybody talks about it, but nobody does anything."

But a few people have done something, and what they have found provides direct evidence that human beings did live on the continental shelf during the Palaeolithic, Mesolithic, and Neolithic periods, and that the remains of those cultures survived inundation by the oceans.

Mediterranean and Middle East

The work of Richard Leakey, Donald Johanson, and other biological anthropologists has shown that modern man originated in Africa more than 1 million years ago. The human expansion from Africa into Asia and Europe could have taken place entirely through the isthmus of Sinai, which has its narrowest point at the location of the present Suez Canal. When we use the terms expansion, or migra-

tion, we should not envision thousands of people with their flocks marching like a biblical scene from a movie. Rather, we must envision a gradual extension of hunting and seasonal migration patterns such that the boundary of the area occupied or used is moved on average less than one kilometer in a year.

Nevertheless, our understanding of these early years of human history is different if we presume that all human contact was through Suez, or if we assume that crossings could also take place across the southern end of the Red Sea; from Tunisia to Sicily and Italy; or from Morocco to Spain. Comparison of stone tool assemblages on each side of these channels indicates that there probably was direct contact across each strait tens of thousands of years ago, and that people were crossing the straits. As yet, there is no direct evidence from beneath the sea, but it is very important to find it. In the 1960s, this author explored a series of submarine caves off the southern tip of Gibraltar, down to a depth of 25 meters, and sport divers and off-duty military divers have now taken up the search. Other groups of divers are searching submarine caves around Malta.

The earliest evidence of exploitation of marine resources consists of layers of oysters, mussels, and limpets found at Terra Amata, near Nice, in the south of France. This is a land site, but it indicates that the occupants were collecting shells between 235,000 and 400,000 years B.P.

So far no signs of submerged habitation sites or hunting tribes have been found on the continental shelf immediately adjacent to the critical straits of the Mediterranean or Middle East. However, a large number of submerged Bronze Age and Neolithic sites have been found around the Mediterranean, and a few Paleolithic sites are now being explored by divers. These discoveries establish beyond any doubt that human occupation did take place below present sea level, and that the artifacts can survive the traumatic transgression of the high-energy surf zone.

Jean Guilaine, Director of the Center for Anthropology at Toulouse, France, and a team of distinguished colleagues have been working for 10 years on the mass of artifacts and food remains brought to the surface by a dredger working in the saltwater lagoon of the Etang de Leucate on the south coast of France. A Neolithic village was established at about 6,800 B.P. on a ridge of gravel brought down by the nearby river. The occupation level is now 4.5 to 6.0 meters below sea level. Archaeological analysis of recovered material shows that the people kept domestic animals, such as sheep and cattle, and that they hunted wild boar, deer, and birds. They collected shellfish and wild plants, and also caught deep sea fish. They used tools made of stone and bone, and made pottery, which they decorated by impressing the patterns of seashells into the wet clay. The excavators of this site concluded that coastal and maritime diffusion

of Neolithic skills in food production took place on the now submerged continental shelf.

In 1981, two submerged Neolithic sites in Greece were surveyed and small test excavations made. At Franchthi Cave in the northern Peloponnese, John Gifford, Associate Professor of Anthropology at the University of Miami, and his team of divers worked in a water depth of 4.5 meters and cored the sea bed to a depth of 5.5 meters (10 meters below sea level). At two locations Neolithic pottery fragments, charcoal, and vegetable remains (dated to between 6,000 and 7,000 B.P.) were recovered from about 10 to 11 meters below present sea level. Lack of abrasion of the pottery, and lack of sorting of the associated sediments and vegetable remains suggests that there has been minimal transport or reworking of the deposit by waves, implying that the materials were deposited close to the shoreline of that time.

Farther north, the author worked with a team of divers from London University and the Greek Archaeological Eforiate of Volos to survey the sea bed around the tiny island of Aghios Petros in the Sporadhes. Although the sea bed at first seemed featureless and unvarying, we eventually identified an anomalous zone of 50 by 35 meters, and made some small test excavations of 1 meter squares. One 1 meter square excavated to a depth of 5 centimeters produced 123 pieces of goat and sheep bones, 347 sherds of Neolithic and Bronze Age pottery, 7 obsidian blades, assorted flakes of flint, chert, and quartz, and a primitive ceramic figurine. A further 1 meter square test produced almost identical results, even including another figurine. Embarrassed by the prolific haul, we then cut the test quadrats to 0.5 meters square. The results on a total of four more pits were similar, though proportionately smaller. The test quadrats were dug at depths below present sea level ranging from 3.8 to 8.8 meters. I concluded that there was a coastal settlement on the island, with trade communications with the mainland of both Greece and Turkey.

On the Mediterranean coast of Israel, Avner Raban and his colleagues at the University of Haifa (see page 59) have discovered numerous submerged sites of the Neolithic period, containing floors, pottery, hearths, burnt tree roots, tree trunks, and a host of associated materials. Most of the sites are in shallow water, less than 3 meters deep, on the gently sloping, sandy shore, but deeper sites may soon be found near the offshore ridges that run parallel to the shore. Most of the sites date from 6,000 to 7,000 B.P.

During 1984, the author visited Corfu to check on reports of Paleolithic implements being washed up by the sea. With the assistance of some local experts, we were able to find Levallois-Mousterian tools (from approximately 40,000 years B.P.) about 200 meters offshore, in 3 meters of water. Meanwhile, preliminary reports from Italy suggest

that divers have found submerged caves and rock overhangs associated with flint tools nearly 100,000 years old.

Thus, the evidence from the Mediterranean shows that the continental shelf was occupied definitely to a depth 10 meters below present sea level, and over a time span of at least 40,000 B.P. to 6,000 B.P. That is the evidence. Venturing slightly into Hilaire Belloc country, one might suggest that the evidence is compatible with occupation at deeper levels and over longer periods.

Northwest Europe

The volume of Mesolithic and Neolithic village sites now discovered by divers in the shallow Baltic waters off Denmark and Sweden is so great that only the most important can be excavated in detail. Joergen Skaarup, a regional director of archaeology in Denmark, has worked with amateur scuba divers to map and recover artifacts from numerous submerged villages of the Mesolithic. A.S.H. Andersen, another regional director, excavated a Mesolithic settlement at Tybrind Vig off the island of Fyn which was occupied from 6,000 to 3,600 B.P. The remains included tools made of flint, wood, and antlers. There were a few sherds of pottery, leaves, fruit, seeds, and branches preserved in the underwater clay. The divers found the grave of a woman and child, and the scattered bones of at least four individuals. Most amazing of all, a perfectly preserved dugout canoe was embedded in the clay, 9 meters long, 0.65 meters wide, and cut from a single lime trunk. Nearby were oars, bows, and spears. Carbon-14 dating indicated an age of 5,700 years B.P.

On the stormy west coast of Scotland, the Hebrides are among the wildest islands of Europe. Sheltered by Islay, Colonsay, and other islands, Jura is relatively secluded. Mesolithic settlements there are associated with ancient raised shorelines, but the oldest sites at around 10,000 B.P. are so low that they can only be examined at low tide. The scattered flints seem to continue under the water, and divers are planning to expand the work to below low-tide level.

So the story continues around the coast of Brittany in France, and through the Channel Islands. Even from the sandbanks on the floor of the North Sea, the Dutch fishermen dredge up carved antlers and bones in their nets. When the sea level was lower, tribes migrated into Britain by walking across the North Sea as the ice sheets retreated.

Southeast Asia

Twenty thousand years ago when the sea level was about 100 meters lower than at present, Australia, Tasmania, and Papua-New Guinea were joined into a single continental landmass known as Greater Australia. All the islands of Indonesia were joined



The author snorkel diving on the Paleolithic site off Corfu. Flint tools and cores have been found between fallen slabs of conglomerate. (Photo courtesy of Kleinberg Photographic)

from Malaysia to Bali. From there to the east there were a number of channels that would have to be crossed if people or animals were to reach Australia. From the bones of so-called Java Man we know that humans reached that island about 1 million years ago, while recent discoveries in several parts of Australia show that the first Aborigines were well distributed in Greater Australia before 30,000 B.P. Sometime between these two dates, and probably later rather than earlier, humans crossed into Greater Australia, but exactly when and how is still a mystery.

Joseph Birdsell, Professor of Archaeology Emeritus at the University of California at Los Angeles, has presented maps and analyses estimating the degree of difficulty for each route through the eastern Indonesian Archipelago at times of low sea level. Whatever route was used, the journey to Australia must have included several sea channels, with one on the order of 50 to 80 kilometers in width. We are forced to the conclusion that Paleolithic tribes crossed sea channels of this width by boat, and that they did so in sufficient numbers to establish a permanent breeding population that could sustain itself in the face of all the hazards of the arid Australian climate.

Again we are in the land of Hilaire Belloc. "Scientists who ought to know assure us that it must be so. Oh let us never never doubt what nobody is sure about." But who made the sea craft that could cross the Timor Sea? When? How? Where did they leave from, where did they land? Why did they undertake such a voyage? (Indonesia seems so much more lush and fruitful than Australia.) And strangest of all, how did the peoples of 30,000 years ago have the technology to make such voyages? I am not suggesting anything wild about mysterious lost civilizations. I am just asking the blunt question: assuming a primitive culture using clumsy stone tools – of which examples have been found – how did they do it? The only fact we know is that they did.

The northwest continental shelf of Australia, the so-called Sahul Shelf, is a broad, undulating submerged landmass approximately 600 by 300 kilometers. Much of it is deep and sparsely surveyed. In 1982, with the support of a number of Australian and British institutions, and with financial support from the Australian Submarine Prehistory Research Foundation, I led an expedition to examine the Cootamundra Shoals, on the Sahul Shelf, 200 kilometers from Darwin. We did not immediately find human remains. The purpose of the expedition was to explore and describe the landscape of the shoals as it would have appeared when the sea level was about 60 meters below present sea level. This was the maximum depth to which we could descend on scuba.

We found that the shoals could indeed have been inhabited, and that the coastal environment would have provided food resources. The main land surface was about 34 meters below the present surface of the sea, and deep sinuous valleys wind between the banks, which are themselves fossil coral reefs. The reefs have been exposed many times to wind and rain at periods of low sea level, so that the landforms are a composite of reef-building, erosion, and rainwater solution. Several of the valleys have deep inland depressions showing internal drainage, probably associated with underground rivers.

Use of submarine television cameras, echosounding, and diving, revealed several submerged beach levels, while carbon-14 dating of fossil corals carried out by the Australian National University provided estimates of the rate of rise of sea level. Much more work is needed on the Sahul Shelf before we can have a chance of actually discovering the remains of human occupation, but at least we have established that Cootamundra Shoals is a good place to start.

Siberia to Alaska and the Americas

David Hopkins, Distinguished Professor of Quaternary Studies at the University of Alaska in Fairbanks, has devoted many years to the study of the

ancient landmass that included eastern Siberia and Alaska, known as Beringia. Ecologically, this area was cut off from the rest of North America and Asia by ice sheets during times of low sea level.

There was dry land from Siberia to Alaska, the Bering Land Bridge, for most of the time from 80,000 to 14,000 years ago. Shallow episodes of flooding occurred at about 45,000 and 35,000 B.P. Cores from the land and the sea bed provide evidence for the pollen types at different dates, the sediment movements, and the stages of marine transgression or emergence. From the point of view of human occupation, the inhospitable nature of Beringia was not just because of the cold, but also the severe dryness for most of the time from 60,000 to 14,000 B.P. Pollen indicates a sparse tundra vegetation with dwarf birch widely distributed, and willow trees in the river floodplains.

The low-lying plains on the continental shelf were probably wetter than the highlands that can be studied on the present continents, and mammoth, horse, and bison ranged widely. Hopkins has documented a series of climatic and vegetation changes with increased rainfall during the marine transgression. As the waters of the Arctic Ocean flooded into the basin of the Chukchi Sea and joined to the Pacific, the last sill at the Shpanberg Strait, only 30 to 32 meters deep, was flooded at about 12,000 B.P.

The date and manner of the first human crossing of the Bering Land Bridge is, to put it mildly, controversial. This author does not intend to join the controversy, or even try to describe it. From land evidence most archaeologists agree that there was human occupation of Siberia by 70,000 years ago, and recent unconfirmed press reports suggest that Russian scientists have found much earlier remains during the past year. One uncontested occupation site in the United States is the Meadowcroft Rockshelter in Pennsylvania, which gives an earliest date of about 19,000 B.P. Suggestions for the most probable time of human entry into North America range from 20,000 to as much as 150,000 B.P.

Michael McBride, a conservationist and amateur archaeologist working in China Poot Bay, Alaska, has found intertidal remains of human occupation sites, and is planning to explore deeper using scuba gear. David Hopkins reports a single granite tool dredged up from the Bering Strait in a trawl, while Nikolai Dikov reports possible artifacts recovered from underwater by geological drills. These incomplete reports are the only suggestion so far that submerged materials might be found in Beringia. Further exploration is vitally important, especially in view of the extreme uncertainty about the date of first occupation of Alaska. Land evidence already indicates that the onset of the last Ice Age forced some people to migrate westward out of Alaska toward Siberia, so the evidence from beneath the sea might reveal movement in both directions.

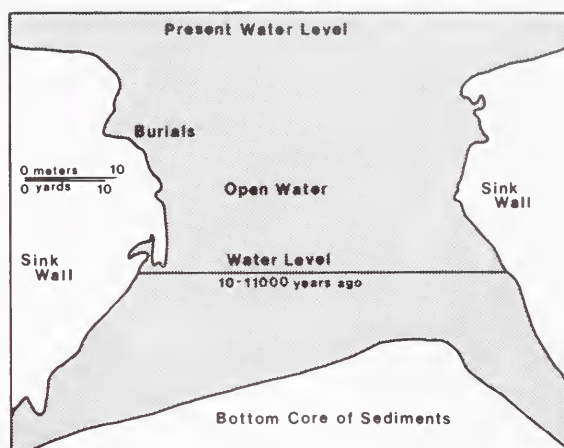
Early Paleo-Indian sites have been found below sea level off the southern coasts of the United States (see page 27). On the coast of Florida, Wilburn Cockrell, a marine archaeologist with the Florida Department of State, has recovered human bones and mammoth bones dating from 6,000 B.P. from a submerged site near Cape Kennedy. Near the Gulf Coast of Florida two flooded limestone caverns, Little Salt Springs and Warm Mineral Springs, have both been excavated by divers, and show Indian occupation down to 20 meters below present sea level and dates of 10,000 to 11,000 B.P. These excavations disclosed a rich variety of tools, seeds, bones, shells, pollen, nuts, human skulls, and even an oak boomerang. At the time of occupation of the caves the sea level would have been about 30 to 40 meters lower than at present, and the groundwater level in the caves proportionately lower than at present.

Underwater study of lithic culture sites in North America and especially in Beringia may contribute strongly to an understanding of early maritime technologies, and to the migration process itself. At the moment, the established finds are exciting in themselves, but no submerged site provides an earlier date than the best dated sites on land, and no submerged site has yet been found in the Bering Strait.

Conclusions

Ten years ago most geologists or archaeologists asked to give an opinion on the chances of finding Stone Age relics on the continental shelf would have rated the chances very low indeed, perhaps infinitely small. Since then a series of reputable publications have shown beyond doubt that lithic artifact sites are being found by divers off the coasts of many parts of the world, while amateur exploration and reports of work in progress suggest that the near future will produce deeper and older discoveries.

The area of the continental shelf is 5 percent of the entire area of the Earth, equivalent to a continent the size of North America. This continent was once available for exploitation by Stone Age peoples, and its exploitation contributed mightily to the growth of early technology, marine skills, the origins of seafaring and sea fishing, the origins of agriculture, and of civilization itself up to the start of the Bronze Age in the Middle East. It is unscientific to go on saying "This must have happened . . ."; "That must be so. . ." Now is the time for earth scientists, oceanographers, and archaeologists to combine in the exploration of the drowned continent, and to obtain reliable scientific evidence. Above all, we need to know exactly where the shorelines were at each date with an accuracy of about 1.0 meter vertically, and 1,000 years in date. The discoveries of artifacts can then



Cross section of Warm Mineral Springs, Florida. Paleo-Indian burials are located on ledges halfway down to the ground-water level at the time of occupation. (After Wilburn Cockrell)

be related to the land and water masses of the time.

Nicholas C. Flemming is an oceanographer/marine archaeologist at the Institute of Oceanographic Sciences, Wormley, England.

References

- Allen, J., J. Golson, and Rhys Jones, eds. 1977. *Sunda and Sahul*. Academic Press: London, New York, Toronto.
- Clark, G. 1969. *World History, A New Outline*. Cambridge University Press: Cambridge.
- Clausen, C.J., A.D. Cohen, C. Emiliani, J.A. Holman, and J.J. Stipp. 1979. Little Salt Spring, Florida: a unique underwater site. *Science*. 203: 609-614.
- Guilaine, J., A. Freises, and R. Montjardin, 1984. *Leucate-Corregé, Habitat noyé de Neolithique Cardial*. Centre d'Anthropologie des Sociétés Rurales: Toulouse.
- Hopkins, D.M., ed. 1967. *The Bering Land Bridge*. Stanford University Press: Stanford, California.
- Hopkins, D.M., J.V. Matthews, C.E. Schweger, and S.B. Young, eds. 1982. *Paleoecology of Beringia*. Academic Press: New York, London, Tokyo.
- Isaac, G., and R.E.F. Leakey, eds. 1979. *Human Ancestors. Scientific American readings*. W.H. Freeman and Company: San Francisco.
- Johanson, D.C., and M.A. Edey. 1981. *Lucy, the Beginnings of Humankind*. Granada, London, and New York.
- Masters, P.M., and N.C. Flemming, eds. 1983. *Quaternary Coastlines and Marine Archaeology*. Academic Press: London, New York, Toronto.
- Mörner, N-A., ed. 1980. *Earth Rheology, Isostasy and Eustasy*. Wiley: New York.
- Shackleton, J.C., T.H. van Andel, and C.N. Runnels. 1984. Coastal palaeogeography of the central and western Mediterranean during the last 125,000 years, and its archaeological implications. *Journal of Field Archaeology*. 11: 307-314.