not clear that South Africa is any worse than any other country in Africa. I suspect that the difference between being a Kikuyu and being a Masai in Kenya, for example, is exactly the same as the difference between a white and a black in South Africa. The Bushmen are adults, they're ever so much more able to judge their own interests than we are. They're not poor helpless savages."

Wilmsen also feels strongly that anthropologists who protest the !Kung's recruitment by South Africa are acting inappropriately. "My own view of anthropology is that it's still embedded in nineteenth century paternalism and colonialism," he says.

In Wilmsen's opinion, many of the anthropologists protesting the !Kung's situation are motivated by a romantic wish that the !Kung be protected from modern societies and go back to being hunter-gatherers. "I don't hold with keeping people in what amounts to a zoo," he says.

In any event, the !Kung are no longer noble savages, if indeed they ever were, and what Poos describes as the "dirty little war" in Namibia is likely to continue for some time. It remains to be seen whether the !Kung are better off for having aligned themselves with South Africa but, considering the lack of opportunities for them and their extreme poverty, their behavior is certainly explicable. Says Harpending, "If I were a !Kung, I'd be doing exactly the same thing as they are just to feed my family." As for whether anthropologists should try to intervene to help the !Kung, says Lee, "We're damned if we do and damned if we don't."—GINA BARI KOLATA

# Lake Bottoms Linked with Human Origins

*The climatic backdrop to human origins in Africa is virtually blank. An adventurous project seeks to read climatic records trapped in lake bottom sediments*

Duke University biologist Daniel Livingstone has been nurturing what some might consider a wild idea for many years now: he wants to take a core through several kilometers of sediments at the bottom of one of East Africa's deep rift valley lakes. It's a project with considerable practical risks attached to it, and could cost upward of $10 million. Suddenly, following a sequence of events that has left him "surprised and a little breathless," Livingstone finds himself on the verge of fulfilling his dream. Backed by the National Science Foundation (NSF) and funds from a French oil company, a Duke University team will set out for Africa next month to do a preliminary seismic survey of three East African lakes. The results of the survey will determine which will be the chosen site for the coring program, supposing the required funds become available.

Why embark on such a risky and expensive venture? "We know in considerable detail the climatic history of Europe and North America over a period of several million years," Livingstone explains, "and yet equivalent records for Africa are very patchy indeed. Analysis of lake sediments is one of the best ways of reconstructing past climates, and the resolution is often good enough to be able to see season by season changes." Work with lake bottom sediments in Africa so far goes back just 45,000 years. If Livingstone's project is eventually carried out, the climatic record will run back a continuous 5 or even 10 million years.

In many ways the proposed lake core program is a dry-land extension of the massive Deep Sea Drilling Project (DSDP) that over the past decade has cost more than $160 million. And, like the DSDP, the lake project will be a rich source of information for geologists, geophysicists, and petrologists, in addition to providing a glimpse into the African continent's climatic history. But there are other bonuses too. For instance, biologists will be poring over the cores in search of clues to the mechanism of certain evolutionary processes. Strangest of all to relate, however, is the fact that perhaps the people most enthusiastic about the project are the paleoanthropologists, those who study human origins.

"In response to prompting from some prominent figures in the field," recalls John Yellen, director of NSF's anthropology program, "the Foundation organized a meeting in May 1978 to discuss major directions human origins work should take. Dan Livingstone was there, as an interested sympathetic outsider, and he mentioned his lake drilling idea as providing a way of sketching in the climatic and environmental background to human evolution." Livingstone has had a long interest in paleoecology and he appreciates the vital need for understanding the full environmental context of evolutionary change. He was, however, "pleasantly surprised at the enthusiasm with which the paleoanthropologists took up the idea."

A report of the meeting, drafted by Yale paleoanthropologist David Pilbeam, included a long list of recommendations, one of which was to increase the NSF human origins budget by $0.5 million each year for the next 5 years; another was to seek ways of supporting a lake drilling project. "The diversity and antiquity of tropical African lakes provides unique opportunities for obtaining a long stratigraphic record from part of the early hominid homeland and interpreting that record in terms of changing vegetation and climate. . . . It may even open the possibility of understanding human origins within a context of changing climates and expansion of nonforest habitats," recorded the report.

"The proposed incremental increase in funding has yet to receive Foundation approval," says Yellen, "but the lake drilling project immediately excited a lot of interest." Livingstone and Columbia University geologist Neil Opdyke were encouraged to submit a proposal for a preliminary seismic survey of a number of potential drilling sites. "Neil and I drew up a plan for surveying eight lakes, and we were staggered at the cost: $620,217; but this included funds for a planning meeting at which we would gather all kinds of specialists, including engineers and people from the Deep Sea Drilling Project."

Impressed though the NSF was by this cross-disciplinary project, the extent of its blessing was just one-third of the support requested, $217,000. "Most of the funds came from the directorate level, not out of the anthropology program," notes Yellen, an arrangement that reflects the unusual nature of the operation. "We had to trim the scale of the


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seismic survey from eight lakes to just two, though with an additional $130,000 from Elf Aquitaine, a French oil company, we can now add a third," says Livingstone. "And we'll have to transport a lot of the equipment by road rather than by air as we'd originally hoped," he adds with the resigned tone of one who knows well the endless opportunities for mishap that attends such a mode of transportation through central Africa.

August 1980 saw the planning meeting, held at the NSF headquarters in Washington, D.C. "At the end of the third day we made a blackboard list of the most suitable lakes, and then outlined the advantages and disadvantages of each," says Yellen. "With so many specific technical interests involved, and with the conditions at each lake varying so much, the final choice just has to be a compromise of some sort."

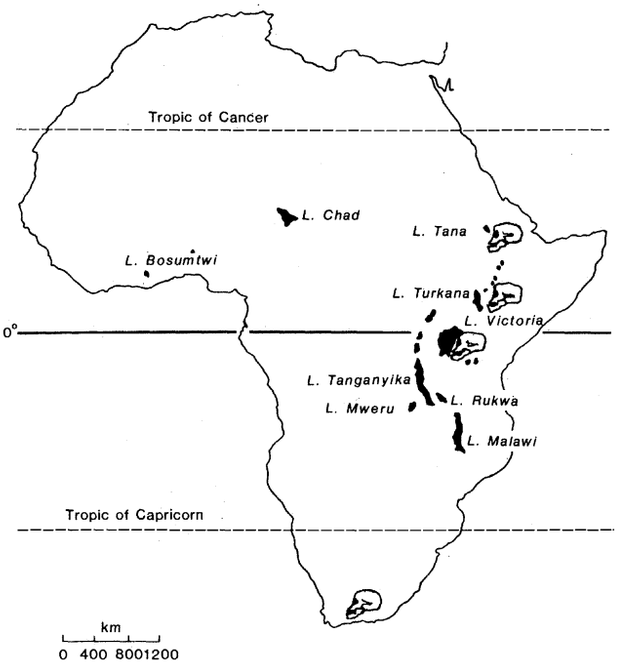
Take Lake Turkana, a 150-mile stretch of water in northern Kenya. The east shore of the lake is one of the richest sites for early human fossils in all of Africa; archeological and paleontological work is just beginning on the western shore, taking the potential fossil sequence back beyond 4 million years; and a large research team, including geologists, geophysicists, and biologists, is well established there. The paleontologists would dearly love to have a securely based climatic and environmental record for the area, against which to interpret more perceptively the important fossil sequences. Indeed, Lake Turkana is roughly at the center of all the major East African fossil sites. "Yes, there are many tempting reasons why one might want to choose Lake Turkana," admitted Glynn Isaac, the Berkeley archeologist who leads much of the work in the area.

It's not just the paleoanthropologists who have a deep interest in Lake Turkana. "This lake could be one of the most interesting of all," says James Natland, a member of the DSDP. "If you want to see how a continent is pulled apart by tectonic forces, then the lakes in the East African rift, such as Turkana, give you the best opportunity to see how fast and in what sequence things occur," he explains.

That would appear to be two strong votes for Lake Turkana. But there are problems. "One of the most important items in any core we take will be the pollen," says Livingstone, "and unfortunately the Lake Turkana area is very sparsely vegetated and therefore lacks a good pollen record." Without a sharp profile of windblown pollen from trees, bushes, and other plants it would be very difficult to infer a clear picture of the prevailing environment. "It's a combination of pollen, grass cuticles, and diatoms (single-celled lake-living organisms) in the cores that fills out the picture of past vegetation cover, moisture levels, and temperature," Livingstone says, "and an incomplete record could give us an incomplete picture."

Another problem with Lake Turkana is a practical one. "It would certainly cost $10 million, and the chances of striking a gas pocket and blowing the whole thing up are not negligible," warns Livingstone. Another problem with Turkana is that, because it is a large lake, it is often quite stormy. "The one great disaster would be to spend all that money and then not get a core," concurs Isaac. "Initially, I was all for going straight for Lake Turkana, but I now think it would be much better to do something with less risk where we can get a solid achievement, and then drill in Lake Turkana," he says.

This tactic of choosing a smaller, less stormy lake on which to test the project's techniques at low risk appears to be prevailing. "If we went to NSF to do this we could probably manage with about $1 million, and then when we had got a core we could go back to ask for the big one," suggests Livingstone. "NSF would be much more likely to be willing to support us once we'd proved the system works." With his DSDP experience behind him, Natland feels he must disagree with this cautious approach. "The techniques are definitely well established to drill in the East African lakes," he avers; "that's what they should go for."



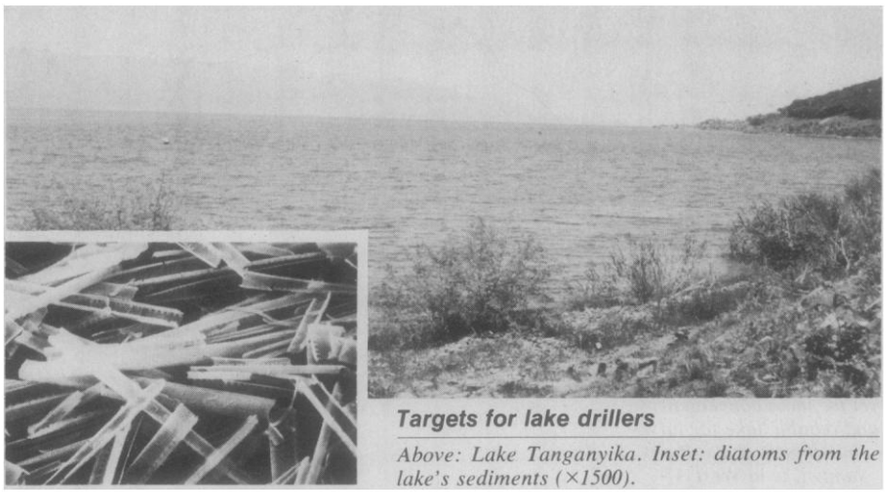

**Lakes of Africa**

*All the major archeological sites (denoted by skulls) are located in East and southern Africa. The lakes of interest to geologists, for tectonic information, are in East Africa. And yet the most convenient and reliable lake for an initial core, Lake Bosumtwi, is in West Africa.*

The smaller, safer lake that Livingstone has in mind is Lake Bosumtwi in Ghana, West Africa. Formed about a million years ago by meteor impact, the lake is shallow and sheltered, its sediments are undisturbed by tectonic activity, pollen and grass cuticle preservation is excellent, and it is readily accessible for the import of drilling equipment. "It's well situated to detect the expansion and contraction of the Sahara, and there's no doubt that we'd get a good climatic profile from the cores," says Livingstone. But: it is very far from the early fossil sites; it is only a million years old; and the lack of tectonic activity that has left the sediments intact makes the lake so much less interesting to the geologists.

Back in the east, what of Lake Tanganyika? The very deep sediments may contain a vast climatic record, with good pollen and diatom preservation; the high organic content makes it particularly interesting to geochemists studying the processes of petroleum formation; and many species of fishes and other organisms are endemic to the lake, making it a potentially fascinating source of information about the mechanisms of evolution. But: the lake is very deep and stormy; and faulting in the rift may make it impossible to take a continuous core.

Seismic surveys already completed show that Lake Bosumtwi is suitable for retrieving a continuous core, and the studies that Livingstone's colleague Bruce Rosendahl is soon to begin will produce verdicts on the structure of the sediments in Lakes Turkana and Tanganyika. The third lake in Rosendahl's



**Targets for lake drillers**

*Above: Lake Tanganyika. Inset: diatoms from the lake's sediments (×1500).*

survey is to be Lake Malawi. Like its rivals, it has a mix of advantages and disadvantages. One particular disadvantage it suffers, however, is that it is surrounded by leguminous woodland, and this might tend to buffer the record against significant climatic change. As Karl Butzer of the University of Chicago warns, "You might just see a continuous succession of forest that would tell you nothing whatsoever."

Butzer is also skeptical about the utility of just one, or even a small handful, of cores, no matter how clear a record each shows. His criticism is on two levels: microenvironments and climatic zones over the continent as a whole.

"A good climatic backdrop would make the hominid fossils much more valuable," he says, "but we're talking of evolution to do with microenvironments, mosaic habitats. You need to know about subtle environmental and climatic variations over relatively narrow areas," he insists.

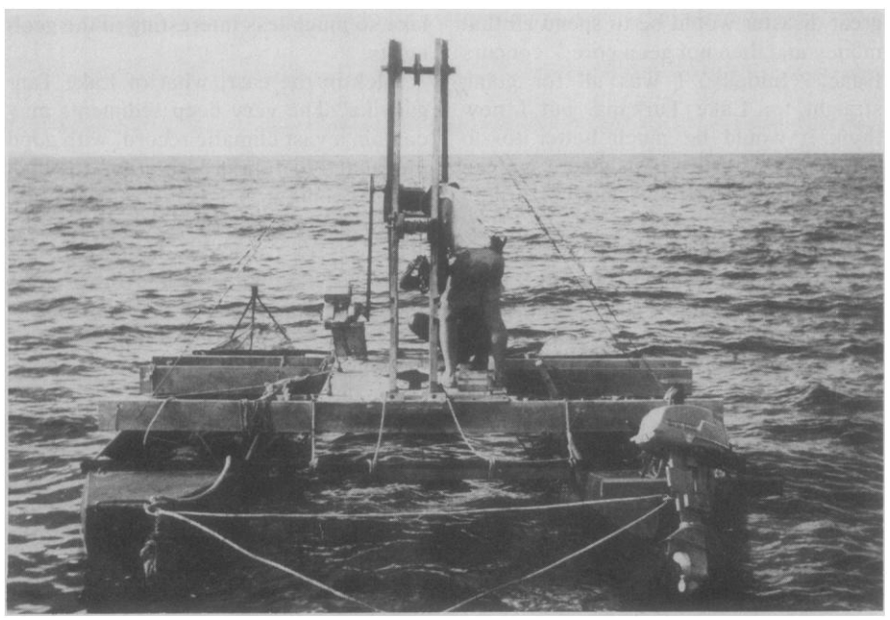
Butzer has made many studies of Africa's climatic history, and he has noted, as have others, indications of significant geographical inconsistencies. For instance, Chicago paleoanthropologist Richard Klein points out that "sometimes it has been relatively dry in East Africa while at the same time being relatively moist in southern Africa." Klein admits that "this is always going to be a difficulty." Livingstone suggests, however, that "even with information from cores taken only from the equator I could make a pretty good guess at climatic changes occurring in southern Africa."

Isaac takes Butzer's challenge about microenvironments, saying, "Sure, human evolution is related to complex environments, but we need to know something about how these environments changed as a whole; at present we know virtually nothing." He adds a barb: "Invoking mosaic habitats can be an excuse for not having to explain anything." Pilbeam agrees: "It's unlikely that any habitat is not mosaic to some extent, except steppe or tropical forest," he says. "Any information we can get about past climates in that part of the world will be better than what we have now," he admits, echoing Isaac's lament. "Many of the stories told about human evolution and the expanding savannah are just that—stories," Pilbeam says sharply.

It is therefore easy to see why the paleoanthropologists are so enthusiastic about the lake drilling project: the cores will provide facts where previously there were fairy tales. "A good climatic profile is essential background for understanding evolutionary patterns," agrees Livingstone, "but it's difficult to see what specific paleoanthropological questions might be answered by this project." This is not meant as a criticism, just a statement. Isaac offers no specific question to be answered: "It would be simplistic to look for simple associations between shifts in climate and changes in the human evolutionary pattern," he states, "but it would be important to see whether the prime feature of human beings—behavioral flexibility—evolved against a background of oscillating climates. We need to know what these early hominids had to cope with."

The project began life in the paleoanthropologists' cradle, and, if it eventually goes ahead with NSF and possibly European backing, no doubt human origins will play a prominent role in the inevitable public relations program. But, as Yellen is first to admit, "the project is now about much more than just paleoanthropology." Indeed, paleoanthropology is rather a small part of its scientific justification: "It wouldn't float on that alone," observes Yellen.

On a practical level, Natland comments, "There's more science, dollar for dollar, in this lake drilling program than there is in the Deep Sea Drilling Project." But Livingstone is intrigued by the less tangible unknowable possibilities. "When you do things like measuring something at two orders of magnitude more accurately than you could before, or you drill vastly deeper than you've gone before, then you usually come up with something unexpected and interesting," he observes. "This is one of those projects."—ROGER LEWIN



***Drilling raft on Lake Tanganyika***

*Test cores can be made from a raft. Full cores require a boat and heavier equipment.*