measurements is to resolve the details of the quantum states in systems in which the interaction between electron spin and orbital angular momenta are important. For example, in solids the quantum states are arrayed in bands, which may be split by the so-called spin-orbit interaction into multiple bands. In one experiment published last April, a group headed by Ulrich Heinzmann of the Fritz Haber Institute characterized the surface quantum states of platinum by this means.

BESSY was built and commissioned remarkably quickly. Following formation of the company, groundbreaking took place in September 1979, with construction finished in 2 years. The first stored beam was achieved immediately, and after a 6-month commissioning process, the facility was opened to its first users.

The combination of adequate funding and Mülhaupt's conservative approach to the accelerator complex no doubt go a long way toward accounting for the success. Comparison of total costs of American and European projects is always a contentious undertaking, partly because of shifting currency exchange rates, different accounting practices, and variations in funding mechanisms. But no one would argue against the proposition that, as compared to the NSLS, for example, BESSY has been well supported.

Although not so widely appreciated then as now, accelerator specialists have always understood that it is much better to inject the large electron currents needed for a powerful synchrotron radiation source into the storage ring at the energy at which the beam will circulate. The synchrotron radiation acts immediately to calm down the beam, which is always jittery immediately after injection, whereas there is not much radiation emitted for this purpose when the beam energy is low.

A so-called full energy injector (which usually means a synchrotron of energy equal to the storage ring energy) is expensive. But BESSY has one, and this has enabled operators there to bypass some of the problems encountered in the NSLS x-ray ring and at the University of Wisconsin Synchrotron Radiation Center, where accelerator operators are still trying to commission a storage ring similar to BESSY (*Science*, 11 January, p. 154).

Another BESSY feature is the ability to vary the magnetic optics of the storage ring. The optics determine how tightly focused the electron beam is, as measured by the parameter called the emittance. A low emittance translates into a small beam and hence a bright source. BESSY has both high- and low-emittance optics. Since it is easier to operate with a high emittance, this was the mode chosen until accelerator engineers learned how to accumulate and store large currents (several hundred milliamperes) reliably. In recent months, only the low-emittance optics have been used with beam currents of more than 600 milliamperes and beam lifetimes of 3 hours.

As successful as BESSY is, between runs the eyes of synchrotron light researchers around the world are increasingly turning to third generation or ultrahigh-brightness sources, such as the x-ray generating machines being planned in the United States (*Science*, 25 January, p. 396) and Europe (*Science*, 27 July 1984, p. 391 and 14 December 1984, p. 1294). So plans are already forming for a BESSY II, which would again concentrate on serving ultraviolet users. Mülhaupt says he does not expect a formal proposal to be made until about 1988 and, assuming approval, construction to begin before the next decade. But one can already assume that, when BESSY II does arrive, it will be a beauty.

—**Arthur L. Robinson**

Paleoclimates in Southern Africa

The Antarctic ice sheet has probably been an important driving force of African climate and biotic evolution; this idea begins to be tested

The slightly bizarre, Las Vegas–like setting of Sun City, Bophuthatswana, southern Africa, was the venue of a recent workshop* on paleoclimates and evolution, the second in a series of five or six such gatherings contemplated over the next 5 years. The overall aim of the workshops is to see what—if any—patterns of speciation and extinction are to be discerned in the fossil record during the past 25 million years; to discover how—if at all—these patterns relate temporally to global and local climate change; and, if there is a relationship, to decide if it is causal.

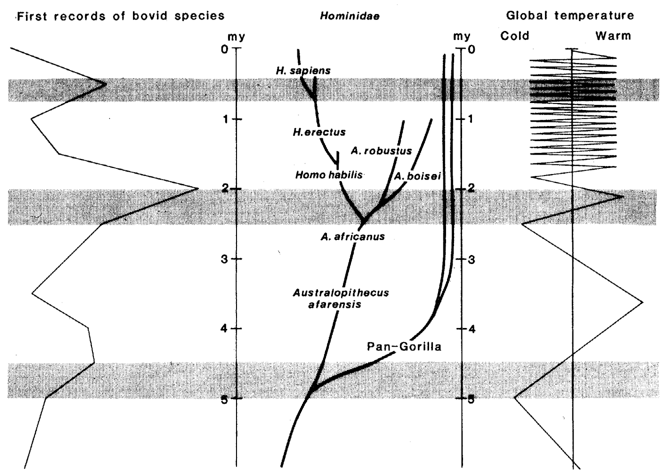
The first workshop, held last fall at the Lamont-Doherty Geological Observatory, New York, reviewed glacial information relating to the Antarctic, climatic and microfossil evidence from deep-sea cores from around the globe, and terrestrial faunal evidence, principally from East Africa and Eurasia (*1*). The Sun City gathering concentrated, appropriately enough, on southern African.

The conclusion from Lamont, as expected, had been that the deep-sea record is far superior in quality and continuity to the continental data. The same can be said of the second workshop, only more so. For instance, John Harris, of the Los Angeles County Museum, pointed out that barely 40 percent of the Miocene (25 to 5 million years before present) is at all well represented faunally in the southern African sites. And Elizabeth Vrba of the Transvaal Museum, Pretoria, remarked that, for a variety of reasons, accurate dating of material continues to be a severe problem.

"Nevertheless, it was extremely valuable to obtain an overview of what is currently available," said C. K. Brain, also of the Transvaal Museum, "even if it turned out to be rather less rosey than one had anticipated." As a result of the meeting, the South African Society for Quaternary Research has asked Tim Partridge of the University of the Witwatersrand to convene a group whose responsibility is systematically to develop sites that will begin to fill in some of the temporal gaps

The notion that the environment—specifically environmental change—is important in evolutionary change has long been part of biological theory. As a result there is a diversity of hypotheses about how this might occur and how it might manifest itself. Vrba has been developing an additional hypothesis, called the turnover-pulse hypothesis, which draws variously on the ideas of punctuated equilibrium and vicariance (the fragmentation and coalescence of species' geographic ranges).

*Workshop on Neocene Paleoclimates and Evolution in Southern Africa, Sun City, Bophuthatswana, 6 and 7 February 1985.



Species turnover and climate

Increased first appearance of bovid species accords well with global coolings. This picture of hominid history, which would be disputed by some authorities, also fits the pattern.

Put simply, the hypothesis predicts that under conditions of significant climatic change diverse lineages will undergo evolutionary change—speciation and extinction—synchronously. For various reasons, not all lineages will be pushed into evolutionary change when the environment is modified through climatic shifts, but those that do will do so in concert. No other current evolutionary hypothesis specifically predicts such a pattern. Hence the search for patterns that is being undertaken through these workshops is a test of competing evolutionary hypotheses.

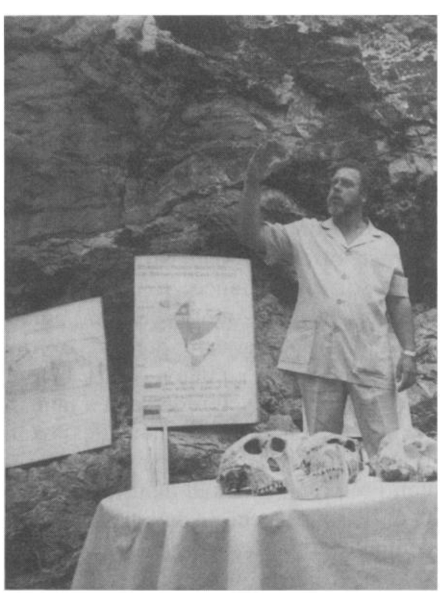
It has recently become clear that climatic effects of polar ice sheets are very much restricted to their own hemisphere. For southern Africa, therefore, the Antarctic ice is probably driving its climate and perhaps its biotic evolution. The problem here, as George Denton of the University of Maine recorded, is that although a good deal of the southern ice sheet's history has recently been reconstructed, much of it is from indirect inference.

Although there is evidence of earlier ice, many experts agree that the first sheet was probably in place around 15 million years ago, since when it has fluctuated in extent, growing to massive proportions at least three times and collapsing—perhaps disappearing altogether—on an unknown number of occasions. The ice sheet is thought to have been restricted at first to the mainly land-based eastern sheet, with the marine-based western sheet (in the Ross and Weddell seas) developing about 5 million years ago, that is, at the end of the Miocene. There are signs of warmer times following the Miocene/Pliocene boundary, with a possible disappearance of the ice sheet between 3.1 and 2.5 million years ago. Then, at 2.4 million years ago there was a short-lived but very severe cooling, which may have occasioned a build-up of ice that overrode the Transantarctic mountains. This event was accompanied by apparently the first appearance of the northern ice sheet.

In addition to these events, data from southern ocean microfossils indicate times of cooling at 10.2 and 8.9 million years ago, which so far at least are not reflected in the Antarctic record.

Working mainly with plant and pollen records, E. M. van Zinderen Bakker and J. A. Coetzee of the University of the Orange Free State have independently been piecing together something of Africa's climatic history through the Neocene. One of the main climatic signals has been the fluctuation in extent of the Congo Basin rain forest. Very extensive in the middle Miocene, some 15 million years ago, it shrank about 9 million years ago, expanded between 8.8 and 6.4 million, and experienced a dramatic contraction at 5.2 million. This latter period coincides with a marked global cooling, fall in sea level and the concomitant drying of the Mediterranean.

Forest expansion resumed between 5 and 3.5 million years ago, followed by reduction in the 3.5- to 3.2-million period, the time at which the Sahara Desert was established. A brief warm, moist period presaged the dramatic cooling and drying of 2.4 million years ago. Data are relatively poor during the late Pleistocene, but pick up again at a number of cave sites in the Cape area, which record the climatic effects of the glacial fluctuations leading up to the warmer Holocene, 10,000 years ago.



Partridge explains sedimentation in the Sterkfontein cave, the Transvaal.

The coincidence between Antarctic ice advances and continental cooling seems clear at 5 and 2.3 million years and the later part of the Pleistocene. Just how fine-grained a match can be achieved remains to be seen. Denton hopes that within the next few years direct evidence on the configuration of the Antarctic ice will allow accurate reconstructions to be made for particular periods, which can then be fed into a mathematical climatic model, such as that of Syukuro Manabe at Princeton. Such a model, which has recently produced some success with Northern Hemisphere calculations, should be able to predict climatic conditions prevailing in the Southern Hemisphere at chosen periods.

With the possible notable exception of fossil data on antelopes (bovids), which unfortunately are restricted pretty much to the late Miocene onward, attempts to trace faunal responses to environmental change in southern Africa are at present unwise, if not impossible.

Vrba has been developing the bovid data for some years and finds them to be good predictors of environment. For instance, in areas with low rainfall and therefore a low ratio of tree to grass cover, the Alcelaphini (the hartebeest-wildebeest-blesbok group) and Antilopini (the gazelle-springbok group) together never represent less than 65 percent of the antelope population. Using such data, Vrba was able to identify a distinct shift in climate to cooler, drier times between the occurrence of the hominid *Australopithecus africanus* at the Sterkfontein caves in the Transvaal and the first appearance of the robust australopithecine, *Australopithecus robustus*, and *Homo* in the nearby Swartkrans cave and in a later member of the Sterkfontein sediments. This change occurred somewhere between 2.5 and 2.0 million years ago, which turned out to concur nicely with data from East Africa.

In addition to being good indicators of environment, the bovids, being highly speciose and having high habitat specificity, present a good potential test fauna of the turnover-pulse hypothesis. So far the fit between environmental cooling, which fragments the bovids' habitats, and increased rate of species turnover looks good at 5 and 2.4 million years ago. These two dates, incidentally, coincide suggestively with the possible origin of hominids and the subsequent origin of *Homo*. A third peak in bovid speciation occurs around 0.5 million years ago, which coincides with the probable first appearance of *Homo sapiens* and follows a climatic cooling, mainly recorded in the north, initiated at about 0.9 million years ago.

By themselves, the hominid data cannot be used to test the turnover-pulse hypothesis, because they are so sparse. But, to some eyes at least, they do fit the requirement of turning over in concert with other lineages.—**ROGER LEWIN**

Reference

1. R. Lewin, *Science* **226**, 154 (1984).

Why Do People Get Fat?

A group of researchers at Rockefeller University has evidence that the signals to overeat may come from the fat cells themselves

Living on the ward at Rockefeller University is a man who weighs 500 pounds. He has numerous medical problems, and when these get overwhelming, he "is available for study at the clinical research center," says Jules Hirsch of Rockefeller, "where we take a couple of hundred pounds off of him." That is why he is there now. But after reducing his weight somewhat, he returns home, only to put the weight back on again.

The question is, Why is this man so fat? And why are 34 million Americans at least 20 percent above their desirable weights? Few people want to be obese, but it is inordinately difficult for overweight people to get their weight down to normal and keep it there. The recidivism rate in obesity treatments is estimated at more than 95 percent for the morbidly obese and about 66 percent overall.

After decades of research on the causes and effects of obesity, Hirsch is certain that it is not just a matter of slovenliness or poor eating habits or a lack of good nutritional information. Nor is it a problem that just requires some behavioral modification. "We are absolutely convinced that when a person says he can't control his eating, there is a biological basis for it," Hirsch says.

And, at last, Hirsch and his associate Rudolph Leibel believe they are on the right track to specifying just what that biological basis is. The signals to eat seem tied to the biochemical status of the fat cells themselves, Hirsch and Leibel find. They emphasize that they do not have a way to chemically prevent people from wanting to overeat. But they do think they can tell when a person's fat cells are in a state that will result in overeating, and they do think they can explain, in biochemical terms, why some people put on weight primarily in their hips and others tend to gain weight in their abdomens. In addition, Hirsch suspects that it is the metabolic state of fat cells that makes obesity a health hazard and that those fat people whose cells are biochemically normal may be healthier if they stay obese than if they reduce and make their cells metabolically abnormal.

The story begins with an observation that has been made by numerous researchers over a period of decades: most animals seem to have stable weights. If they are given all they want to eat, they somehow eat just enough to maintain their weights at their own particular ingrained levels. If they are force-fed, they get fatter, but the moment the force-feeding is stopped, their weights return to normal. If they are semistarved, they lose weight, but the moment they are given free access to food again, their weights return to normal.

Then researchers began to investigate whether an animal's stable weight, sometimes called its set point, has something to do with the fat cells in its body. Fat cell number is not necessarily fixed, says Irving Faust of Rockefeller, although once an animal gains fat cells it never loses them. But what does seem to be closely regulated is how large fat cells become. "Fat cell size is elastic and the cells can store very small or very large amounts of lipid," Faust remarks. "An animal with neurological lesions [that cause it to grossly overeat] has fat cells that are 4 to 5 times larger than normal. On the other hand, we can push the fat cell size in any animal to a bare minimum by depriving it of food. Knowing this, it is interesting to observe that if you leave an animal or a person alone, their fat cells will stay constant in size. It suggests to us that there is some sort of regulation in effect. We feel that there are signals between the fat tissue and the central nervous system." In obesity, these signals may be perturbed, Hirsch and Faust point out, because obese people tend to have fat cells that are two to two and a half times larger than normal.

The Rockefeller University researchers did two kinds of experiments to look at the influence of fat cell number on total body fat. In one, they looked at what happens when rats have double the usual number of fat cells. These rats, Faust and Hirsch found, regulated the size of their fat cells so that they were always the same size as the fat cells of control rats fed similar diets. But, since they had twice as many fat cells, they were twice as fat as the controls.

Faust also tried the reverse experiment. He took young rats and cut fat out of them so that they had only half as many fat cells as their littermates. Once again, these experimental rats seemed to regulate their fat cell size, not total body fat, when they were given high-fat diets, normal diets, or were deprived of food. In all circumstances, they were half as fat as the controls.

Now, says Hirsch, take a look at people. "We can take obese people and reduce them in the hospital so that their body weight is perfectly normal. But then we discover an astonishing thing. They are not normal. They need fewer calories than people who weigh the same as them but who were never obese. Their caloric need is 25 percent below normal and it persists that way forever. There is also abundant evidence that when you get normal volunteers to gain weight, they start to burn more calories." It is as though the body adjusts its metabolism to encourage a particular fat cell size.

Hirsch and Leibel are following a group of women and one man who belong to Overeaters Anonymous. All are formerly obese, weighing more than 200 pounds before they dieted and got their weights down to normal. But although