baleen gave Schell and Haubenstock an independent way of determining the length of the carbon-13/carbon-12 cycles. With this method they confirmed that the cyclic isotopic changes were annual.

The isotopic shifts in the baleen, along with isotopic studies of whale muscle tissue, enabled Schell and Haubenstock to estimate where the bowheads were doing most of their feeding. Contrary to previous thinking, says Schell, the whales are getting about 60 percent of their food in the Bering Sea, and not from the Beaufort. Schell hopes that with further work comparing carbon and nitrogen isotope ratios, his group will be able to pinpoint where the whales spend their time.

"One of the most important aspects of this whole study is to find out where the animals' energy comes from at different times of the year," he says.

The annual isotopic shifts also enable Schell and Haubenstock to determine the age of the animals. Until now, scientists have estimated bowhead ages by looking at the size distribution of bowheads harvested by Eskimos and assuming that the largest numbers were 1 and 2 years old. With the baleen, however, the researchers have found that the whales are considerably older than they were reported to be in the literature. This technique, says Schell, provides marine biologists with a powerful tool for describing life histories of the bowheads, including their age of sexual maturation and their growth rates. It could also play a role in decisions about their management.

Schell plans to focus next on the isotopic variations of the zooplankton and to determine how oceanographic conditions, including El Niños, affect these variations. "This study has led us in so many directions so fast that it's been a full-time effort to keep up with it," he says.

Beyond its importance to the bowhead, Schell adds, the study demonstrates the use of stable isotope chemistry in ecological studies in general. "This use," he says, " . . . is the field of the future," as evidenced by the "rapid growth in the audience size of these stable isotope lectures" at meetings like the one in San Francisco. *—S. Weisburd*

The 2-million-year-old meat and marrow diet resurfaces

Two scientists have taken the first detailed look at a collection of stone tools and fossilized animal bones found in East Africa 25 years ago and, as a result, have put early human ancestors back on a red-meat and marrow diet.

Henry T. Bunn and Ellen M. Kroll of the University of Wisconsin in Madison say that early members of the human lineage appear to have hunted at least small animals and possibly driven predators away from still-meaty carcasses of large animals. Whatever the ratio of hunting to scavenging, choice pieces of prey were carried to the site containing the bones and stones.

"Given the large quantities of meat and marrow available during hominid [human-like species] feeding events, it is likely that cooperative food sharing on a scale unknown among modern non-human primates occurred nearly two million years ago," they report in the December CURRENT ANTHROPOLOGY.

In a sense, this conclusion brings paleoanthropologists full circle. About a decade ago, it was widely assumed that hominids were meat-eating hunters who took animal remains back to "home bases," where bones and stone tools were discarded. In the last several years this view has succumbed to a number of other explanations (SN: 3/9/85, p.155). Researchers have suggested that hominids mainly scavenged fat and bone marrow, with a few bits of remaining flesh on the side, at lion kill sites. Some investigators say that human ancestors were primarily interested in obtaining usable material such as tendons and skin from animal carcasses. Another proposal is that hominids were marginal scavengers of bone marrow from carnivore kills.

But Bunn and Kroll contend that the remains they studied, which were first uncovered in 1959, show that early hominids were avid meat-eaters. The collection of thousands of stone tools and fragmented animal bones was found at Olduvai Gorge, Tanzania, in sediment dating to 1.75 million years ago.

After reconstructing long-bone shaft fragments, the researchers found that skeletal parts at the site that could be clearly identified — which numbered about 3,500 — included a high proportion of prime meat-bearing bones from large, adult mammals and whole haunches of smaller mammals. This indicates, in their view, that selected, highly nutritious carcass portions were transported to the site.

The scientists then microscopically studied 172 bone specimens containing cut marks. These marks were concentrated toward the meatier, midshaft areas of limb bones from both small and large animals. According to Bunn and Kroll, the cut marks most likely resulted from the slicing motion of a simple, sharp stone tool edge. In bones from large animals, a higher proportion of cut marks occurs on nonlimb parts, add the investigators, since meat is more abundant on these animals' ribs, vertebrae and pelves.

This pattern, they say, suggests that "early hominids at Olduvai were butchering carcasses by an efficient and systematic technique that involved skinning, dismemberment and defleshing operations."

Since smaller animals are eaten rapidly by predators, the researchers hold that hominid hunting of these creatures was likely. They are less certain of how large animal parts were obtained. Hominids may have scavenged carcasses at times of the year when predators eat less of their prey, a practice documented among modern savanna predators. Hunting cannot be discounted, but Bunn and Kroll say it is most likely that hominids drove predators away from carcasses soon after the kill.

Some paleoanthropologists writing in the same issue agree with Bunn and Kroll's interpretation. Stanley Ambrose of the University of Illinois in Urbana-Champaign adds that the brain expansion of early *Homo* species around 2 million years ago would have required the consumption of nutrient- and energy-rich foods such as meat. Henry M. McHenry and Christopher J. O'Brien of the University of California at Davis note that a reduction in hominid cheek-tooth size at around the same time probably heralded a greater reliance on meat and on tools for food preparation.

Anna K. Behrensmeyer of the Smithsonian Institution in Washington, D.C., finds the evidence for carnivorous activity among hominids convincing, but adds a caveat. A previous study of bone weathering (SN: 4/26/86, p.261) indicates, she says, that carcasses slowly accumulated over five to 10 years at several Olduvai sites; thus, seasonal scavenging most likely took place. Bunn and Kroll contend, however, that bone weathering at the Olduvai site suggests carcasses were taken there over two to three years.

A more pointed criticism of the Olduvai study is lodged by Lewis Binford of the University of New Mexico in Albuquerque. Binford, who conducted a preliminary analysis of the same bone collection several years ago, says the data actually show that hominids probably scavenged bits of leftover meat and marrow from previously ravaged carcasses. Skeletal-part frequencies are similar to carcasses left behind by predator and scavenger animals, he asserts. Cut mark occurrence is overestimated in the study, according to Binford, and marks on bone shafts suggest hominids had difficulty processing limb remains. Extensive gnaw marks, he adds, indicate that predators and scavenging carnivores such as hyenas had first crack at the meatiest portions.

The proportion of gnawed bones, respond Bunn and Kroll, is markedly smaller than that now observed in spotted hyena dens. Furthermore, they note that similar cut mark frequencies were found on limb shafts at a more recent site of carcass defleshing by stone-tool-using modern humans. *—B. Bower*