to $16.2 billion in the current fiscal year (*2*, p. A-296, table 3.3). The number of families served by HUD low-income housing programs increased from 3.1 million in 1980 (*4*) to 4.2 million in 1988 and has climbed to 4.4 million today (*5*).

The budget authority figures have fallen because the federal government has shifted since 1980 from subsidizing new construction of low-income housing, where spending is authorized in advance for the life of the housing, to assisting the poor through rental subsidy certificates and vouchers, where spending is authorized one year at a time.

With federal, state, and local governments spending about $200 billion per year to help the poor, Dewhurst's suggestion that poverty in America is due to government apathy is hard to maintain. What he does not consider is that the poverty programs he touts are part of the problem, rather than part of the solution.

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Racemization Dating

The dismal appraisal of amino acid racemization (AAR) dating of fossil bones by Eliot Marshall (News & Comment, 16 Feb., p. 799) implies that this research has not yielded meaningful results. This one-sided assessment is championed by P. E. Hare and is apparently based on the controversy associated with the AAR dating of some paleo-Indian skeletons from California first published in *Science* in 1974 (*1*). It is important to put the California results in their true perspective.

AAR analyses of a fossil yield D to L amino acid ratios that can only be converted to age estimates if the rate of racemization (the rate of interconversion of the enantiomers) can be evaluated. This is best accomplished by measuring the extent of racemization in a reference specimen whose age is known from some other independent dating method (*2*). This "calibration" permits the calculation of the in situ rate of racemization, which can then be used, with certain well-defined limitations, to date other similar type fossil specimens from the area. Some fossil types appear to be better suited for AAR dating than others, although each has its own unique problems. The AAR dating of bones can be problematical, but no more so than their radiocarbon dating, because both methods are similarly dependent on the extent of bone protein preservation and the absence of contaminants.

In the case of the controversial California ages (*1*), the racemization rate in bone from coastal Southern California was calibrated with the Laguna skeleton, which had been dated at 17,150 ± 1,470 years when the conventional radiocarbon (β-counting) collagen-based method was used (*3*). The calibration constant thus determined appeared reliable because the AAR age of 26,000 years calculated for the Los Angeles skeleton was consistent with its radiocarbon age of >23,600 years (*3*). With the calibration constant derived from the Laguna skeleton, AAR ages of 40,000 to 50,000 years were calculated for other coastal Southern California paleo-Indian bone, such as the Del

Mar skeleton. The Upper Pleistocene ages for these skeletons were at odds with the dogma of when humans first settled the New World. Thus began the controversy, which raged for more than a decade, about the validity of AAR ages of bone. Curiously, there was little concern about the "old" radiocarbon ages of the Laguna and Los Angeles specimens used for AAR calibration.

The development in the early 1980s of the accelerator mass spectrometry (AMS) radiocarbon dating method permitted me, in collaboration with the Oxford University AMS faculty, to date the amino acid extracts used in the original AAR studies (*4*). The resulting AMS radiocarbon dates indicated that the Laguna, Los Angeles, and Del Mar skeletons were all less than 6000 years old. The conventional radiocarbon ages of the skeletons used for AAR calibration and verification were thus three to eight times too old, and as a consequence so were the AAR-based ages. I have shown that if the AMS radiocarbon ages for the Laguna and Los Angeles skeletons are used to recalibrate the racemization rate, AAR ages are obtained for the disputed skeletons that are generally consistent with their AMS radiocarbon ages (*4*).

The important lesson learned from these investigations is irrefutable. Namely, AAR dates, regardless of the type of fossil material, are accurate only if the specimen used for calibration is reliably dated. It is indeed unfortunate that AAR dating continues to be viewed in negative terms by archeologists and paleoanthropologists who could benefit from its use. For example, AAR dating appears to work well for tooth enamel, with the results obtained at Olduvai Gorge, Tanzania, providing the best demonstration (*2*). Assertions that the problems associated with the AAR dating of bones and other noncarbonate skeletal materials are "almost unsurmountable" impede progress and help foster attitudes by potential beneficiaries that AAR "is some sort of joke." The continuing investigations of AAR in fossils will determine on whom the joke has been played.

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Marshall tries in his summary "Racemization dating: Great expectations" to present a balanced view of where this geochronologic method now stands. In the process, however, he does disservice to the achievements of Jeffrey L. Bada of the Scripps Institution of Oceanography. The summary implies that Bada's use of amino acid racemization (AAR) techniques has been disastrous. The opposite is true. Bada has clearly demonstrated that AAR techniques not only are applicable—in carefully controlled studies—to geochronology, but his work has also led to important applications of AAR in other areas of scientific research. For example, with the AAR technique he has been able to determine the age of such diverse animals as narwahls and moose. His work established the basis for in vivo racemization studies of red blood cells, brain protein, and eye lenses in relation to the process of aging. The in vivo studies have led indirectly to the application of AAR in forensic chemistry. These examples show the remarkable imagination of Bada's research. Marshall's summary implies that Bada's early work was "nonsense." Quite to the contrary, the research has led to a better understanding of AAR in geochronology and to applications far beyond the dating of fossils.

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