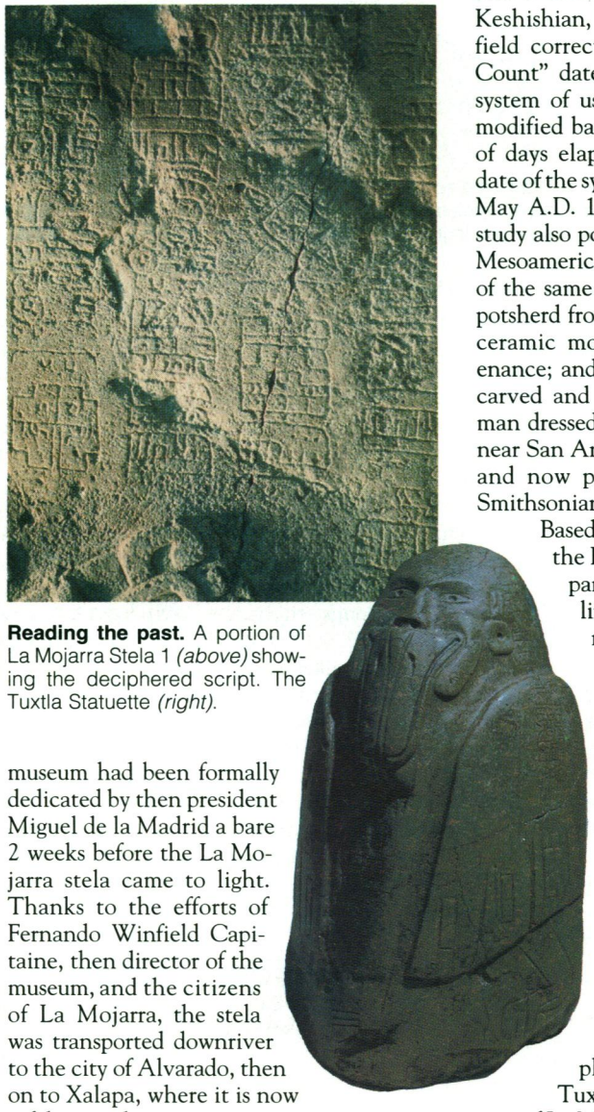
# The Carved Stela from La Mojarra, Veracruz, Mexico

George E. Stuart

For those experts who have seen it, La Mojarra Stela 1 is generally acknowledged as one of the most important carved monuments ever found in Mesoamerica by virtue of its second century A.D. date, its location in southeastern Veracruz State, Mexico, and the image and text it bears. All these factors make this single stone a sort of "missing link" in what is arguably the most important epoch of development in Mesoamerican culture history—the little-understood span of centuries between the time of the Middle Preclassic "Olmec" culture and the literate Classic Period civilizations of the Maya and others. In their article on page 1703 of this issue, John S. Justeson and Terrence Kaufman describe the methods behind their decipherment of the hieroglyphic script on La Mojarra Stela 1, and their result—the initial reading of the earliest complex writing system we know of in Mesoamerica.

The accidental discovery of the 4-ton carved monument of basalt took place in mid-November 1986 at La Mojarra ("the perch"), a small ranching and fishing settlement on the Acula River in southeastern Veracruz. According to the sketchy local accounts of the event, a crew of men was placing the log pilings for a small boat dock on the east bank when the bare feet of one encountered a large stone about 2 meters beneath the water. In that area of wide meandering rivers and deep alluvial deposits, stone of any sort is rare, and this one seemed not only large but unusually regular. The reason became evident when it was laboriously pulled from its muddy bed and lifted to the adjacent riverbank: The face of the massive stone had been smoothed, carved, and incised, and it bore the full-figure portrait of a richly attired individual and an unusually long hieroglyphic text. Considering the circumstances, the La Mojarra stela, though damaged in places by breakage and erosion, was in remarkably good condition.

Word of the discovery traveled rapidly and soon reached the authorities at the Museum of Archaeology in Xalapa, the justly famous repository of many of the greatest archaeological treasures of the state of Veracruz, including the finest of the colossal stone heads from San Lorenzo and other nearby Olmec archaeological sites. Coincidentally, new modern quarters of the Xalapa museum had been formally dedicated by then president Miguel de la Madrid a bare 2 weeks before the La Mojarra stela came to light. Thanks to the efforts of Fernando Winfield Capitaine, then director of the museum, and the citizens of La Mojarra, the stela was transported downriver to the city of Alvarado, then on to Xalapa, where it is now safely stored.



**Reading the past.** A portion of La Mojarra Stela 1 *(above)* showing the deciphered script. The Tuxtla Statuette *(right)*.

La Mojarra Stela 1 consists of a roughly trapezoidal slab of varying thickness finished on one side only. Its carved face is 2.34 meters high and 1.42 meters wide, and the monument was clearly designed to stand upright, for its lowermost portion—about one-seventh of the total height—was left plain. As may be seen in Fig. 1 of Justeson and Kaufman and on the cover of this issue, the area of carved surface is about equally divided between the depiction of the standing figure and the accompanying hieroglyphic text, which forms 21 vertical columns above and in front of the imposing portrait. Fortunately, most of the surface damage to the carving is confined to the lowermost portions of the figure.

The excellent description of La Mojarra Stela 1 published by Winfield Capitaine (see reference 12 of Justeson and Kaufman), accompanied by my drawing of the monument based on close personal inspection, detailed photographs by E. Logan Wagner, and a careful rubbing made by John M. Keshishian, has become a classic. In it, Winfield correctly interpreted the two "Long Count" dates—the ancient Mesoamerican system of using a five-place notation in a modified base-20 system to render a count of days elapsed since the traditional base date of the system—in the text as equal to 21 May A.D. 143 and 13 July A.D. 156. The study also pointed to other objects found in Mesoamerica that appeared to bear samples of the same script, among them an incised potsherd from Chiapa de Corzo, Chiapas; a ceramic monkey face of unknown provenance; and the famed Tuxtla Statuette, a carved and inscribed nephrite figure of a man dressed as a duck, plowed up in a field near San Andrés Tuxtla, Veracruz, in 1902, and now part of the collections of the Smithsonian Institution.

Based on evidence in the main body of the La Mojarra stela text, and an apparent offset in certain calendrical linkages they see reflected in date notations of the period, Justeson and Kaufman put the actual date of the monument some 3 years after its latest Long Count date, or at about A.D. 159. The Tuxtla Statuette bears a Long Count date equal to 14 March A.D. 162—less than 3 years after the latest date assignable to La Mojarra Stela 1. By coincidence, the very individual depicted by the Tuxtla Statuette is apparently mentioned on the La Mojarra stela—not too surprising, given the closeness of the dates and the geographic proximity, for San Andrés Tuxtla lies only about 60 kilometers east of La Mojarra.

Even within the greater context of ancient Mesoamerica, defined by anthropologists as the area that reaches from the high volcano-studded plateau of central Mexico to the rain forests of the Yucatán Peninsula and adjacent areas of Central America, the archaeological remains in the region centered by La Mojarra indicate it to have been an important focus of cultural activity from very early times on. During the Middle Preclassic Period (about 1200 to 300 B.C.)—and long before the carving of the La Mojarra stela—the region witnessed the florescence of the yet ill-defined cultures of the Olmec and other Middle Preclassic

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cultures, whose cross-influences are apparent in many areas of Mesoamerica during the period. The art of the Olmec and their Middle Preclassic neighbors appears to reflect many fundamental patterns seen in later Mesoamerican remains, including certain political and religious motifs and themes, the use of the calendar, and the beginning of writing—although examples of the latter are rare.

The archaeological picture of what happened in the La Mojarra region during the succeeding Late Preclassic Period (around 300 B.C. to A.D. 300), after the waning of Olmec culture, has proven to be one of the most perplexing questions facing Mesoamericanists. Fortunately, the dates on the La Mojarra stela fall within this "epi-Olmec" span. Just as important is the sheer size and weight of the monument itself: Unlike the Tuxtla Statuette and several other artifacts that bear samples of the same script, it is emphatically not a portable object whose appearance by the bank of the Acula River might be ascribed to ancient or recent caprice.

Justeson and Kaufman, faced with that which brings joy to even the most staid and sober student of epigraphy and linguistics, namely, a lengthy and uncommonly clear text in what stands so far as Mesoamerica's earliest complex system of hieroglyphic signs for words and syllables, have wrested much information from the La Mojarra stela. Using it and the much shorter inscription on the Tuxtla Statuette as an independent control (for no single text can serve alone as its own key), they identify the language of the text as pre–proto-Zoquean, an ancestor of languages still spoken in the heart of Mesoamerica and, perhaps, a direct descendent of the language spoken by the Olmec themselves. Many graphic elements in the script itself, they point out, appear closely related to later Maya hieroglyphic writing.

Fully as important as these purely linguistic and epigraphic deductions is the specific content of the La Mojarra text. According to the proposed decipherment, the 21 columns of hieroglyphs constitute a sort of Late Preclassic "political poster" dealing with the accession to power of the individual portrayed. The text refers to warfare, ritual activity, astronomical events, and calendar anniversaries. Such subject matter perfectly anticipates the content of later Classic Period images and inscriptions from the Maya area and elsewhere in Mesoamerica.

The discovery at La Mojarra reminds us that much remains to be done, not only in looking for previously unrecognized examples of this unexpectedly elaborate writing system, but also in systematic programs of field investigation among the silent mounds that fill the pastures of present-day La Mojarra and at other sites in southeastern Veracruz. It is surely one of the most crucial regions for our understanding of the course of culture and civilization in ancient Mesoamerica.

# Does *E. coli* Have a Nose?

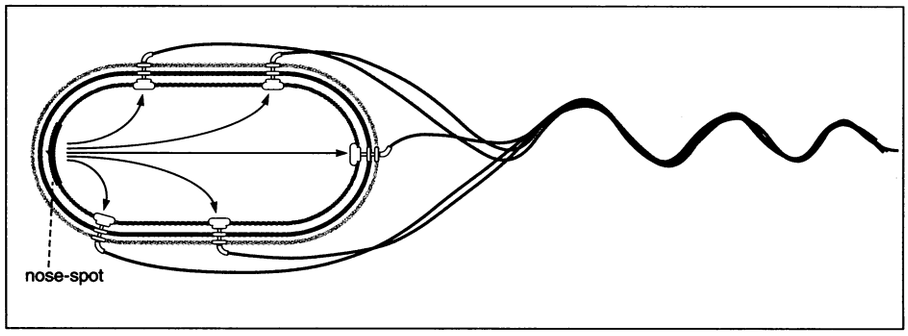
John S. Parkinson and David F. Blair

The remarkably sophisticated chemotactic behavior of *Escherichia coli* offers a tractable system for elucidating principles of sensory transduction at the molecular level. Julius Adler, who initiated modern work on bacterial chemotaxis in the 1960s, showed early on that *E. coli* has specific receptors for sensing chemicals in its environment (*1*). Although attracted to various nutrients and repelled by alcohols and other noxious compounds, the cells clearly detect the chemicals themselves, not the physiological benefits or harm they cause.

Unlike the situation in eukaryotic cells, where sensory receptors can be arranged in patches for spatial discriminations, the small size and rapid movements of bacteria effectively preclude gradient sensing based on comparison of chemical concentrations at different points on the cell. Instead, bacteria determine their heading in chemical gradients by measuring temporal concentration changes as they move about. Typical *E. coli* swimming speeds are 10 to 20 body lengths per second. By comparing current chemoreceptor occupancy with that during the previous few seconds, the cell is able to make measurements over distances of many body lengths.

If spatial discrimination is futile, how should a bacterium best deploy its chemoreceptors? The factors that limit the precision of measurements made by chemoreceptors were elaborated by Berg and Purcell (*2*). These authors concluded that for an idealized spherical cell, a uniform distribution of chemoreceptors would confer optimal sensitivity. Moreover, the capture of small molecules by cell surface receptors can be surprisingly efficient. About 3000 receptors, each with an effective radius of 1 nanometer, should be enough to capture half of all the molecules that diffuse to a cell the size of *E. coli*. Although that number of receptors represents only a small fraction of the total surface area, their capture efficiency is high because a molecule, having arrived at a cell, will usually encounter the cell surface many times again before finally diffusing away. On average, a molecule makes hundreds of "tries" at finding a receptor but does not roam widely on the cell surface. Thus, if it lands in a sizable patch of membrane devoid of receptors, it will usually escape undetected.

Nonuniform receptor arrangements would appear to be a poor strategy for bacteria, if efficient detection is their main concern. Yet, two papers in this issue of *Science* convincingly demonstrate clustering of chemoreceptors in *E. coli* and its distant relative *Caulobacter crescentus* (*3*, *4*). The *Caulobacter* case can be rationalized in terms of its unusual life-style: a sessile, stalked mother cell buds off motile daughters with a polar flagellum. The juvenile swarmers are chemotactic and probably seek out good neighborhoods before maturing into mother cells by shedding their flagellum and growing a stalk. The immotile mother cells have no need for chemoreceptors, so newly synthesized recep-




***E. coli*'s nose.** Localization of chemoreceptors in a patch at the leading end of the moving cell may be the best strategy for smelling attractants and eating them, too.

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