(and thus their electrotonic length) increases so much that deep tubular membranes are, in effect, electrically isolated from the surface membrane. While this effect may occur to some extent, indirect evidence suggests that it is not sufficient to explain the observed blockade of excitation-contraction coupling. For instance, citrate-blocked muscle fibers did not show even local surface contractions in response to action potentials or intense applied depolarization. Also, the action potential evoked in citrate-blocked muscle fibers (Fig. 1) still shows an afterdepolarization, a feature attributed to transverse tubular depolarization which totally disappears in muscle fibers whose transverse tubules have been dissociated from the surface membrane by glycerol treatment (*12*). We think it more likely that transverse tubular calcium contributes to excitation-contraction coupling by crossing depolarized tubular membranes and directly or indirectly enhancing release of calcium from the terminal cisternae. In this regard it is of interest that hypertonic solutions, which also block excitation-contraction coupling, block calcium influx in crab muscle fibers (*13*). Alternatively, tubular calcium may contribute to excitation-contraction coupling by permitting the activation of some other calcium-releasing mechanism.

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7. The reduction in the measured input resistance in low [Ca^{2+}] solutions was due primarily to current leakage around the sites where the electrodes penetrated the muscle membrane; local microperfusion of this small region with a solution containing normal [Ca^{2+}] restored the input resistance (measured at −80 mV) to normal values and frequently restored the resting potential as well.
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Flake Tools Stratified Below Paleo-Indian Artifacts

Abstract. *In northwest Missouri, Lithic stage flake tools struck from prepared cores have been excavated underlying a Paleo-Indian fluted point assemblage. These assemblages were in two different loesses of the last glaciation. Thermoluminescent analysis of stone tools dates the Paleo-Indian occupations at 8690 ± 1000 B.C. and 12,855 ± 1500 B.C.; the Lithic stage occupations must be older than 13,000 B.C. on the basis of geologic correlation, lithic analysis, and cultural stratigraphy.*

Archeological excavations (*1*) conducted in 1975 at the Shriver site (23DV12) in Daviess County, Missouri (39°58′30″N, 94°5′45″W) (Fig. 1), have recovered stratified remains of a Woodland assemblage and a Paleo-Indian fluted point assemblage overlying a lower stratum of earlier cultural remains. These lowermost artifacts were manufactured predominantly from flakes struck from discoidal-shaped prepared cores, by a technique reminiscent of the Old World Levalloisoid technique. The recovery of such a flake-tool assemblage, deemed an important research goal (*2*), provides important information needed to delimit the early prehistory of North America (*3*) prior to the Paleo-Indian Period (*4*).

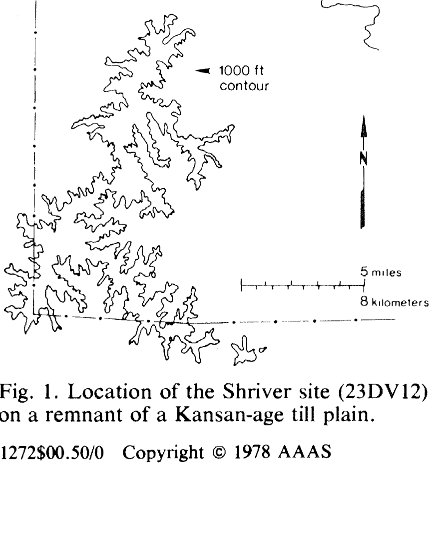

Fig. 1. Location of the Shriver site (23DV12) on a remnant of a Kansan-age till plain.

The Shriver site is located in an open-ground upland setting on a remnant of the eroded Kansan-age till plain (Fig. 1). The site sporadically but recurrently attracted early American inhabitants, probably in part because of a spring just 40 m away and the location of the site at the apex of a spur overlooking the Grand River Valley. Artifacts lie in the uppermost sedimentary units composed of deeply weathered loess.

A research approach including comparative geology, soil analysis, and palynology attempted to facilitate understanding of the geologic and cultural stratigraphy. Comparisons with known regional geologic profiles indicated that several loess depositions had occurred. Soil analysis, incorporating comparison of sand and clay size particle distributions and studies of phosphorus (P_2O_5) and potassium (K) patterns, indicates that the loess at the site could be separated into two deposits. The boundary of these deposits was an erosional surface ±40 cm deep. On this basis, site stratigraphy includes several sedimentary units tentatively identified by stratigraphic correlation as (i) unit 1, Bignell loess 8,000 to 13,000 years before the present (B.P.); (ii) unit 2, Peorian loess, 13,000 to 18,000 B.P.; (iii) unit 3, other glacial and erosional sediments; and (iv) unit 4, Upper Pennsylvanian bedrock. Amounts of fossil pollen preserved were inadequate to permit interpretation of a pollen column.

Cultural stratigraphy includes three

occupations within the first two geologic units. The uppermost was a Woodland Period occupation appearing just below the modern vegetational zone in heavily weathered humus. It was radiocarbon dated at A.D. 1110 ± 110 by charcoal from an excavated fire hearth located just under the present ground surface (5). Artifacts included only a few scattered chert flakes. The Paleo-Indian occupation occurs 30 to 40 cm below the surface in the base of the Bignell loess deposit. Tool forms in the Paleo-Indian assemblage include one fluted projectile point (Fig. 2A), several end scrapers (Fig. 2, B and D), as well as associated lithic debris.

When subjected to attribute analysis, the fluted point clusters with Folsom points rather than with typical Clovis projectile points. The associated flake assemblage lacks elaborate core preparation and burins of the lowest cultural stratum, but it does contain the spurred end scraper (Fig. 2C) common in Paleo-Indian assemblages. The fluted point assemblage lacks the large prismatic blades

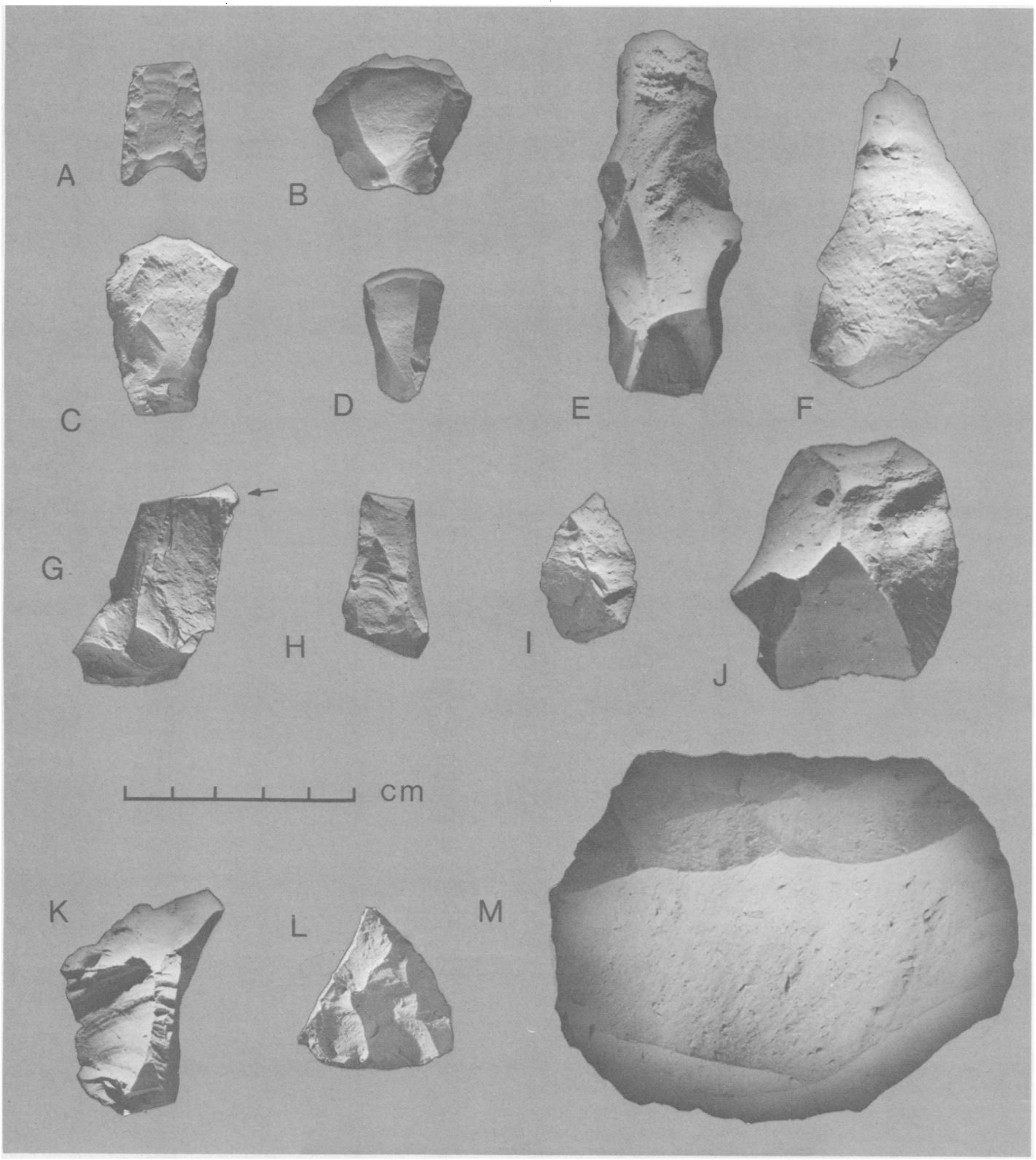

Fig. 2. A sample of stone tools from the Shriver site (23DV12). (A to D) Paleo-Indian. (E to M) Lithic Period. The artifacts are coated with aluminum hydroxychloride.

found at the Naco and Lehner sites (*6*).

The third and lowest occupation, located in the top of the Peorian loess unit, is characterized by (i) essentially unifacial tools; (ii) flakes, the overwhelmingly predominant blanks for manufacture; (iii) prepared tortoise and tabular cores for flake and flake-blade production, respectively (Fig. 2M); (iv) a low incidence of bifacialism; and (v) tool forms that are not readily characterized by preexisting typological categories in American archeology. The heavy utilization of these tools, visible both macroscopically and microscopically, fails to support the hypothesis that this site was merely a later chipping station for manufacturing tools. One of the forms represented is apparently the result of intentional production of curved flakes (Fig. 2K). Cores still bearing the negative scars of such flakes show that this result could be achieved by allowing one of the distal corners of a core to remain thick and high, so that the plane of fracture veered toward the thinner, less resistant corner. A preference for these curved flakes is also demonstrated by the higher proportion of these than other flakes being chosen for subsequent retouch (χ^2 test, d.f. = 1, N = 186, $P < .054$).

Cores from this level were prepared by peripheral flaking and often (58 percent) striking platform retouching (faceting), much like that of the Levalloisian technique widely used in Mousterian and contemporary industries in the Old World. While the cores broadly resemble Levalloisian ones, the shape of the flakes produced, including pointed flakes, are unlike Levalloisian flakes. Striking platform angle, as measured on both cores and flakes, averages 72°. Although striking platforms are often convex, the Levalloisian bell-curved *chapeau de gendarme* striking platform occurs only once, seemingly fortuitously. Because of these fundamental differences clearly seen in an entire unmixed assemblage, it would be well to avoid attaching the "Levalloisoid" label to this particular prepared core assemblage. Flakes constitute 84.9 percent of the assemblage, and flake blades, seldom retouched although produced mostly from a special kind of tabular core, constitute 8.2 percent. Those 92 retouched pieces excavated directly from beneath the fluted point provide the clearest evidence of the lithic technology of the lowest assemblage. With the exception of laterally retouched flakes, miscellaneous retouched flakes, a pick, and a chopping tool, the more familiar tool forms are end scrapers on flakes (7.6 percent), spurred end scrapers (5.4 percent), denticulated scraper planes (2.2 percent), spokeshaves (5.4 percent), strangled tools (1.1 percent), and steep end scrapers (2.2 percent).

Tools less familiar to New World archeologists, requiring categorization in somewhat novel terms [as Rouse expected might happen when a pre-fluted-point assemblage was encountered (*7*)], are boat-shaped pieces (2.2 percent) (Fig. 2E), transverse burins (4.3 percent) (Fig. 2G), burins on truncations (2.2 percent) (Fig. 2F), flat-faced burins (3.3 percent), wide-edged burins (1.1 percent), backed knives (5.4 percent) (Fig. 2H), beaks (6.5 percent), chisel-shaped corners (5.4 percent) (Fig. 2K), concave truncated flakes (1.1 percent), obliquely truncated flakes (5.4 percent) (Fig. 2I), pyramid scrapers (6.5 percent) (Fig. 2J), transversely retouched fan-shaped flakes (7.6 percent), scalloped end scrapers (4.3 percent), trihedral pointed tools from prepared cores (3.3 percent), and transected bifaces (2.2 percent) (Fig. 2L).

Lacking radiocarbon samples, age determinations were attempted by thermoluminescent dating (*8, 9*) of heated chert artifacts. The contrast between the glow response of heat-treated and untreated chert of the Pennsylvanian age is quite marked (*10*), even with cherts of low response such as the fossiliferous cherts from the Shriver site. The environmental radiation of 0.178 rad/year was determined by burying three calcium fluoride dosimeters in the soil for 6 months. Study samples were prepared for cherts ostensibly heat-treated on the basis of visual criteria by sawing off thin samples (2 by 2 mm), which were subsequently thinned to uniform thickness on a lapper. Heated materials from the top and bottom of the fluted point horizon were given an artificial dose of 2000 rads representing 11,236 years, giving dates of 8690 ± 1000 and 12,855 ± 1500 B.C. for this horizon, calculated according to the formula discussed by Gosku *et al.* (*8*). These independent dates agree well with the geologic stratigraphic correlation previously hypothesized for the region.

Six other samples from the lowest cultural strata were also tested, since by visual criteria they appeared to have been either intentionally or accidentally heated. Although they exhibited reduced thermoluminescence compared with freshly mined chert their calculated apparent dates were considerably varied, which implies low-temperature heating that would, in turn, obviate the possibility of accurately dating these samples by thermoluminescence. On the basis of dates for superimposed strata, these tools must date from before 12,855 ± 1500 years B.C. The position of these tools within the top of the Peorian loess deposit would suggest a date before 13,000 B.C.

Artifacts from the Shriver site represent stratified occupations of the Woodland Period, Paleo-Indian, and the Middle or Early Lithic (prior to 12.855 ± 1500 B.C.). Evidence from geology, soils, stratigraphy, lithic technology, and thermoluminescence tests congruently indicate that the lowest cultural assemblage of prepared core, chiefly unifacial tools, represents the lithic material culture of some of the earliest known inhabitants of North America, dating back into the last glaciation. This assemblage ought not be grouped with proposed preprojectile point cultures, as here there is a discrete industry of distinctive, if unfamiliar, tool forms. The antiquity of the assemblage may exceed any known from northeastern Asia, except Japan, and therefore perhaps provides a clue for Asiatic archeologists as to the kind of industries which might be found on the western side of the Pacific.

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An El Jobo Mastodon Kill at Taima-taima, Venezuela

Abstract. *Excavation at Taima-taima in 1976 recovered artifacts of the El Jobo complex in direct association with the butchered remains of a juvenile mastodon. Radiocarbon dates on associated wood twigs indicate a minimum age of 13,000 years before the present for the mastodon kill, a dating significantly older than that of the Clovis complex in North America. The El Jobo complex must have evolved independently in northern South America.*

The El Jobo lithic complex was first defined by one of us (J.M.C.) from a surface collection consisting of distinctive long lanceolate projectile points with thick cylindrical cross section, large bifaces, choppers, and flake tools found on a high flat in the valley of the Rio Pedregal in the state of Falcón approximately 70 km southwest of the town of Coro, Venezuela (*1*). Subsequently, several fragments of El Jobo projectile points were found in excavations at the water hole of Muaco, approximately 10 km east of Coro, together with bones of mastodon, glyptodon, and other extinct taxa (*2*). Burned bone from Muaco was radiocarbon dated between 16,000 and 14,000 years before the present (B.P.) (*3*). Since modern artifacts such as glass fragments were also found in the spring deposits, many archeologists doubted the association of man with the early-dated extinct faunal assemblage at Muaco despite published illustration of modified mastodon bone from the site (*4*).

In 1962 another water-hole site yielding bones of extinct Pleistocene fauna was found by J.M.C. and Alex Krieger at Taima-taima, about 3 km north of Muaco. J.M.C. subsequently excavated an extensive area at this site during four field seasons (*5*). In a basal gray sand unit, among bones of mastodon and glyptodon, he found three fragments of El Jobo points and one uniface knife or scraper, together with rough stones probably used as choppers or pounders and scarred long bones of mastodon probably used as anvils. A series of 14 radiocarbon dates ranging between 14,000 and 12,000 years B.P. from the water-saturated gray sand unit in which the bones and artifacts occurred were announced by 1971 (*6*).

Archeologists continued to express doubt about the antiquity of El Jobo points (*7*). Taima-taima was perhaps like Muaco: the deposits disturbed by spring action, the evidence of association of man with the extinct fauna perhaps fortuitous, the series of radiocarbon dates questionable. In view of the doubts, J.M.C. agreed with A.L.B. and R.G. to conduct further excavations jointly at the site of Taima-taima in the summer of 1976 in order to confirm the association of man with extinct animals and to clarify the stratigraphy and dating. C.O. contributed to paleoenvironmental studies at the site, and the faunal remains recovered were analyzed after the excavation by R.M.C. The results of these researches are conclusive. El Jobo artifacts were found in direct association with the skeleton of a young mastodon killed and butchered in situ approximately 13,000 years ago.

Fig. 1. The remains of the slain juvenile mastodon as exposed in the lower part of a saturated gray clayey sand stratum (unit I). The posterior portion of the skeleton is in the foreground.

The mastodon, a juvenile *Haplomastodon* to judge from the mandibular molars and the unfused epiphyses, had collapsed on its left side (Fig. 1). The mandible was lying about 3 m to the left of the skeleton. The cranium, all of the cervical vertebrae, and a number of the upper thoracic vertebrae had been removed; the entire right forelimb had also evidently been carried away. The left forelimb was dismembered, with six sharp cut marks at a tendon attachment point on the left humerus. Ribs remained in articulation with the lower thoracic vertebrae, and two ribs bore the marks of sharp knife cuts. Most of the remaining thoracic vertebrae were in line, but the lower part of the spinal column had been forcibly turned to the left. The pelvic bones were in anatomical relationship although splayed by collapse. The bones of the right hind limb were in anatomical relationship but the left hind limb had been dismembered. Most of the foot bones were missing, as well as all of the caudal vertebrae. No bones showed intentional breaking for marrow. Most importantly, there was no evidence of subsequent geological disturbance of the partially dismembered skeleton after it was buried by gray clayey sand.

Two flaked stone artifacts were exposed in situ in direct association with the skeleton of the young mastodon. The midsection of a quartzite El Jobo projectile point was situated within the cavity of the right pubis (Fig. 2). A utilized jasper flake was situated within 3 cm of the midshaft of the left ulna. In addition, a rough pointed stone cobble had been jammed in the right acetabulum between the head of the right femur and the acetabulum. Other rough stones found in the vicinity of the skeleton and likely used in the butchering process are being studied.

The mastodon skeleton was embedded in a water-saturated fine clayey gray sand zone (unit I) just above a pavement of cobbles and pebbles formed from a Miocene limestone. The area of the Taima-taima water hole is a much faulted and uplifted region of marine sand and consolidated fossiliferous limestone beds determined to be of Miocene age. Below the cobble pavement is a compact ma-