Explosions in the solid earth. Surface waves from the two largest nuclear explosions fired deep underground in Nevada were recorded at Palisades. Rayleigh-wave trains very similar to those recorded when the source was in the air over Nevada were detected. Periods of these waves range from about 13 to 6 seconds. In addition, Love waves in the period range between 19 and 7 seconds with amplitudes generally comparable to those of the Rayleigh-wave train were recorded. Identification of these waves is quite certain, being based on measurement of group velocity, phase velocity between Waynesburg, Pennsylvania, and Palisades, surface particle motion, and correlation between the two shots. Furthermore, Love waves in the same period-range were also recorded from one of these underground explosions by similar instruments at Resolute Bay, Northwest Territories, Canada. In this case, the amplitudes of the Love waves are, in general, larger than those of the Rayleigh waves. This surprising result indicates that the heterogeneities of the earth which are effective in producing transverse horizontally-polarized shear waves of short period, as indicated by data from nuclear explosions, are also effective in the case of wavelengths as great as at least 70 kilometers.

A discussion of methods for use of dispersed trains of long-period surface-waves to obtain information on the source, including an illustration based on Rayleigh waves from an underground explosion in Nevada recorded in Wyoming, has been published (*3*).

Most chemical explosions are considerably smaller in yield than the nuclear explosions discussed here. One study of surface waves from very large chemical explosions is that of Kogan *et al.* (*7*). Their results, based on two such explosions, suggest that long-period waves are excited more efficiently by natural earthquakes than by explosions of the same magnitude, but data are limited.

Although there is great contrast between the explosive sources discussed in this paper and natural earthquakes, and although several unexpected waves were generated by nuclear explosions, virtually all the waves so generated can be identified and explained in terms of our knowledge of seismic-wave propagation based on earthquake data. This clearly illustrates the great value of coordination between studies of these two closely related phenomena.

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Early Man Site Found in Highland Ecuador

Abstract. Field investigations in Ecuador have produced archeological evidence for the occupation of the northern Andes by early nomadic hunters. Surface collections and test excavations have demonstrated a complex of stone tools with typological relationships to level I at Fell's Cave in southern Chile, and technological relationships to the late Pleistocene "fluted point" complexes of North America. The date of these materials is estimated at 7000 to 8000 B.C.

From 23 January to 7 February 1960 we carried out preliminary investigations at an early archeological site in the Ecuadorian Andes near Quito. We located the site which had been reported to us earlier by Allen Graffham, an Ardmore, Okla., geologist, and collected a large number of obsidian and basalt artifacts from the surface of El Inga, a badly eroded hillslope flanking Ilalo Mountain, near the town of Tumbaco.

Obsidian artifact types found include several styles of projectile points, side and end scrapers, ovate blades, gravers, drills, prismatic blades, microblades, and small hemispheric polyhedral cores. Two projectile point styles appear from field observation to be most significant: the dominant style is a large stemmed point (Fig. 1*A*), identical in form to the points which characterize level I at Fell's Cave in Chile (*1*); one of the several minority styles, found only in fragments, is a lanceolate form (Fig. 1*B*) like the North American Clovis point. Both of these styles are characterized by basal and edge grinding and have irregular channel flakes removed from either one or both faces. They are, in fact, "fluted" points of two distinct forms.

Basalt artifacts are generally irregular, but well-made scrapers, choppers, "pulping planes," and manos, as well as used flakes and cores, have been recovered.

Two test excavations made in one of the uneroded portions of the site demonstrated that the artifacts are contained in the layer of dark soil 12 to 15 inches thick that comprises the soil mantle at the site. These tests clearly demonstrate the feasibility of extensive excavation at El Inga.

Typologically, there seem to be many elements at El Inga previously unknown in South America. The stemmed point of the Fell's Cave type seems the best chronological marker; in Chile it is associated with extinct sloth and horse, and has been dated by carbon-14 at 6900 B.C. The presence of the fluting technique and channel flake removal, as well as the lanceolate form, suggest early North American types. The presence of blades and microblades is rare for South America, but probably also

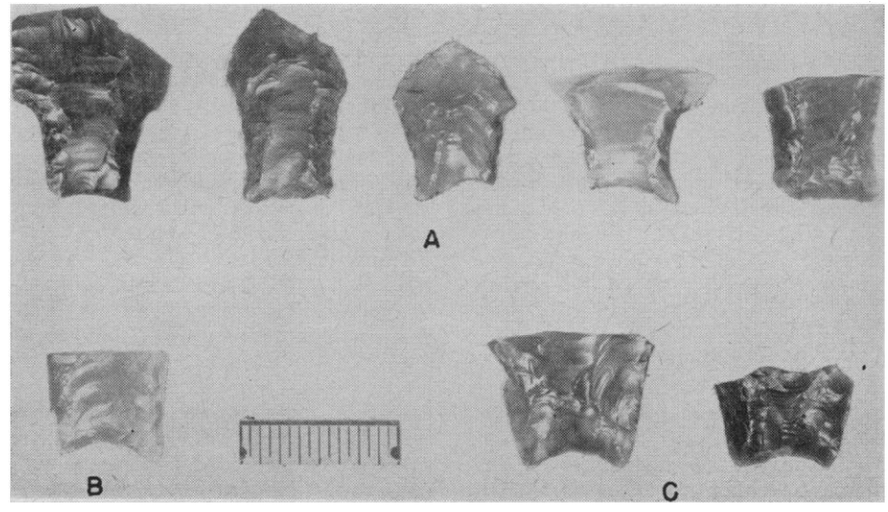

Fig. 1. Projectile points from El Inga, Ecuador. Marker represents 1 inch. (*A*). Fell's Cave (level I) stemmed type (fluted). (*B*). Base of "Clovis fluted" type. (*C*). Thinned bases of lanceolate type.

reflects a relationship with early North American technology.

Samples of the obsidian are being submitted to the Smithsonian Institution obsidian-dating project, but definitive samples must await the major excavation planned for the summer of 1960.

El Inga is considered to be the camp and workshop site of some of South America's earliest men. The inhabitants were probably part of the first wave of migrants from North America, and would thus predate the Fell's Cave people by a thousand years or more. In this interpretation it is quite likely that early North American styles and traits would be most prominent in northwestern South America.

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Response of Cupressus funebris Tissue Cultures to Gibberellins

Abstract. Gibberellins are a specific growth requirement of tissue cultures derived from the staminate cones of *Cupressus funebris.* The tissue originally required coconut milk for growth. However, a mixture of acid-hydrolyzed casein hydrolyzate and gibberellins replaces the coconut milk entirely and permits even better growth. It is tentatively suggested that coconut milk contains gibberellins or related substances and that these substances are involved in the nitrogen metabolism of the tissue.

Accounts of the effects of gibberellins on intact plants have been accumulating for several years. Stowe and Yamaki (*1*) have recently written two reviews concerned with this literature. Generally, the response of intact plants to gibberellins have been quite striking. These responses are most commonly manifested by spectacular increases in stem length, especially of certain genetic dwarfs, and in flower production by long-day plants with the substitution of gibberellins for the inductive photoperiod.

Attempts to elicit responses of tissue cultures to gibberellins have been rather disappointing. Netien (*2*) tested the effects of gibberellins on tissue cultures of *Helianthus tuberosus, Rubus sp., Daucus carrota,* and crown-gall tissue of *Scorsonera sp.* and observed that there was either no effect or a slight inhibition of growth. Various types of auxin used in conjunction with gibberellins did not change the response appreciably. Henderson (*3*) used tissues of *Helianthus annuus* as the test material and found no appreciable response to gibberellins. Nickell and Tulecke (*4*), in an extensive series of tests utilizing 49 strains of tissue cultures representing 25 species, found that inhibition of growth was the most common result of the incorporation of gibberellins into the nutrient medium. Two tissues died, while several showed a slight increase in weight over the controls. Schroeder and Spector (*5*) reported a synergistic action of gibberellins and indoleacetic acid in the induction of callus growth in explants of mature citron fruit tissue. Gibberellins alone were about one-third as effective as a mixture of gibberellins and indoleacetic acid. The greatest increase in fresh weight was about 100 percent at the end of the experimental period. It can be seen from this short review that plant tissue cultures in general have not been reported to respond very markedly to gibberellins.

The present report is concerned with a spectacular growth response to gibberellins by tissue cultures derived from the staminate cones of *Cupressus funebris.* These tissues were originally isolated by C. D. LaRue in 1954. After his untimely death in 1955, one of us (J. S.) acquired the tissues from his laboratory. The tissues were maintained on White's medium containing 20 percent (vol./vol.) autoclaved coconut milk obtained from mature nuts.

During investigations of certain aspects of the carbohydrate metabolism of the tissue, it became imperative to grow the tissue on a synthetic medium, or at least one which did not include unknown soluble carbohydrates. Consequently, attempts were made to replace the coconut milk with acid-hydrolyzed casein hydrolyzate, indoleacetic acid, adenine, kinetin, and 1,3-diphenylurea. These were used alone and in various combinations. None of the media so prepared permitted much growth of the tissue. However, when a medium containing acid-hydrolyzed casein hydrolyzate (2 gm/liter) and gibberellins (1 mg/liter) was tested, the tissue grew very well. Table 1 summarizes the data obtained with varying concentrations of gibberellins (*6*).

Concentrations of gibberellins between 0.5 and 2.0 mg/liter in conjunction with acid-hydrolyzed casein hydrolyzate permit better growth than coconut milk. Increased concentrations of gibberellins are somewhat inhibitory. Indoleacetic acid was tested for a possible synergistic action with gibberellins. A single concentration of indoleacetic acid of 0.5 mg/liter was tested with media containing different concentrations of gibberellins. In each case, the growth of the tissue was inhibited. The inhibition caused by indoleacetic acid ranged from 40 percent when used in conjunction with 0.1 mg of gibberellins per liter to 58 percent when added to media containing these substances at 2 mg/liter.

Table 1. The effect of concentrations of gibberellins on the growth of tissue cultures of *Cupressus funebris.* CH, acid-hydrolyzed casein hydrolyzate; GB, gibberellins. Concentration of CH in all cases was 2 gm/liter. The basal medium consisted of White's solution, 2 percent sucrose, and 0.9 percent agar.

Addendum to basal medium	Increase in fresh weight after 35 days (%)
None	84
Coconut milk, 20 percent (vol./vol.)	912
CH	228
GB, 1.0 mg/liter	260
CH + GB, 0.10 mg/liter	620
CH + GB, 0.50 mg/liter	943
CH + GB, 1.0 mg/liter	1003
CH + GB, 2.0 mg/liter	1004
CH + GB, 10.0 mg/liter	720
CH + GB, 20.0 mg/liter	538

It is tempting to speculate that gibberellins are somehow concerned with the nitrogen metabolism of the tissue. Without any organic nitrogen added to the medium, gibberellins at 1 mg/liter permit three times the amount of growth obtained on basal medium alone. Acid-hydrolyzed casein hydrolyzate added to the basal medium permits almost as good growth as gibberellins alone. Thus, while the tissues appear to be unable to utilize the inorganic nitrogen in the basal medium, under the influence of gibberellins some utilization is possible. The amount of growth under these circumstances may be limited by the low concentration of nitrate in White's medium (approximately 3.2 mmoles of nitrate ion). We have found that 2 gm per liter is the optimal concentration of the hydrolyzate for these tissues. It would seem, then, that gibberellins enhance the utilization by the tissue of both organic and inorganic nitrogen sources.

One of the implications of this work is that gibberellins or related substances are responsible for some of the growth-promoting activity of coconut milk for these tissue cultures, at least. Radley and Dear (*7*) have shown that extracts of the milk, solid endosperm, and embryo of the coconut accelerate the growth of dwarf peas. They therefore suggest that coconuts contain gibberellin-like substances. In addition, when one considers the report of MacMillan and Suter (*8*), which announced the isolation of gibberellin A from young seeds of the runner bean, and the specific response to that gibberellin by