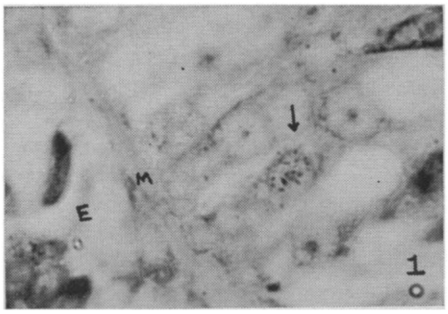

Fig. 1. Uptake of tritiated thymidine into nucleus of a gastrodermal digestive cell (arrow). Toluidine blue, *p*H 8, about × 600; *M*, mesogloea; *E*, epidermis.

were at least ten grains located directly over the nucleus. A few epitheliomuscular cells of the epidermis were also labeled during this 10-minute period, but usually no more than two or three labeled cells of this type were found in one section in contrast to interstitial cells and digestive cells which contained from ten to 25 labeled members per section. All of the cell types labeled during this period were found immediately adjacent to the wound area.

Animals exposed for longer periods, 6 to 12 hours, were labeled profusely not only in the wound area but along the length of the gastric region as well. In each case the label was limited to interstitial cells, epitheliomuscular cells of the epidermis, and digestive cells of the gastrodermis. On a few occasions, cells resembling mucous cells of the gastrodermis appeared to be labeled, but more investigation will be necessary to confirm this observation. At no time was label sighted in the peduncular region of the animal or in the basal disk, but it is possible that the isotope had not diffused to this area at the time of observation.

At the 24-hour stage label was sighted in cnidoblast cells, mucous cells, and gland cells of the gastrodermis. This observation suggested that these cell types, since they did not take up the label during earlier stages, were perhaps formed by the differentiation of interstitial cells. This observation was strengthened by the fact that animals which remained in the thymidine for 1 hour and were then removed and washed thoroughly and then fixed at various intervals did not contain label in the cnidoblast or gland cells until the 18- to 24-hour period.

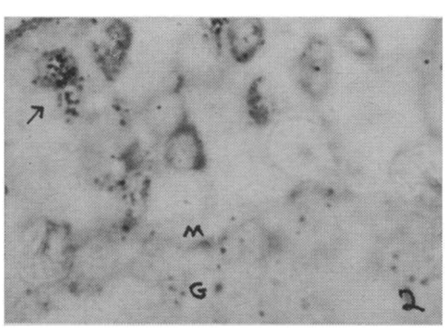

Fig. 2. Uptake of tritiated thymidine into two interstitial cells. Toluidine blue, *p*H 8, about × 600; *M*, mesogloea; *G*, gastrodermis.

The foregoing observations confirm the fact that interstitial cells are not the sole autoreproductive elements of hydras (*5, 6*), and casts some doubt upon the concept of "totipotency" of the interstitial cell. It is quite conceivable that interstitial cells are capable of differentiating into only a few select cell types, and during the life of the hydra never differentiate into epitheliomuscular cells and digestive cells.

One observation made during the course of these studies deserves special mention. It was of common occurrence throughout all of the stages examined to find that entire nests of interstitial cells were labeled. These nests may be composed of 12 to 15 cells. Moreover, it was observed that during the early stages of regeneration most of the interstitial cells which had begun to differentiate, that is, had grown three or four times in size and taken on a spindle shape, were unlabeled. Burnett (*6*) has reported that animals whose interstitial cells have been selectively destroyed are still able to regenerate if they contain a large reservoir of partially differentiated interstitial cells in their tissues. The lack of label in interstitial cells which have already begun to differentiate suggests strongly that these cells did not arise from interstitial cells which divided in response to the wound stimulus. It is quite possible that the dividing interstitial cells function mainly to restore the original embryonic reserve of the animal and do not contribute directly to the early processes involved in tissue repair.

Now that tritiated thymidine can easily be introduced into the tissues of hydras, it should be possible to trace the entire sequence of cell differentiation in this form. This may be accomplished by labeling the interstitial cells of a regenerating animal and grafting this animal to a hydra whose interstitial cells have been selectively destroyed by nitrogen mustard or irradiation with x-rays. Interstitial cells readily migrate into the host animal and repair the irradiation damage. An examination of the host animals over different time intervals will reveal the differentiated cell types which contain the label. Experiments of this type are under way in our laboratory at the present time.

In conclusion, although it is not known with certainty why hydras "leak" during the regeneration period, it appears that a simple excision through the body column may be an extremely effective method of introducing relatively large molecules into the tissues of the animal. Initial attempts to introduce tritiated uridine by this method have also been successful (*7*).

ALLISON L. BURNETT
RONALD BAIRD
FREDERICK DIEHL

Developmental Biology Center, Western Reserve University, Cleveland 6, Ohio

References and Notes

1. X. Kolenkine, *Bull. biol. France Belg.* **89**, 169 (1955).
2. H. Lenhoff, *Exptl. Cell Res.* **17**, 570 (1959).
3. W. F. Loomis and H. Lenhoff, *J. Exptl. Zool.* **132**, 555 (1956).
4. No attempt is made in this report to give a detailed account of the numbers of particular cell types labeled or to stress in every instance the exact body region where the label was sighted. A longer paper is in preparation.
5. C. H. McConnell, *Biol. Bull.* **64**, 86 (1933).
6. A. L. Burnett, *Twentieth Growth Symposium—Regeneration* (Ronald, New York, 1961).
7. This work was supported by grant G18683 from the National Science Foundation.

20 August 1962

Archeological Investigations in East Central Arizona

Abstract. A blend of traditional and new methodologies is being employed to analyze extinct cultural systems up to 4000 years old. A Univac computer was used to demonstrate a functional attribute of ceramics, and sociological inferences were made from spatial distributions of pottery designs.

For six years a group of us at the Chicago Natural History Museum (*1*) have been making a broad-scale study of the prehistory of eastern Arizona—specifically in the area lying between the towns of Snowflake, Show Low, Springerville, and St. Johns. Our basic objectives have been to understand and to explain similarities and differences in patterns of culture and the processes by which these patterns have developed from simple to more complex. We hope to correlate the adaptation of the extinct cultural systems under investigation to the ecological situations. Such an investigation involves the collaboration of a number of scientists from other natural sciences. To date we have followed several lines of inquiry: archeological excavations of key sites; sociological inferences from ceramics; Univac analysis of sherds; archeological surface survey; palynological and geological studies; and botanical analysis of cultivated plant remains.

About 250 prehistoric sites have been located during several seasons of surveys (*2–5*). Twelve sites, ranging in time from about 1550 B.C. to about A.D. 1350, had been investigated earlier; work on the 13th, the Carter Ranch site, was completed last summer. Monographs describing 11 of the sites have been published (*2*, *3*, *6*). The study of the material from Carter Ranch is not yet complete, but this preliminary report describes new techniques used in the analysis.

The potsherds and whole pots from Carter Ranch were subjected to a detailed analysis aimed at gaining sociological inferences. Forty whole vessels and approximately 6400 decorated sherds from excavations and surface survey were used for this study. With the assistance of S. Seaberg (department of art, Northwestern University), W. A. Longacre undertook to define the smallest elements of design. These were chosen as important because it was assumed that these individual elements might not have been "in focus" to the potter and therefore might have been selected by her in a nonconscious manner that would represent learned patterns within the potter's social milieu. One hundred seventy-five elements were isolated.

The results demonstrate that there is a statistically nonrandom distribution of elements and of groups of related elements. Within the Carter Ranch site, one finds a twofold pattern emerging: (i) roughly 60 percent of the design elements show a pan-village distribution without any clustering or preferential grouping; (ii) the other 40 percent, of what may be "sensitive elements," did cluster, some at one end and some at the other end of the pueblo. Longacre's interpretations of this (along with all other evidence at hand) is that the Carter Ranch site was occupied by at least two matrilineal, matrilocal descent groups. Ethnographic evidence supports this interpretation. This suggests that two kin-based groups of female potters occupied the pueblo; that each one favored certain design elements and rejected others; and that the potters from both ends of the pueblo used some designs in common. These differences in groupings of design elements within the village did not appear to be due to any temporal deposition.

No two villages show identical frequencies of design elements or groups of elements. This suggests separate village ceramic traditions. When frequencies of favored design elements in a group of villages in valley "A" are compared with those in a group of villages in valley "B," all comparisons being confined to one pottery type, we find intergroup or regional preferences. Accordingly, we think that we have documented several levels subordinate to the type-variety concept: (i) kin-based, intramural traditions of pottery decoration; (ii) a village tradition of pottery decoration; (iii) a regional tradition (style) composed of traditions of pottery decorations from several villages within the same valley.

Statistical analyses of sherd frequencies of 12 different pottery types were undertaken with the aid of Univac (*7*). Differences between archeological samples have usually been explained as due to sampling error or temporal differences. Functional differences between types have often been overlooked or relegated to a minor place. Approximately 1000 different statistical calculations were run as a result of about 500 individual questions that were asked of the data.

Briefly, after sampling error was taken into account, possible functional differences appeared among parent populations. Four possible functional constellations of pottery types were discovered; four types of rooms, having possibly different functional uses, were isolated; a probable ceremonial complex of five pottery types was recognized; and an area given over to the dumping mostly of a particular pottery type was discovered. It was impossible to demonstrate any major temporal differences between provenience units of the site on the basis of sherd frequencies. It was concluded that any such differences, if they existed, played a minor role in contributing to sample variation as compared to the differences in functions between parts of the pueblo. These results (*4*) could not have been derived from the type of seriations that we have formerly employed.

Some preliminary conclusions follow. The first settlers were groups of nonsedentary peoples who sustained themselves by means of an exploitative-adaptive economy based on collecting wild plants and on hunting. After foreign exploitative-adaptive methods of subsistence were introduced (about A.D. 275) we find a shift from collecting to an agricultural adaptation. At about the same time the arts of making pottery and of building houses appeared.

The evidence suggests that as farming became more efficient, population increased; villages became more numerous and larger; budding-daughter-communities moved into unoccupied but exploitable portions of the region; and a settlement pattern evolved that was to flourish for several centuries.

At about A.D. 1200, people began to abandon towns on small streams and to settle along the two major rivers of the area. Palynological studies suggest that a slight change in the rainfall pattern might have commenced about this time; and if this is true, this may be an explanation for, first, partial abandonment, and then, about A.D. 1400, complete desertion of the region.

Palynological and geological inquiries by Schoenwetter (see *3*) and by Hevly and Cooley (*8*) have yielded data concerning climatological conditions for the past 5,000 to 10,000 years, and have suggested a date for the beginnings of agriculture in our area.

PAUL S. MARTIN

Department of Anthropology, Chicago Natural History Museum, Chicago 5, Illinois

References and Notes

1. This report is the result of long-standing interest in the prehistory of the American Southwest by the Chicago Natural History Museum. We at the Museum are grateful for support by the National Science Foundation. Dr. John B. Rinaldo, associate curator of archaeology, has been associated with me for a score of years; William A. Longacre, doctoral student at the University of Chicago, has served with the staff of the Expedition for 4 years. I am indebted to colleagues from other disciplines and institutions for their help.
2. P. S. Martin, J. B. Rinaldo, W. A. Longacre, "Mineral Creek Site and Hooper Ranch Pueblo, Eastern Arizona," *Fieldiana: Anthropol.* **52** (1961).
3. ———, C. Cronin, L. G. Freeman, J. Schoenwetter, "Chapters in the Prehistory of Eastern Arizona, I," *ibid.* **53** (1962).
4. P. S. Martin, J. B. Rinaldo, W. A. Longacre, L. G. Freeman, J. A. Brown, "Carter Ranch site," *ibid.*, in press.
5. J. B. Rinaldo, unpublished data.
6. P. S. Martin and J. B. Rinaldo, "Excavations in the Upper Little Colorado Drainage, Eastern Arizona," *Fieldiana Anthropol.* **51**, pt. 1 (1960); "Table Rock Pueblo," *ibid.* **51**, pt. 2 (1960).
7. L. G. Freeman and J. A. Brown, doctoral students, with the assistance of Professor L. R. Binford, department of anthropology, University of Chicago, conducted these complicated operations.
8. R. H. Hevly and M. E. Cooley, "Paleoecology of Laguna Salada," *Fieldiana Anthropol.*, in press.

23 August 1962