Reports

Archeological Survey and Excavation in Iran, 1961

Abstract. Recent surface survey for prehistoric archeological sites in western Iran has contributed toward defining three centers of early agricultural village settlement. Excavation at a site in upper Khuzistan revealed a sequence of settled life which, at its earliest, may antedate food production. The site also yielded faunal evidence for an ecological change subsequent to the end of the Pleistocene.

The field activities of the joint Rice University–Oriental Institute Iranian Prehistoric Survey (*1*) centered on an archeological survey in the Zagros Mountains in western Iran during the months September through December, 1961. This was originally conceived as a survey of prehistoric settlement pattern in the Karkheh headwaters in southwestern Iran; a major aim was to try to determine whether a climatic change at the end of the Pleistocene (about 11,000 years ago) had influenced the locations of early settlements. A Pleistocene climate, probably colder and wetter than the present climate, is suggested by the meager data now available for western Iran. A change from such a climate to a modern one would have been important to man only insofar as it resulted in a shift of ecological zones from one elevation or latitude to another. Furthermore, a modern climate was probably established in the area between 11,000 and 9000 years ago (*2*).

In order to help clarify the relationship between climate and settlement, a survey for early villages in valleys of different altitudes in the western Zagros was carried out. The assumption behind the survey was that the earliest agricultural villages must have been located in valleys which were within the natural habitats of the plant and animal domesticates. If the earliest villages occurred in valleys which are now outside the present natural habitats of the domesticates, there must once have been a more favorable environment to allow such settlement. We further assumed that climatic change would have been the most likely cause of an ecological change because at the beginnings of, and prior to, food production man's effect on the landscape must have been relatively small. For such arguments to have weight, food production must have begun by the end of the Pleistocene. Within the present natural habitat no agricultural site has been dated back that far.

A second aim was to test the hypothesis that, after the establishment of the early village farming community in the mountain valleys, the farmers moved downslope and out onto the alluvial plain, where civilization rapidly followed. Again, by plotting distribution of sites we hoped to learn where the earliest villagers settled and whether they moved upslope or whether they might have moved downslope as well (had there been no climatic change, movement could have been in either direction). The area most affected by such change would have been the margins of the natural habitat—that is, the verge of the alluvial plain and the mountains. In conjunction with the survey we planned to dig key sites to supplement what we could learn from surface survey.

The heart of the survey was to be in the valleys of Kuh-i-Dasht, Hulilan, Rumishgan, Tarhan, and Deh Luran, situated at elevations of from 4000 to 600 feet, between 32°30′ and 33°50′N and 47° and 47°40′E (see Fig 1). In contrast to the great abundance of prehistoric sites located in the Kermanshah and adjacent valleys in 1959–60 (*3*), we found few early sites as we worked our way southwest through Luristan into valleys at successively lower elevations. It soon became apparent that, however good for agriculture the lower valleys might seem to be at first glance or on a topographic map, concentrations of early prehistoric village sites were limited to the Kermanshah and upper Khuzistan valley plains. Closer examination of such valleys as Rumishgan and Tarhan showed that at present, because there is no surface water, settlement is impossible without digging wells. Even though soil conditions and rainfall are suitable for dry farming over most of the mountain region, in the area we surveyed Kermanshah and Shahabad are unique in having numerous springs and good-sized permanent rivers.

The lowest area we surveyed, Deh Luran, is on the fringes of the Khuzistan plain, about 70 miles west of Dizful. The hot, dry, and often barren plain surrounding Deh Luran is spotted with sites, the most prominent of which is Mussian, sounded by the French Archeological Mission to Iran some 60 years ago. On this plain, in addition to 11 sites with prehistoric pottery, we located one site which had been occupied before the use of pottery.

We thus found that the Kermanshah and Khuzistan regions were separated by vast areas of mountain valley and slope pasture, especially suitable for nomads on a seasonal basis, and that these areas were apparently not well suited for settlement by the earliest settled peoples. By its very nature a surface survey, such as ours, is unable to reveal traces that might have been left by prehistoric nomads, whose refuse would not have mounded up.

Because we found few sites, the survey of the Karkheh headwaters did not give us the kind of information we had sought regarding climate, settlement, and population movements.

Having some extra time, we decided to push north through Iranian Kurdistan and into Azerbaijan, which is today the most densely populated and agriculturally productive region in Iran. Aside from locating prehistoric settlements we wanted to learn more about the different ecological zones within western Iran and the potential of each zone for early agriculturalists.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and two carbon copies.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each. Submit three copies of illustrative material.

For further details see "Suggestions to contributors" [*Science* **125**, 16 (1957)].

Immediately north of Kermanshah the mountains are extremely rugged, leaving little room for valleys. None of the mounds that we located in this, the heartland of Iranian Kurdistan, contained prehistoric pottery. Intensive survey in such country must be made on foot or on horseback; this is a time-consuming task that we did not attempt. Pushing farther north we found the valleys widening as the rivers flowed toward the Lake Rezaiyeh depression. For the first time in the mountains we found extensive irrigation systems, some of which rival in size those found on the Khuzistan alluvial plain. Our main survey in the north was in the flat valleys around Lake Rezaiyeh, one of the largest of which, Solduz, includes Hasanlu and the other sites excavated by the University Museum of Pennsylvania (*4*). In view of the size of the area involved, the concentration of sites in Solduz (at about 36°50′N, 45°30′E) rivals that in the Kermanshah valley system. It was interesting to note, however, that the Solduz sequence begins with well-developed pottery and villages but apparently does not include preceramic village sites.

We surveyed one other valley, Sar-i-Pol, on the road to Baghdad between Kermanshah and the Iraqi border. In this valley, first mentioned prominently in Assyrian accounts dating from the 7th and 8th centuries B.C., we found no prehistoric village sites, but we did find a cave. In a brief sounding in the cave, Kal-i-Daoud, we found a good Mousterian deposit, but nothing earlier or later.

Three seasons of survey, including that of R. M. Adams of the Oriental Institute in Khuzistan (*5*), have thus demonstrated that three valley plain systems, in western Iran, Khuzistan, Kermanshah, and Solduz, were important centers of regional prehistoric developments. Survey around Persepolis in southern Iran, by L. Vanden Berghe (*6*), has defined a fourth center. All of this survey has shown that much of Iran is more suitable for seasonal migratory life than for permanent settlements. This was especially true for the earliest villagers, who had neither the population nor the political power to force settlement, nor techniques to exploit areas whose resources were not optimal for year-round settlement. The relation of the herder to the farmer, always important in historical accounts, is not known for the range of time considered here. Neither is the precise nature of the factors that determined where the earliest settlers lived. Such things as availability of surface water, temperature, rainfall, and soil conditions are obvious limiting factors. Other factors that must be considered are size of game reserve, for peoples whose agriculture was rudimentary; location of summer and winter pasturage, for keepers of flocks; and access to other groups of settled people and trade routes.

Though we are able to distinguish four centers surrounded and separated by rugged, valleyless mountain blocks, we are not yet able to demonstrate the chronological priority of the agricultural sequences in the various regions. At the moment it seems that Kermanshah and Khuzistan, having preceramic villages, are earlier than either the Solduz or Persepolis areas. In an effort to understand and date these preceramic developments we decided to dig the site of Ali Kosh (at 32°33′N, 47°05′E), near Deh Luran.

Because of rain and shortage of time we were forced to leave the site without having plumbed its total depth, but we now know that it contains at least four successive occupations. Beginning with the uppermost, we have a Susiana *b–c* occupation, a type found in abundance in Khuzistan and dating back to about 5000 to 5500 B.C. Lying below it is an occupation which has pottery (as yet undescribed), figurines, flint, and stone bowls much like those found at Jarmo and Sarab, sites excavated in recent years by Braidwood (*7*, *8*). By analogy with Jarmo, this occupation probably dates back to between 6000 and 7000 B.C. Lying still lower were two preceramic occupations. Conspicuous in the upper-most of these were substantial walls of unbaked mud slabs faced with plaster.

Floors from five successive building

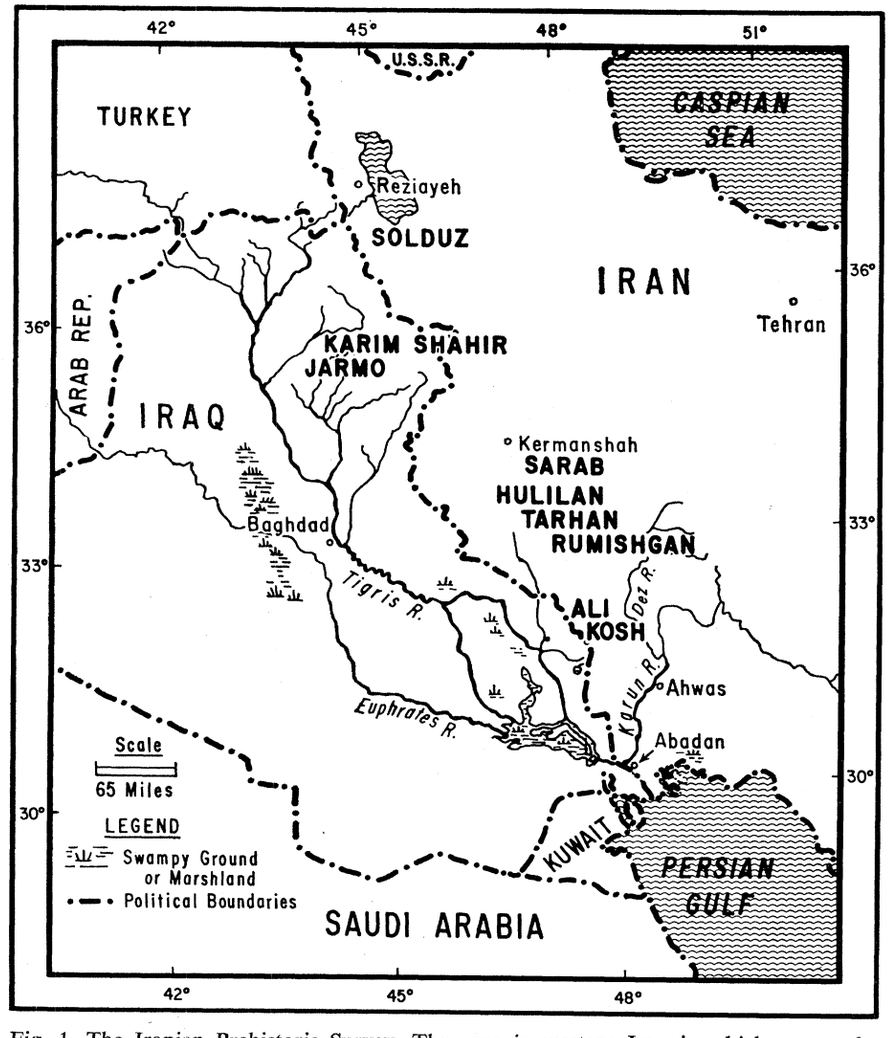

Fig. 1. The Iranian Prehistoric Survey. The area in western Iran in which survey for early village sites was conducted in the autumn of 1961. Excavation in the site of Ali Kosh revealed settled life that may antedate food production.

levels associated with the brick walls were exposed in the small excavation. Lying alongside a wall, in association with the bones of wild animals, was an impressive array of kitchen utensils, including large stone meat cleavers, slicing slabs, grinding stones, mortars, pestles, and knives. In-the-field analysis showed that the goat may have been domesticated but that the greater part of the meat diet came from anatomically wild animals. There was a large brick-lined hearth sunk into one of the floors; this was not a bread oven, but it may have been used for roasting animals. Still lower we hit the edge of what was probably a pit house. In the area exposed it looks as if a pit had been dug about 1½ feet into earlier refuse and then faced with mud plaster. From this level we extracted a large fragment of an asphalt-coated mat of a type also found in the levels above. Typologically the pit-house artifacts are similar to artifacts from Karim Shahir, excavated in northeastern Iraq and there probably dating back to about 7000 to 9000 B.C. (*7*).

Radiocarbon determinations on charcoal from the two lower levels have recently been completed by Shell Development Company, Houston. Charcoal (sample DL-21, No. 4) from the brick-wall levels was dated 6888 ± 210 B.C., and charcoal (sample DL-21, No. 9) from the underlying pit house was dated 6448 ± 200 B.C. Other samples have not yet been dated. This inversion of dates with respect to levels is curious. Though there was no evidence of it in the field, there is a chance that the samples had been contaminated in some way. The closeness of the two dates may also indicate that the people living in the pit house were abruptly replaced by newcomers at a date later than we would have guessed. We have excavated only to the very top of the early occupation level; we do not yet know when the early occupation began.

Work was brought to a halt before the pit-house level had been completely cleared, but we do know that the flint tools are very different from those found in the levels above and that none of the bones recovered was from a clearly domesticated animal. The list of fauna from this level and from the brick-wall levels is impressive because the Deh Luran area today is marginal agricultural land, lacking fresh surface water except during the few months of winter rain and supporting only a very scrubby vegetation. Gazelle, in remarkable abundance, is the only game animal now present, yet when Ali Kosh was first occupied the area teemed with a varied fauna. Animals whose butchered remains were recovered include onager, gazelle, Mesopotamian deer, wild cattle, wild pig, and goat. In addition, fragments of a fresh-water clam are abundant.

Impressions of plants in brick and clay building material were recovered, along with reeds and possibly grasses which were used for matting. No impressions of grain were noted, though grinding stones attest to the use, for food, of wild plants at least. Not until floral analyses have been made, and perhaps not until the site has been opened further, will we know whether then, as today, Deh Luran lay outside the natural habitat of the grains.

The recency of the radiocarbon dates bears on this question. If correct, they indicate a persistence of the wild fauna well beyond the time when climatic change would have been a factor in their extinction. We are thus led to believe that such ecological changes as are indicated must have been caused by man's destructive hand. It may be that before he had a substantial agricultural base to support a more dense population, and hence more hunters, man was unable to exterminate the wild fauna. The variety of animals whose remains occur in the lower two horizons at Ali Kosh could not occur in the Deh Luran area today. Whether the implied ecological change can eventually be construed as climate-induced or whether it was produced by other natural factors or by man's activity remains to be seen, when plant analyses have been completed and a geological study of the area has been made.

Further work, especially excavation of early sites in Khuzistan, should now be undertaken, because Ali Kosh or a similar site may hold the key to our understanding of some of the factors lying behind the spectacular rise to civilization which occurred in the area a few thousand years later. We do not claim to have at Ali Kosh an unbroken sequence from a hunter's camp to an agricultural village. We can say, however, that the four successive occupations exposed in our small sounding represent, in one site, a development unprecedented outside of Tell-es-Sultan, the Jordanian site said to be the Biblical Jericho.

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References and Notes

1. This project is a part of continuing research into the origins of agriculture and settled life in southwestern Asia [see R. J. Braidwood, B. Howe, C. A. Reed, *Science* **133**, 2008 (1961)]. Working with me in the field was Kent Flannery, a graduate student in the department of anthropology, University of Chicago. Flannery, an archeologist-zoologist, made the faunal identifications. In Iran we benefited from the interest and aid of the Iranian Government's Antiquities Service, the National Iranian Oil Company, the Khuzistan Development Service, and interested Iranian and American officials, missionaries, and private citizens.
2. H. E. Wright, Jr., *Eiszeitalter Gegenwart* **12**, 162 (1961).
3. R. J. Braidwood, B. Howe, C. A. Reed, *Science* **133**, 2008 (1961).
4. R. H. Dyson, Jr., *Illustrated London News* **239**, 534 (1961); *Science* **135**, 637 (1962).
5. R. M. Adams, personal communication; *Science* **136**, 109 (1962).
6. L. Vanden Berghe, *Jaarber. Ex Oriente Lux* **13** (1954).
7. *Prehistoric Investigations in Iraqui Kurdistan*, vol. 31 of "Oriental Institute Studies in Ancient Civilization" (Univ. of Chicago Press, Chicago, 1960).
8. R. J. Braidwood, *Illustrated London News* **237**, 695 (1960).

26 February 1962

Stranded Arrangement of Sporopollenin in the Exine of Microspores of Poa annua

Abstract. In the early microspore wall of the grass *Poa annua* L., sporopollenin is arranged in bundles of anastomosing strands. Each bundle contains at least two strands, each about 50 A in diameter, which anastomose or intertwine and look like a meshwork with pores of the mesh up to 50 A in diameter. After the early microspore stage the exine becomes homogeneous; it is similar in this respect to the exines or ornamented parts of the exines of pollen of other angiosperms examined by electron microscopy.

The chemical and physical properties of sporopollenin have been reviewed by Zetzsche (*1*), Erdtman (*2*), Frey-Wyssling (*3*), and Roelofsen (*4*). Like other highly organized biological materials, sporopollenin is characterized by a refractive index between 1.5 and 1.6 (*5*), a weak form birefringence but no intrinsic birefringence (*6, 7*). In the exines of *Alnus glutinosa* and *Lycopodium clavatum* sporopollenin did not produce x-ray interferences (*8, 9*). The empirical formula for sporopollenin worked out by Zetzsche and Vicuri (*10*) was $(C_{10}H_{16}O_3)_n$, and they suggested $C_{90}H_{120}O_{12}(OH)_{15}$ as a reasonable approximation of the molecular formula for sporopollenin from *L. clavatum*. Zetzsche considered that sporopollenin might be a polyterpene. Sporopollenin is far more resistant to reduction than soft rubber but is similar in many respects to hard rubber. It breaks down at 300°C, burns with a sooty flame, and in exines which have