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CURRENT PROBLEMS IN RESEARCH

Agriculture and Urban Life in Early Southwestern Iran

Archeological survey provides a basis for observing broad changes during 7000 years of sedentary life.

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Modern agricultural development programs promise to transform the levels of economic well-being of much of southwestern Asia. Among the many integrated steps comprising such programs are the application of chemical fertilizers, shifts to more intensive and better-balanced systems of crop rotation, comprehensive drainage schemes, and above all the acquisition of storable water surpluses behind high dams for greatly extended summer irrigation. Where these technical benefits are made widely available through accompanying social and economic reforms, the means clearly are now at hand by which the prevailing vicious circle of rural underemployment and poverty can be broken.

The frequent dependence of these programs on foreign technical direction, and the unprecedented investments of scarce capital they require of the nations undertaking them, combine to underscore the break that the new programs represent with the recent past. Yet in another sense they focus attention on the past as well. How do the current plans and promises compare, we may ask, with earlier achievements in the same area, whether under the hegemony of ancient Ur, or the Persian Empire of Cyrus and Darius, or the "golden age" of the Abbasid Caliphate? Fortunately, a minor by-product of the present widespread concern over development is the opportunity it sometimes affords to study these questions.

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The Khuzestan Region

This has been the case in Khuzestan (Fig. 1). Geologically, this area represents only an extension of the great Mesopotamian alluvial plain into southwestern Iran, but its inhabitants have often participated closely in—and sometimes have briefly exercised a determinative influence upon—the political history of the alluvial zone as a whole. Moreover, the initial appearance here of agricultural villages and, several millennia later, of an urban civilization centered in the ancient Elamite capital of Susa, proceeded step by step with similar developments in Mesopotamia proper. Nevertheless, new resources of data like soil surveys, hydrographic reports, and aerial photographs call attention to significant environmental features in Khuzestan that are not found elsewhere in lower Mesopotamia. This suggests in turn that gross descriptive categories like "semiarid steppeland" and "dependence on large-scale irrigation agriculture" may be as inadequate for a deeper historical understanding as they are for the contemporary planner. In brief, the ambitious development program currently underway in Khuzestan thus has stimulated and made possible a reappraisal of historic patterns of human subsistence and settlement within that region. By combining the results of a recent archeological surface reconnaissance with historical and documentary records, we can briefly and tentatively chart the changing conditions of human occupance in the area (*1*).

The Mesopotamian plain was earlier regarded as a trough slowly filling with alluvial soil carried down from the mountains to the north and east; it was assumed that there had been a regular withdrawal of the Persian Gulf before the advancing deltas of the major rivers. According to a more recent view that is supported by much convincing evidence of local geological uplift and subsidence, the entire basin is in fact a complex and unstable geosyncline which probably has tended to settle about as rapidly as it has filled. On the other hand, the testimony in the itineraries of Assyrian and Greek travelers (particularly that of Nearchus, admiral of Alexander's fleet on its return from India) continues to support the assertion that marshy but navigable lagoons, tidewater mudflats, and perhaps even open sea, extended well to the north of their present limits as late as the first millennium B.C. (*2*). Reports of the topography of the time are somewhat confused and contradictory, but the mouth of the Karun River, for example, apparently lay not much more than 27 kilometers below what must have been a precursor of the modern town of Ahwaz, on a large inland lake that was in turn connected with the sea. Moreover, archeological explorations of the lower plain, although still unsystem-

atic and very limited in scope, thus far at least have failed to disclose any evidence of widespread occupation there antedating the Christian era. Only in Sassanian or Islamic times, as will be shown presently, did these lower plains become a major focus of settlement and agricultural activity—and probably then as a consequence not merely of an advancing shoreline but of broad administrative and social changes affecting the methods of land use and the incentives to its exploitation.

Above the old shoreline there is a much longer and fuller record upon which this discussion will necessarily concentrate. The last anticlinical outlying fold of the Zagros Mountains crosses the Khuzestan Plain from the northwest just above Ahwaz, but except at the strategic crossing and rapids on the Karun River at Ahwaz itself there is nothing to attest a significant occupation prior to Alexander's conquests for perhaps 50 kilometers further north. In this intermediate zone the presence of the sea hardly can be adduced as an explanation for the paucity of human settlement after Pleistocene times at the latest. However, modern conditions of widespread salinity, poor drainage, and extensive dune formation may account for the relative neglect of this area for almost 3000 years after Susa had crossed the threshold of urbanism not far to the north. Before the arrival of the Greeks, and probably for several centuries afterward as well, it would appear that land had not been a directly limiting factor upon population but instead was available in sufficient quantities to be utilized selectively where conditions were optimal. The exceptional grain yields of 100-fold and more which Strabo reports for Susa may have their explanation in this abundance of unused land, for he adds that furrows in that district were widely spaced to maximize sprouting.

The band of upper plains in which Susa lies presents a quite different picture than either the lower or intermediate zones. Increased surface gradients and widespread underlying gravel deposits provide sufficient natural drainage over most of the area to minimize the problems of salinization and waterlogging that usually attend irrigation agriculture. These conditions also must have been advantageous during the early stages in the development of irrigation, since they permit an adequate level of flow during the winter growing season with relatively short and easily maintained canals. In addition, the pebbly soils in the upper portion of this region receive natural subirrigation from underground springs, while rainfall on the steep slopes which bound the plain is carried out onto it for some distance by numerous winter and spring freshets. Under these conditions rich natural pasturelands tend to form (when not destroyed by overgrazing), containing a wide variety of leguminous herbs and grasses. According to the medieval Arab geographers these meadows were covered with wild narcissus; moreover, they provided the chief winter grazing lands for large groups of nomadic Bakhtiari tribesmen until well into the present century. To be sure, the attractive conditions which prevailed from October through April were balanced by the oppressive summer heat and desiccation for which Khuzestan is notorious; but cooler hill slopes and upland valleys with good forage that could no longer be found on the parched plains have always been available during the summers within easy marching distance into the mountains. It is, in fact, erroneous to consider the upper plains as a zone of occupance distinct from the surrounding uplands. Both together constitute a single natural ecosystem, whose seasonal alternation of resources provides as strong an inducement to migratory stockbreeding as to intensive, settled agriculture.

More important even than all these factors is the volume of precipitation that the upper plains receive. Under Mesopotamian conditions, the 200 millimeter isohyet is generally regarded as the absolute lower limit within which dry farming is possible. However, there is a substantial "zone of uncertainty" above this limit within which permanent settlement will be avoided even though sporadic catch-crop cultivation may be practicable. In Khuzestan the essential point is that permanent settlement based on dry farming is roughly coterminous with the upper plains, extending to the north and northeast of a line slightly below what is shown in Fig. 2 as the 300-millimeter isohyet. In an area now under development above this line to the north of the Shaur River (see Fig. 3) a recent agricultural appraisal showed average net wheat yields of 410 kilograms per hectare (about 6 bushels per acre) from dry farming as compared with 615 kilograms per hectare on irrigated land. In short, irrigation on the upper plains around Susa is a valuable adjunct in the cultivation of the basic cereal crops during the traditional winter growing season, but it is by no means an indispensable condition for the practice of agriculture (*3*).

Early Village Settlement

The earliest major phase of settlement on the upper plains of Khuzestan is illustrated in Fig. 3. This map records all of the known sites where prehistoric painted pottery has been obtained in surface collections; thus it covers the long span from perhaps as early as 5500 or 6000 B.C. to about 3500 B.C. However, all but a few of the sites shown (116 out of 130) were occupied during the latest part of this span, so that the map can be regarded as a representation of the distribution of settlements particularly during the relatively brief "Susa A" period soon after the beginning of the fourth millennium B.C. The hallmarks of this period, incidentally, are the highly stylized and beautifully decorated pottery beakers and other vessels which, since their excavation from basal levels at Susa by an impressive series of French expeditions beginning in the last century, have graced the pages of many histories of art (*4*).

The most obvious feature of the pattern shown in Fig. 3 is its density—a grid of villages fully comparable to that of the present day in spacing, and in some cases extending into areas no longer permanently settled. All of these sites are small, most of them covering 1 or 2 hectares or even less, but the considerable heights of the mounds which mark their ruins suggest that they were occupied relatively continuously and for long periods.

It must be stressed that the vigorous growth of settlement evident here at an early time-level almost certainly does not stem from any priority of the region in the basic practices of cultivation and stockbreeding. The potential domesticates are thought to have occurred naturally only at somewhat higher elevations, and in any case these animals must have been at home all along the lower slopes of the mountains overlooking the Mesopotamian plain

Fig. 1. Location of Khuzestan, the Persian Gulf, Iran, and Iraq.

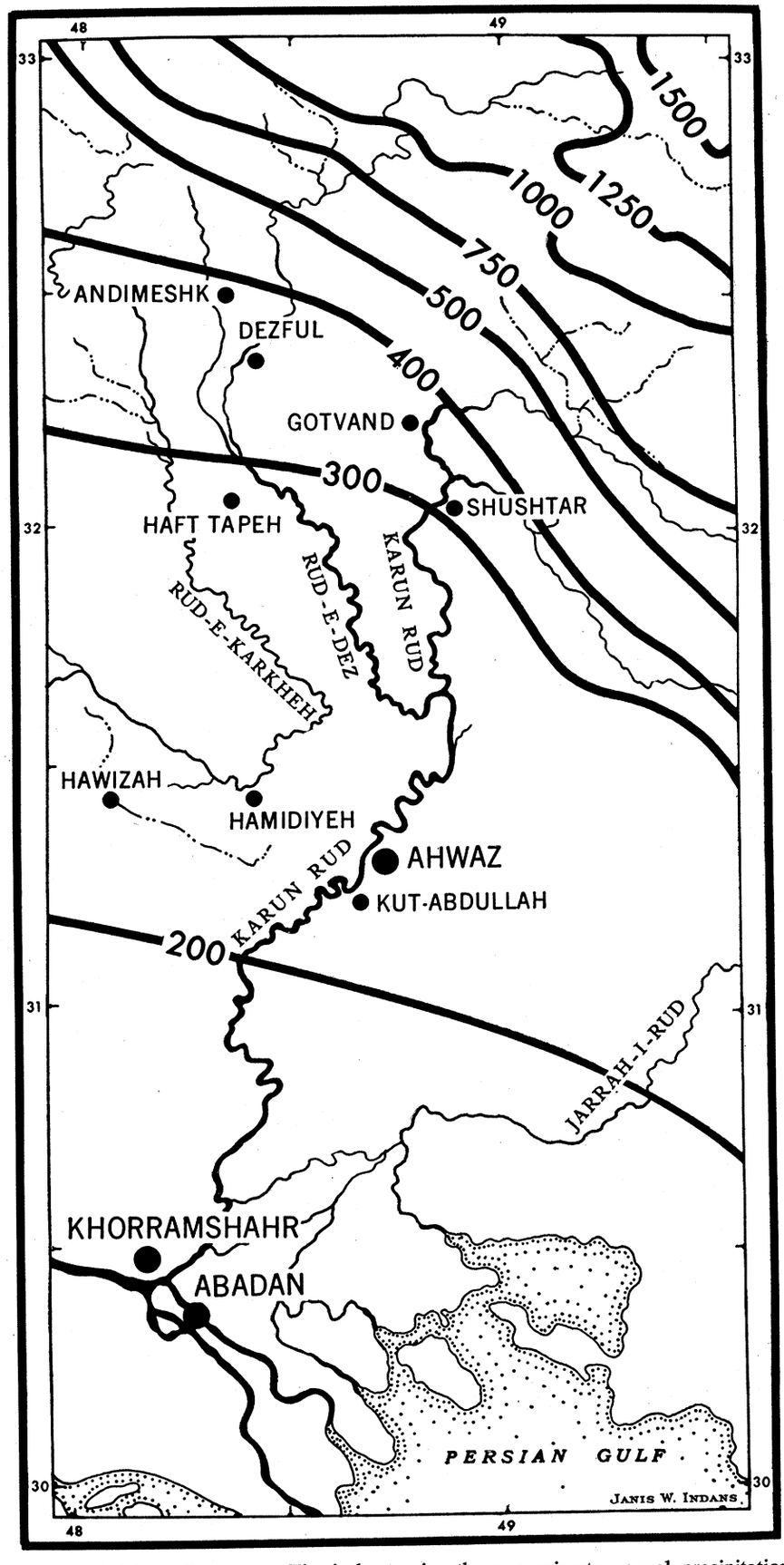

Fig. 2. Rainfall in Khuzestan. The isohyets give the approximate annual precipitation, in millimeters.

(wherever favorable soils and microclimates created suitable niches) and not merely in the Persian uplands surrounding Khuzestan. Instead, the high early density of settlement in this region perhaps can be traced to the exceptionally favorable circumstances the region would have offered for the transition from dry farming to irrigation agriculture, a transition which began only after the initial food-producing revolution had been consummated elsewhere. Chief among these locally favorable factors, of course, was the adequacy of precipitation for dry farming while rudimentary irrigation systems were being developed, together with the suitable slopes and soils on the upper plain and the numerous small, easily diverted watercourses.

Some further light is shed on the time of introduction of irrigation techniques by comparing the patterns of settlement for the different component periods into which the long prehistoric span can be divided. For the earliest of these, the Susiana *a* period, only 34 sites are known. It is noteworthy that these uniformly small mounds occur almost exclusively in the northern part of the upper plains, where also the highest annual rainfall is encountered. Moreover, a number of them, like those west of the Karkheh River and on the rolling downlands near the modern town of Dizful, are so located that irrigation would not have been possible in their vicinities without the great irrigation works which are known only to have been constructed much later. From these observations it would appear that, in the earliest known phase of settled village life in Khuzestan, agriculture depended mainly or even exclusively on rainfall.

In the immediately following periods of the Susiana prehistoric sequence, probably equivalent to the Halaf and early Ubaid horizons in Mesopotamia and falling within several centuries after 5000 B.C., the number of known village sites jumps to 102, and the sites assume a distribution which then continued with little change for at least a millennium. This pattern differs from its predecessor not only in the sharply increased number of sites but also in the geographical extension and concentration of the sites much further to the south. On the other hand, the new lower limit of settlement still conforms roughly to that existing today for villages partly dependent on dry farming.

From this it seems reasonable to conclude that, while some irrigation practices had been introduced and had led to a greatly expanded population, they were still quite localized and probably were regarded merely as an adjunct to farming practices oriented in the main toward rainfall.

Also worth noting is the fact that these later prehistoric sites were not uniformly spaced but in many cases tended to form clusters, some of them being grouped along the margins of shallow fossil valleys that are still traceable at intervals on the alluvial land surface. Considering these valleys together with the general distribution of sites, it is apparent that fundamentally different river regimes must have obtained for at least the Karkheh and Diz rivers along this part of their courses. Instead of the single, rapidly degrading channels that they occupy today, these rivers seem to have divided themselves into numerous bifurcating and rejoining channels of a presumably aggrading character. While no clear overall pattern of the more important contemporary watercourses can be distinguished from the position of settlements—in part because alternative sources of domestic water were so readily available that villages were not closely bound to the major stream levees—Fig. 3 suggests that during this period a large part of the drainage from the present Karkheh watershed may have run southeastward along what is now the bed of the Diz River. In addition there are suggestions that some of the minor outwash channels reaching the plain between the Diz and Karun rivers may have carried a larger, or at least less strictly seasonal, flow than they do at present. Quite possibly both tectonic activity and the effects of human settlement (principally wood cutting and overgrazing) have contributed to the subsequent far-reaching changes.

Virtually nothing is directly known at present of the subsistence practices of the established early village range in Khuzestan, although an investigation of the transition from food-gathering to food-production has recently been undertaken in the higher valleys to the north (*5*). Widely distributed flint sickle-blades, hard-baked clay sickles, and stone hoes attest the existence of a specialized tool kit associated with cultivation by the late 5th millennium. At the same time, chipped flint arrow heads, carved gazelle bones, and stylized but plausible representations of bowmen and of the pursuit of wild game with dogs provide fragmentary suggestions of the continued importance of the hunt. By the time of the proto-Elamite tablets, around the end of the 4th millennium, signs representing orchards as well as fields can be distinguished, and the existence of a plow also can be demonstrated. The latter implies the domestication of bovids or equids, and contemporary representations (including animals with mounted riders and others pulling chariots or carts) and administrative records of both are found. However, it is not certain how much earlier than the introduction of the tablets the plow and these domesticates can be assumed to have made their appearance in Elam. The specific identification of animals from their highly stylized representation on the pottery of the Susa A period is difficult, but at least it is clear that fish, birds, and members of the *Capra* and *Gazella* genera are very numerous, while bovids and equids are decidedly rare. Conceding the unsatisfactory state of the evidence, it might be tentatively concluded that hoe cultivation constituted the dominant form of food production at that time, and that livestock was largely limited to sheep and goats.

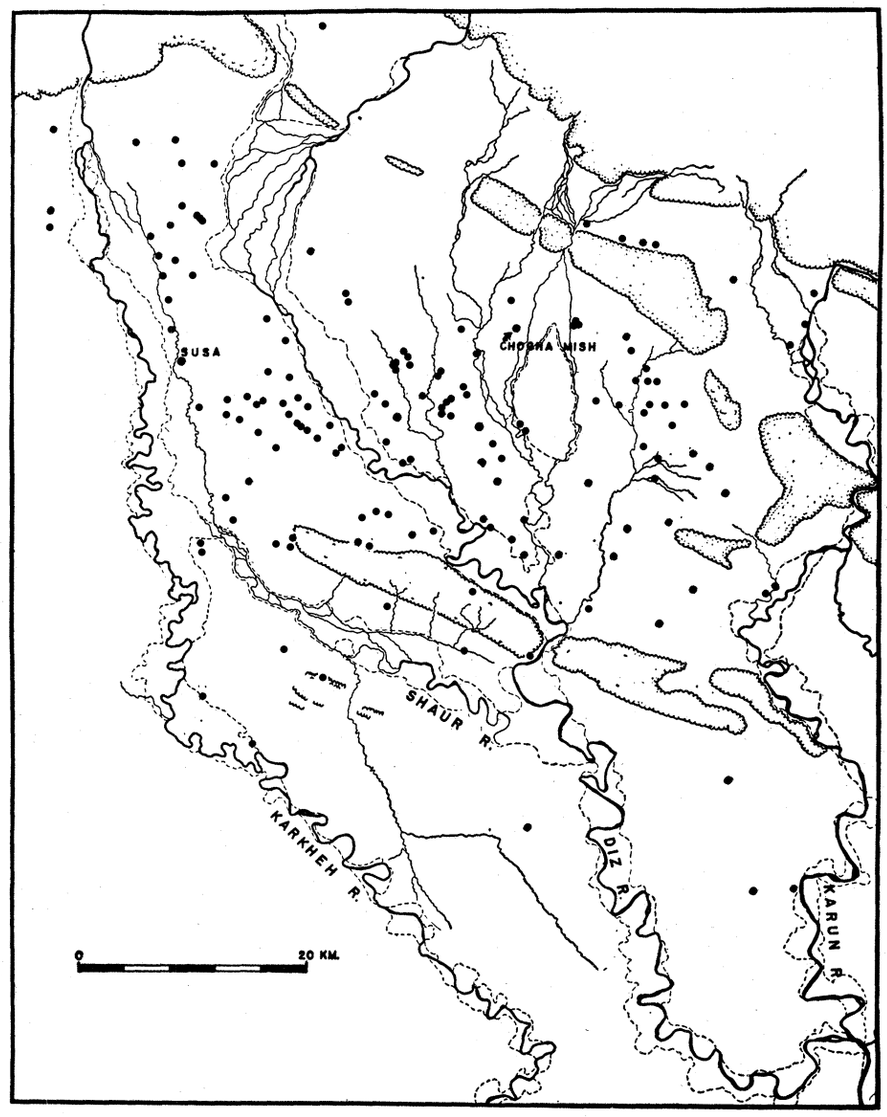

Fig. 3. Prehistoric agricultural settlement in the upper Khuzestan plains prior to about 3500 B. C. Numerous villages and a few small towns formed a widespread, relatively dense network over the area. Linear groupings of sites generally conform to former channels of natural watercourses; irrigation was of limited scope and secondary importance. Villages (here defined as settlements occupying less than 4 hectares, or slightly less than 10 acres) and small towns are shown much enlarged.

Growth of Towns and City-States

The pattern of subsistence and settlement described above reached its apogee during the Susa A period, roughly equivalent to the terminal Ubaid and early Uruk horizons in Mesopotamia and falling within the first half-millennium after 4000 B.C. By this time (if not somewhat earlier) a few sites began to stand out as larger centers among the numerous small villages. The contemporary remains at Susa itself are too deeply buried for their extent to be plotted, but a small number of other mounds then covered 4 or 5 hectares and so perhaps can be classified as small towns. This process of differentiation intensified further during the Susa B and C periods that followed. Exclusive of Susa, individual centers are known which extended over as much as 20 hectares, and we may infer from its thousands of proto-Elamite account tablets that Susa was at least as large as any of the contemporary unexcavated towns around it.

On the other hand, the total number of settlements declined by almost two-thirds, for only 39 are known in the surveyed area which were occupied during the half-millennium before 3000 B.C. Without more extensive excavations it will be impossible to determine all of the factors involved in this decisive shift. Some instability of population is suggested by the sharp cultural break that is especially evident in ceramics, but its character remains elusive. Moreover there is contrary evidence for considerable continuity of settlement in the fact that less than a sixth of these sites were newly founded during the Susa B and C periods. In part at least, the newly emerging pattern must have consisted of the drawing together of the population into larger, more defensible political units, some of which—on the analogy of the better-known Mesopotamian sequence—began at this time to attain truly urban status and to be enclosed by massive walls. At the same time, large areas that formerly had been settled and cultivated were well beyond the radius of easy communication from any of the reduced number of towns that remained and hence must have reverted to pastureland or other nonintensive use. Thus, to continue with the reconstruction advanced earlier, we may visualize the growth of large towns and urban centers like Susa as proceeding hand-in-hand with changes in the exploitation of the surrounding hinterlands. Small-scale irrigation, the planting of intensively cultivated gardens and orchards, and plow cultivation were all adopted increasingly within limited enclaves around the towns. Elsewhere, however, considerable tracts were abandoned to shifting cultivators or nomadic herdsmen, who would have left few material remains for the archeologist and no written records for the historian.

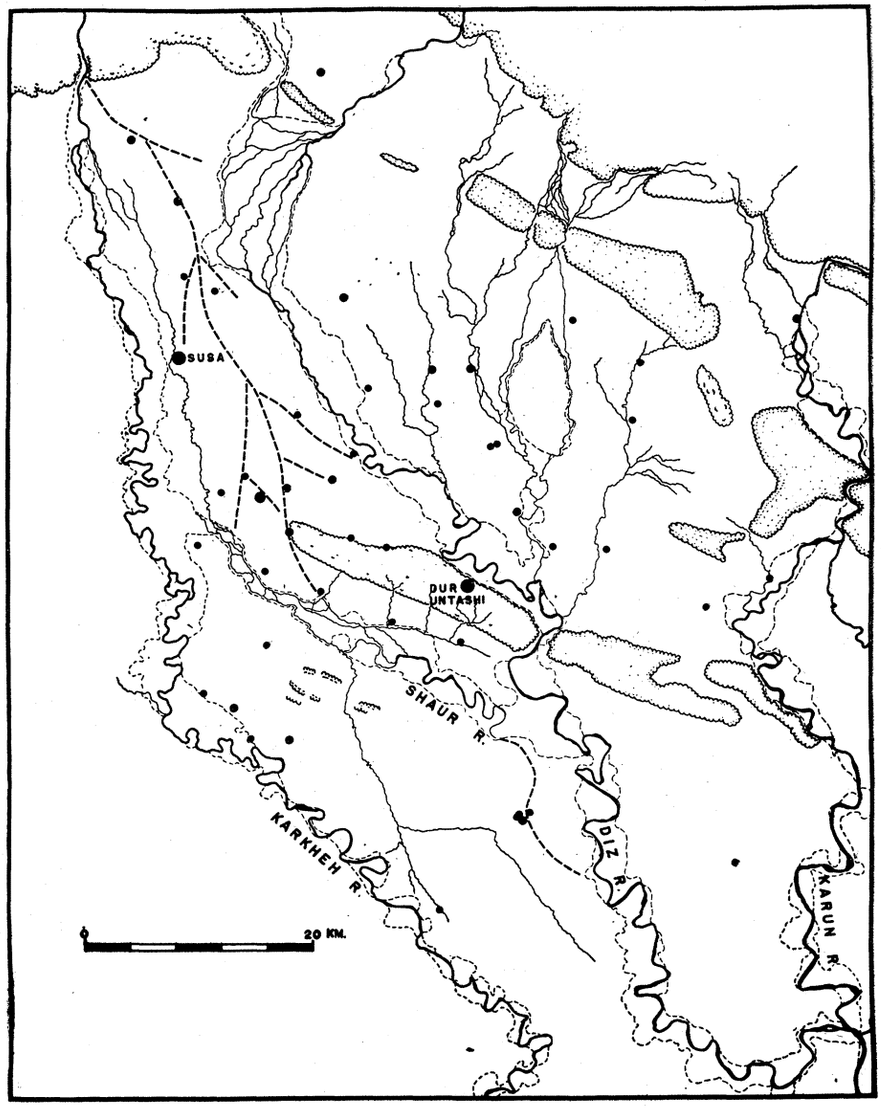

Fig. 4. Late Elamite settlement, about 1200 to 640 B.C. This was the culminating phase of a slow process of town growth, although the number of individual sites did not approach the prehistoric total. Only the two urban centers are drawn approximately to scale. Except for the area around Susa, settlements tended to lie along natural watercourses, and probably only local irrigation was practiced. Susa lay in the center of a larger enclave, which may have been continuously cultivated, but elsewhere there still must have been many tracts of good land used only seasonally for grazing. Because of the overlying deposits, the canal system shown around Susa is a largely speculative reconstruction.

The trends set in motion before 3000 B.C. seem to have continued throughout the 3rd and into the 2nd millennium. To judge from the strength occasionally displayed by rulers of Susa, like Puzur-Inshushinak who campaigned successfully as far afield as Opis (probably not far below Baghdad) and Kirkuk in the late 3rd millennium, Susa must have been a substantial and prosperous city for at least part of this time.

Still, even a calculation based on the larger, later area of its ruins and the unusually high assumed density of

400 persons per hectare within its walls suggests that ancient Susa did not exceed—and quite possibly never approached—a maximum of 40,000 inhabitants. This population, it should be pointed out, is about at the level which could be adequately provided for with irrigation of no more than the area between the Karkheh and Diz rivers, within less than a day's walk from the capital to the furthest of its supporting fields. As for other towns in the region, their number and average size declined somewhat further during the Susa D or protohistoric period and only began to increase again very slowly afterward. As late as 2000 B.C., in spite of the greatly intensified administrative and economic relations with southern Mesopotamia that were maintained under the hegemony of the Third Dynasty of Ur, not more than two towns seem to have existed in the surveyed area which covered as much as 10 or 15 hectares. In short, well into the 2nd millennium B.C. Susa was the only known settlement on the upper Khuzestan plain west of the Karun River which might be called a city or even a large town, while substantial parts of that plain were not regularly settled at all.

Thus it would appear that Elamite military prowess did not derive from a large, densely settled peasantry occupying irrigated lowlands in what is often loosely considered the heart of Elam. Instead, the enclave around Susa must have been merely one component in a more heterogeneous and loosely structured grouping of forces. Other towns and settled districts that were strung out along somewhat higher valleys like those of the Middle Karkheh, Saimarreh and Kashgan rivers to the northwest of the Khuzestan plain, and perhaps even seminomadic tribal groups with no major centers, often must have been of roughly equivalent political importance. A reflection of this distinctly hybrid geographical character probably is to be found in the successive roles played by towns like Awan, Simash, Anzan, and Madaktu, all probably to be sought in the higher valleys and each with at least comparable prestige and importance to that of Susa in external political relations and royal titulary during the whole of Elam's pre-Achaemenian history.

Second millennium texts from Susa attest the presence in considerable quantities of a number of domesticated plants and animals. While the specialized transactions recorded in the texts may be unrepresentative of the broader subsistence picture, wheat and barley obviously were the most important crops. In addition, dates, chick-peas, and lentils, as well as considerable quantities of sesame, are mentioned. Most of the sesame probably was converted to oil, while some of the barley was used for beer. The most numerous category of livestock seems to have been sheep, and both sheep and cattle in some cases were specified to have been fed on barley. Goats and donkeys also were present.

The details of the later political history of Elam are not important here (*6*). A dynasty of "kings of Anzan and Susa," vigorous contemporaries of Hammurabi and his successors in the First Dynasty of Babylon, seems to have been followed by a long and uncertain interregnum and then by a powerful but short-lived "empire." By the time of the latter, the total number of occupied settlements on the upper plains between the Karkheh and Karun rivers had slowly increased to 48, less than half of what it had been in prehistoric times but more than twice its total at any time during the 3rd millennium (Fig. 4). In this process the disparity was somewhat alleviated between urban Susa and a surrounding region with no more than widely scattered small towns and villages. Eight other towns each now occupied more than 10 hectares and one of them, Chogha Zanbil or the ancient Dur Untashi, covered about 1 square kilometer and thus stands comparison as a city with Susa itself (*7*). Relative to the available land, however, these changes did not basically alter Khuzestan's earlier aspect as a still lightly settled region in which towns and their regularly cultivated hinterlands formed only widely separated enclaves.

The Assyrian Invaders

Elamite power culminated during the reign of Shilhak-Inshushinak (about 1165–1151 B.C.). Afterward Elam and Babylon were increasingly drawn together to resist the growing strength of Assyria. In spite of this alliance, the Assyrian annals describe campaigns which gradually subdued the desert tribes west of Elam, ravaged its border districts, and even descended upon its seacoast in assaults launched from across the Persian Gulf. As the consolidation of Assyrian rule continued to be resisted in Babylonia, these attacks increased in what has been called their "calculated frightfulness." Ultimately, under Assurbanipal (668–626 B.C.), the struggle was carried not merely into the intervening mountain valleys to the northwest but directly into Khuzestan itself, and most or all of the royal strongholds there were stormed and sacked. The Assyrian king boasts of the slaughter of his Elamite enemies and the burning of their cities, of having carried off population and livestock "more numerous than grasshoppers," and even of the scattering of salt over the devastated province.

For once, the Assyrian version does not seem to have been greatly exaggerated. Virtually every town of the period that was visited during the archeological survey was found to have been abandoned at a time roughly corresponding with these campaigns, and to have remained unoccupied for a long time afterward. More than a century elapsed before Darius undertook to restore Susa as an Achaemenian capital (about 521 B.C.), and in spite of the ambitiousness of his constructions there the level of population in the surrounding region apparently failed to approach what it had been at the outset of the Elamite-Assyrian rivalry. To Herodotus, two generations later, the plains around Susa and even the city itself were merely part of Cissian territory. The Cissians were described by the Greeks as rude and warlike mountaineers whom the Persian kings had placated with annual tribute in order to prevent infestation of the plains with brigandage, and their gradual infiltration and resettlement of the plain is further evidence that much arable land had been left empty in the wake of Assurbanipal's armies. Under these conditions it would have been unlikely for the Achaemenians to initiate an extensive program of agricultural development, in spite of their concern with fostering commerce and their renown as builders (*8*). And in fact only along the eastern margin of the surveyed region, on the right bank of the Karun River below Shustar, is there evidence suggesting that a group of small agricultural villages may have been linked by a new canal dug during the time of Darius or one of his successors.

Emergence of a New Pattern

Although there are numerous accounts of the conquests of Alexander, the confrontation of Greek and Persian that continued in Khuzestan under his Seleucid heirs (about 311–140 B.C.) is virtually unreported. Accordingly, the enduring effects of those conquests upon patterns of subsistence and settlement can only be discerned in very general terms. The absence of detailed, local sources is particularly unfortunate in that many decisive changes must have had their origins in the intensive cultural interchange that went on during this period, although these changes do not come clearly into focus until 500 or more years later.

Among the most crucial effects of Greek influence was a renewed emphasis on city building. This entailed in some cases the actual foundation of important urban centers, like one of the numerous Alexandria's which continued on into Parthian times as the kingdom of Charax. Situated on the lower Khuzestan plain near the mouth of the Tigris, its location implies some effort at systematic settlement and cultivation of the marshes along the lower edge of the alluvium, an effort of which we are otherwise largely ignorant. Other Greek cities were strategically located so as to pacify mountain peoples like the Cissians, in turn providing the security which permitted a renaissance of settled life around cities like Susa on the plains as well. Another Macedonian practice was to implant garrisons of soldier-colonists in the major existing towns, surely stimulating the growth in Asia of juridical and institutional concepts upon which the independence and prosperity of the Greek *polis* had been based. Finally, mention might be made of the diffusion of particular cultural activities like grape cultivation, for Strabo says of Khuzestan that "the vine did not grow there until the Macedonians planted it." The cohabitation of Greeks and Persians must have had many other, less simple and overt, effects upon agricultural techniques, but they escaped the notice of the chroniclers and hence remain largely for speculation.

Sources on the Parthian period (about 140 B.C.–A.D. 226) are, if anything, more fragmentary and less informative than those on the preceding Seleucids (*9*). The impressive showing of Parthian armies against the Romans in the west implies at least a periodically effective internal administration and a reasonably adequate level of economic well-being, but Khuzestan was too distant from the frontier for Roman accounts to furnish many details. From an inscription in Susa we learn that the Greek garrison there still retained its corporate identity, and that it recorded its gratitude to the governor of the province for initiating certain irrigation works. Possibly the installations referred to include several impressive networks of canals which can be shown from aerial photographs to have antedated the still greater networks constructed early in the Sassanian period. At any rate, both kinds of data make it clear that a considerable program of canal building was under way before the end of Parthian times. Similarly, the remains of Parthian towns located during the archeological reconnaissance suggest a substantial increase in the extent and density of settlement, although their full area is often masked by the massive Sassanian ruins which almost always overlie them. Such general indications as these, however, are at best vague and unsatisfactory. Only new historical sources and extended, patient excavations will illuminate more fully the changing practices and conceptions of land use which prepared the way for the Sassanians.

As in other parts of the Mesopotamian plain, one of the most striking observations of recent archeological reconnaissance has been the immense and variegated impact of the Sassanians (A.D. 226–637) upon the Khuzestan landscape (*10*). In a way which seemingly had no parallel in earlier periods, vast efforts were devoted to comprehensive programs of irrigation extending over virtually the entire arable surface. This entailed bold and imaginative planning and administration, a whole series of technical innovations, and above all the investment of state funds on what must have been an unprecedented scale. The Sassanian effort differs from its modern counterpart in that it aimed to increase agricultural output (and thereby, of course, state revenues) primarily by extending the area of cultivation and only secondarily by introducing a more intensive agricultural regime and increasing labor productivity. Still, since this choice was dictated by the existing socioeconomic system and level of technology, it provides a distinction more apparent than real. For Iran at least, we are justified in regarding the Sassanian administrators as the spiritual ancestors of the modern teams of developers, and in hoping that the latter are as successful by contemporary standards as the Sassanians must have seemed in their own time.

Some elements of the Sassanian program have long been known. Great weirs were constructed of stone and brick across the Karkheh River at what is now Pa-i-Pol, the Diz River at Dizful, and the Karun River at Shustar and Ahwaz. Although the available flow varied widely and was markedly reduced in summer due to the absence of water storage, radiating canal networks from these strategic locations at least could provide more reliable winter irrigation than had existed heretofore. The remains of these dams are still identified locally as "Roman," and there seems little reason to doubt the statements of medieval Arab historians and geographers that a central role in their construction was played by 70,000 Roman legionnaires who, together with the Emperor Valerian, had been captured by King Shapur I at Edessa. With positions reversed since the time of Macedonian conquests, soldiers from the west again played a vital part in Khuzestan's agricultural development (*11*).

A fuller view of the Sassanian program is made possible by linking the study of aerial photographs with ground reconnaissance. Figure 5 illustrates the layout of the major branches in the Sassanian canal system, even though the system is now obscured by long-continued erosion, modification and re-use. Several aspects deserve brief mention. In the first place, the readiness of the Sassanian engineers to cut through ridges and other natural obstacles can be documented in many places. By brute force, as it were, they undertook to impose a unified system of canalization upon a broken topography which always before had been irrigated (where it was irrigated at all) in relatively small, unrelated segments. In one particularly illuminating case water diverted from the Diz River was conducted southeastward by canal near the upper limits of the plain to lands on the right bank of the Karun which were too high to be irrigated directly from the latter. This bold re-

shaping of basic drainage patterns is fully consistent with the approach followed in the design of the system as a whole.

Another feature of the general pattern shown in Fig. 5 is the attention that was obviously devoted to providing irrigation supplies not only for large, topographically suitable, highly productive areas but also for small and marginal tracts which hardly seem to have warranted the investment that was made in them. This determinedly full utilization of land does not suggest a grandiose project whose potentialities were never fully realized but, on the contrary, a system which operated so successfully that it was ultimately extended to the fullest possible limits.

A final point, related to the previous ones, is that at least the major canals in this system apparently were designed and executed under a series of comprehensive plans. This is evident both from the regularly branching patterns of minor distributary canals and from the directness of most of the larger channels. By contrast, the small-scale private irrigation networks that have been introduced in the Near East in recent years are characterized by extremely broken and erratic patterns of canalization in which the absence of central planning is immediately apparent. There were, of course, periodic changes in the scope and objectives of the Sassanian system, so that Fig. 5 presents a composite rather than an actual layout. It has been possible to distinguish some of the major phases within this composite, beginning with the initial construction of the weirs and the first of their offtakes early in the Sassanian period. Not suprisingly, the main trunk canal leading southeast from the Karkheh weir and the vented tunnel proceeding southwest from the Karun at Gutwand—both major undertakings with a large water-carrying capacity—appear to date from the latter part of the period. Probably they are to be attributed to the reign of Chosroes I (A.D. 531–579), whose military successes and administrative reforms placed him in control of unprecedented state revenues for costly enterprises of this kind (*12*).

Apart from the well-planned and well-executed construction of the weirs themselves, the principal innovation that appears in this great system is the extensive use of tunnels with periodic vent holes, not only as subsurface conduits through ridges and other topographic obstacles to ordinary canal construction but also as collectors for ground water. Knowledge of the technique of constructing these tunnels may well go back to Achaemenian times or earlier (although probably not earlier than the introduction of cheap iron tools), but their first extensive application in Khuzestan came only under the Sassanians. Another interesting innovation, suggestive of the technical ingenuity which originally must have been applied at many points, was the construction of an inverted siphon (a ruined example of which survives below the modern town of Gutwand) to carry a large canal across a seasonal watercourse.

While the introduction of an extensive network of irrigation canals is the most tangible surviving evidence of the development of the area during the Sassanian period, the full range of measures that were taken was far more extensive and complex. A greatly increased stress upon commercial crops and handicraft industries, centering on the manufacture of fine silks, satins, brocades, and cotton and woolen textiles, accompanied the resettlement of

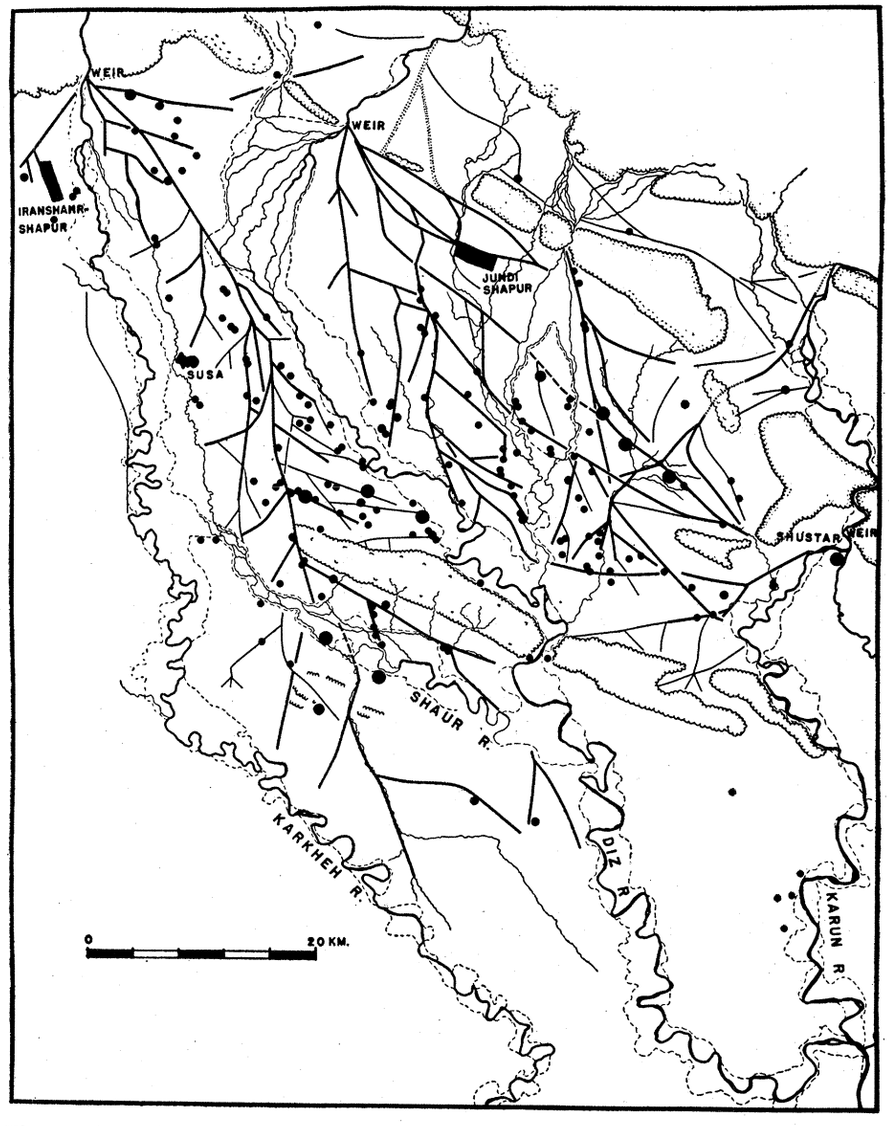

Fig. 5. Sassanian settlements and irrigation canals, about A.D. 226 to 639. The extension of the irrigation system to virtually the widest possible limits was accompanied by new and more intensive irrigation techniques, state-directed urbanization, and a population maximum. The three largest cities are drawn to scale, but nine others are shown only slightly enlarged. Note that what is today the Shaur River was apparently at that time a major branch of the Karkheh River. Dotted lines represent vented tunnels used as water conduits.

prisoners here after successful western campaigns. Some of the rich variety of orchard products for which Khuzestan was praised by early Arab writers, including plums, pears, melons, pomegranates, olives, and citrus fruits, must have been introduced at the same time. Date palms, already native, were spread so widely that later it was claimed there was no place in Khuzestan without them. Probably from the east came sugarcane, implying a new emphasis on year-round irrigation within the limits of the available summer supplies of water. By Arab times at least, Khuzestan's annual tax payments included 20 metric tons of refined sugar and most or all of the sugar that was traded throughout the eastern Caliphate (at a normal market price of about $3.30 per kilogram, sufficient to maintain a couple in modest circumstances for a month) is said to have come from this province; much additional cane was described as unsuitable for refining, so that the raw stalks were consumed locally. Rice, another summer crop, had already been noted in Khuzestan by companions of Alexander, but only later became an important item in the diet. By the 10th century rice-flour is reported so much a staple in Ahwaz that people sickened and died if forced to eat bread made of wheat-flour instead.

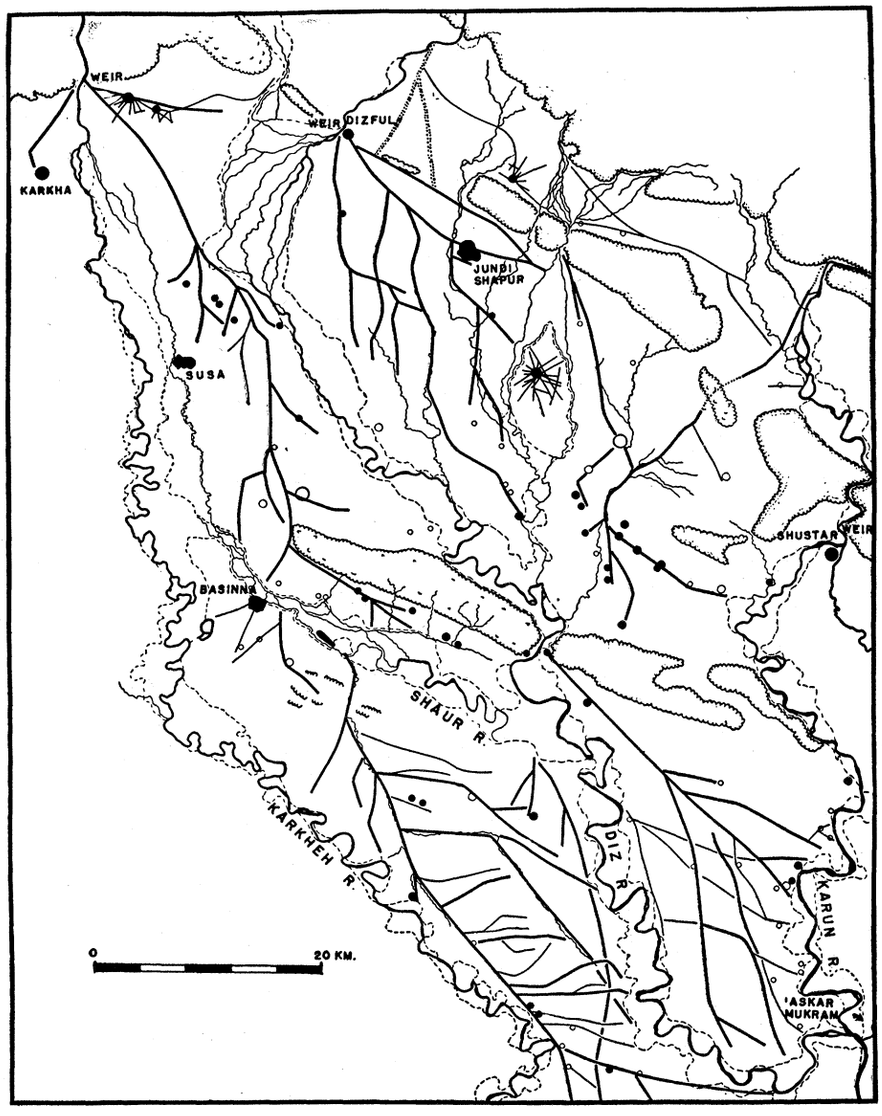

Fig. 6. Islamic settlements and irrigation canals, from the 7th through approximately the 9th century A.D. Sites shown as hollow rings were apparently much reduced or abandoned by A.D. 900, while those shown as solid circles continued for varying periods. New, but generally short-lived, irrigation enterprises were constructed in the less productive lower (southern) part of the area, while on the upper plains the Sassanian system gradually deteriorated. The small-scale canal networks that are shown around some of the surviving towns must have been constructed only after the weirs and main supply canals had ceased to function; hence, they may be somewhat later than the period covered by the map as a whole.

Taken together, the newly introduced crops signify more than simply an increase in the *number* of cultivated plants known to Khuzestan's agriculturalists. Most of them required new and highly specialized cultivation procedures (elaborate Arab accounts of those for sugar fortunately have come down to us), provisions for more intensive irrigation than previously had been necessary, and in some cases the investment in semi-industrial processing equipment before the natural harvest could be utilized. Moreover, as a group the new crops imply the growth of a market economy at the expense of the subsistence economy which had prevailed previously. Thus their appearance suggests a qualitative change in the orientation, structure, and technological complexity of agriculture as a whole. Still, limitations on the available water supply must have restricted cultivation of at least four-fifths of the arable land on the upper plains to the winter production of wheat and barley under the aboriginal system of alternate years in fallow.

Since both sugar and rice became important crops in the districts served by the new dams, part of the original purpose of the weirs may have been the encouragement of summer cultivation. On the other hand, numerous later references to lifting devices along the major streams, particularly undershot waterwheels, may indicate that summer cultivation was largely independent of the great canal networks radiating from the weirs. Probably there was considerable variation in how the problem of summer cultivation was met. Above Jundi Shapur vented tunnels were dug as an alternative source of water for the main canals after the dam on the Diz River had been built. Their installation may have been related either to an increasing need for summer water, or merely to the need for assuring winter irrigation supplies during periods when the weir was inoperative due to washouts.

There is both archeological and documentary evidence that the agricultural and commercial development of Khuzestan was accompanied by the

multiplication of urban settlements on an unprecedented scale. Royal concern for the area is shown by the construction there of two new capital cities, Jundi Shapur by Shapur I (A.D. 241–271) and Iranshahr-Shapur by Shapur II (A.D. 306–380), each with a planned rectangular layout comprising several square kilometers within impressive outer walls. In addition, the ancient mound at Susa was extensively rebuilt, and Shustar became an important fortified town. Between these walled major centers, as Fig. 5 records, a great number of sprawling (presumably undefended) towns and villages sprang up —not a few of them approaching the maximum size that even Susa had achieved in earlier antiquity. The total population of at least the upper plains during Sassanian times thus appears to have exceeded by several times what it had ever been previously, and in fact to have reached a level which has not been equalled since.

Although details are lacking, something similar probably happened on the lower plains as well. At any rate, Ahwaz (originally Hurmuz-Shahr) was founded by Ardashir I (A.D. 226–241), the first of the Sassanian kings, and other towns still further out on the lower plains are known to have been occupied at the time of the initial Arab conquest. Given the poorer soils and the virtual absence of leguminous weeds on the alluvium below Ahwaz, the extension of agriculture into this area required greater innovations than merely the introduction of irrigation canals. Drainage systems comparable to those so important in development programs today apparently were never constructed, perhaps suggesting that irrigation water in the canals was usually inadequate and had to be sparingly applied. But at least by Arab times there are references to the importation by barge of plant-ash and night soil for fertilizer from the great metropolitan center of Basra in lower Iraq.

This article is concerned primarily with the material conditions of life, but it is worth noting in passing that the benefits of Sassanian policy extended into other realms as well. Shapur II is credited with having founded a University in Jundi Shapur which became widely noted in the ancient world as a center of astronomical, theological, and medical learning. A marked religious tolerance generally prevailed as Sassanid policy, and to the large and thriving Jewish communities dating from the neo-Babylonian period were added Nestorian congregations fleeing Byzantine persecution. To the emerging syncretistic traditions of science and theology, thus there was added the polyglot confusion of Pahlavi, Greek, and Syriac in the marketplace, symbols of a cosmopolitanism for which the early medieval world provided few equals. This was a milieu in which the products of Classical learning were valued and preserved, and from which they were handed on in time to the Arabs (and ultimately to the West) with the rise of the Abbasid Caliphate. As the vigorous commercial orientation of many Khuzestan towns implies, it was also a milieu that stimulated practical enquiry. The process of refining sugar is said to have been worked out at Jundi Shapur, only a short distance from the site where, after a lapse of many centuries, a new sugar plantation and refinery have recently been put in operation by the Iranian Government. A Great Pharmacopoeia, probably the first of its kind ever to be issued officially, also was a product of the Jundi Shapur hospital and medical school. Although appearing only in the 9th century, it surely embodies a tradition of scholarship there that was deeply rooted in the Sassanian period (*13*).

The Medieval Breakup

The initial effects of conquest by invading Arab armies in A.D. 639 were relatively mild. Resistance was mainly confined to the important fortified towns, and while the defenders in some cases held out and were put to the sword they more often capitulated and resumed a life little different from what it had been earlier. Nevertheless, documentary sources and the results of archeological survey converge to indicate that the agricultural economy failed to return quickly to its previous levels, and in fact went into a discontinuous but cumulative decline which has only been reversed in the modern period.

Taxes submitted to the central government provide perhaps the simplest and most clear-cut index to this process, although it is a very imperfect index at best. To begin with, direct comparisons between the Sassanian and Islamic periods are obscured by changes in the breadth of application of land and poll taxes as a result of religious conversions (*14*). A further difficulty is that even within the Islamic period collections probably decreased more rapidly than economic well-being, as the central government's means of coercion were attenuated by unsettled conditions. But since the Muslims took over the Sassanian tax system substantially as they found it, it does not seem unwarranted to assume that at least some degree of correspondence held in the long run between the volume of tax receipts, on the one hand, and the volume of agricultural produce and activity from which those revenues had been derived on the other.

With due allowance for their defects, the trends in state revenues are very striking. In the late Sassanian period, tax receipts in Khuzestan had reached 50 million dirhems, equivalent to $5 million or more at current price levels—and something on the order of 12 times more than the annual tribute exacted from approximately the same area by the Achaemenian kings a thousand years earlier. While they fluctuated widely afterward, receipts never again reached this figure, and within three centuries or so after the Arab conquest they had been reduced to less than 40 percent of it. Four centuries later they were reported to have been only the equivalent of about 6 percent of the Sassanian amount—even ignoring the effects of the debasement of the currency. In the mid-19th century, before the consolidation of modern Iran had begun, collections still remained at approximately the same level.

The progressive economic decline suggested by these figures—and corroborated by other accounts and archeological data—obviously is only a local manifestation of processes which were at work through much of the Islamic world. Moreover, declining commerce and agriculture were an integral part of a series of interdependent changes affecting the whole fabric of society, and they hardly can be understood without reference to this broader context within which they occurred. The destructive long-term consequences of the introduction of tax farming as a general practice, the increasingly corrupt and inefficient character of the Abbasid Caliphate

after the 9th century A.D., the replacement of citizen-soldiers by bands of power-seeking mercenaries, the break-up of the former domain of the Caliph into unstable local polities, and finally the appearance of great conquering armies like the Mongols who swept over the whole area, all are important components of any full account of the events in a particular district (*15*). But having admitted this broader historical context, here we can only describe some of its consequences in concrete, local terms.

New Patterns

From a comparison of Sassanian and early Abbasid settlement patterns on the upper plains (Figs. 5 and 6) it is apparent that by the time of the latter a considerable retraction had taken place outside of the cities and their immediate environs. Substantial areas of formerly dense occupation now were more or less abandoned. And while a few new towns were founded (the most important of them being 'Askar Mukram, where Khuzestan's sugar crop was brought for refining), surface reconnaissance of the ruins suggests that more commonly there was a reduction in the occupied quarters of even the more populous centers. At Jundi Shapur (Fig. 7), for example, the zone of continuing Islamic occupance seems to have been confined to roughly the central third of the great walled rectangle that Shapur I originally laid out.

While large areas of good land on the upper plains were being abandoned, it is interesting to note that some new lands of marginal quality appear to have been irrigated for the first time. Within the surveyed area a good example is furnished by the Shu'aibiyah district immediately north of the confluence of the Diz and Karun rivers. This is a poorly drained and moderately saline tract which had been very sparsely settled previously and which even today receives only some speculative, tractor-based rainfall farming from very few permanent settlers. Yet Fig. 6 shows that early in the Islamic period a fairly large trunk canal and numerous offtakes were placed in operation across this district, possibly even requiring the installation of some sort of diversion structure in the bed of the Diz River. What explanation can there be for the simultaneous taking-up of unproductive land on the one hand and the abandonment of larger areas of much better soil on the other?

Too little is known of the above example for the question to be answered on the basis of evidence from that district alone, but the same practice of large-scale development of marginal lands had a wider occurrence. Another example of the practice is reported from the Masrukan district, on the opposite bank of the Karun, where one of the early Arab generals is said to have turned his attention to the irrigation of lands which previously had been uncultivated waste. A different, more illuminating case is provided by the events leading up to a great slave rebellion centering in lower Khuzestan and the lower Tigris marshes, as they were set down in surprising fullness by the great contemporary historian, Tabari. The social content of the rising was a militant protest over the intolerable conditions of servitude on great latifundia or landed estates, where masses of slaves (15,000 are mentioned in one district) apparently were employed in the physical removal of the saline surface crust which had prevented cultivation over great areas of the lower plains. In the sequel, the Zanj (after Zanzibar, for most of the slaves were from East Africa) held out for 14 years of frequently heavy struggle (A.D. 869–883), in the course of which many of the towns of Khuzestan were repeatedly and heavily damaged (*16*).

To generalize from these examples, the development of marginal lands probably stemmed at least in part from the availability of unprecedented numbers of unfree laborers, who could only be economically supervised in great gangs (one of 500 men is reported). Since the initial Arab conquest had not immediately led to the wholesale expulsion of the indigenous population from the more productive land, this placed a premium on the development of large undivided tracts, if necessary even on poor soils where potential yields were relatively low and where salinization would become a problem after a few years. In addition, the rapidly shifting winds of court intrigue in Baghdad encouraged grandiose, speculative, usually short-lived undertakings; for example, a case is known in which a minister out of favor at the court spent 10 million dirhems merely to obtain restitution of his former Khuzestan holdings. From the paucity of accompanying settlement and the absence of any substantial canal levees, it is clear that the example in Shu'aibiyah is one of those that ended quickly. So, in fact, did most of the agriculture on the lower plains. It was only the firmly rooted peasantry around towns like Shustar and Dizful in the north that continued to cultivate their lands through the turmoil of the later middle ages.

A succession of reports by Arab travelers and geographers makes it possible for the history of many individual towns in Khuzestan to be pieced together (*17*), providing an "urban" perspective on the history of the region to complement the more "rural" view obtained from the study of changing canal patterns. Of Jundi Shapur, for example, we learn that already by the 10th century it was suffering from inroads by nomadic Kurds, while to Yakut, a generation before the sack of Baghdad by the Mongols (A.D. 1258), it was a ruin whose glories lay in the past. Susa still was a thriving mercantile and textile center in the 10th century, and as late as 1170 a widely traveled rabbi reported that 7000 Jews were numbered among its inhabitants. Shortly afterward it was precipitately but temporarily abandoned in one of a continuing series of local military actions, and then perhaps was reoccupied on a declining scale until its final destruction by Tammerlane late in the 14th century. Basinna, in the 10th century, was a smaller but thriving town, the fine workmanship of whose veils and tapestries is said to have promoted their export to the furthest ends of the earth. Still commercially active in the time of Yakut, it disappears from view within a century or so afterward. Its name is no longer known in the area, and the location given in Fig. 6 is provisional.

Ahwaz, the chief city which gave its name to the whole province in Arab times, suffered particularly heavily under Zanj assaults but subsequently was partly rebuilt. The trade upon which the importance of the city was based had begun to bypass it, however, and by the mid-12th century the greater part of it was reported to

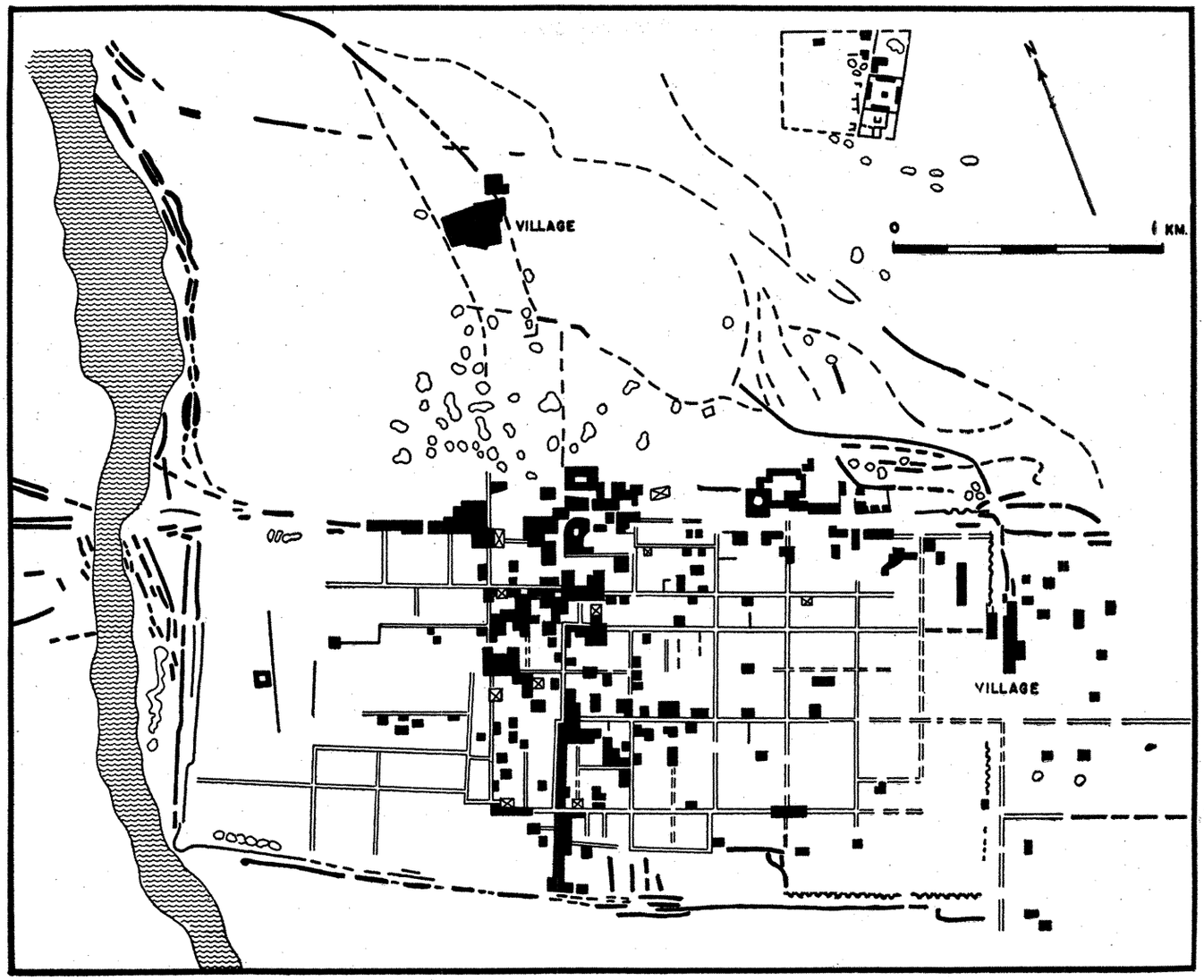

Fig. 7. The city plan of Jundi Shapur, as reconstructed mainly from aerial photographs.

be in ruins. The great weir at Ahwaz must have gone out of service not long afterward, and with it the canals radiating from the city onto the marginal lands of the lower alluvium. By the 19th century the lower Karun's banks below Ahwaz were entirely uncultivated and virtually without permanent settlement. Ahwaz itself may have survived uninterruptedly through the succeeding centuries, but by the 1870's it had shrunk to a small village. The center of political power in the province, meanwhile, inevitably moved northward toward the remaining concentrations of settled population. Shustar, already so noted a textile center that its brocades once draped the walls of the Ka'ba in Mecca, became the capital of the province after the Mongol conquest. It only finally relinquished that position, first to Dizful and subsequently to Ahwaz, in the 19th century after a particularly devastating epidemic. The return of Ahwaz to its present prominence stems from the opening of steamship navigation on the Karun, and still more from the development of Khuzestan's oil resources after World War I.

It is important to note that the withdrawal of settled life from the lower plains was accompanied by a deterioration of agriculture on the upper plains as well. While Susa could exist as a prosperous enclave for long periods 3000 years earlier, such enclaves now were frequent prey to overwhelming external forces. The growth and coalescence of numerous other power centers all over the Near East, and the corresponding evolution of new and increasingly predatory sociopolitical forms, seem to have made the small, independent city-state a helpless anachronism by the later middle ages.

The fate of Khuzestan's vaunted sugar production illustrates one of the new threats to a local agricultural economy. With proper care this crop thrived on the upper plains, as it is doing again today. Yet, in spite of the continuity of agricultural settlement around centers like Shustar and Dizful, even the memory of its cultivation had disappeared before the current development program was launched. The exact circumstances behind the total disappearance of so well-adapted a crop are obscure, but a plaintive account of contemporary events in Egypt provides a likely parallel. To increase state revenues some of the Mameluke sultans imposed strict monopolies on the production and exchange of certain commodities, and it was said that under

Barsbai (A.D. 1422–38) the cost of sugar rose so high as a result that even victims dying of plague were unable to obtain their customary syrups as palliatives. Surely in a similar artificial constriction of the sugar crop for some such purpose as this lies at least the precondition for the abandonment of sugar cane cultivation in Khuzestan altogether. Damascus merchants who were victims of this monopoly are said to have imported sugar from Khuzestan in 1433, but thereafter the records are silent. From the 17th century onward Indian sugar was one of the most lucrative products imported into Iran by European traders.

A different kind of illustration of the declining potentialities of the upper plains as the prosperous, continuously cultivated zone they had become in Sassanian times is provided by archeological reconnaissance. Outside of the few large towns, we can trace the withering away of all of the smaller settlements which had grown up at a distance from the main streams and hence had come to depend on the great Sassanian canal network for irrigation water. One by one they were abandoned, the last holdouts abandoning hope for water from the accustomed sources and desperately seeking to develop tiny enclaves of intensive cultivation by tapping small seasonal watercourses. It is uncertain whether their inhabitants ultimately moved into the larger fortified towns for better protection against marauding nomads, or instead became nomads themselves.

Conditions were not much pleasanter even in Shustar and Dizful. European visitors to them both in the early and middle 19th century are impressively united in their descriptions of prevalent disease, corruption, poverty, abandoned living quarters, stagnant commerce, and declining agriculture. Thus only a thin thread of never-quite-extinguished urban life ties the bustling Khuzestan towns of today to their more remote and prosperous past.

In the face of the great physical and economic changes contemplated by present planners, practical discoveries from this long record of human settlement that can be directly applied to our contemporary needs are few and minor. But if valid general insights ever can be sought in the history of so small an area, two may be suggested here. The first is that at least the immediate opportunities and impediments to the enhancement of man's economic well-being seem to have lain more often in his social institutions than in the presence or absence of particular items of material equipment. The second is that the myth of the "changeless Orient" is ready for burial.

References and Notes

1. I conducted field reconnaissance from December 1960 through March 1961, under joint sponsorship by the Oriental Institute of the University of Chicago and the Development and Resources Corporation of New York. Thanks are due to the Khuzestan Development Service, operating instrumentality of the D.R.C. in Iran, for unstinted cooperation and material support. In particular, I am grateful to Leo L. Anderson, its chief representative, for assistance in understanding many complex problems of agricultural development —present as well as past. The cooperation of the Iran Antiquities Service, and especially of Professor E. O. Negahban and M. M. Moshirpour, also is gratefully acknowledged.
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