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CONTENTS

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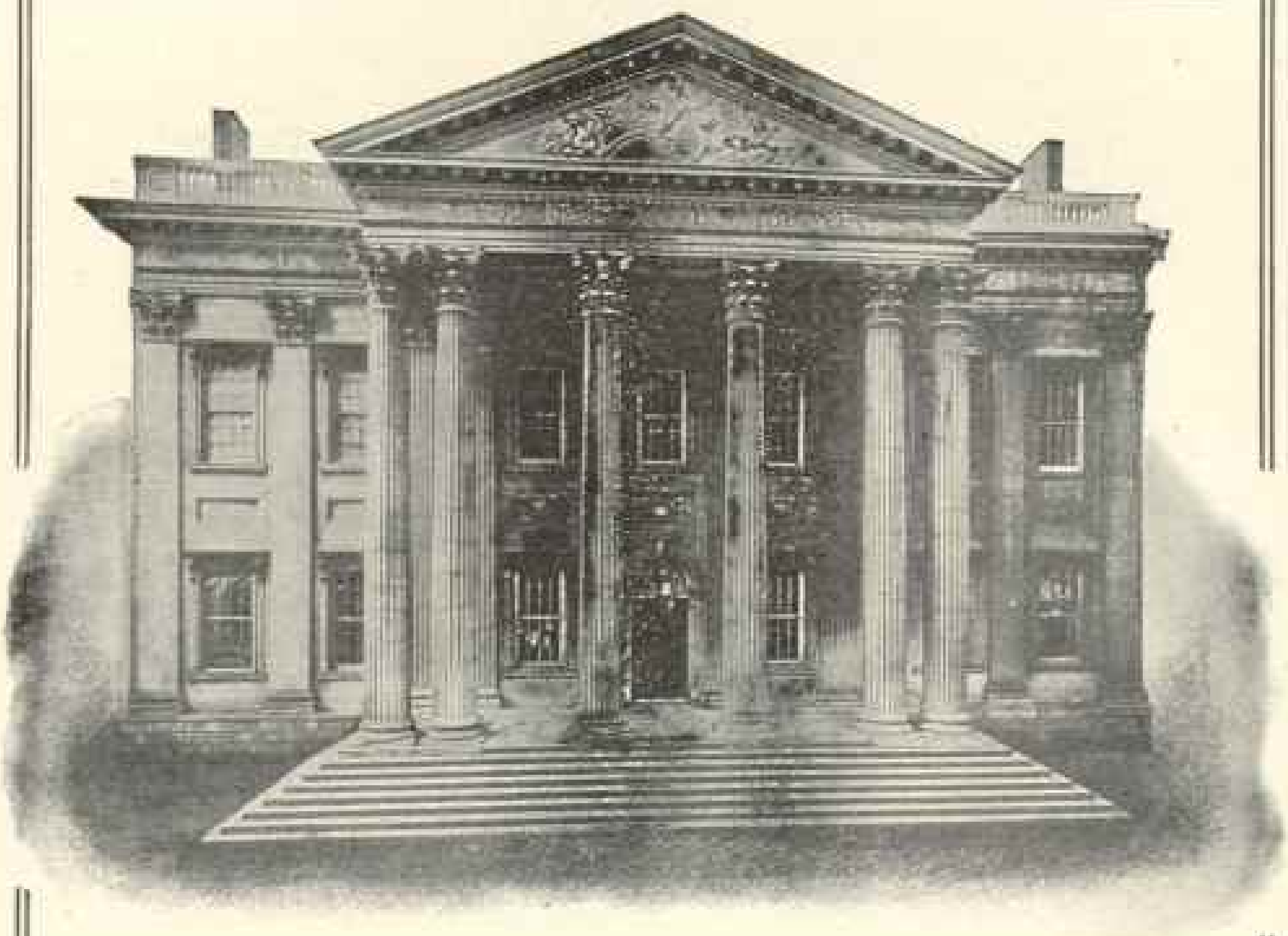

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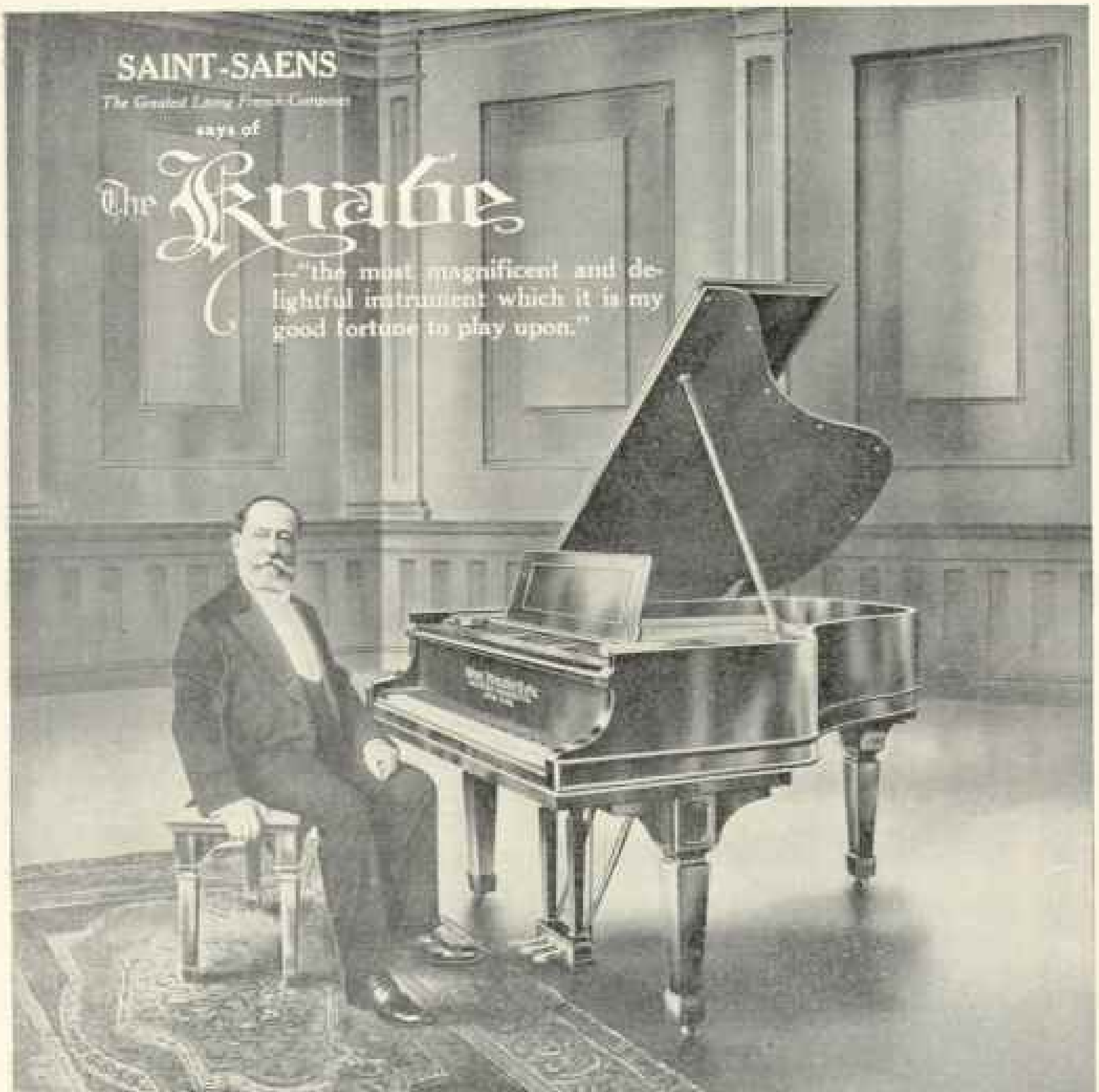

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Vol. XX, No. 8 WASHINGTON August, 1909

THE NATIONAL GEOGRAPHIC MAGAZINE

THE COLORADO DESERT*

By W. C. Mendenhall, of the U. S. Geological Survey

With Photographs by the Author

THE Colorado Desert is not in Colorado nor even near that imperial State. Instead, it is in the extreme southeastern part of California and adjoining parts of Mexico, and represents one of the geographical and physical extremes for which California is noted.

This state extends for 1,000 miles north and south along our Pacific shore line, so that it passes from tropical to temperate conditions and from the most arid to one of the most humid sections of the continent. It includes the great Sierra, dominated by Mount Whitney, 14,501 feet above the sea, while just east of this culminating peak of the United States lies Death Valley, the lowest point on the continent, 276 feet below sea-level. These physical contrasts are matched by contrasts in vegetation and temperature, so that nearly every type of natural environment under which man exists is represented within the boundaries of the state, and often, as in the case of Death Valley and Mount Whitney, the juxtaposition is so immediate as to greatly accentuate the contrasts.

The valley of southern California, with its orange and lemon groves, its acacias and palms, its geranium hedges, and its riot of roses, is only 100 miles from the region that is the subject of this sketch, originally one of the most desolate spots on the globe, a veritable furnace in midsummer, with recorded official temperatures of 130 degrees in a shadeless land, but now destined through the agency of man to become a unique agricultural section, in which products not capable of production elsewhere in the United States can be successfully grown.

This desert derives its name from the Colorado River, its creator and until recently the erratic master of its destinies. Now the river is sullenly yielding to man the dominion that it has maintained since the evolution of the desert from sea bottom to arid valley. This evolution is a very recent event, in a geologic sense, and is one which the scientist is able to decipher with exceptional and satisfactory definiteness.

The desert valley is a northeastward extension of the depression whose southern portion is filled by the Gulf of California. During a time that is not at all remote, geologically speaking, the gulf occupied all of this depression, extending

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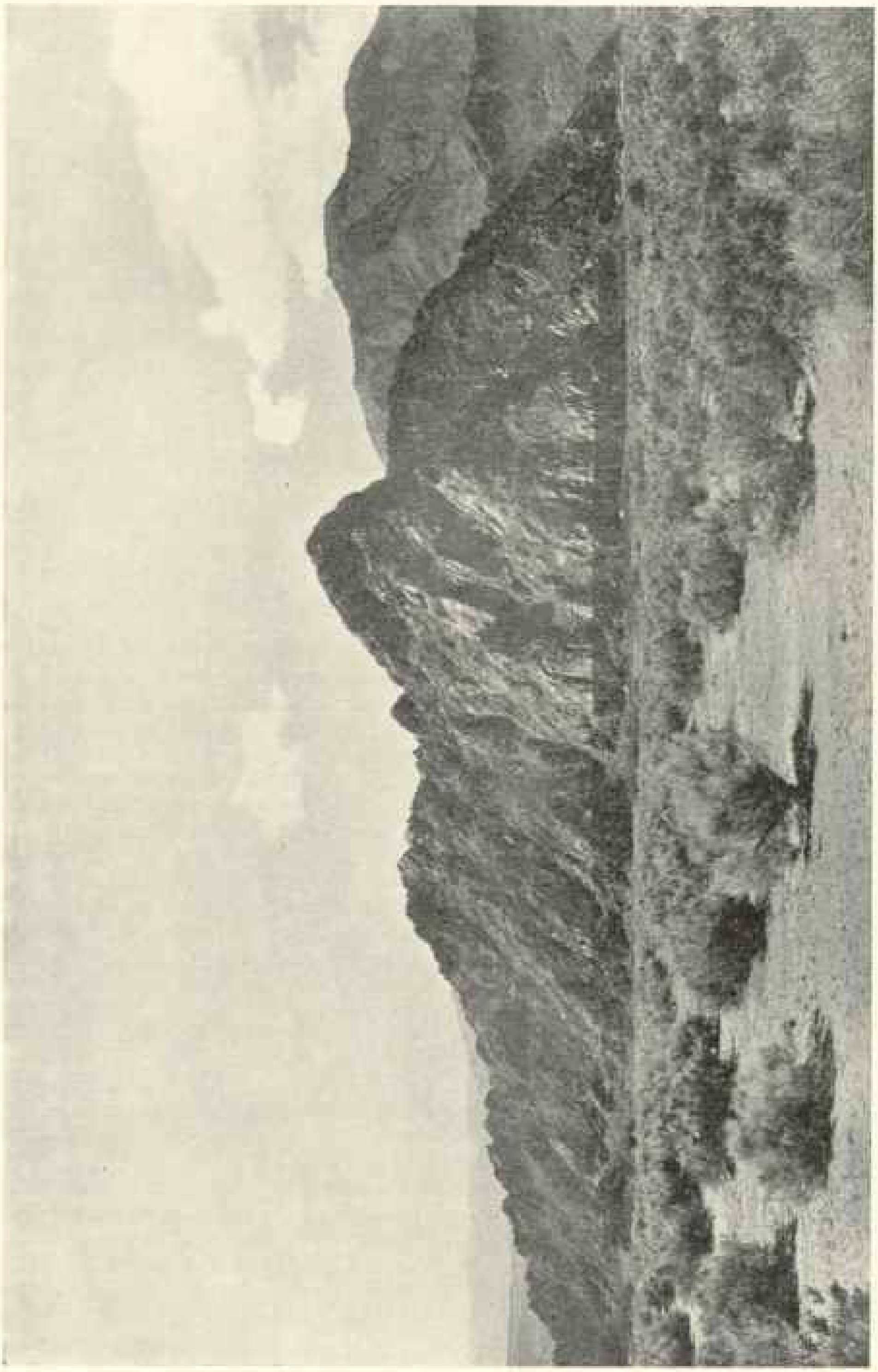


THE WATER LINE THAT MARKS THE SHORE OF THE LAKE THAT ONCE OCCUPIED COLORADO DESERT

inland 200 miles farther than at present, so that its waves lapped the base of the Santa Rosa Mountains and of San Jacquito Peak—physical features that are now far inland. At that time the mouth of the Colorado River was in the vicinity of Yuma, Arizona, 60 miles in an air line north of where it now is. Presumably, then as now, the river discharged annually into the gulf sufficient silt to cover one square mile to a depth of 53 feet. This material represented the products of the erosion of the great canyons in Utah and Arizona that are properly regarded as among the wonders of the western world.

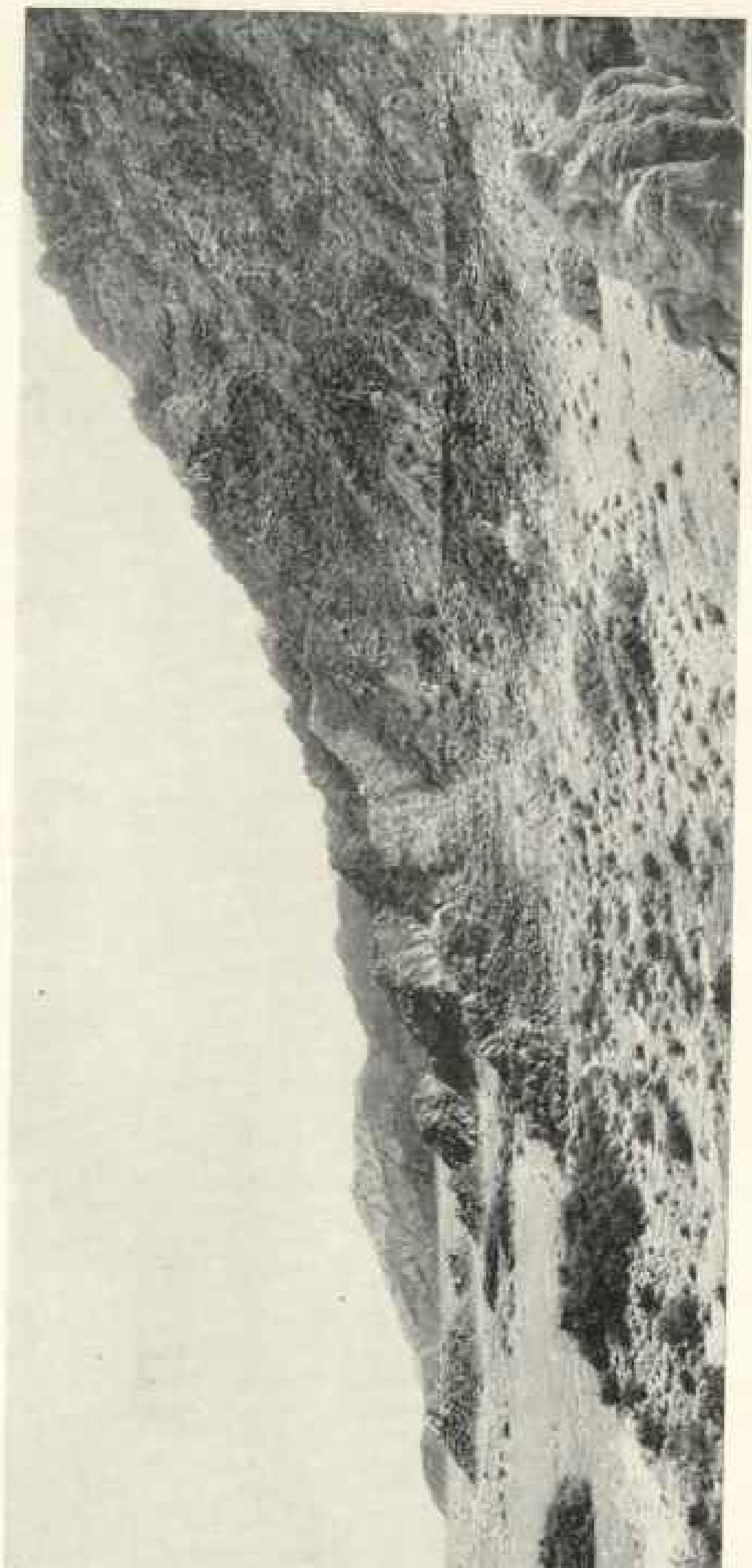
At the point where the river discharged into the old gulf this silt was deposited as a great delta which gradually extended entirely across the gulf to the Cocopah Mountains on its western shore. As a result of this extension the water body was divided into two parts, the one an inland sea and the other the modern gulf, with about the same dimensions and outlines that it has today.

Delta growth, however, did not cease with this separation; silt continued to be brought down by the Colorado and to be deposited in its bed, along its banks, and in the still waters at its mouth. By this process a stream builds up its immediate channel until this channel is higher than the adjacent land on either side. It is then in an unstable condition and will shift to more favorable courses at times when extreme floods breach its immediate banks. By this process continually repeated it comes eventually to flow over all parts of its delta, building up each part in turn, until the whole stands well above sea-level. By such a process the Colorado River has built the famous delta lands of the Imperial Valley, and meanwhile has discharged alternately into the Salton Sink and the Gulf of California.

During those periods when it discharged into the sink this basin was filled with water and became an inland lake. During the other periods when it discharged southward away from the lake the supply of water which it contained quickly dried away and left the old lake bottom as the Colorado Desert. Doubtless this process was repeated many times, but there exists clear evidence of only the last occupancy. This evidence is in the form of a remarkably well-preserved old water line (see page 682) that rims the desert from Indio to the Cerro Prieto at a height of 40 feet above sea-level. On the rocky points that projected into the lake this shore line is indicated by thick deposits of calcium carbonate, usually spoken of as coral by the desert dwellers because of a fancied resemblance to this mineral. Where alluvial cones and the sandy floor of the desert formed the shore line, beaches have been developed, and although of soft sand and easily eroded, they are even now well preserved, thus testifying to the recency of the action that produced them. Over the floor of the desert and along the sandy beaches are myriads of shells of brackish water mollusks that lived in the lake. So abundant are these tiny fossils in the northern end of the desert that it has been called, on account of their numbers, the Conchilla (Little Shell) Valley.

It is not possible to state the exact period at which this lake disappeared. The time units of geology are too large and too indefinite to translate satisfactorily into years, so that when we say the last existence of the lake and its disappearance are the most recent of geologic events, we still leave the mind groping for a definite human standard of time. It is the crudest of estimates, merely a guess, indeed, to state that, reasoning from geologic evidence alone, it may be a thousand years since the lake vanished, yet it puts in concrete form such a guess as the geologist is able to make.

When human records are studied, some evidence on this point is found, but it is almost as uncertain as to time as that furnished by the physical features. The Indians now living at Toro and Alamo Bonito have distinct legends to the effect that at some time in the past the valley was occupied by a large body of water. They record that this water contained many fish, and that it disappeared grad-



THE LAKE THAT DISAPPEARED

General view southward along the shore line of Lake Cahuilla from a point upon the western edge of the Coachilla Valley, near El Toro Indian Reservation

nally until eventually the lake became dry. When questioned as to the date of this event they state that it occurred as long ago as the lives of four or five very old men, say three or four centuries ago at the most. It is not probable that their statements are at all accurate as to time, but by combining them with the evidence furnished by physical conditions it is possible to say that the lake may have disappeared and left the desert, as we have known it in historic time, 600 or 800 years ago.

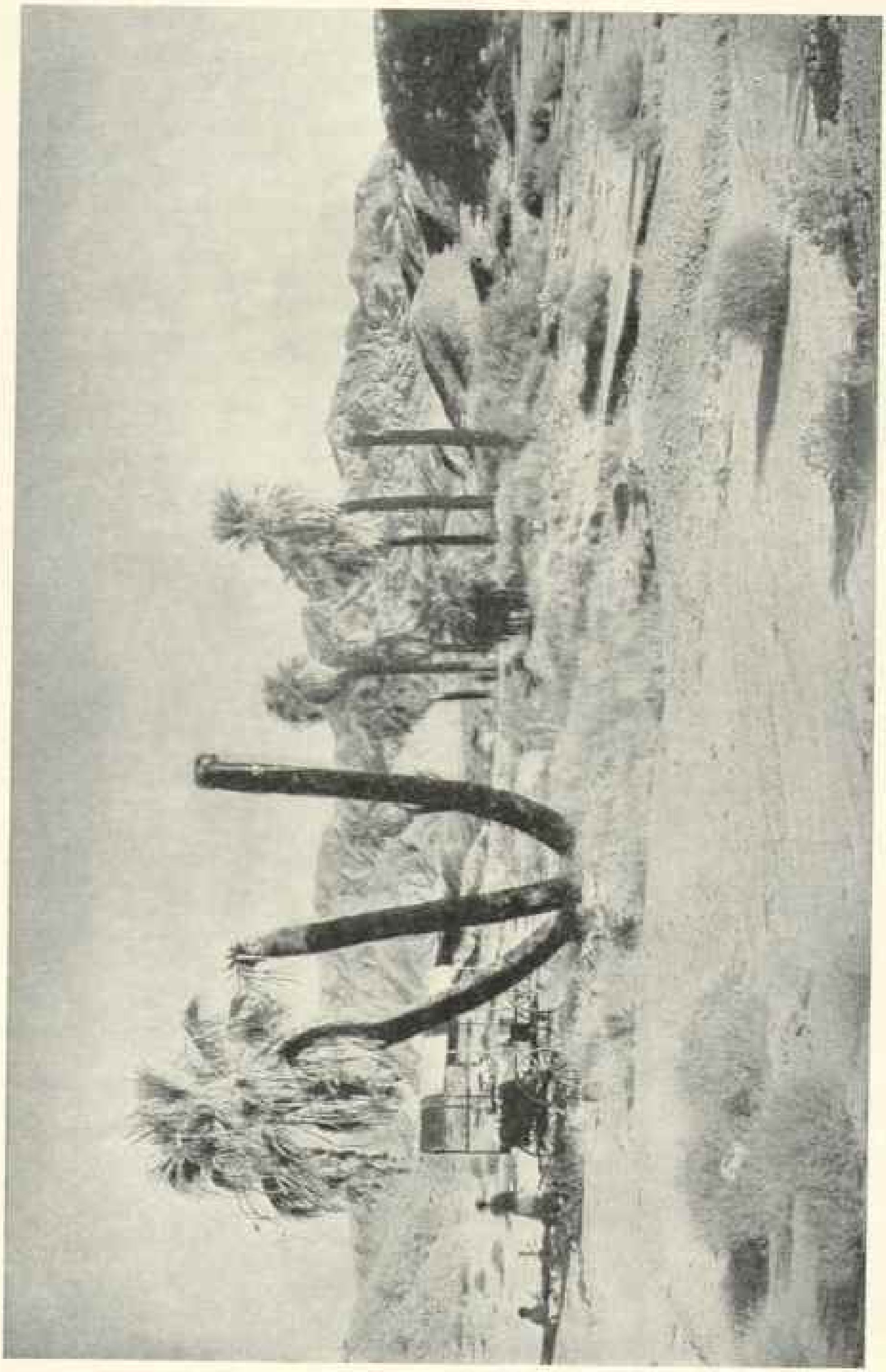
With the establishment of routes across the continent, as a result of the discovery of gold in California in 1849, the westward-faring emigrant who selected the southern route regarded the Colorado Desert as the last and most difficult of the areas to be crossed before the promised land was reached. Its summer heat is extreme and its aridity is such that sometimes a year or more passes without a drop of rain, and the average for many seasons is less than 3 inches annually—much less in twelve months than in New York city in one month. The native vegetation includes such curious and distorted forms as the ocatilla, the spiny barrel cactus, the dreaded cholla, the leafless palo verde, the ironwood, whose fiber is so dense that the dry trunk will sink in water, and here and there clumps of greasewood or gray sagebrush.

Many legends have been related of the desert and the tragedies enacted within it, and among these one of the most interesting appeared in a magazine of wide circulation in September, 1891. This article was a graphic account of the finding of the hulk of an old Spanish galleon in the playa which at that time formed the lowest part of the desert.

The story was reported to have been told to the writer of the article by a prospector who, leaving the groups of springs in the vicinity of what is now the Toro Indian Reservation, attempted to cross the 100 miles of waterless desert that separates these springs from the old Butterfield stage line far to the south near the Mexican line. The narrator states that while riding down the western edge of the basin his attention was attracted by a curious object within the lowest part of the sink. He attempted to ride to it, but when still some distance away his horse broke through the salt crust of the saline marsh and was so injured that it had to be killed. The rider then tried to approach the hulk on foot, but the marsh was too treacherous and he was not able to reach it. He states, however, that it was distinctly visible; that it was clearly the hull of a vessel of antique type, with high prow and stern and stumps of broken masts.

After his attempt he retraced his steps to the western border of the desert and continued his journey to the south on foot, but long before getting to his objective point, Carrizo Station, the water that he carried in his canteen was consumed and he was in danger of death. He wandered on in delirium across the sandy wastes and through the bad lands, losing consciousness and reviving again and again, and was finally found barely in time to save his life by the keeper of the station. The tale is graphic and picturesque enough to be its own excuse, but it bears the earmarks of belonging to the type with which the imaginative and sardonic western plainsman is wont to beguile the tenderfoot.

No later explorer has found a trace of the old Spanish galleon, although many have visited the Salton Sink, and before its inundation by the Colorado River salt mining was carried out on a commercial scale within it for many years, so that it was intimately known. Furthermore, it must have been inherently impossible for any of the earlier Spanish explorers who passed up the west coast of North America and into the Gulf of California to penetrate to the Salton Sea, even had it existed at the time of their explorations, because so nearly did evaporation balance inflow from the Colorado that the stream connecting the lake and the gulf must have been too small for navigation and, if we may judge from present grades, too swift for ships of the old galleon type to make headway against the current. But even



SEVENTEEN PALM SPRINGS NEAR THE SOUTH END OF SANTA ROSA MOUNTAIN, ON THE WESTERN BORDER OF COLORADO DESERT

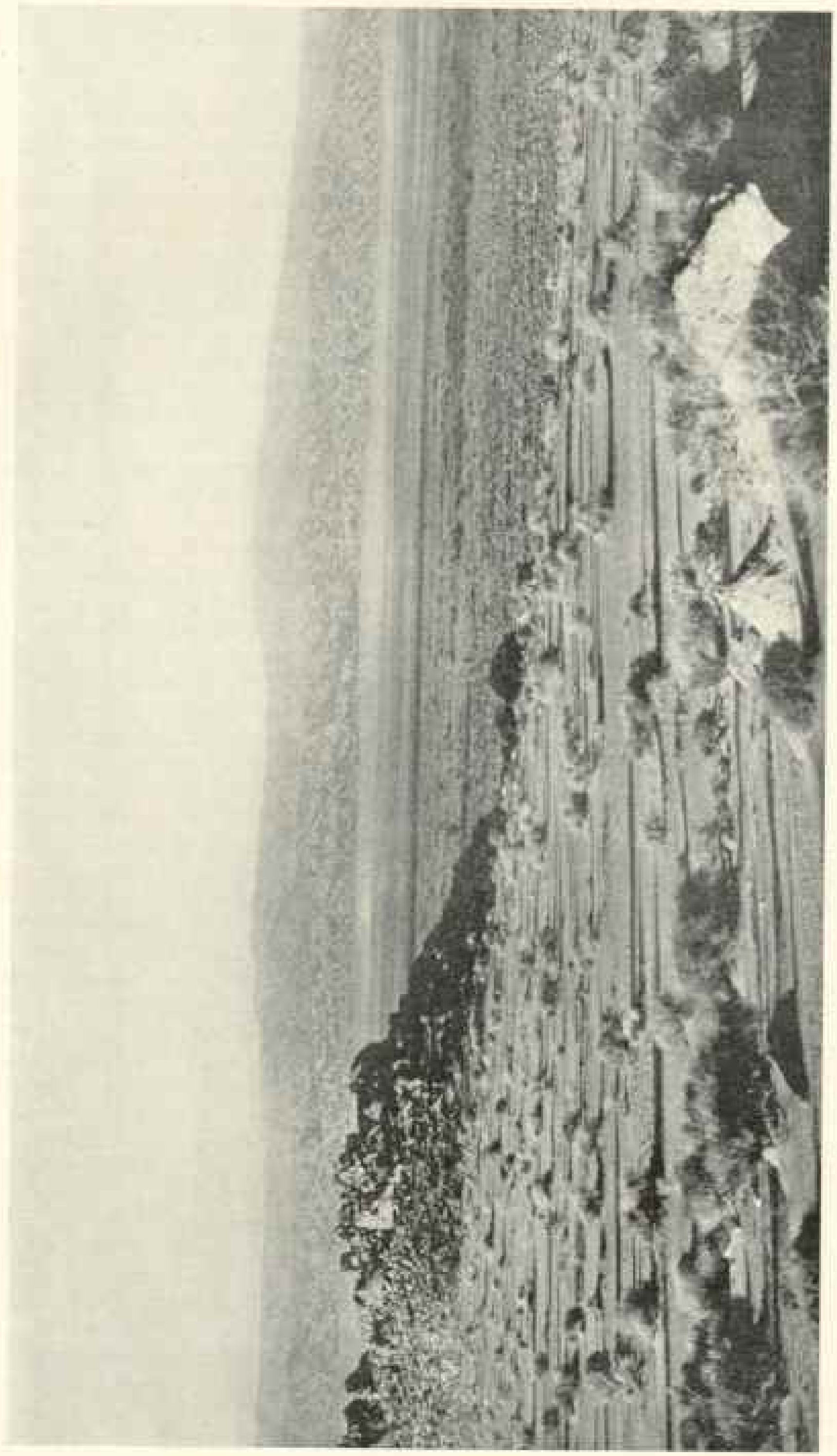
though there is no Spanish hulk in the bottom of the Salton Sink and no evidence that a lake had existed there within historical time, there can be no possibility of doubt of the existence of this lake in the latest of prehistoric periods.

The desert became known to white men through the activities of the early Spanish explorers, who, pushing northward from Mexico into Arizona and California, finally established an overland route connecting the Mexican missions with that Pacific Coast group that stretches from San Diego to San Francisco. The earliest of these Spanish explorers to leave a full record of his journeyings is Father Francisco Garces, who made at least four trips on foot through the Sonoran deserts into southern California, and on one of these journeys passed northward nearly to San Francisco Bay. The simple and devout padre, urged onward by the desire to extend his faith to the California Indians, at last lost his life in the massacre on the Colorado at the mouth of the Gila in 1774. This massacre checked the missionary activities for a time, but occasional explorers continued to penetrate the region, so that it had become known in a general way when the discovery of gold in California in 1849 led to the crowding of all the western trails by the argonauts.

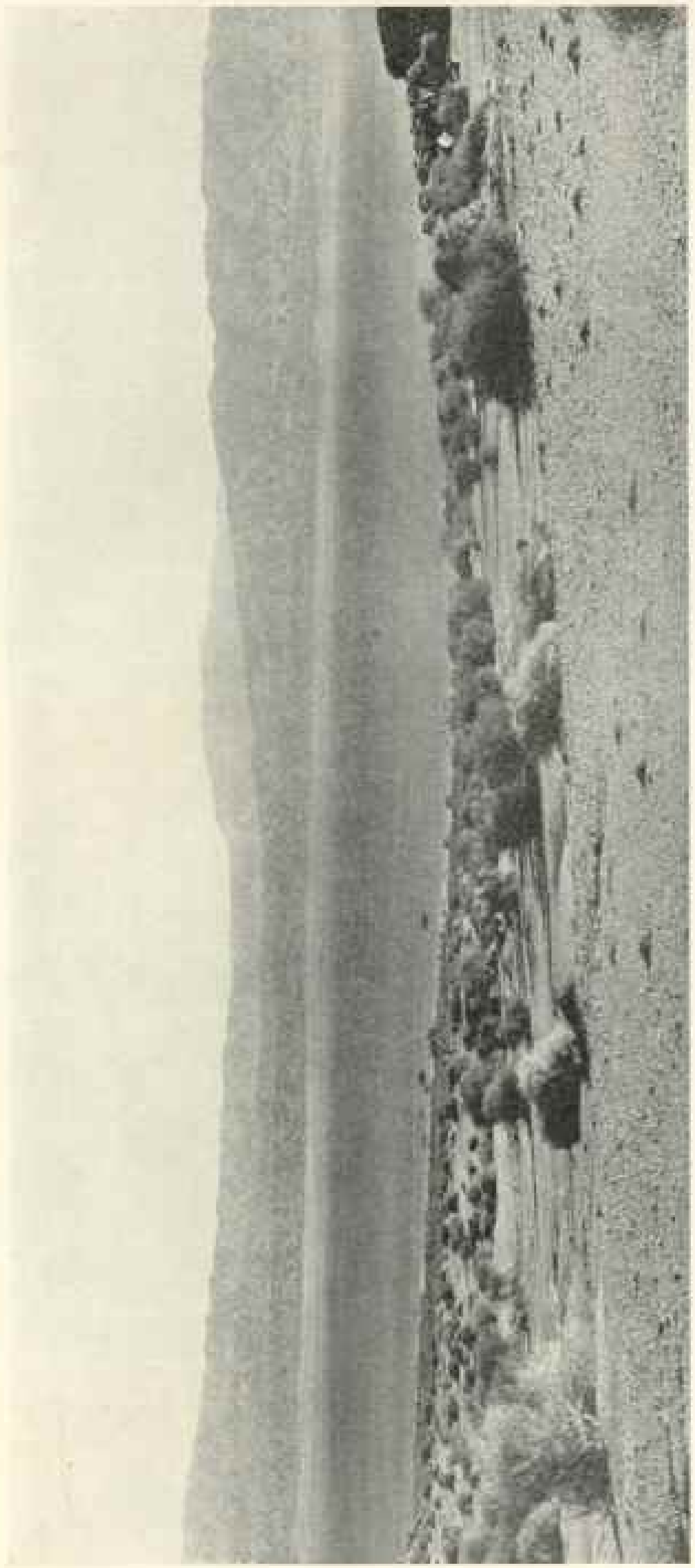
One of the results of the stimulus given to western exploration by the gold discovery was the organization, under the auspices of the army engineers, of a series of expeditions whose object was the determination of possible railroad routes to the western coast. One of these explorations, commanded by Lieutenant Williamson, was assigned to the southwestern field, and to it was attached Prof. Wm. P. Blake, now Territorial Geologist of Arizona. In the course of the explorations of this party Professor Blake visited the Colorado Desert between November 13 and December 19, 1853. In the volume based on his explorations Professor Blake gives a complete and graphic account of the great desert and the phenomena displayed there. He recognized that the depression was but the bottom of a vanished lake, whose depth and extent, however, he was unable to outline definitely because of the lack of accurate maps. All later scientific descriptions of the desert are based on Blake's account and have done nothing more than add detail to the general principles which he outlined more than half a century ago. The work, though done in the briefest time and under great physical difficulties, has borne well the tests of all later investigations.

The desert, although known and traversed when necessary, continued to be shunned and dreaded until as late as 1879, when the Southern Pacific Railway became a transcontinental line by connecting New Orleans with Los Angeles along a route that crosses the southern extension of the Sierra by San Gorgonio Pass and follows the arid valley from north to south between the pass and Yuma. Since then access to this section has been relatively safe and easy, but it has been so uninviting and so apparently worthless that until about the beginning of the present century it contained no permanent human inhabitants except a few railroad and mine employees, who regarded their assignment as worse than exile.

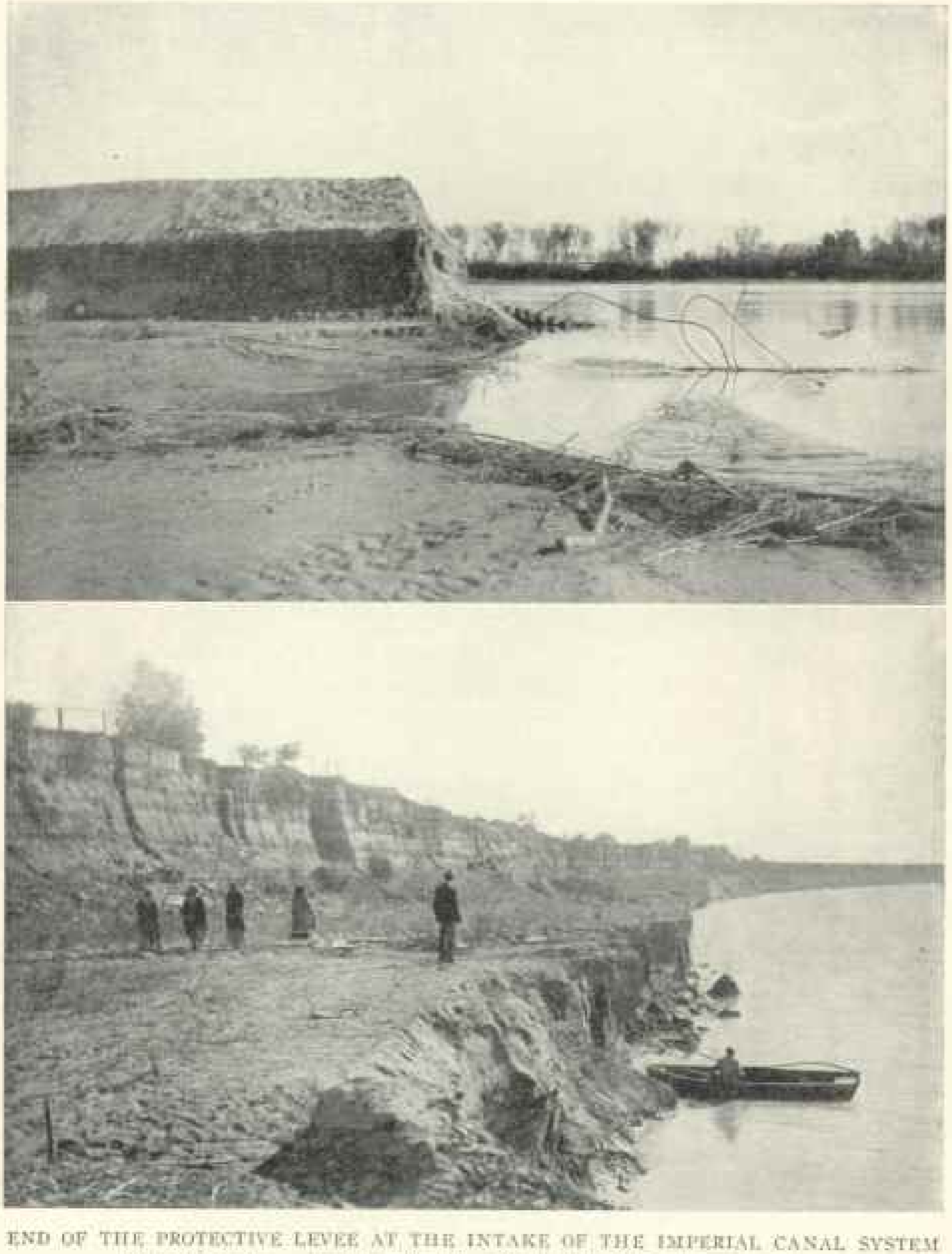
Engineers, however, had long realized that the silt-covered floor of the desert required only the application of water to become a most productive agricultural area. The fact that it is a portion of the original delta of the Colorado River, across which that stream has meandered many times during the past centuries, means that the task of conducting Colorado River waters to it is a comparatively simple engineering feat; hence several attempts had been made to finance a plan to build such a system as the present Imperial Canal System before the successful organization of the California Development Company. Following the organization of this company construction was begun in 1900, and in 1901, in the month of June, water was delivered across the international boundary at Calexico and the first Imperial Valley lands were irrigated.



GENERAL VIEW OF THE UPPER END OF THE COLORADO RIVER CANYON, SHOWING THE INFLOW OF THE COLORADO RIVER FROM THE WEST SIDE BEFORE THE DAM IS BUILT ACROSS THE RIVER



GENERAL VIEW OF THE COLORADO DESERT AND THE SALTON SEA AFTER THE INFLOW OF THE COLORADO RIVER WAS CONFINED TO ITS MAIN CHANNEL



END OF THE PROTECTIVE LEVEE AT THE INTAKE OF THE IMPERIAL CANAL SYSTEM BELOW YUMA. CUT THROUGH AND DESTROYED BY THE COLORADO RIVER IN DECEMBER, 1906

THE GORGE CUT BY THE NEW RIVER AT CALEXICO IN THE SUMMER OF 1906
FERRY-BOAT OPERATED BY INDIANS

Development from that time until 1904 was rapid, but the silt carried by the Colorado River tended to clog the canals of the irrigation system and to make it difficult to secure sufficient water through them to irrigate the tributary lands. In order to overcome this difficulty, new intakes were repeatedly cut at the head of the system, and during the flood period of 1905 the river, enlarging one of these intakes, abandoned its normal course to the Gulf of California and, following the Imperial Canal nearly to the international boundary, flowed again into the Salton depression as it had doubtless done at many periods in prehistoric time.

So we had the strange spectacle of a mighty river wholly abandoning the lower 80 miles of its course and ceasing utterly to discharge into the sea. During the next two years repeated efforts were made to redivert the river from its course inland to that toward the gulf; but these were all unsuccessful until February, 1907, when, after the expenditure of hundreds of thousands of dollars, the stream was finally controlled and the menace to the valley removed; but during the two years or more of inflow a great lake nearly 500 square miles in area had accumulated in the bottom of the Salton depression to a depth of nearly 80 feet, inundating 40 or 50 miles of the main transcontinental line of the Southern Pacific and forcing that road to rebuild on higher lines at great expense.*

With the control of the river regained and the menace to property interests in the valley thus removed, development, suspended for a long time, has been resumed at a rate that promises to more than make up for the delay.

The principal elements in the history of this extraordinary region may be briefly summarized: First, in earlier prehistoric time it was an arm of the Gulf of California; then, perhaps during the Middle Ages of human chronology it had become an interior lake, separated from the gulf by the delta of the Colorado River; after its separation the lake eventually evaporated and its site became the hottest and dryest as well as one of the lowest points in the United States. It was in this condition when it first became known to civilized man.

By the practice of the art of irrigation a part of it was later transformed from an absolute desert to a unique agricultural community, but as an incident in this reclamation a lake has again been created in the bottom of the depression, and for a long and anxious period there was serious danger that the inundation might extend over practically all of the lands that had been reclaimed. Fortunately this menace is passed and development again continues unimpeded by fear that the erratic river will destroy what in times past it has created.

The desert is interesting for other reasons than those due to its strange history. Within it or about its borders are most striking land forms of bizarre types. East of Holtville is a zone of sand dunes 12 miles wide and 50 miles long—a region unsurpassed in aridity and in menace to the inexperienced traveler by the worst of the Saharan or Tibetan deserts. (See page 700.)

In the western edge of the Imperial Valley, at the east base of the Peninsula Range, are bad lands quite equal in picturesqueness and in uselessness to the worst of the Dakota bad lands. (See page 696.)

The rare torrential storms of the region have caused the streams that drain from the bordering mountains into the desert to cut strikingly deep, narrow canyons through the sandstones around the desert margin. Some of these cleft-like gorges are scarcely wide enough at the bottom for a man to pass, yet have walls two hundred feet high or more. Others are broader and deeper, but with sheer sides that cannot be scaled except where broken down at the junction of some tributary arroyo. (See page 693.)

Among the most incongruous elements in the desert physiognomy are two groups of mud volcanoes that seem uncanny, so strangely out of place are

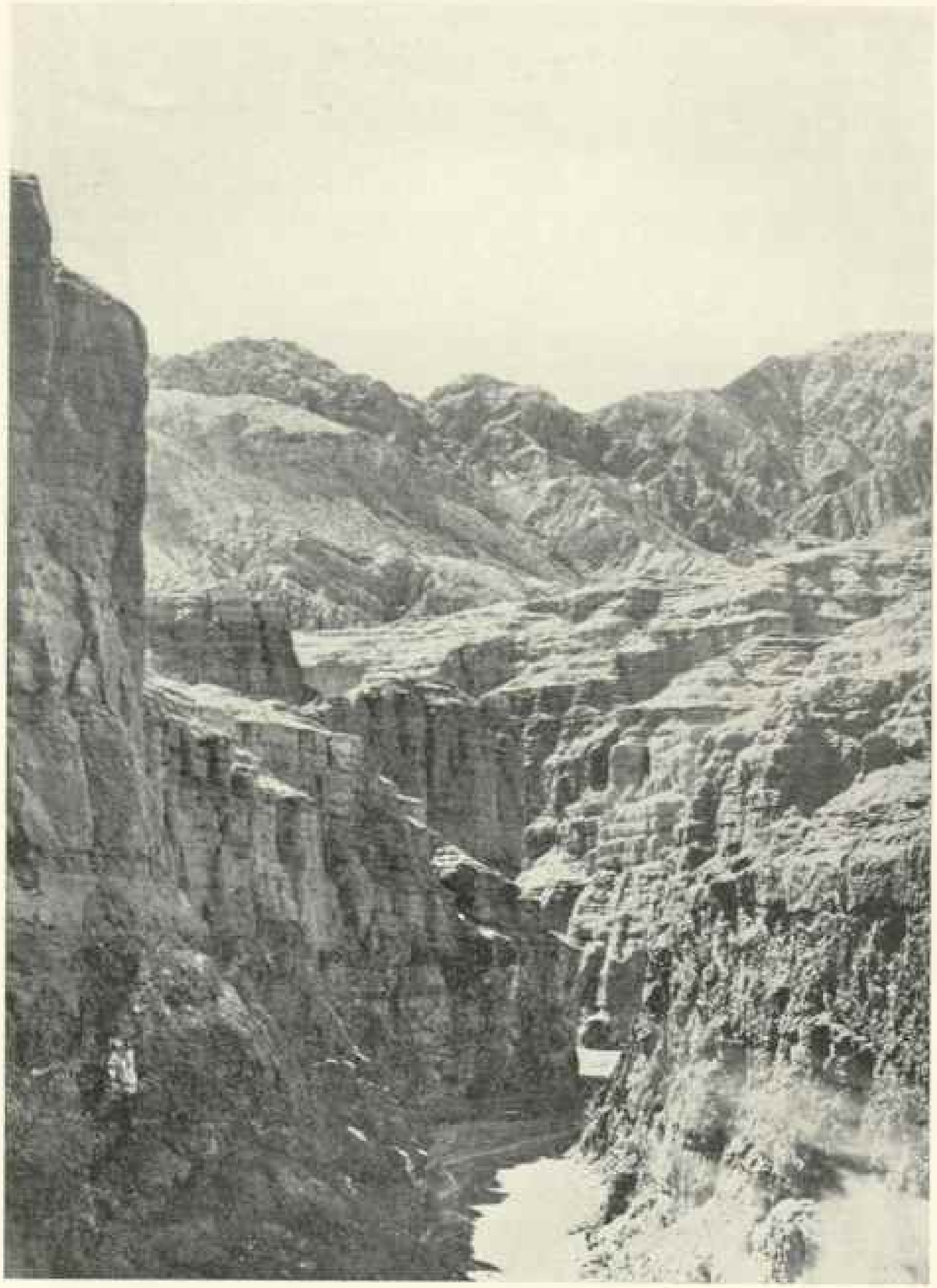
* For further description of this break of the Colorado River see "The New Inland Sea," by A. P. Davis, in NAT. GEOG. MAG., January, 1907.

COLLAPSED MUD VOLCANO—A CALDERA IN MINIATURE—NEAR VOLCANO LAKE, MEXICO, 40 MILES SOUTH OF THE INTERNATIONAL BOUNDARY LINE

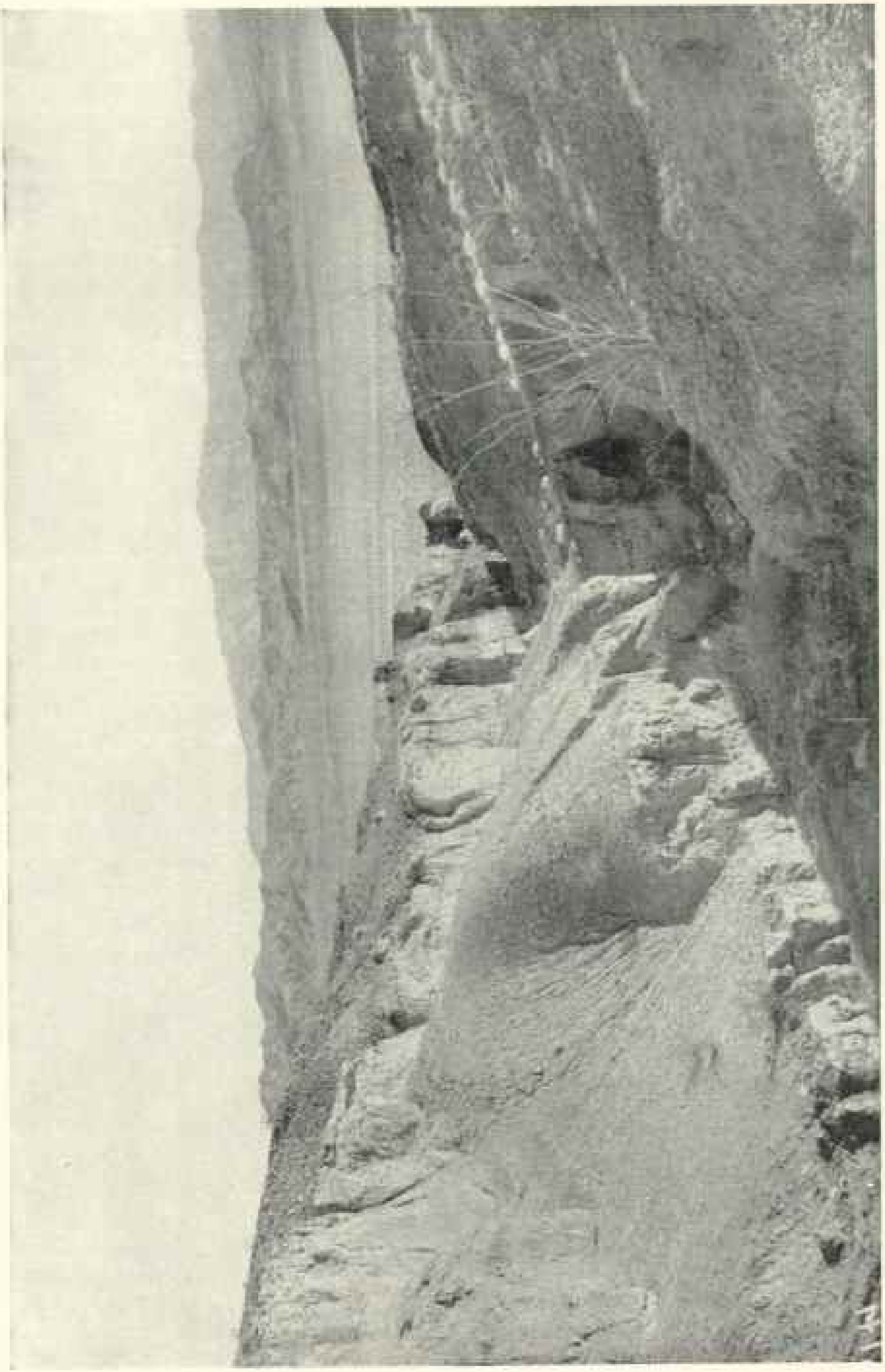
they in the featureless silt plain which constitutes most of the desert surface. The best known of these groups is now submerged by the Salton Sea. Its situation is about 6 miles south of the station of Old Beach, the junction point for the Imperial and Gulf branch of the Southern Pacific Railroad. These solfataras, before their submergence, were distributed in two or three sub-groups, near some mounds of volcanic rock which rise above the desert floor. They have been visited at various times by explorers and during at least one of these visits a tragedy was narrowly averted. The explorer, in attempting to cross the thin crust that covers the hot mud bog which separated the mounds from the solid ground around them, broke through the crust and was so scalded that his explorations had to be given up and his life even was for a time in jeopardy.

The craterlets of mud look more like irregular beehives in various stages of dilapidation than like any other familiar form which might be mentioned (see page 698). In the tops of these mounds there are often cup-shaped depressions, and from these or from vents in the sides steam and other gases are constantly rising (see page 699). These gases contain much sulphurous vapor, and this vapor, condensing as it reaches the air, lines the vents with brilliant yellow crystals and powders the adjacent surface with a golden dust that gives curious and even attractive effects. Round about the mounds are pools of hot mud or water, the latter often so acid that shoes or wearing apparel moistened with it are destroyed.

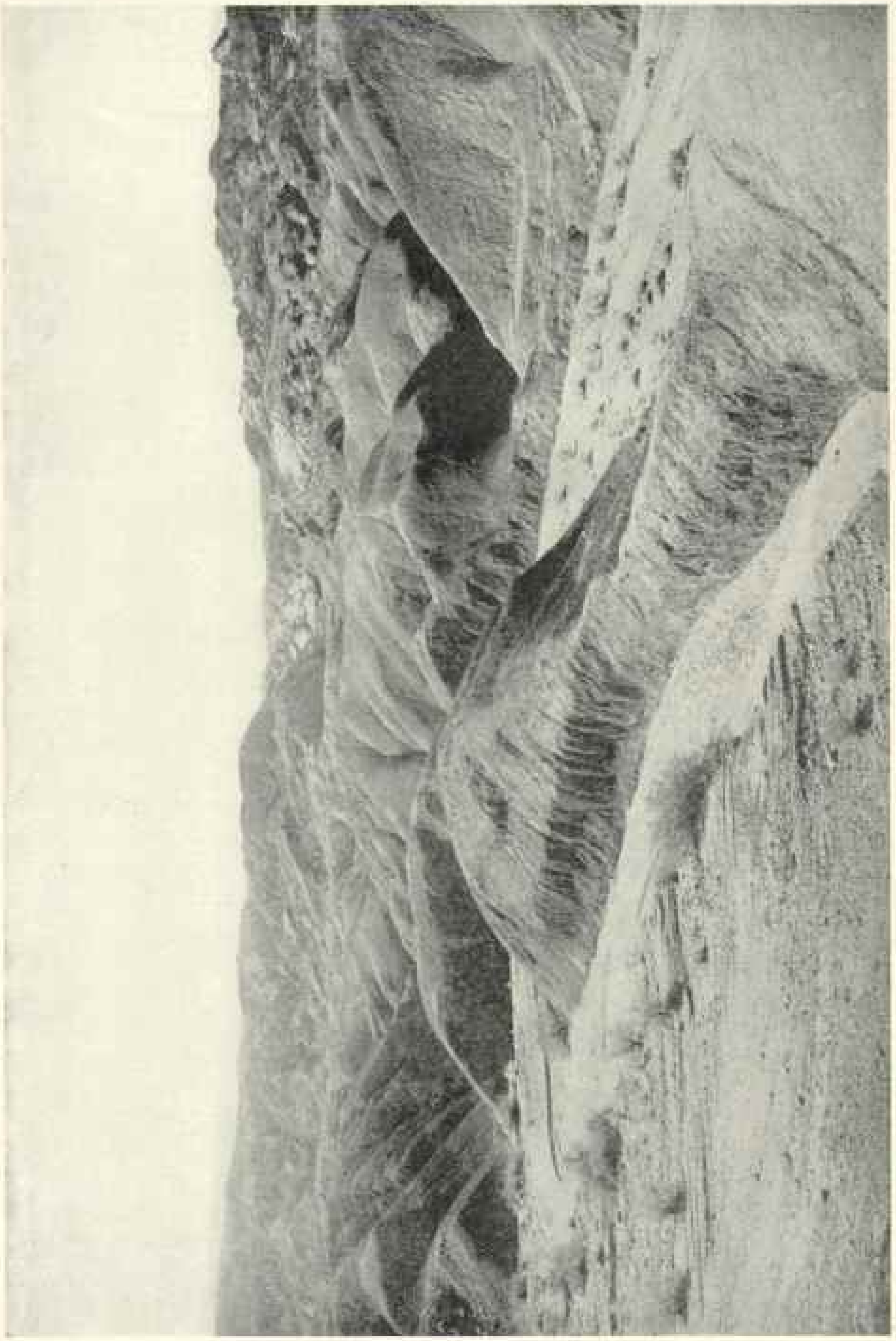
The second important group of solfataras lies not in California, but about 40 miles south of the international boundary in Mexico, along the western shore of Volcano Lake and near the base of a dark butte called Cerro Prieto. The volcanoes here cover many acres (see pages 698 and 699) and are much more active than those on the American side of the line. Many of them are boiling and bubbling continually, emitting weird muffled



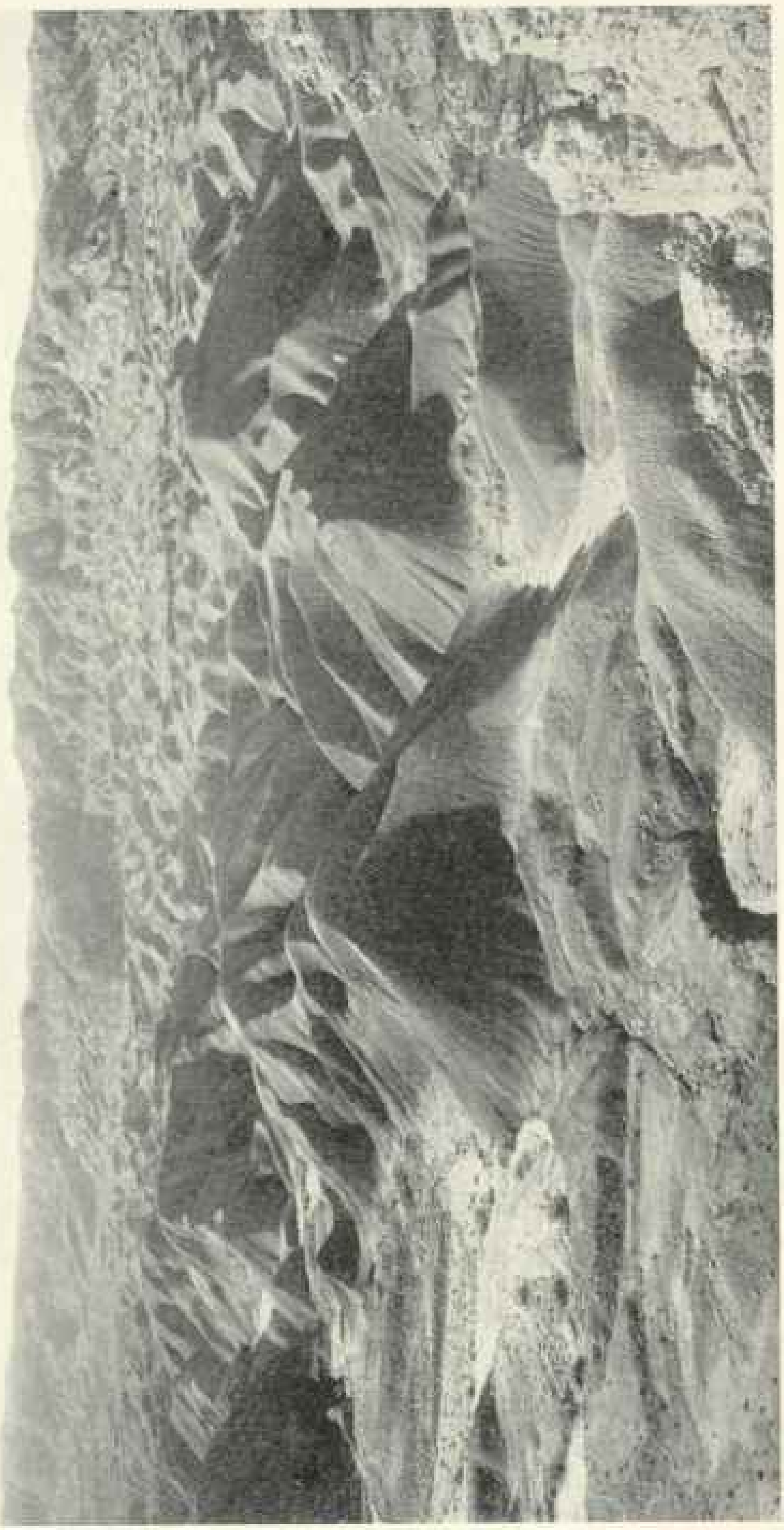
AN EXAMPLE OF DESERT EROSION. A DEEP-CUT CANYON EAST OF CONCHILLA VALLEY (SEE PAGE 691)



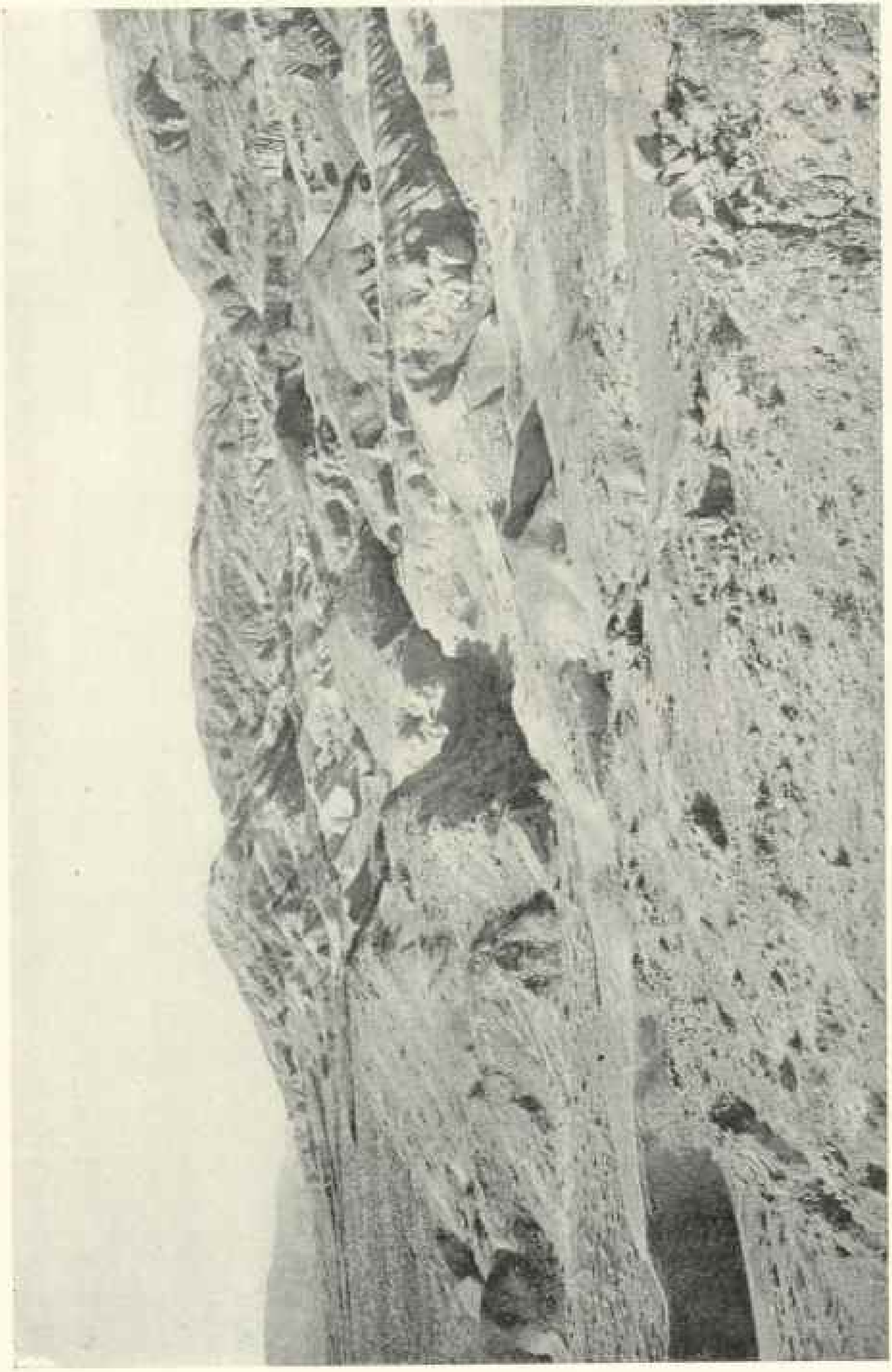
COYOTE WELLS VALLEY AND THE EASTERN FRONT OF THE SOUTH SLOPE OF THE PENINSULA RANGE VIEWED FROM CARRIZO MOUNTAIN



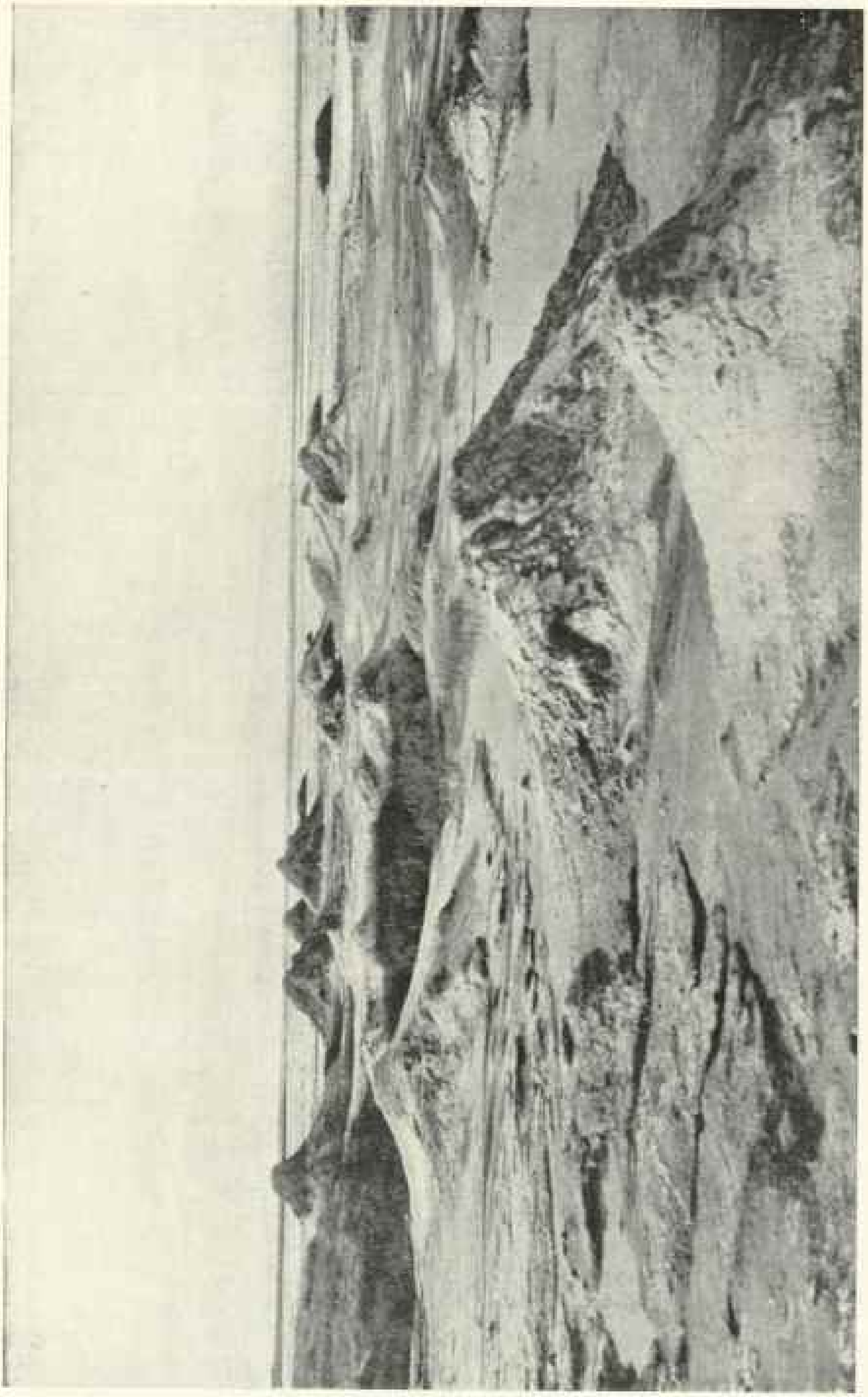
AN ARROYO WITH ITS SURROUNDING BARE CLAY HILLS IN THE CARRIZO VALLEY, A TRIBUTARY TO THE DESERT FROM THE WEST



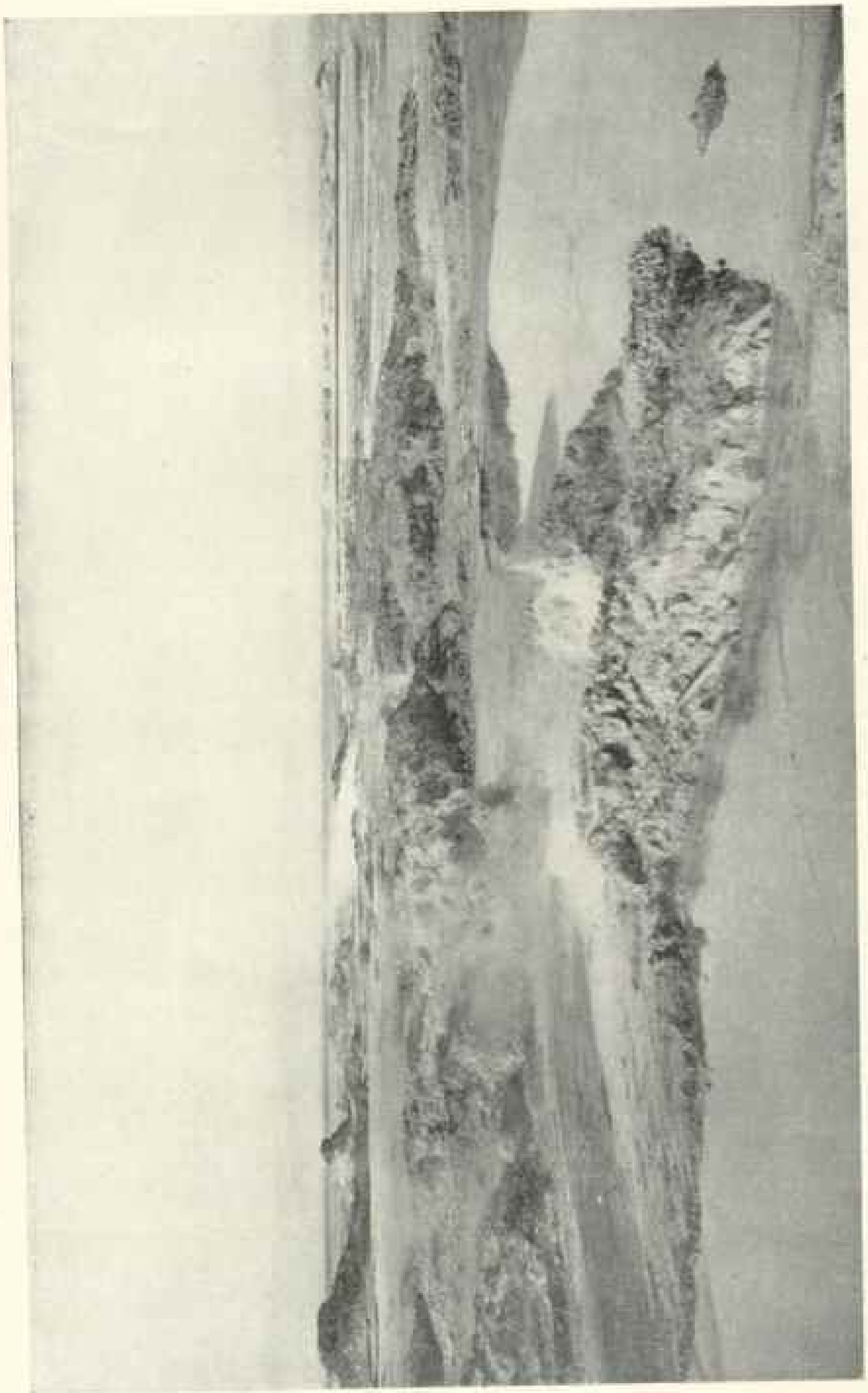
BAD LANDS IN THE COLORADO DESERT



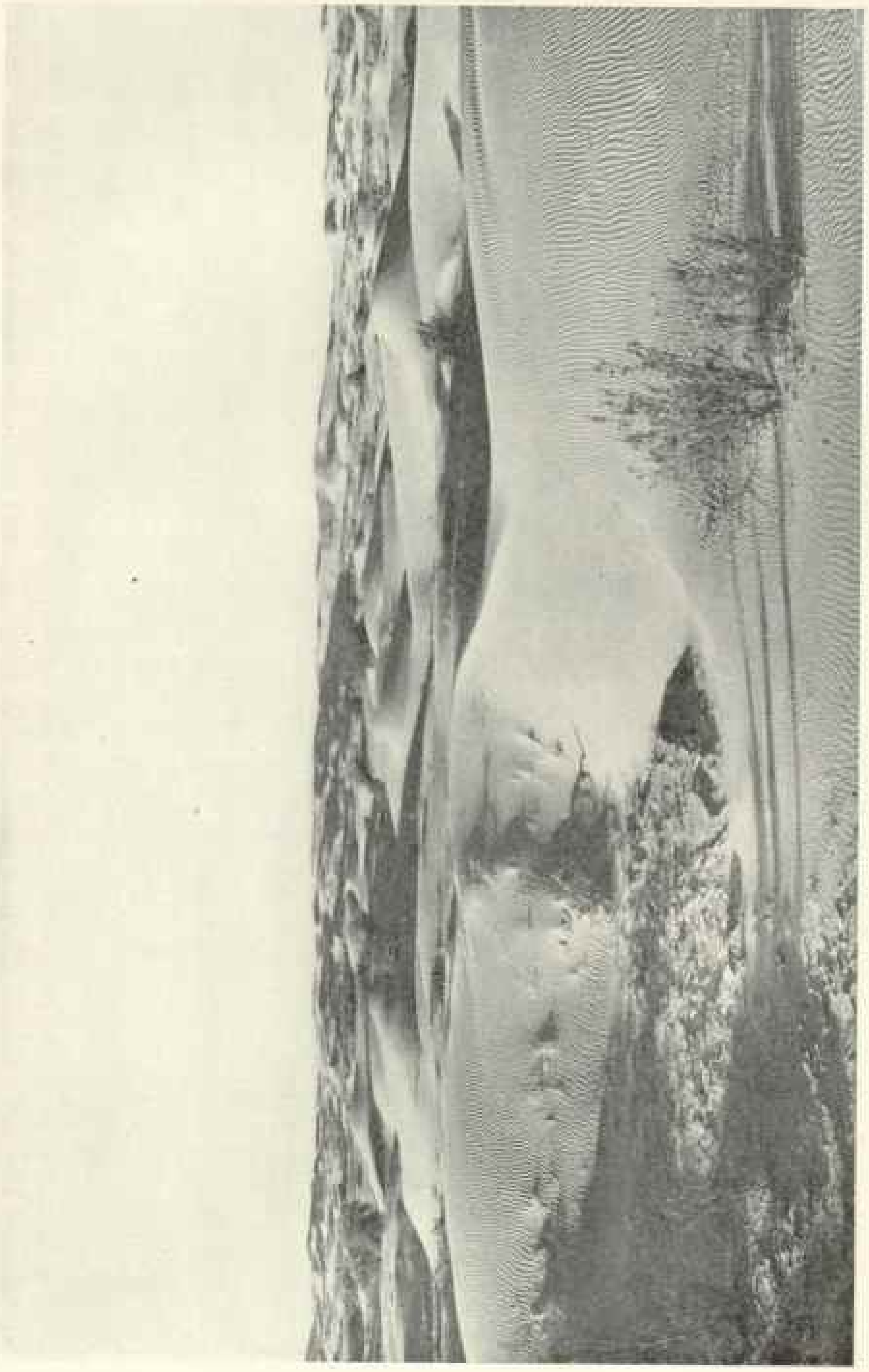
THE SOUTH SIDE OF CAMPBELL BUTTE, A DISTANT VIEW OF THE WESTERN EDGE OF THE COLORADO DESERT; BEYOND, MOUNTAINS NEAR THE MEXICAN BORDER



A GROUP OF QUIESCENT MUD VOLCANOES ON THE SHORES OF VOLCANO LAKE, MEXICO, 40 MILES SOUTH OF THE INTERNATIONAL BOUNDARY LINE



SAND VOLCANOES IN ACTION NEAR IMPERIAL JUNCTION, CALIFORNIA



SAND DUNES, THE LAST MAMMOTH STATION, AND PART OF THE DESERT NEAR MAMMOTH STATION

sounds that give the vicinity an uncanny aspect. This effect, moreover, is increased by the strange hues of the surface, the white of the alkaline efflorescence being tinted yellow by the sulphur or dark red or orange by mercury sulphides.

A sharp bluff separates the area occupied by the solfataras from the flat occupied during times of flood by Volcano Lake, and small openings lead from the shore of the lake into this bluff. These openings, like the volcanoes themselves, usually discharge vapors, and from some of them hot springs or mud flows issue.

It is related that one of the riders employed by a big cattle company that controls the greater part of the range south of the line decided in a moment of alcoholic inspiration to explore one of these uncanny caves. He came out quickly, sobered and shaken, and started for his pony. "The crust's too thin in this neighborhood for me," he is reported to have said. "I don't believe the end of that hole is more than forty feet from hades, and while I'm a fair gambler and only an ordinary sinner, I don't want to take any chances hereabouts. Calexico and the forget-it-water for mine."

But for the sober man the region about Volcano Lake, although a veritable inferno in the desert summer heat, with the puffing of the steam jets, the sulphurous odors, the treacherous, hot marshes, and the weird coloring, is perhaps for that very reason an area of deep interest; but it is only one of many interesting features in a most unique and even yet very imperfectly explored corner of North America.

KING HERRING

An Account of the World's Most Valuable Fish, the Industries it Supports, and the Part it Has Played in History

By Hugh M. Smith

U. S. Deputy Commissioner of Fisheries

WHEN one takes a bird's-eye view of the fisheries of the world he quickly perceives that there is no family of fishes and no group of aquatic animals that contributes so largely to the support of the human race as the herrings. The family has 200 members, nearly all of which exist in great abundance.

In nearly every country having extensive fisheries some kind of herring is of importance, and in many countries representatives of the family are among the most valuable of the water products. Some of the herrings live exclusively in salt water, some exclusively in fresh water, and some alternately in the sea and streams.

Characters by which the herrings may readily be recognized are the presence of a single dorsal fin, which, like all the other fins, is composed only of soft or non-spinous rays; the absence of an adipose dorsal fin, such as occurs in the salmons and trouts; a swim-bladder, which communicates with the esophagus by a pneumatic duct; four gills; a forked tail; a terminal mouth with weak or deficient teeth; a fully scaled body but naked head; the absence of a series of "lateral line" organs, and a generally silvery coloration. The structure of the mouth parts determines the food, which usually consists of minute animals and plants, strained from the water by the numerous gill-rakers.

On the east coast of North America we have such well-known and important members of the family as the sea-herring, the shad, the river herrings or alewives, the West Indian sardine, and the menhaden, the last doubtless the most abundant fish on our shores. On the Pacific coast of North America are the California sardine and the sea-herring. On the shores of Europe are the Allice shad and the Twaite shad; the pilchard, which when young is canned under the name of sardine and sent to the outermost confines of civilization; the sprat, and the sea-herring. In the Caspian and Black Seas and in the Volga herrings occur in great abundance and are the principal fish of those regions. The seas that wash the shores of northern Asia, particularly those of Siberia, Korea, and Japan, teem with a number of kinds of herrings and sardines. In the waters of the Philippine and East Indian archipelagoes small and large members of the family abound. In the rivers of India runs the hilsa, which is similar to the American shad, and on the coast of India occur schools of the oil sardine. Herrings likewise exist in Australia and New Zealand; in the rivers and coastal waters of Africa, and at the southern extremity of the Western Hemisphere, where the Chili sardine abounds.

THE SEA-HERRING HAS DETERMINED THE DESTINY OF NATIONS

But the herring par excellence is the sea-herring of the North Atlantic and the scarcely distinguishable sea-herring of the North Pacific. This fish—biologically two species, commercially one species—is the most abundant and most valuable in the world, and is therefore entitled to be called king.

The sea-herrings are cold-water fish and reach their greatest abundance in far northern latitudes. The herring of the Atlantic, called *Clupea harengus* by Linnæus, has a remarkably wide distribution. On the western shores of Europe its southern limit is the Strait of Gibraltar, whence it ranges to the White Sea and the Arctic Ocean as far north as Spitzbergen, occurring in enormous numbers in the Bay of Biscay, North Sea, Baltic Sea, and Norwegian Sea. It is thus found on the coasts of Spain, Portugal, France, Belgium, Holland, England, Wales, Scotland, Ireland, Denmark, Germany, Russia, Finland, Sweden, and Norway. With Iceland as an intermediate station, the fish crosses to the shores of Greenland, and extends its range southward and westward to Labrador, Newfoundland, Quebec, New Brunswick, Nova Scotia, and the New England shores, going in winter occasionally to New York and exceptionally as far south as the Virginia capes. The North Pacific herring, first called *Clupea pallasi* by Cuvier and Valenciennes, exists in the same extraordinary abundance as the Atlantic fish and has also a very extensive range, being found from California to Alaska and from Siberia to Korea and Japan.

A tale as stirring as any fiction could be based on the part played by the sea-herring in the history of some of the principal countries. "Its spawning and feeding grounds have determined the location of cities," and in several instances the actual destiny of nations and the fate of monarchs appear to have been involved in the herring fishery.

Countries in which the quest of the herring is an important industry are the United States; the Canadian provinces of New Brunswick, Nova Scotia, Quebec, and British Columbia; Newfoundland; England, Scotland, Wales, and Ireland; Norway, Sweden, and Denmark; Russia; Germany; Holland; Belgium; France; Japan, and Siberia.

THE HERRING FORMS THE PRINCIPAL FOOD OF THE COD, HADDOCK, AND HOSTS OF OTHER FISH

The chief purpose the herring subserves in nature is to be the food of a host of other creatures, some of which are of great economic value. The most important of the fishes that subsist regularly on herring are the cod, haddock, hake, and pollock, all of which consume immense quantities of herring and her-

ring spawn. Mackerel, albacore, and various other high-sea fishes prey largely on herring at times, and numerous species of little or no value to man—like the sharks, dogfishes, sculpins, and flounders—often gorge themselves with herring and their recently deposited eggs.

Among the marine mammalia, whales, porpoises, dolphins, and seals prey on the herring and sometimes subsist almost entirely on this fish.

On parts of our northeast coast probably the worst enemy of the young herring is the squid, which frequents the inshore waters in immense numbers and is most adept and insatiable in capturing the unlucky herring, both in open waters and in the weirs of the fishermen.

Small fishes, birds, and a perfect host of other minor creatures find a large part of their sustenance in the eggs and young of the herring, and in the aggregate are doubtless much more destructive than any of the major enemies mentioned.

As the herring is probably more extensively preyed on than any other fish, and as it is entirely lacking in offensive and defensive powers, it is evident that its perpetuity depends on its abundance and its prolificacy.

THE WONDERFUL FECUNDITY OF THE HERRING

The average number of eggs deposited annually by a full-grown herring is 30,000. This is not a particularly large number by comparison with the egg-laying capacity of many other marine food-fishes, but it is noteworthy in view of the small size of the fish and its remarkable abundance. If all the progeny of a single pair of herring were to reach maturity and spawn, and if all of their progeny were to survive and spawn, and if this were to go on for a few generations, the resulting volume of fish would be beyond comprehension. In fact, if such unrestricted multiplication were to continue for a period as short as ten years, all of the seas of the earth would be filled solid with herring, all land would be submerged, and all other creatures in the world would be crowded out of existence.

USES OF THE HERRING

The extraordinary value attained by the sea-herring as a fishery product has depended in no small degree on the manifold uses to which it may be put and the numerous ways in which it is susceptible of preservation. As a fish for consumption in a fresh condition, the sea-herring does not rank high by comparison with various other marine food-fishes inhabiting the same waters; nevertheless, a perfectly fresh herring, when broiled, fried, or baked, is excellent.

An important use for fresh herring is as bait in the line fisheries for bottom species like halibut, cod, and haddock. Immense quantities are thus consumed, particularly in New England and the British provinces. The herring for this purpose are taken mostly in winter and are frozen in bulk for preservation.

The simplest method of preservation is that of drying without salt. This is a favorite method for small herring in Japan, and such fish, strung on straws or sticks, are seen exposed for sale in all parts of that country and are extensively eaten.

A favorite and simple way of preparing herring for food in America and Europe is by smoking, which is usually preceded by a short immersion in brine. Smoked fish, however, will not keep indefinitely, and the herring that enter most largely into the commerce of the world are preserved by various degrees of salting. On the coast of Maine small herrings in bulk, preserved in pickle and seasoned with spices, are known as Russian sardines.

One of the principal uses made of the sea-herring in New England is for canning as "sardines." In the same region the fish are also canned under the name of herring, and before the enactment of the present beneficent pure-food law were sometimes sold to the unsuspecting consumer as "brook trout" and "mackerel." In Great Britain a favorite canned preparation is kippered herring.

The waste parts of herring at the sardine and salting establishments are convertible into an excellent fertilizer, called

"pomace" in Maine; and in Japan, owing to lack of markets for the fish, immense numbers are caught for the special purpose of being converted into guano. Another product, usually made in connection with fertilizer, is oil, which has a wide use in the trades.

HERRING IN THE WATERS OF THE UNITED STATES

The herring fishery of the United States has always held subordinate rank. Although prosecuted from Puritan times and attaining great value, it has always been exceeded in importance by other fisheries in the states where the herring abounds. Owing to the distribution of the fish, Maine and Massachusetts have the most extensive fisheries, and the quantity of herring taken in the other New England states and in New York and New Jersey is very small. At no point south of Block Island does the fish occur in sufficient numbers or with sufficient regularity to support an established industry.

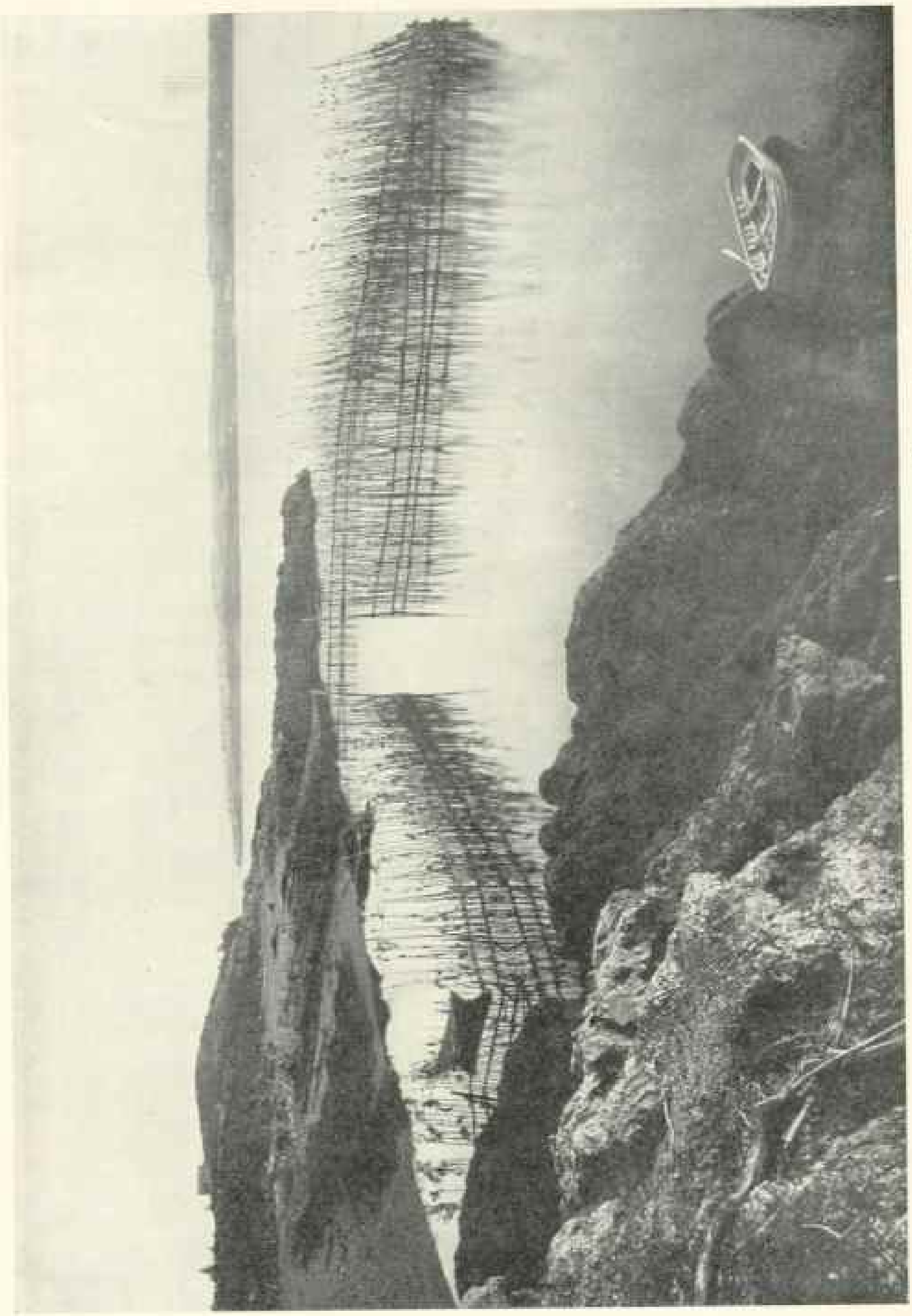
Owing to the great abundance of herring in the shore waters of Maine and Massachusetts, and of the British provinces, there has been no occasion as yet to seek the herring offshore, and hence the American fishery differs markedly in methods from the European. The oldest, and for a long time the most common, manner of fishing for herring is torching—a method learned from the aborigines. Up to about 1820 herring were caught in no other way on the eastern Maine coast. Torching depends on the well-known instinct of herring and other fishes to seek and follow a light, and is carried on with very simple apparatus. Projecting over the bow of a boat propelled by oars is a small iron basket, in which a fire of birch bark or other highly combustible material is kept burning while the fishing is going on. As soon as darkness comes on, the boat is rowed to the fishing grounds, one man steering, one man standing in the bow with a large dip-net. As the herring gather in little bunches in front of the light, they are readily caught with the dip-net, and sometimes fifteen to twenty barrels may thus be taken in a few hours. This method is followed chiefly in Passamaquoddy and Ipswich bays.

THE HERRING ARE CAUGHT PRINCIPALLY IN WEIRS

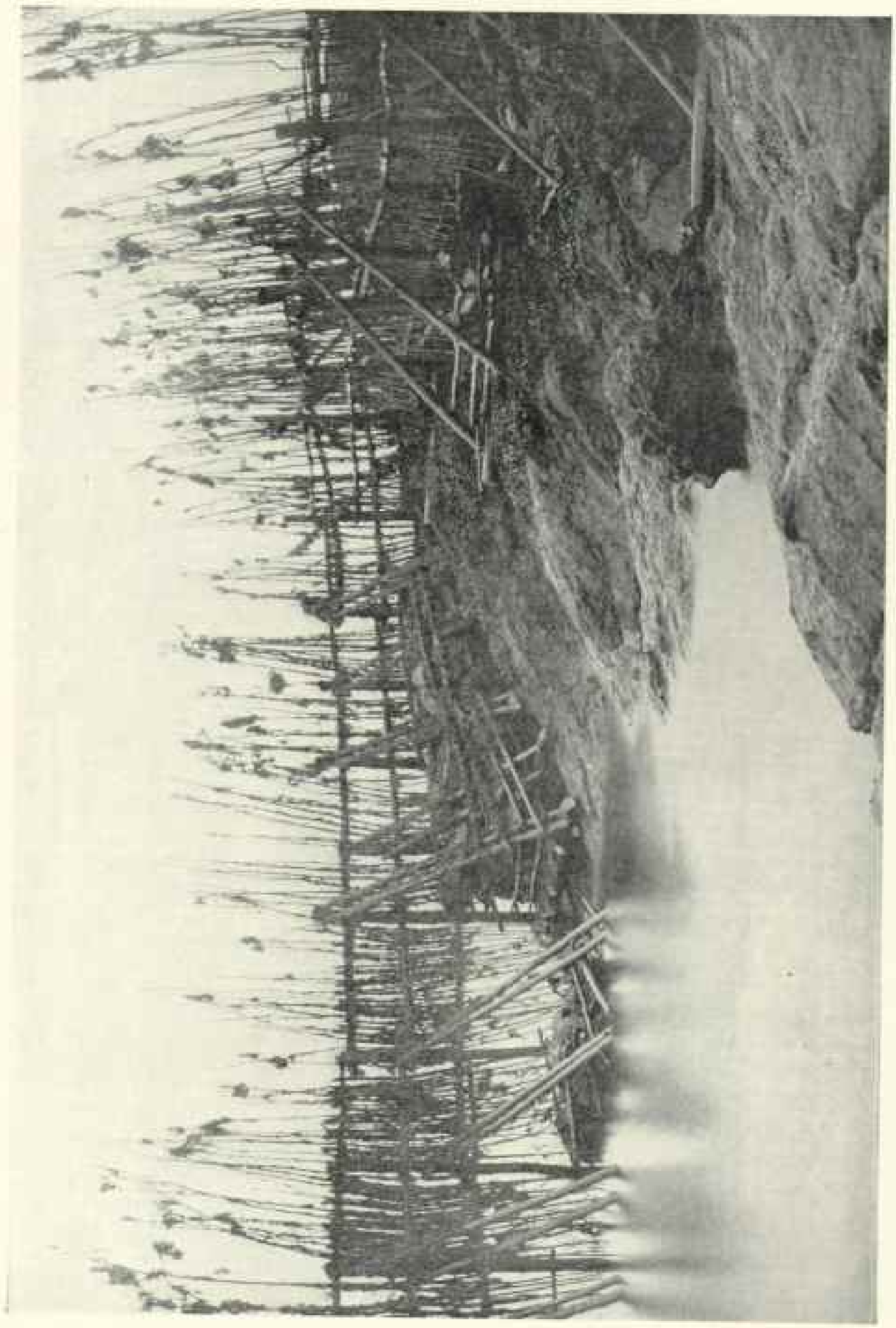
Gill nets, haul seines, and purse seines are more or less extensively employed for herring on various parts of our coast, but the characteristic apparatus in the region of most important fishing is the brush weir, which came into use about 1820 and for many years has been the principal means of taking herring in Maine, New Brunswick, and Nova Scotia, being particularly important in Passamaquoddy Bay and its tributaries. The brush weir is an aboriginal fishing device in all parts of the world, and variations in structure are numerous; but its essential feature is an inclosure made of brush, located on the shore, on a bar, between the mainland and an island or between two islands, into which the fish wander and from which they are prevented from escaping by their inability to find the exit, by the fall of tide, by the closing of the entrance, or by peculiarities of construction.

The herring brush weirs of the northeast coast are very substantially built and some are of large capacity and of considerable value. The stout stakes or posts are driven into the bottom at close intervals, or, in case the bottom is rocky, are attached to large stones, and this framework is strengthened by heavy horizontal stringers. The portion below low-water line is closely woven with branches of trees running horizontally, these being pushed to the bottom by means of a forked stick. The upper part of the weir is of loosely woven brush extending vertically two or three feet above high water. As the average tidal movement is twenty feet, and in spring nearly thirty feet, the amount of material required is considerable. Some weirs are mere semicircular inclosures, while others are provided with leaders or wings or both.

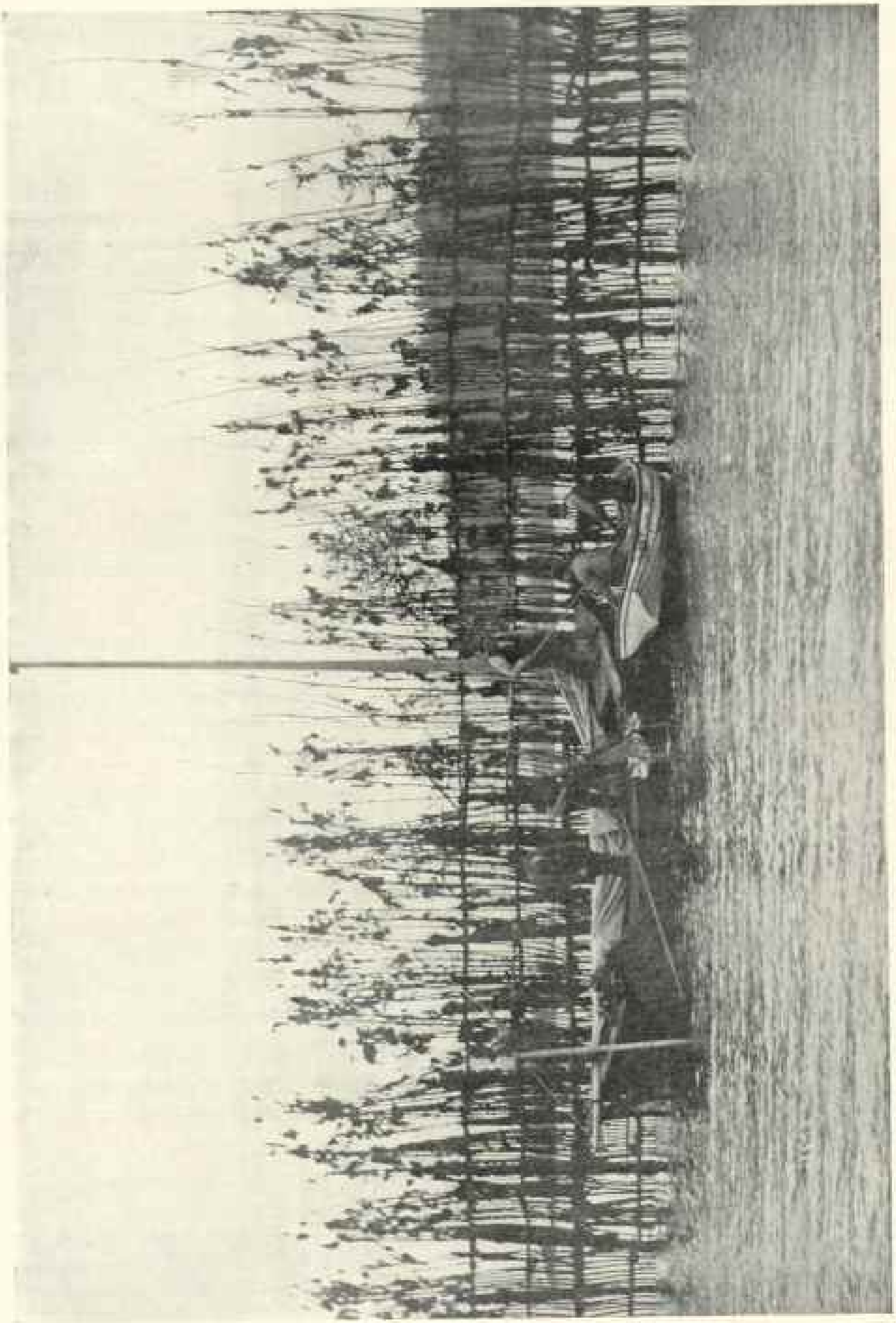
The weirs are always fished at low



BRUSH WEIR ON THE COAST OF MAINE FOR CATCHING HERRING (SEE PAGE 704)



A VIEW OF A DRUSH WELL AT LOW TIDE



GATHERING THE CATCH IN A BRUSH WEIR ON THE MAINE COAST (SEE PAGE 704)

tide, as then the herring are concentrated and may be more readily secured. The fishermen enter the weirs in boats, set a seine and haul its ends together, and then take out the fish with huge dip-nets. In some places the fish are left dry by the receding tide, and may be gathered by hand or with pitchforks. From 200 to 400 brush weirs are operated in waters adjacent to the international boundary between Maine and New Brunswick. They supply herring for bait, smoking, salting, and canning, and often yield very large profits to their owners. The unit of measure in this fishery is the hogshead, holding fifteen bushels, and many hundreds of hogsheads—sometimes several thousand—may be taken in a single weir in the course of a season.

$20,000 WORTH OF HERRING CAPTURED BY ONE WEIR

Upward of $20,000 has been received for the herring taken in one fortunately located weir, and there is a record of a weir on the Canadian side of Passamaquoddy Bay which was leased by Americans at an annual rental of $2,000, with a bonus of $3 for each hogshead of fish caught; yet, notwithstanding this seemingly exorbitant price, the lessees, before the close of the first season, were able to pay three years' rental in advance, owing to the large catch and high prices of small herring.

The prosperity, if not the very existence, of the herring weir fishery on the northeast coast depends on the presence of a large number of canneries at Eastport, Lubec, and other places on or near the Maine border, where herring are converted into "sardines." Weirs have also been constructed along the central and western districts of Maine in order to supply raw material for canneries and smoke-houses, and large catches are often made at points remote from the center of the herring industry. It is recorded that in October and November, 1908, a brush weir in the Ragaduce River near Castine took 20,000,000 small herring—a quantity so large that no local market could be found and the catch had to be sent to places as far eastward as Lubec.

THE AMERICAN "SARDINE"

The most valuable branch of the American herring industry is the canning of small herring under the name of "sardines." The business began in 1875, preceded by six or seven years of experimental work, and has continued up to the present time. The factories are located at suitable points along the entire Maine coast, but are most numerous on or near the eastern boundary, for reasons elsewhere stated. These factories give employment to many thousand men, women, and children; utilize immense quantities of herring that would otherwise find little market, and produce a wholesome food that for many years was marketed largely under French labels, but is now sold under its proper name and on its own merits, with a resulting improvement in quality.

The most valuable herrings for canning are the young, from three to five inches long, suitable for packing in "quarter" cans. The demand for these has at times been so active that fabulous prices—far beyond the real worth of the fish—have been paid. As much as $100 per hogshead was given one season, and a price of $30 per hogshead has not infrequently prevailed; but, on the other hand, the price has often fallen to $2 and has not averaged more than from $5 to $8. Herring of larger size are put up in oil, mustard, and tomato sauce in "half" and "three-quarter" tins, but the chief use made of the larger fish is for smoking. The Maine coast is dotted with herring smoke-houses, some independent, others in connection with canneries, and several million boxes of delicious smoked herring are there placed on the market each season.

The New Englanders have not been content with the supplies of herring obtainable from home waters, but have for many years engaged in a herring fishery and trade on the shores of the Canadian maritime provinces and of Newfound-

land. This business has been conducted mostly in winter, when the fishing vessels were otherwise idle, when the fish were schooling in the waters of the neighboring provinces, when there was a scarcity on our own shores, and when there was a good demand for herring for use as bait in the line fisheries. For this purpose our vessel fishermen resorted to various regions and engaged in the business in various ways, depending on local conditions, sometimes catching the herring themselves, sometimes hiring the provincials to fish for them, sometimes buying outright the herring already caught and awaiting a purchaser. The principal localities thus visited by our vessels were Passamaquoddy Bay and other waters near the mouth of the Bay of Fundy, the Magdalene Islands, and the treaty shores of Newfoundland. At present only the last-named region is concerned in this trade.

TROUBLES WITH NEWFOUNDLAND AND GREAT BRITAIN CAUSED BY THE HERRING FISHERIES

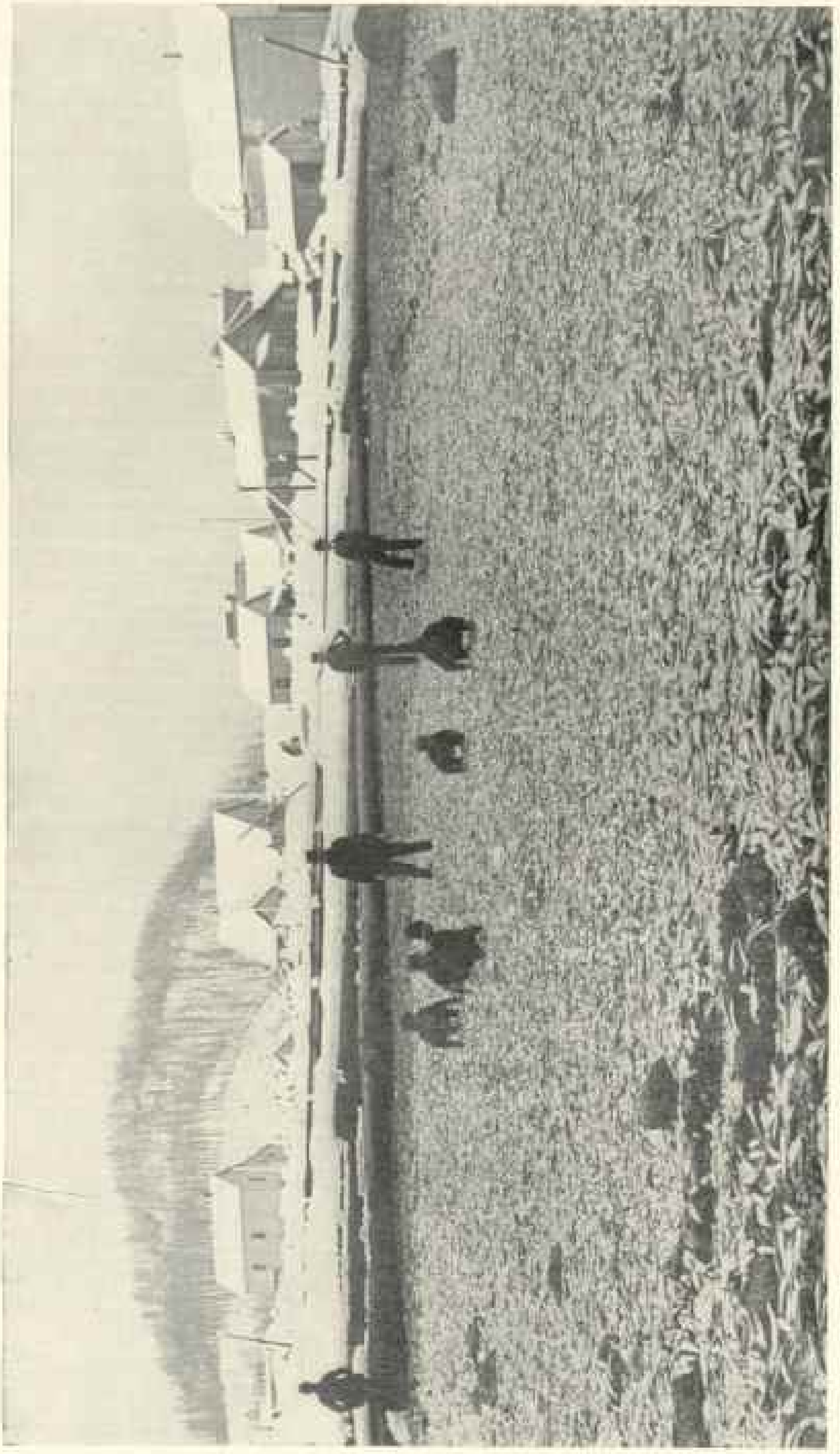
Some of the most serious international questions that have arisen in American history have been due to the operation of our herring fishermen in the waters of Canada and Newfoundland. The difficulties grew out of ambiguities in the Treaty of 1818 between the United States and Great Britain, and have continued, with violent exacerbations, up to the present moment; for the Treaty of 1818 has remained the chief instrument defining the rights of the American fishermen in British North American waters, and it has never been construed in a way satisfactory to both governments. It is very likely that had the controversy been between the mother country and her principal daughter it would have been amicably settled many years ago; but each of the maritime provinces as well as Newfoundland sought to have a hand in construing the treaty and in making modifications thereof to suit local conditions, and the result has been what would naturally have been expected. Fortunately the fishery question is now quiescent over a large part of His Britannic Majesty's North American coasts, and it is only in his oldest colony of Newfoundland that the bony herring has continued to be a bone of contention.

The recent history of this dispute is well known. For a number of years the United States government has had a representative on the ground in the person of an expert of the Bureau of Fisheries, who has remained there during the entire season for the threefold purpose of keeping our State Department informed of the condition of affairs, of advising our fishermen of their treaty rights, and of dissuading them from any attempt to violate the proper local regulations. Being in a staunch naval tug or revenue cutter, this representative has also been of material assistance to our fishermen in pulling out of the ice herring schooners that have stayed too late and been frozen in—a courtesy that has been extended also to vessels from the Canadian provinces.

The efforts of the Newfoundland government to restrict and modify the rights enjoyed by our fishermen under the Treaty of 1818 have been the subject of diplomatic correspondence between the United States and Great Britain, with the result that pending the settlement of the matter the home government has taken charge and approved a *modus vivendi* which permits greater freedom of fishery than the colonial authorities were willing to accord. Happily the entire controversy will soon be adjudicated by arbitration at The Hague.

VALUABLE HERRING FISHERIES ON PACIFIC COAST AS YET UNDEVELOPED

The herring fishery of the west coast of the United States is of comparatively minor importance but of great prospective value. The herring abounds, but the demand is limited in the regions of greatest abundance. The largest fishery is at Killisnoo, Alaska, where, in 1908, about 25,000 barrels of herring were converted into oil and guano. The manufacture of these secondary products began many years ago and for a long time was



A HAUL OF HERRING ON THE BEACH IN GASTINEAU CHANNEL, DOUGLAS CITY, ALASKA, ABOUT 1903

The Alaska herring are largely used for bait in the halibut fisheries

the only use to which the Alaskan herring was put. At other points in southeast and central Alaska the herring is utilized in fresh and salted conditions for human food and for bait in the halibut fisheries. In all the coast states there is a limited herring fishery, the most important interests centering at San Francisco.

The herring fishery of the United States at the present time yields about 130,000,000 pounds annually, for which the fishermen receive $870,000. Of this quantity about 10,000,000 pounds are obtained in Pacific waters. The manufactured herring products—oils, fertilizers, sardines, etc.—are worth several million dollars.

CANADA'S EXTENSIVE HERRING FISHERIES

The Dominion of Canada has the most extensive herring fisheries of the Western Hemisphere. All of the maritime provinces of Canada have an abundance of herring, and in all of them large quantities of this fish are placed on the market in various forms. Among all the foodfishes of Canada, the herring is exceeded in value only by the salmon and the cod. As the most abundant of the shore fishes of the eastern provinces, the herring played an important part in their colonization and has continued to be a large factor in their growth and prosperity.

It is in Nova Scotia and New Brunswick that the herring fisheries have attained their greatest development. As early as the eighteenth century large quantities of smoked herring in boxes were exported from Nova Scotia, and Lorenzo Sabine in his report to the Secretary of the Treasury on "The Principal Fisheries of the American Seas" (1853) said of the herring of Annapolis Basin:

> This fish, well smoked and of approved color, is a great luxury for the forenoon lunch and for the tea-table, and the time has been when a herring box branded 'Digby' or with the name of a well-known curer there, passed as current in our markets, without examination, as coin received at the mint.

The beautiful town of Yarmouth, Nova Scotia, remains true to its name and has for years sent to the market "bloaters" that for quality would reflect no discredit on the fish so called that originated at Yarmouth, the great herring center on the North Sea. On the shores of New Brunswick large quantities of small herring are caught, and some of these are canned locally; a very large percentage, however, are sent to the sardine factories at Eastport and Lubec.

Lying in the middle of the Gulf of St. Lawrence is a group of small, picturesque islands known as the Magdalenes, which have had an interesting history in which the herring fishery has been closely entwined. Their value consists almost exclusively in their fishery resources, chief among which is the herring; this fish resorts to the shores in immense shoals at times, and for at least 250 years has been a source of livelihood to the hardy inhabitants. Many of the fishermen are lineal descendants of those Acadians who, under De Monts and Champlain, made the first permanent settlement in New France; and up to a comparatively recent time, and doubtless to some extent even down to the present, they preserved the dress, language, and customs of their ancestors.

The tenure of these islands and their rich fishing privileges was once granted by the British crown to Richard Gridley, of Massachusetts, who in 1775 constructed the defensive works on Bunker Hill and became chief of the engineer department of the Revolutionary army. Under the Treaty of 1818 American fishermen enjoy the same fishing rights at the Magdalenes as the resident Canadians, and in former years many New England vessels resorted to these islands to participate in the herring fishery. The fish here taken are noted for their large size, and 25,000,000 pounds have been taken some seasons. In the middle of the nineteenth century as many as 150 fishing vessels from Maine and Massachusetts have sometimes been observed catching herring here at one time, but of late years the value of the islands to our fishermen has become insignificant.

A REMARKABLE VISITATION OF HERRING IN BRITISH COLUMBIA

The abundance of herring on the coasts of British Columbia has been known for many years. A herring fisherman from Yarmouth, England, has expressed the opinion that the herring fishing grounds of the North Sea cannot compare with those off the shores of British Columbia, and he reported a remarkable visitation of herring near Nanaimo recently, when the shore for two miles was knee deep with these fish, that had been crowded ashore by millions more while on their way to the spawning grounds. The provincial fishery authorities, who are well aware of the conditions of the herring fishery in England and Scotland, are convinced that the British Columbia herring can be put on the market in such a way as to command the price received for the transatlantic fish, and they see no reason why an industry worth from $5,000,000 to $6,000,000 yearly may not be established.

The herring catch of the Canadian provinces in the fiscal year 1907-8 was about 155,600,000 pounds, of which the first value was $2,225,000. Taking into consideration the immature fish utilized in the preparation of sardines, considerably more than 1,000,000,000 herring are taken annually in Canada.

NEWFOUNDLAND

The herring fishery of Newfoundland is important to that colony, but adds comparatively little to the world's supply of fish. It is chiefly noteworthy for the international complications to which it has given rise from a very early date.

The principal fishery is carried on in winter at the Bay of Islands, on the "treaty shores," and owes its success, if not its existence, to the American schooners from Gloucester which resort there every season and leave among the local fishermen a large amount of money, expended for labor and fish. In 1907, out of a total catch of 154,709 barrels of fresh, frozen, and pickled herring, valued at $406,400, American vessels or vessels chartered by Americans took to Gloucester 113,326 barrels, which were used for bait in the line fisheries of Massachusetts.

The friction that has frequently arisen over the herring fishery in Newfoundland has been due in part to ambiguity in the phraseology of the Treaty of 1818 and in part to the action of the colonial authorities in making the broad provisions of the treaty subordinate to local regulations. The effort to negative the treaty rights of American fishermen became more pronounced after the failure of Newfoundland to secure reciprocity with this country, and recently necessitated the interference of the mother country.

THE HERRING WAS LARGELY RESPONSIBLE FOR CHARLES I'S TROUBLES

For many centuries the herring has been the object of extensive fisheries in England and Scotland, and in recent years has attained greater importance than ever before. In both England and Scotland the fish has figured in history more than any other water creature, and has not only been of inestimable economic importance, but has had noteworthy influence on national affairs.

The prosecution of the herring fishery and trade has been considered not beneath the dignity of nobility and royalty. Fitz-Greene Halleck tells us that

> Lord Stafford mines for coal and salt,
> The Duke of Norfolk deals in malt,
> The Douglas in red herrings.

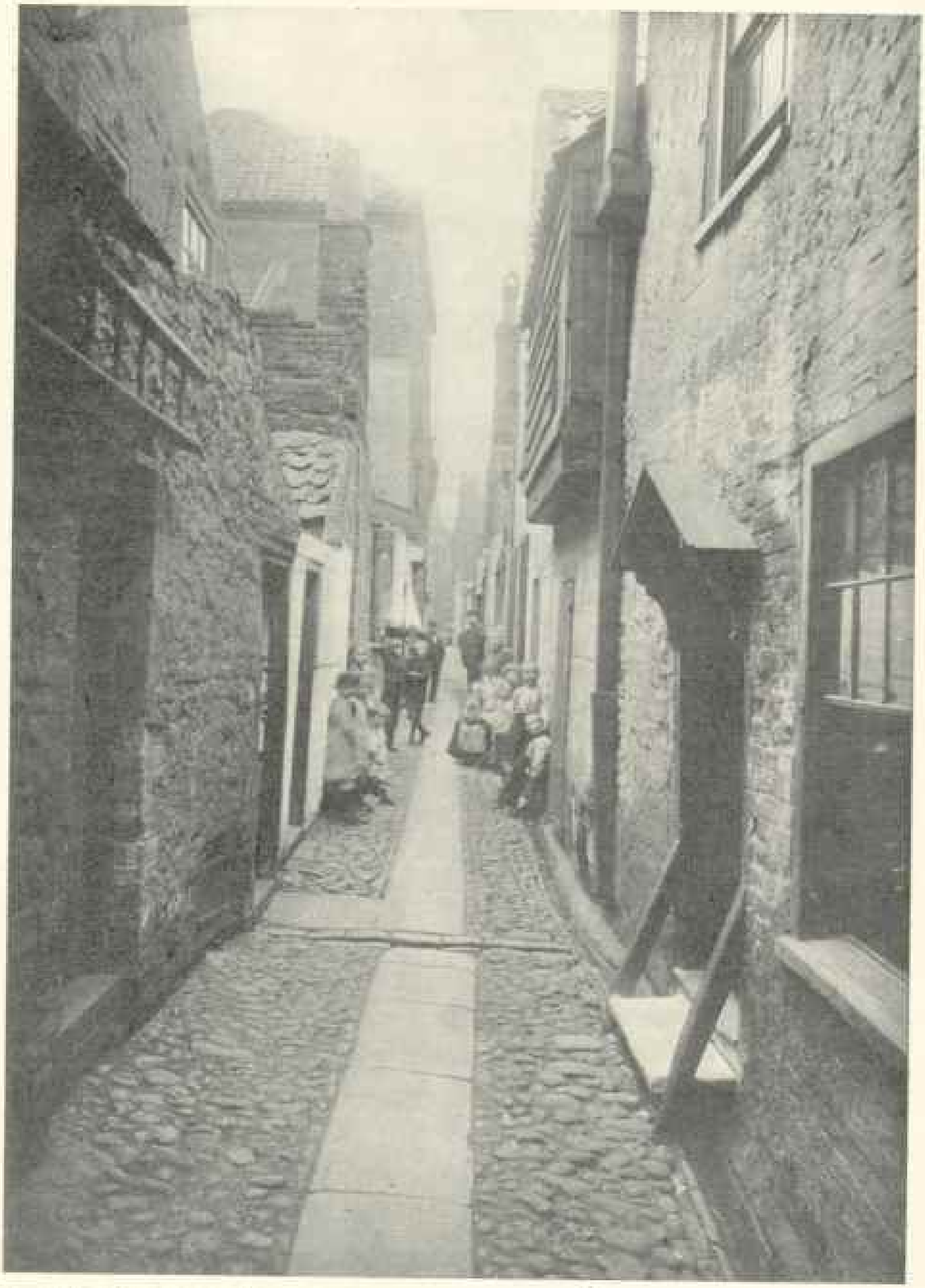
In 1677 the Duke of York and other personages of rank formed a corporation, called "The Company of the Royal Fishery of England," for the purpose of carrying on the herring fishery in the North Sea. They built a fleet of Dutch "busses" and manned them with Dutch fishermen, and then were bankrupted by the capture of their vessels during a war with France. In 1720 some two thousand of "the principal gentlemen of Scotland" formed a company for herring fishing, but were quickly disrupted, leaving a mournful lot of stockholders. In 1750 the Prince of Wales became president or

THE HERRING FLEET AT YARMOUTH, ENGLAND

governor of a herring fishery company with a capital of £500,000, whose members "were among the first men in the kingdom," one of the promoters being General James Oglethorpe, founder of the State of Georgia. Stock was taken with eagerness, vessels were built quickly, and efforts were made to learn the secrets of the Dutch methods of curing herring; but the company soon suspended and its failure cast on the English herring fishery an odium that continued for a long time.

It is a matter of great historical interest that the herring fisheries should have been a prime, and perhaps the most important, factor in the overthrow of Charles I, whose attitude toward the development of home and colonial fisheries was most unreasonable and unfortunate. At a time when the Dutch herring fishery had attained such magnitude and importance that it was regarded as the "right arm of Holland," and when the sturdy Dutch fishermen were pursuing their lucrative calling under the encouragement of their government, the English people were chafing under the grievous restrictions imposed, by royal approval, on all who desired to engage in fishing anywhere off the American coast between the fortieth and forty-eighth degrees of north latitude. This effort on the part of the crown to interfere with the cherished privilege of "free fishing" had begun under James and was bequeathed to Charles, and was perhaps the first in the series of far-reaching differences that sprung up relative to the prerogatives of the crown as against the rights of the subject. At the same time there was another restriction placed on the fishermen at home. When James ascended the throne of England his navy consisted of but thirteen vessels, and Charles succeeded to a war fleet but little stronger and utterly inadequate to cope with the navy of the Dutch or French.

After Charles had been successfully opposed by the Commons in his plan to have no fishing conducted on the American shores except by permission of the company of "noblemen, knights, and gentlemen," known as the Council of Plymouth, he levied "ship money" on the fishing and mercantile vessels at home



A STREET IN YARMOUTH, ONE OF THE GREAT HERRING PORTS OF THE WORLD, WHERE THE HERRING FISHERMEN LIVE

in order to build up his navy, with the distinct object of breaking up the Dutch herring fishery on the shores of England and driving the Dutch from "the four narrow seas" over which England claimed jurisdiction. At the expense of the fisheries and navigation, Charles finally fitted out the largest war fleet England had ever had and succeeded in his purpose so far as the Dutch were concerned, but the levying of "ship money" stirred up civil war at home and Charles paid the extreme penalty.

THERE HAS NEVER BEEN A FAILURE IN THE HERRING FISHERY OF YARMOUTH

Grimsby, Lowestoft, North Shields, and Yarmouth, the important English fishing centers on the North Sea, have great interests in the herring fishery. At Grimsby, the world's greatest fishing port, and North Shields the herring is overshadowed by the bottom fish caught with beam-trawls, but at Lowestoft and Yarmouth the herring predominates. The fishery at Yarmouth, which may be taken as a type, is carried on with steam and sail vessels called luggers, having a crew of eleven men and carrying, as means of capture, 200 gill-nets costing $10 each. These nets are 30 yards long and 20 yards deep, the average size of the mesh, bar measure, being equal to a shilling piece. When fishing begins the nets are tied together and the entire complement is shot at one time.

As the water is thick for fifteen or twenty miles off Yarmouth, fishing may be done at any hour of the day or night, but the best times are about sunrise and sunset. Fish are not left long in the nets unless storms prevent hauling. Some vessels land their fish fresh, others dry-salt their catch at sea and store it in compartments in the hold. A vessel may leave port, set nets, make a catch, and be back home the same day, or it may remain out for two weeks. There has never been a failure in the herring fishery of Yarmouth, and the thousands of persons in this quaint town who are dependent on the herring have few of those apprehensions that come to most people whose welfare is contingent on the uncertain harvest of the seas.

FIGURES SHOWING THE MAGNITUDE OF THE HERRING FISHERY OF SCOTLAND

At the present time the herring fishery of Scotland exceeds in magnitude that of any other country, being about 50 per cent more extensive than that of England, which ranks second. In 1907, when the yield surpassed any previous year, the catch exceeded 630,000,000 pounds, and the fish, if placed end to end, would have extended more than 8,000 miles. The chief centers of the industry are the Shetland Islands, Fraserborough, Peterhead, and Aberdeen. The Scotch fishery, like the English, is undergoing a radical change, consisting in the elimination of sailing vessels and the more extensive use of steamers, which are yielding a much larger proportion of the catch this year. In 1907 the number of steam vessels was about 500 (an increase of 85 per cent over 1906), valued, with their gear, at $6,000,000.

The quantity of gill-netting set for herring in the waters adjacent to the Scotch coasts is almost incredible, and it is difficult to understand how, with the fishing going on day after day for months, any considerable number of fish escape. The fact that the fishery has continued so many years without impairment indicates the wonderful prodigality and remarkable recuperative powers of nature. The gill-nets used by the Scotch in 1907 if made into a band one yard wide would reach three and a half times around the earth and their actual area exceeded 48 square miles.

The fishery is divided into three sections in the official reports, but these are not sharply defined as at present conducted, although doubtless quite distinct originally; thus the "great summer fishery" extends from July 1 to December 31, the "early summer fishery" continues from April to June 30, and the "winter fishery" is conducted in January, February, and March.

The run of herring on the coasts of Scotland attracts fishermen from all over

western Europe and often results in the most heterogeneous aggregations imaginable. Local authorities of the ports adjacent to the fishing grounds have their hands full in order to provide for the proper housing, feeding, sanitation, etc., of a tenfold increase in population during the short period of a "run." I may cite from the report of the Scotch Fishery Board for 1907 the case of a sudden influx of population at Balta Sound, in the Shetland Islands:

> The normal population of Balta Sound is less than 500, but at the beginning of June, during a fairly successful season, this will have increased to about 10,000 persons, and, in addition to the purely Shetland element in this population, there will probably be a fleet of fishing vessels from the east and west coasts of Scotland, steam drifters from England, sailing craft from the Isle of Man and the north of Ireland, and 'booms,' luggers, and steam drifters from France, Belgium, Holland, Germany, Denmark, Sweden, and Norway—the number and variety of the various craft, the picturesque and characteristic garb of the fishermen of different nationalities, and the babel of various tongues forming a scene probably unparalleled at any other fishing port in the world except Lerwick. Notwithstanding this large addition to the population, it speaks volumes for the law-abiding nature of those engaged in the industry that it has never been necessary to augment the staff of police usually employed.

When a herring vessel arrives in port the fish are lifted out of the hold in baskets and spread on deck, where they are counted into baskets by hand, 100 fish to a basket. These baskets are then passed over the rail to the dock and emptied into large, peculiarly shaped baskets holding 500 fish, arranged on the dock in lines or tiers of 20 baskets each. The fish are heaped in 10 piles over the edges of adjoining baskets to facilitate counting. A line of the large baskets constitutes a last, which is the unit of measure in the herring trade. A last represents about 1½ tons of herring, or theoretically 10,000 fish, but as a matter of fact 13,200 fish of any size, as 132 fish are called 100 in counting. Herring are sold at public auction by lasts. The buyer puts his card or tag on the first basket of the tier, and his drayman comes shortly afterwards and takes the fish to the pickling-house or smoke-house. Sometimes, at the height of the fishery, as many as 1,000 lasts (or 3,000,000 pounds) have been landed and sold in one day at Yarmouth and other ports; and whenever the catch is large the wharves present scenes of great activity and excitement.

THE "YARMOUTH BLOATER"

Considerable quantities of herring are consumed in a fresh condition, and the celebrated "whitebait" of England consists almost exclusively of young herring; but the herring fishery and trade owe their importance to the herring that are preserved in various ways. Household names in Great Britain applied to the different kinds of cured fish are "bloater," "kippered herring," "white-cured herring," and "red herring." The "bloater," especially the "Yarmouth bloater," has a world-wide reputation, either in its original form or as now prepared in America and Canada, and it is the favorite herring for local consumption. In the United States a bloater is a large, lightly smoked herring; but in Great Britain a fish of any size may be a bloater, which may be defined as an unsplit, lightly salted, lightly smoked herring intended for immediate consumption. Among the varieties of preserved herring none rank higher than the "kippered" fish, the essential characteristic of which is that before being salted and smoked they are split and eviscerated. "White-cured herring" give to the English and Scotch herring trade the great extent it has attained, as such fish, after being gutted through the gill cavity and heavily salted, are packed in barrels and sent all over the world.

A very elaborate set of regulations for preparing "white-cured herring" has been drawn up by the Scotch fishery board, and each barrel of salt fish is officially guaranteed by a mark or brand showing size, quality, spawning condition, etc., of the fish. "Red herring" are a special grade of heavily salted fish that are smoked for a long time, to give them a rich brown color, and are intended chiefly for the Italian, Grecian, and general

A PART OF THE HERRING FLEET AT LOWESTOFT

ON BOARD A LOWESTOFT DRIFTER

EMPLOYÉS OF AN ENGLISH HERRING FIRM

A GANG OF HERRING CURERS AND PACKERS

Mediterranean trade. There are few kinds of preserved fish which have greater thirst-producing properties; and they became favorites at home at a very early date, and are frequently referred to in the poetic literature of the sixteenth and seventeenth centuries, when it was said of many people that they were "neither fish, nor flesh, nor good red herring."

The handling, smoking, curing, packing, and shipping of herring give employment to a veritable army, a large proportion of which are women. In the Scotch herring industry the shoresmen are drawn mostly from the Highlands and the Hebrides and number fully 50,000, and the curing business of both England and Ireland is dominated by Scotchmen.

The herring fishery of England and Wales in 1906 yielded about 328,000,000 pounds of fish, for which the catchers were paid $6,595,930, the largest price ever received in the history of the fishery. As showing the preponderating importance of the North Sea as a fishing ground, it may be noted that while the south and west coasts of England produced 25,000,000 pounds of herring, the east coast is credited with 303,000,000 pounds. The best year in the history of the Scotch fishery was 1907, when over 631,000,000 pounds of herring, valued at $9,081,300, were taken by 25,000 fishermen in 5,600 vessels and boats. The quantity of herring then cured was 2,578,268 barrels, which brought the packers $13,148,385. Of the foregoing 627,100 barrels were exported to Russia and 1,186,100 barrels to Germany, about fifty per cent of the latter quantity being reexported to Russia.

The herring represents more to the Irish fishermen than any other product of the waters, and its value is nearly one-third of the entire yield of the fishing industry of the country. The fish is taken with drift-nets around the entire coast, but the largest catch is made on the east and north shores. In 1907 the output was nearly 31,000,000 pounds, for which the fishermen received over $500,000. The principal centers of the fishery are Downings Bay, Ardglass, Howth, and Donegal.

FRANCE

France is one of the great fishing nations of the world, and herring is her principal water product. It is true that the value of the French cod fishery somewhat exceeds that of the sea-herring, but nearly all of the cod are caught off Iceland and Newfoundland, leaving the herring easily the leading fish of home and adjacent waters. An established herring fishery was carried on in the North Sea by Dieppe and Rouen fishermen as early as the eleventh century. It had attained great importance by the eighteenth century, but declined during and after the Napoleonic wars.

The French herring fishery is now in a very flourishing condition and is more extensive than ever before, so that in continental Europe France is surpassed only by Holland as a producer of herring. The fishery is naturally divisible into two sections, one conducted in the North Sea and the other along the shores of the north and west coasts of France. The leading center is Boulogne, with Fécamp a close second. Other important points are Calais, Etaples, Saint-Valery-sur-Somme, Dieppe, Honfleur, Trouville, Villerville, and Étretat.

The year 1905 was the most successful recorded up to that time, and for it detailed official statistics are available. It appears that 10,880 fishermen then set their nets for the herring hosts, and that more than 163,000,000 pounds of these fish were marketed. Two-thirds of the product came from the coastal waters and one-third from that greatest of all international fishing grounds, the North Sea. The substantial sum of 18,260,000 francs inured to the French herring fishermen in 1905.

One of the most interesting and far-reaching episodes in French history happened in the year 1428 and was directly connected with the herring. The English, who were then besieging Orleans, which was held by the French, sought to

SCENE IN AN ENGLISH HERRING PACKING YARD

provide a fish diet during Lent for the investing army. The French, however, made a sortie and endeavored to intercept the supply train bringing in the coveted salted herrings. Then was fought the celebrated "Battle of the Herrings." The French were defeated and were ready to surrender the city, but at this critical point the Maid of Orleans made her initial appearance on the horizon of history and accomplished, as her first chosen task, the raising of the siege.

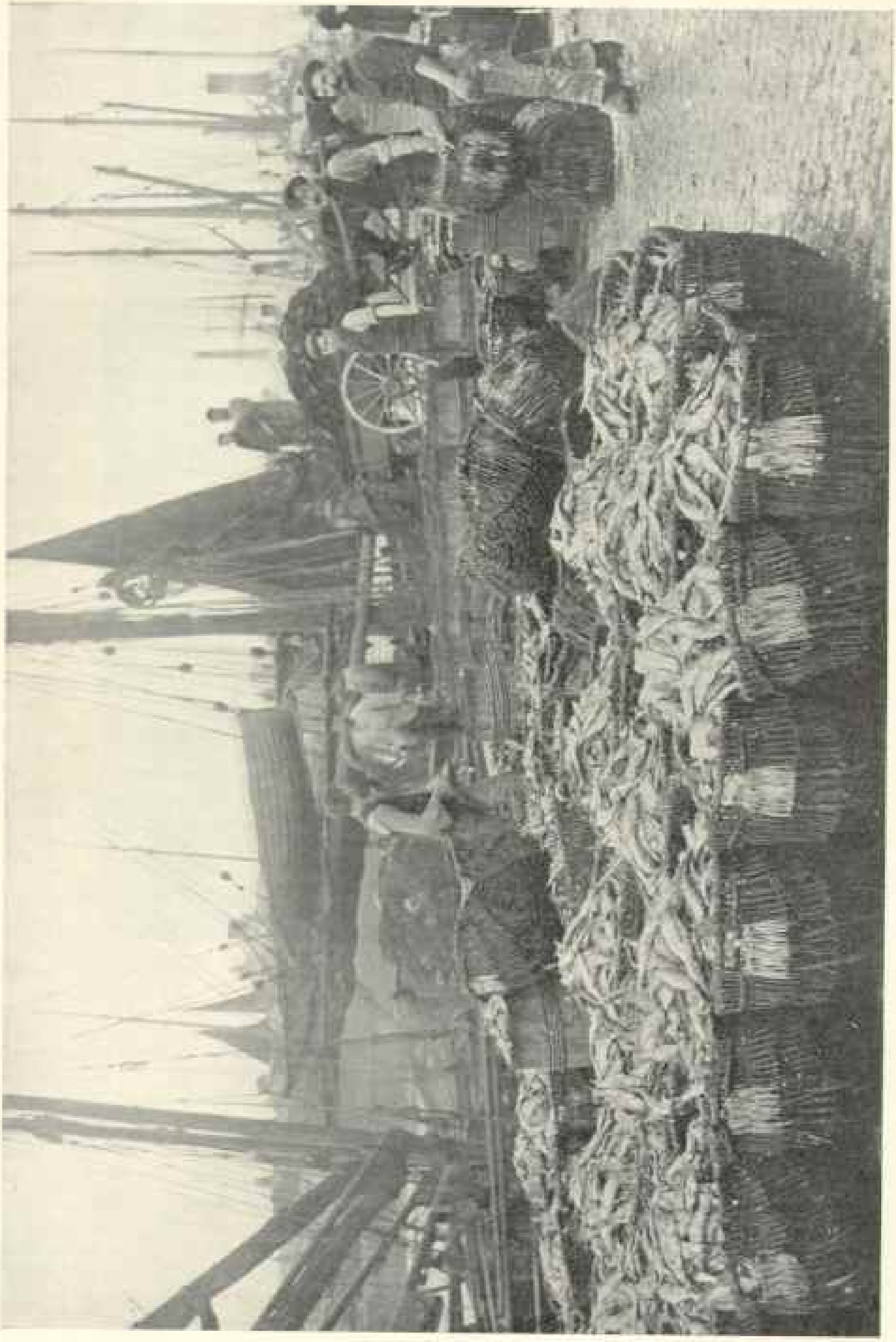
"THE FOUNDATIONS OF AMSTERDAM WERE LAID ON HERRING BONES"

The herring fishery is inextricably entwined with the history of Holland, and in no other country has the herring been relatively so important. The greatness attained by the Dutch as a sea power several centuries ago was due directly to their herring fishery; the Dutch navy, for years the most formidable, was manned by herring fishermen, and the

A STACK OF HERRING BOXES AWAITING THE FISHERY AT A NORTH SEA PORT

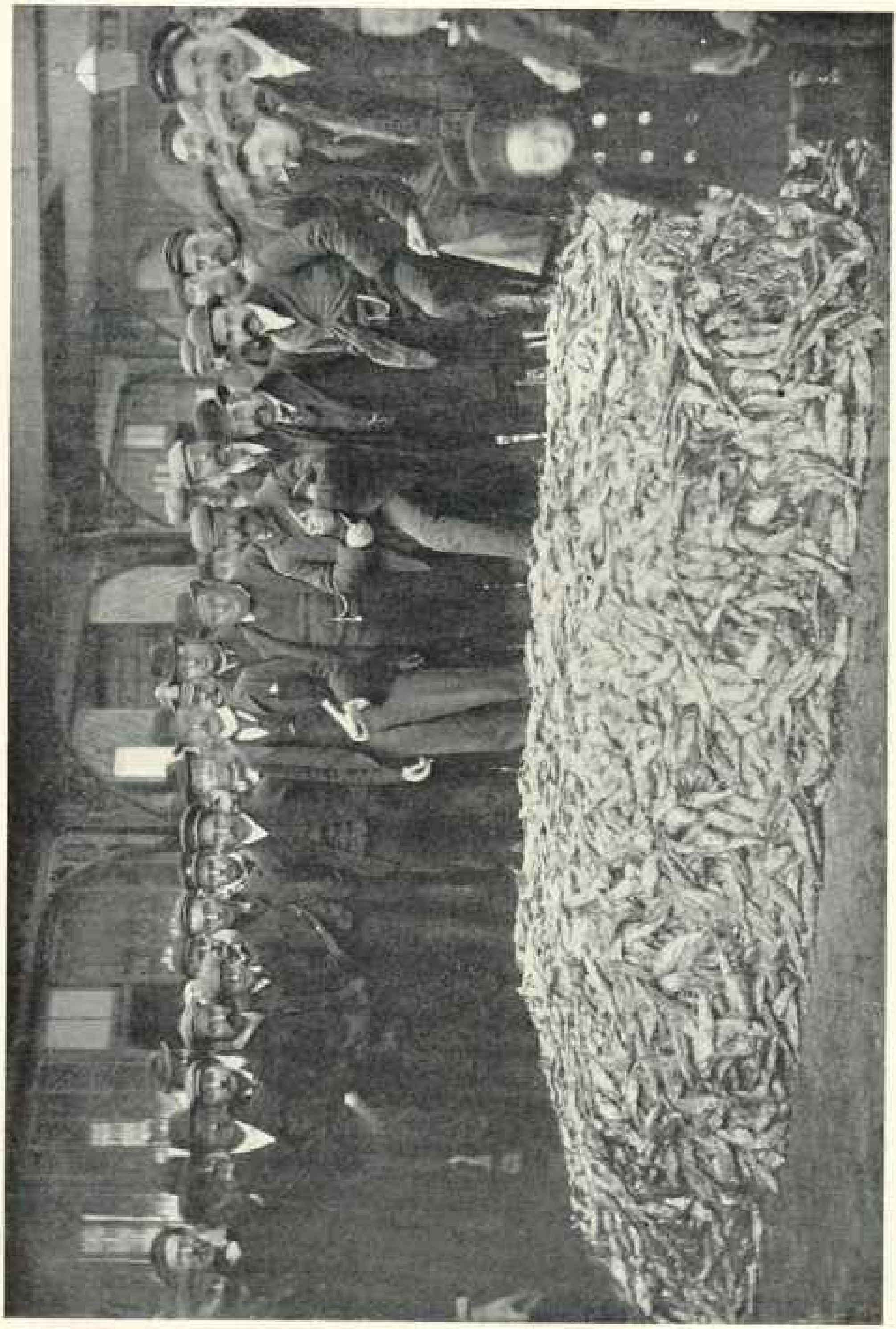
tremendous foreign trade of Holland depended largely on the herring. The old saying that "the foundations of Amsterdam were laid on herring bones" might have been literally true of that place and various other Dutch ports. In the Middle Ages, when all continental Europe ate no animal food save fish during Lent, the consumption of cured fish was enormous and the demand was supplied chiefly by the Dutch.

Only a few figures have been preserved to show how extensive the herring fishery was in medieval times. It is known, however, that at one period in the fifteenth century there were 50,000 Dutch herring fishermen, and between 200,000 and 300,000 people engaged on shore in building vessels, making nets, constructing barrels, and handling the catch; there were also many thousand men on the vessels that transported the



LANDING THE HERRING CATCH AT LOWESTOFT, ENGLAND

SORTING AND PACKING THE CATCH AT LOWESTOFT (SEE PAGE 710)



SELLING A SMALL LOT OF FISH AT AUCTION

salt herring to ports on the Mediterranean and Baltic seas.

Holland has maintained her supremacy in herring among her continental neighbors, but in recent times has been surpassed by England and Scotland.

Vlaardingen, situated on the Maas a few miles below Rotterdam, is the center of the herring trade. There the herring boats fit out, there they land their catch, and there are the substantial houses in which the fish are prepared for shipment. Both steam and sail vessels are employed in the fishery, the former chiefly in the offshore operations in the North Sea. The cotton gill-nets used are 360 meshes deep and 720 meshes long, and are so arranged with corks and leads that they sink six feet below the surface. As from 80 to 150 nets are set at one time, it appears that the total length of netting used by each vessel is from 1½ to nearly 3 miles.

In 1905 the Dutch herring fishery yielded $4,447,470. This sum represented 114,492,000 herring caught in the Zuyder Zee and 608,081 barrels of salted herring caught in the North Sea. The aggregate weight of the product was over 200,000,000 pounds.

That procedure which, more than anything else, has given to the Dutch herring their well-merited reputation for quality is the dressing and salting of the fish immediately after the nets are hauled on board the vessels. Provided with a short knife, tied to the third and fourth fingers of the right hand by a string attached to the handle, the fishermen thrust the knife through the gill cavities of the herring, and in withdrawing it cut and bear away the gills, heart, esophagus, and pectoral fins. The opening of the large blood-vessels leads to free bleeding, and as a result the flesh becomes pale, whereas in the Scotch fishery the cutting is done after the blood has clotted, and the flesh remains dark reddish. The Dutch fishermen become very expert in cutting, and some of them can cut 1,200 fish an hour. As soon as the herring are thus dressed they are salted in barrels and stored on board until the end of the trip.

It is a matter of some local interest to know that many of the barrels in which the Dutch pack their pickled herring and send them all over the world are made from oak staves imported from New York, Baltimore, and Newport News. The hoops are made from willow trees grown on the dikes.

Some very ancient customs connected with the herring fishery are still observed in more or less modified form. The landing of the first haul of herring in a town was the occasion for a general holiday and merrymaking. The fish dealers in some places used to offer a ducat apiece for the first fish caught, and the first herring of the season was placed in a decorated car at The Hague and taken in pomp to the king, who presented 500 florins to the fortunate fishermen.

NORWAY

While the cod overshadows all other fishes of Norway, the herring ranks second in importance, being taken in larger quantities and having greater value than all the remaining water products combined. The fish is found along the entire coast, and is caught for market from the Skager Rak to North Cape, but the principal fishing is in the districts of Stavanger, Bergen, Romsdal, Trondhjem, and Nordland.

Herring fishing on the Norwegian coast has a very romantic aspect. The fjords and bays where the fish are found are picturesque in the extreme, and most of the boats are the old Viking type.

The Norwegians classify their herring as spring herring or spawn herring, summer herring or fat herring, and brisling or small herring, the aggregate catch and value of these being in the order named.

In capturing herring set gill-nets, drift gill-nets, and sweep-seines are used. The usual apparatus for the North Sea and other open waters is the drift-net. Sweep-seines and chains of set-nets are often employed to barricade schools of herring that have wandered or been scared into a cove or an arm of a fjord. The most interesting type of net in the Norwegian herring fishery, however, is the "synkenot," a piece of netting about

250 feet square which is lowered to the bottom while each corner is connected with a boat. Large catches, particularly of fat summer herring, are made with this apparatus.

The Norwegian herring fisheries vary considerably from year to year, but show no striking changes in the past decade. Some seasons the fishermen have gathered less than 20,000 and others as many as 50,000. The catch in 1905 was 291,293,000 pounds, for which the fishermen received $2,473,300.

SWEDEN

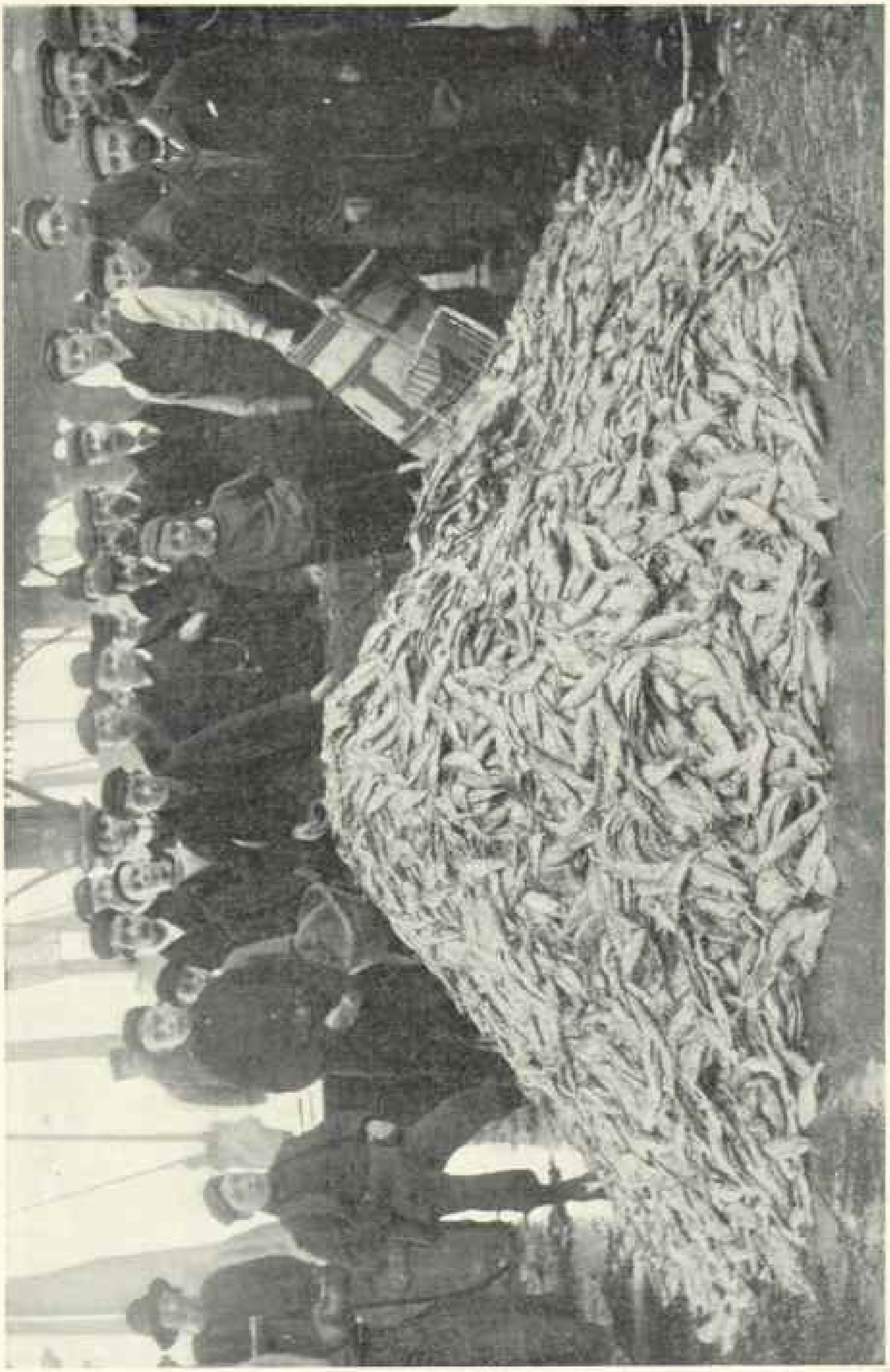
The herring resorts to all the coasts of Sweden, but is most abundant on the western seaboard, in the Skager Rak and Kattegat, becoming less numerous in the Baltic, and still less so in the Gulf of Bothnia. The periodicity in abundance to which the fish is liable in Scandinavian waters has been particularly noteworthy in Sweden, and has meant a great deal to the coastwise districts of that country, where fishing is the leading industry and the herring the principal fish.

In the archipelago forming a part of the districts of Göteborg and Bohus a herring fishery of great importance sprang up at a very early date. Prior to the sixteenth century no records were kept, but as both church and state derived an income from herring tithes and taxation, it has been possible to learn that a fishery existed there as early as the beginning of the eleventh century. It has likewise been established that even at that time, when fishing could not have had any possible influence, there were long series of years when the herring were practically absent from the region, and such times of scarcity have alternated with years of abundance up to the present day. The periods of abundance have lasted from 20 to 80 years, and the periods of scarcity from 60 to 70 years, during the past four centuries. From 1747 to 1808 the herring was present on this coast, and the great prosperity enjoyed by Göteborg in the latter part of the eighteenth century was directly dependent on the herring fishery; but during the next 68 years the herring failed to appear and distress and financial loss resulted. A Swedish clergyman has given some idea of the extent of this calamity, when the herring had been absent less than 25 years. Writing in 1831, he said:

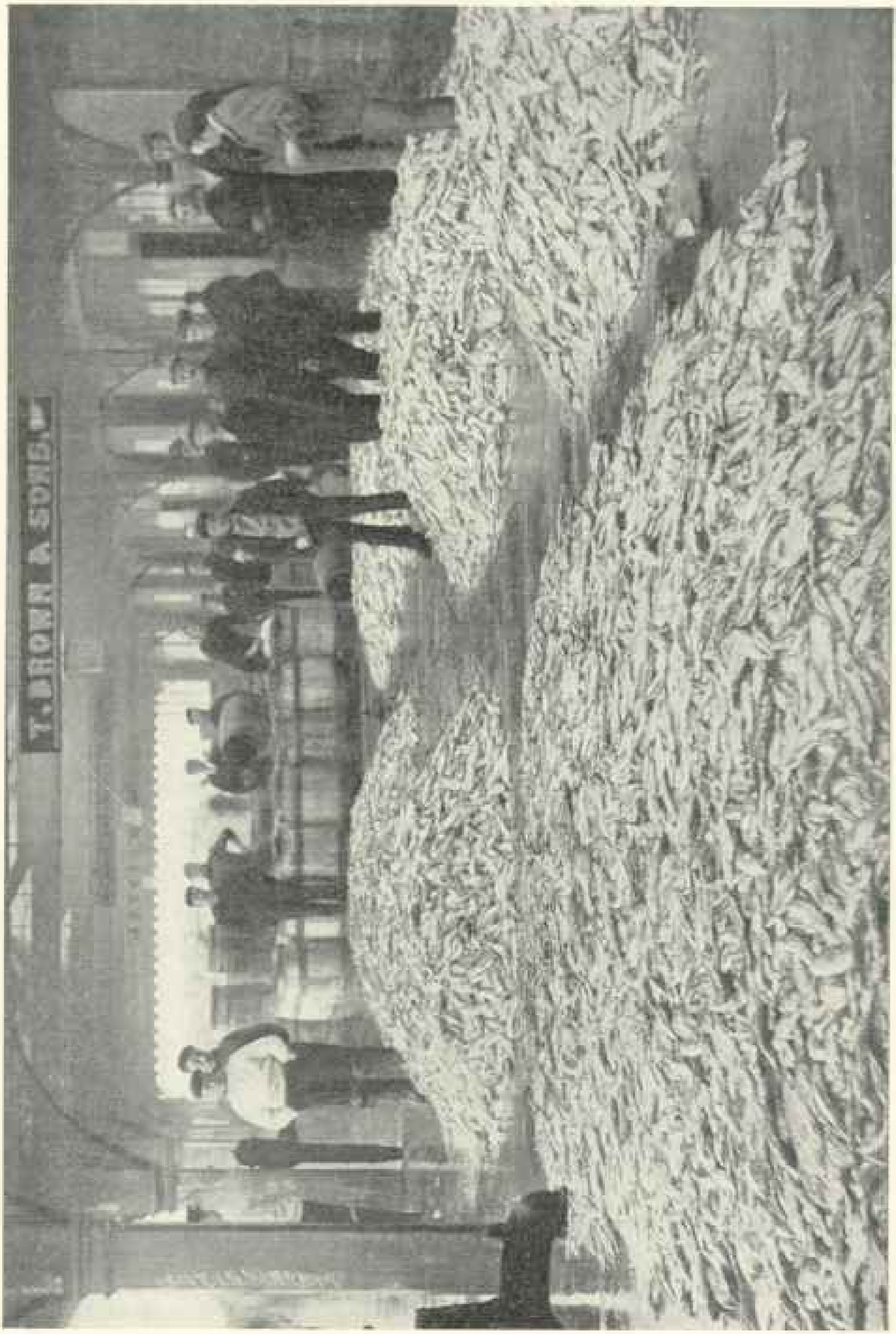
> He who knew the coast of Bohuslän twenty-five years ago and now sees it again will scarcely be able to refrain from tears. Then it presented an imposing appearance. From the sea itself rose massive walls and pillars supporting immense salting houses and oil refineries. Farther inland rich warehouses and busy workshops might be seen, as well as palatial residences of the merchants and neat cottages of the fishermen and workingmen. The coast was crowded with a busy throng and the sea studded with sails. Every night it looked as if there were a grand illumination, many thousand lights shining from the windows and from the numerous lamps along the quays, and being reflected in the waves. Everything was life and bustle, and tons of gold exchanged hands. Now nothing is seen but ruins, only here and there a dilapidated fisherman's cottage, awakening melancholy thoughts in the visitor. Would that those glorious times for which thousands are sighing might return.

In 1877 the herring returned, and immediately there sprang up a great fishery which has continued to the present time. The period of maximum production was 1890 to 1895, since which years there has been a considerable decline, which will doubtless terminate in another withdrawal of the herring from this coast.

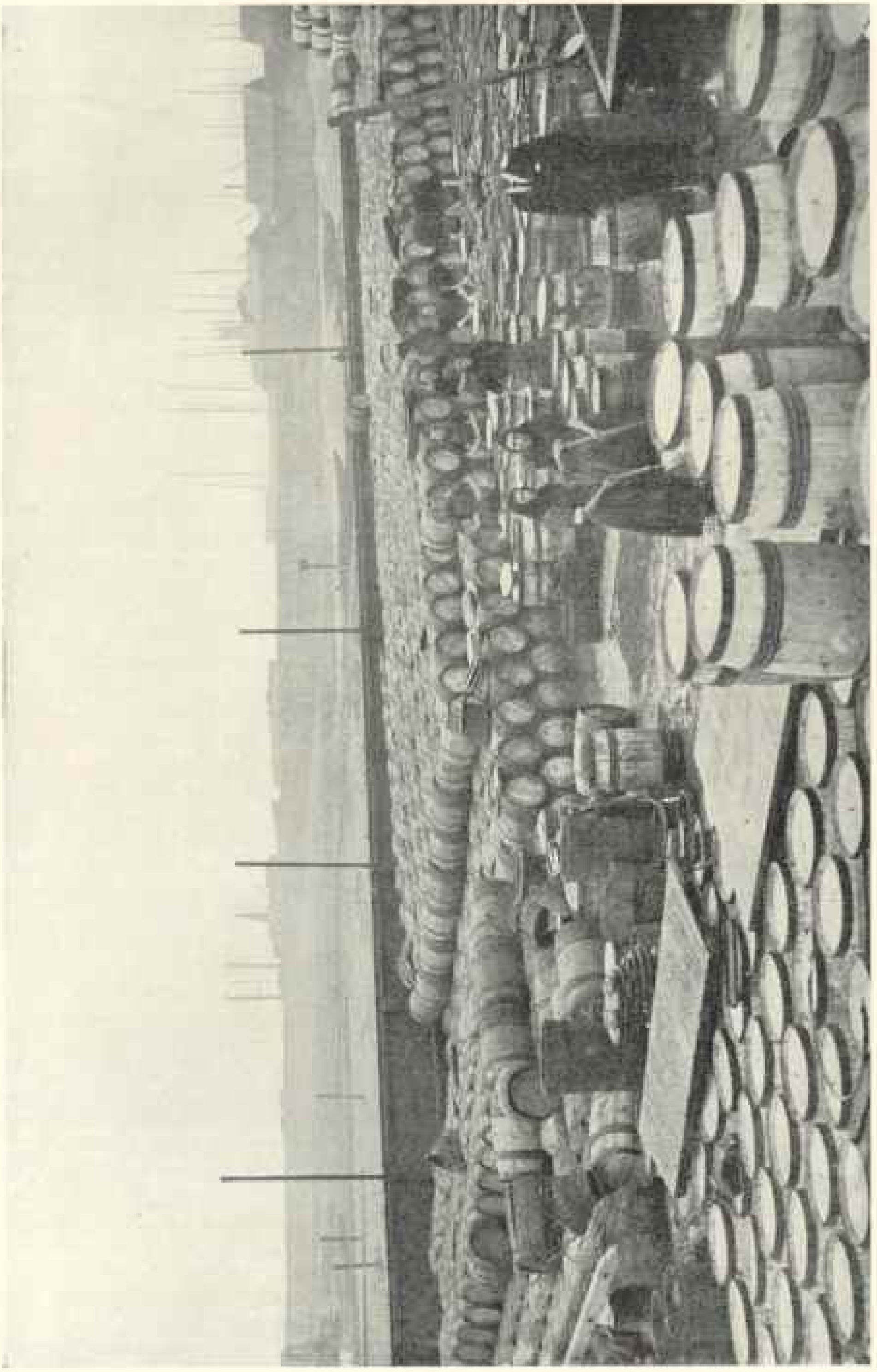
It has been possible only in recent years to offer a rational and adequate explanation of the periodical abundance of the herring on the Swedish shores, although for centuries all kinds of theories have been advanced. As the result of careful studies of the physical and biological conditions prevailing in the North Sea and its tributaries, Scandinavian scientists have reached the conclusion that the cause of the wonderful fluctuations in the herring is to be found in the presence or absence of coastal bank-water coming in from the North Sea and giving to the shore waters of Bohuslän certain peculiarities. When, under the influence of winds or currents, or both, this new mass of water containing food and having the proper density sweeps to the east-



A BIG HEAP OF FISH JUST LANDED BY A NORTH SEA TRAWLER



PILES OF HERRING READY FOR PACKING AT LOWESTOFT



A FEW BARRELS OF SALT HERRING AT A NORTH SEA PORT

The barrels of salt herring packed annually in Scotland would, if placed end to end, extend 1,500 miles, or half across the United States

ern side of Kattegat, the herring go with it and a fishery follows.

Various forms of gill-nets and seines are employed, the most productive apparatus being drift gill-nets. About 1895 fully 10,000 fishermen were engaged in the Swedish herring fishery, and fish to the value of more than $1,000,000 were caught. Ten years later the herring were much less abundant, and the catch fell to $475,000.

OTHER EUROPEAN COUNTRIES

Russia has a fishery for the sea-herring in the White and Baltic seas, but no reliable information relative to the extent of the industry is available. The principal catch of herring is made in the Caspian and Black seas, the species sought being large and similar to our shad.

Belgium's interest in the herring fishery at the present day is comparatively trivial; but in ancient times a large part of the coastwise population made a living by catching and salting herrings. As early as the twelfth century the Flemish herrings were renowned, and the Flemish fishermen visited the coasts of England, Scotland, Norway, and Denmark, to take herring in their drift-nets when for any reason the fish failed to visit the home shores. So valuable was the herring that the fishermen sometimes cruised as far as Iceland when the fish were scarce in nearer waters. The Flemish herring fishermen became particularly prosperous when Edward III of England permitted them to sell their fish in his realm. Today the Belgian herring fishery is restricted to the towns of La Panne and Coxyde, from which about 100 small sloops operate. Their catch in 1906 was worth only $53,050.

Denmark has herring fishing in the North Sea, Skager Rak, Kattegat, Lim Fjord, and Baltic Sea; but by far the most extensive industry is in the waters east of the Skaw, chief of which is the Kattegat. Between 100 and 200 million herring are taken annually, and in a recent year the value of the catch was $619,000.

The herring fishery of Germany is of ancient origin. While there are minor interests in the Baltic Sea, the industry has always centered at Emden, at the mouth of the Ems, and been supported by the shoals of fish in the North Sea. After years of cessation, the fishery sprang up again at Emden in 1872, owing to the advent of a Dutch firm from Vlaardingen, and the growth of the business there has been steady. At present upward of 150 German vessels, including a number of steam luggers, are now engaged in the North Sea fishery, and the annual catch is from 40 to 50 million pounds, worth about $1,000,000.

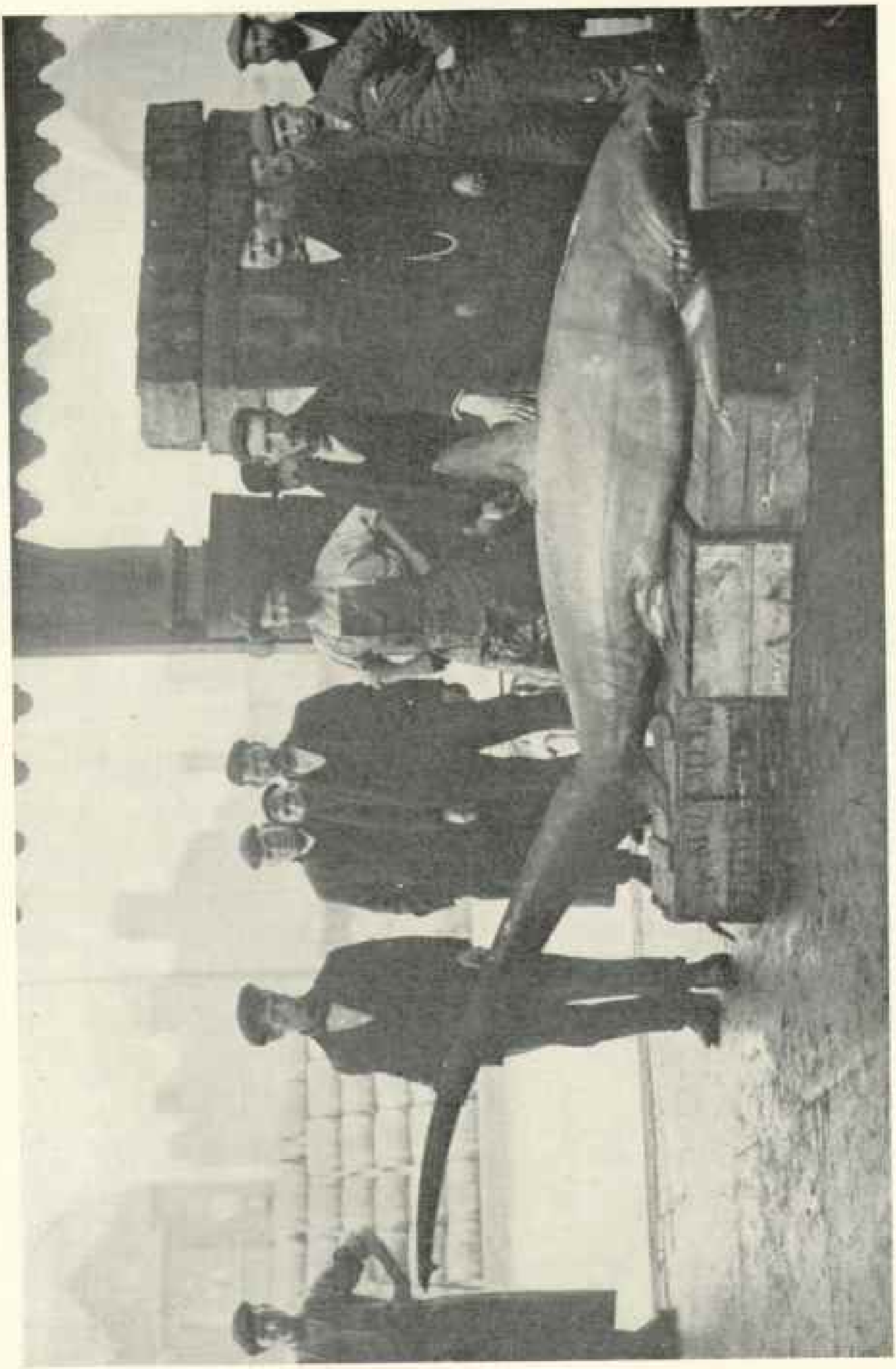
JAPAN

In this country, whose fisheries are comparatively more important than in any other and actually more valuable than in any except the United States and Great Britain, the herring is easily the most valuable product of the waters.

The fish occurs in immense shoals on the northern coasts of Japan, from Sakhalin to the northern parts of Honshu, being particularly abundant and caught in largest quantities in Hokkaido.

The fishery is conducted in spring, and is prosecuted with gill-nets, seines, and pound-nets. In Hokkaido, where 16,000 fishermen engage in this branch, most of the herring caught are made into guano, owing to the immense quantities caught in a very short time and to the lack of facilities for curing or preserving in any other way. The average quantity of herring marketed in Japan annually of late years has been over 325,000,000 pounds, valued at $4,250,000, and has occasionally reached 430,000,000 pounds. In the fisheries of Hokkaido about 300,000,000 pounds of herring guano, worth $3,400,000, are prepared each year.

The acquisition of part of Sakhalin, together with the fishing privileges on the Siberian coasts secured by the Treaty of Portsmouth, has greatly increased the fishing grounds and fishery resources of Japan, particularly in cod, salmon, and herring, and the development of the new grounds that is now in progress will add



ONE OF THE MOST EXCITING MOMENTS IN THE LIFE OF A TUNNY CATCHER—A THRESHER SHARK JUMPS ALONGSIDE

much to the value of the herring fisheries.

TEN BILLION HERRING CAUGHT ANNUALLY

From official statistics of all of the principal and most of the minor fishing countries and from careful estimates for all of the remaining countries, it is quite evident that the sea-herrings of the North Atlantic and North Pacific oceans are easily the most important fishes in the world today, being taken in greater numbers, constituting a larger food supply, supporting more people, and yielding larger money returns than any other product of the seas.

The world's annual production of herring at the present time is about 2,495,000,000 pounds, having a value of $30,895,000 at first hands. The value of the herring as placed on the markets, in the form of salted, smoked, and canned fish, oil, and guano, is not less than $60,000,000.

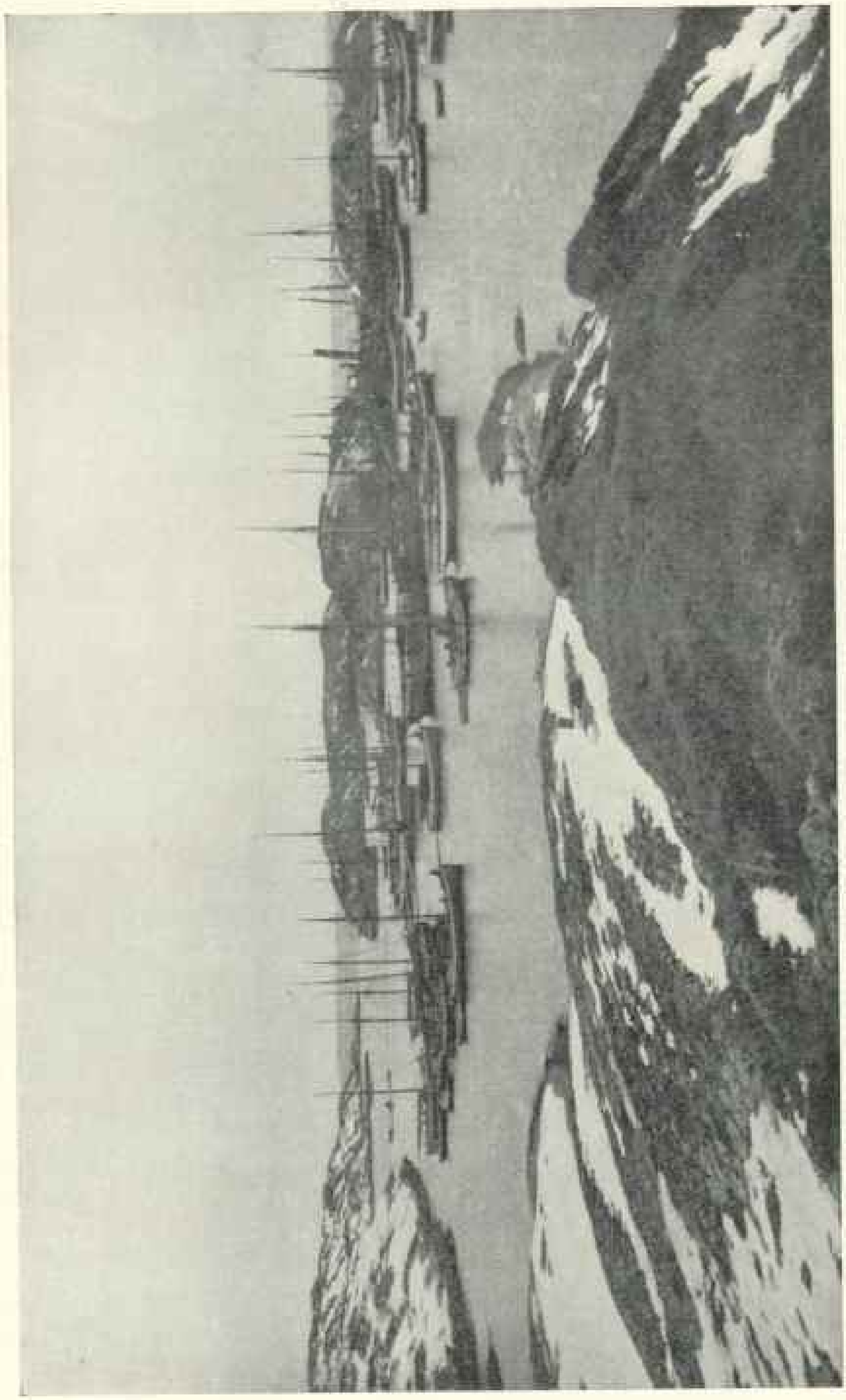
Many years ago Professor Huxley estimated that three billion herring were taken annually in the North Atlantic Ocean and its arms. These figures were doubtless ultra-conservative, as they were based on an allowance of only two fish to a pound, and did not take into consideration the hundreds of millions of pounds of immature and small fish caught in all countries. From an estimate based on the present extent of the fisheries, and on the actual weight of the herring in different countries and industries, varying from less than one-tenth of a pound in the "sardine" fishery of Maine and New Brunswick to nearly a pound in the case of the largest "bloaters" in America and Europe, I have reached the conclusion that the annual destruction of herring by man at the present time exceeds 10,000,000,000 fish, or seven fish to every person in the world.

Some pains have been taken to ascertain the approximate number of people who are engaged in the herring fisheries and their numerous ramifications—fishermen proper, transporters, cleaners, packers, curers, canners, smokers, coopers, net-makers and menders, wharfingers, shippers, vessel and boat builders, and many other trades. From the best information obtainable it seems that not less than 375,000 persons are directly supported by the herring. If to these are added their families, fully 1,250,000 men, women, and children would appear to be dependent upon this fish.

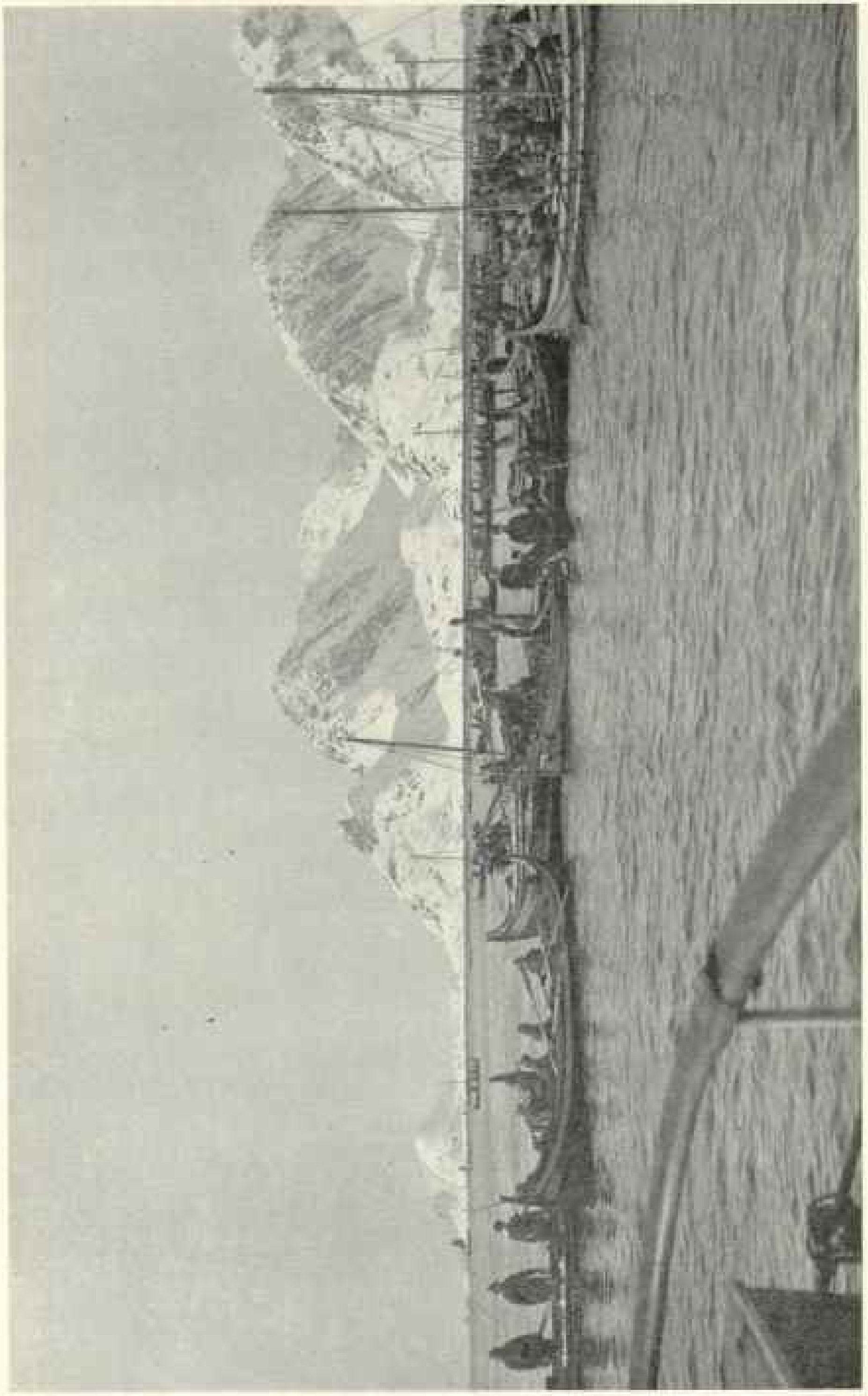
WILL THE HERRING SUPPLY LAST?

The question of the perpetuity or maintenance of a species which is caught in such immense quantities has engaged the attention of governments, scientists, publicists, and fishermen for many years. One of the most philosophical minds ever enlisted in the service of fishes and fisheries was that of Thomas H. Huxley, whose well-known investigations of the herring in behalf of the British government have afforded the best basis for judging of the stability of pelagic fishes like the herring with reference to the possible effects of man's influence thereon. Huxley's researches more than those of any other person have determined the attitude of governments and fishery authorities toward the important question of legislation for the protection of the free-swimming marine fishes.

Huxley concluded that the entire annual take of herring in Europe does not represent more fish than would be contained in any one of scores of shoals existing at one and the same time. The fact that, with a few peculiar local exceptions, the abundance of herring has remained unimpaired for centuries affords ground for Huxley's recommendation that in the case of the herring, and inferentially of other species of similar habits, the best thing for the governments to do regarding the fisheries therefor is to do nothing, letting the "people fish how they like, as they like, and when they like." The destruction wrought by man is, in fact, insignificant when compared with that which must regularly occur independently of him; and, as an average thing, it is doubtful if human agencies are responsible for more than



HERRING FLEET IN A NORWEGIAN HARBOR



HERRING FISHER BOATS OF NORWAY: SMALL-SET FISHING (SEE PAGE 725)

five per cent of the annual losses to which the herring schools are necessarily liable, from whales, porpoises, seals, and other mammals; from cod, haddock, mackerel, sharks, and other fishes; from gulls, gannets, and other birds, and from the thousands of other natural enemies that begin to prey on the herring while it is still in the egg and continue their attacks throughout its entire existence.

As Huxley has shown, the basis on which the permanency of the herring schools depends is not so much the *preservation* of a certain percentage of the fish as the *destruction* of nearly the entire progeny of each female herring each year. If every mature female herring lays 20,000 eggs, a very conservative estimate, and if the numbers of herring are to remain approximately the same from year to year, then 19,998 of the progeny of every mature female must be destroyed before they reach the spawning period; for if more than two out of the 20,000 escape destruction and spawn, then more fish will be produced than are necessary for maintaining the schools.

Thus many thousand times the number of herring contained in the schools of a given region must be destroyed each year if the average size or strength of those schools is to remain the same. Huxley has summed up the case in this lucid language:

> Man, in fact, is but one of a vast cooperative society of herring-catchers, and the larger the share he takes, the less there is for the rest of the company. If man took none, the other shareholders would have a larger dividend and would thrive and multiply in proportion, but it would come to pretty much the same thing to the herrings.

ECONOMIC LOSS TO THE PEOPLE OF THE UNITED STATES THROUGH INSECTS THAT CARRY DISEASE *

By L. O. Howard, Ph. D.

Chief of the U. S. Bureau of Entomology

It has been definitely proven and is now generally accepted that malaria in its different forms is disseminated among the individuals of the human species by the mosquitoes of the genus Anopheles, and that the malarial organism gains entrance to the human system, so far as known, only by the bite of mosquitoes of this genus. It has been proven with equal definiteness and has also become generally accepted that yellow fever is disseminated by the bite of a mosquito known as *Stegomyia calopus* (possibly by the bites of other mosquitoes of the same genus), and, so far as has been discovered, this disease is disseminated only in this way.

Further, it has been scientifically demonstrated that the common house fly is an active agent in the dissemination of typhoid fever, Asiatic cholera, and other intestinal diseases by carrying the causative organisms of these diseases from the excreta of patients to the food supply of healthy individuals; and that certain species of fleas are the active agents in the conveyance of bubonic plague. Moreover, the tropical disease known as filariasis is transmitted by a species of mosquito.

Furthermore, it is known that the so-called "spotted fever" of the northern Rocky Mountain region is carried by a species of tick; and it has been demonstrated that certain blood diseases may be carried by several species of biting insects. The purulent ophthalmia of the Nile basin is carried by the house fly. A

* From Bulletin No. 78, Bureau of Entomology, U. S. Department of Agriculture.

similar disease on the Fiji Islands is conveyed by the same insect. Pink eye in the southern United States is carried by minute flies of the genus Hippelates. The house fly has been shown to be a minor factor in the spread of tuberculosis. The bedbug has been connected with the dissemination of several diseases. Certain biting flies carry the sleeping sickness in Africa. A number of dangerous diseases of domestic animals are conveyed by insects.

The literature of the whole subject has grown enormously during the past few years, and the economic loss to the human species through these insects is tremendous. At the same time, this loss is entirely unnecessary; the diseases in question can be controlled, and the suppression of the conveying insects, so absolutely vital with certain of these diseases and so important in the others, can be brought about.

MONEY LOSS CAUSED BY MOSQUITOES

Entirely aside from the loss occasioned by mosquitoes as carriers of specific diseases, their abundance brings about a great monetary loss in other ways.

Possibly the greatest of these losses is in the reduced value of real estate in mosquito-infested regions, since these insects render absolutely uninhabitable large areas of land available for suburban homes, for summer resorts, for manufacturing purposes, and for agricultural pursuits. The money loss becomes most apparent in the vicinity of large centers of population. The mosquito-breeding areas in the vicinity of New York City, for example, have prevented the growth of paying industries of various kinds and have hindered the proper development of large regions to an amount which it is difficult to estimate in dollars and cents and which is almost inconceivable. The same may be said for other large cities near the seacoast, and even of those inland in low-lying regions. The development of the whole State of New Jersey has been held back by the mosquito plague.

Agricultural regions have suffered from this cause. In portions of the Northwestern States it has been necessary to cover the work horses in the field with sheets during the day. In the Gulf region of Texas at times the market value of live stock is greatly reduced by the abundance of these insects. In portions of southern New Jersey there are lands eminently adapted to the dairying industry, and the markets of New York, Philadelphia, and the large New Jersey cities are at hand. In these localities herds of cattle have been repeatedly established, but the attacks by swarms of mosquitoes have reduced the yield of milk to such an extent as to make the animals unprofitable, and dairying has been abandoned for less remunerative occupations. The condition of the thoroughbred race horses at the great racing center, Sheepshead Bay, Long Island, was so impaired by the attacks of mosquitoes as to induce those interested to spend many thousands of dollars a few years ago in an effort to abate the pest.

All over the United States, for these insects, and for the house fly as well, it has become necessary at great expense to screen habitations. The cost of screening alone must surely exceed ten millions of dollars per annum.

MALARIA IS STILL SPREADING OVER THE COUNTRY

The west coast of Africa, portions of India, and many other tropical regions have always, at least down to the present period, been practically uninhabitable by civilized man, owing to the presence of pernicious malaria. The industrial and agricultural development of Italy has been hindered to an incalculable degree by the prevalence of malaria in the southern half of the Italian peninsula, as well as in the valley of the Po and elsewhere. The introduction and spread of malaria in Greece is stated by Ronald Ross, and with strong reasons, to have been largely responsible for the progressive physical degeneration of one of the strongest races of the earth.

In the United States, malaria, if not endemic, was early introduced. The

probabilities are that it was endemic, and it is supposed that the cause of the failure of the early colonies in Virginia was due to this disease. It is certain that malaria retarded in a marked degree the advance of civilization over the North American Continent, and particularly was this the case in the march of the pioneers throughout the Middle West and throughout the Gulf States west to the Mississippi and beyond. In many large regions once malarious the disease has lessened greatly in frequency and virulence owing to the reclamation of swamp areas and the lessening of the number of the possible breeding places of the malarial mosquitoes, but the disease is still enormously prevalent, particularly so in the southern United States.

There are many communities and many regions in the North where malaria is unknown, but in many of these localities and throughout many of these regions Anopheles mosquitoes breed, and the absence of malaria means simply that malarial patients have not entered these regions at the proper time of the year to produce a spread of the malady. It has happened again and again that in communities where malaria was previously unknown it has suddenly made its appearance and spread in a startling manner. These cases are to be explained, as happened in Brookline, Mass., by the introduction of Italian laborers, some of whom were malarious, to work upon the reservoir; or, as happened at a fashionable summer resort near New York City, by the appearance of a coachman who had had malaria elsewhere and had relapsed at this place. In such ways, with a rapidly increasing population, malaria is still spreading in this country.

MALARIA RESPONSIBLE FOR MORE DEATHS THAN ANY PARASITIC DISEASE

It is undoubtedly safe to assume that the death rate for the whole population of the United States due to malaria is in the neighborhood of 15 per 100,000.

But with malaria perhaps as with no other disease does the death rate fail to indicate the real loss from the economic point of view. A man may suffer from malaria throughout the greater part of his life, and his productive capacity may be reduced from 50 to 75 per cent, and yet ultimately he may die from some entirely different immediate cause. In fact, the predisposition to death from other causes brought about by malaria is so marked that if, in the collection of vital statistics, it were possible to ascribe the real influence upon mortality that malaria possesses, this disease would have a very high rank in mortality tables.

Writing of tropical countries, Sir Patrick Manson declares that malaria causes more deaths, and more predisposition to death by inducing cachectic states predisposing to other affections, than all the other parasites affecting mankind together. Moreover, it has been shown that the average life of the worker in malarious places is shorter and the infant mortality higher than in healthy places.

But, aside from this vitally important aspect of the subject, the effect of malaria in lessening or destroying the productive capacity of the individual is obviously of the utmost importance, and upon the population of a malarious region is enormous, even under modern conditions and in the United States. It has been suggested that the depopulation of the once thickly settled Roman Campagna was due to the sudden introduction of malaria by the mercenaries of Scylla and Marius. Celli, in 1900, states that owing to malaria about 5,000,000 acres of land in Italy remain—not uncultivated, but certainly very imperfectly cultivated. Then also, in further example, in quite recent years malaria entered and devastated the islands of Mauritius and Réunion, practically destroying for a time the productiveness of these rich colonies of Great Britain and France.

Creighton, in his article on malaria in the Encyclopædia Britannica, states that this disease "has been estimated to produce one-half of the entire mortality of the human race; and inasmuch as it is the most frequent cause of sickness and

death in those parts of the globe that are most densely populated, the estimate may be taken as at least rhetorically correct."*

PROSPERITY OF SOUTH RETARDED BY MALARIA

The loss to this country in the way of retardation of the development of certain regions, owing to the presence of malaria, is extremely great. Certain territory containing most fertile soil and capable of the highest agricultural productiveness is practically abandoned. With the introduction of proper drainage measures and antimosquito work of other character, millions of acres of untold capacity could be released from the scourge at a comparatively slight expenditure. These regions in the absence of malaria would have added millions upon millions to the wealth of the country. Drainage measures are now being initiated by the United States. Parties of engineers are being sent by the government to make preliminary drainage surveys in the most prominent of these potentially productive regions. The following statement concerning the effect of malaria on the progress of this work has been made to the writer by Dr. George Otis Smith, director of the United States Geological Survey:

"In one of the Southern States 11 topographic parties have been at work during the past field season. The full quota for these parties would be 55 men, but I believe that something over 100 men have been employed at different times during the season. While I have not exact figures before me, I feel warranted in the statement that at least 95 per cent of these employees have been sick, for periods ranging from a few days up to two weeks, in the hospital. Many of them have been able later to return to work, but at least 30 per cent had to leave the field permanently. By reason of this sickness the efficiency of the parties was reduced, at a very conservative estimate, by 25 per cent.

"In my recent visit in this field I found one man sick in each of the parties I saw and one man who had just returned from the hospital leaving the field for good. A similar state of things was reported from the other parties. I regard the sickness as practically all of a malarial nature, as extreme care was taken in all the camps to use nothing but boiled water except in a few instances where artesian water from great depths was available. In all the camps the tents have been screened, and in every case where the topographer has lived for any time 'on the country' there has been infection. As illustrating the value of the precautions generally taken by our camp parties, I might cite the fact that last year in West Virginia with 30 men living in camp, with typhoid fever prevalent in the neighborhood, no cases developed, while with 6 men living on the country where the same care could not be taken regarding the water supply, two cases of typhoid developed."

In estimating the weight of Doctor Smith's statement, it must be borne in mind that the men of his field parties are exceptionally intelligent and prepared to take all ordinary precautions.

Throughout the region in question malaria is practically universal. The railroads suffer, and at the stations throughout the territory it is practically impossible to keep operators steadily at work. This reduction in efficiency in the surveying parties and in the local railroad officials is moreover probably very considerably less than the reduction in the earning capacity of the entire population, which, however, is necessarily scanty.

In an excellent paper entitled "The relation of malaria to agricultural and other industries of the South," published in the *Popular Science Monthly* for April, 1903, Prof. Glenn W. Herrick, then of the College of Agriculture of Mississippi, after a consideration of the whole field, concludes that malaria is responsible for more sickness among the white population of the South than any disease to which it is now subject. The following forcible statement referring to the States of Louisiana, Mississippi, Alabama,

* See "Darwinism and Malaria," by R. G. Eccles, M. D. Medical Record, New York, January 16, 1909, pp. 85-93.

Georgia, and South Carolina is in Professor Herrick's words:

"We must now consider briefly what 635,000 or a million cases of chills and fevers in one year mean. For laboring men it means an immense loss of their time together with the doctors' fees in many instances. If members of their families other than themselves be affected, it may also mean a loss of time together with the doctors' fees. For the employer it means the loss of labor at a time perhaps when it would be of greatest value. If it does not mean the actual loss of labor to the employer it will mean a loss in the efficiency of his labor. To the farmers it may mean the loss of their crops by want of cultivation. It will always mean the non-cultivation or imperfect cultivation of thousands of acres of valuable land. It means a listless activity in the world's work that counts mightily against the wealth-producing power of the people. Finally it means from two to five million or more days of sickness, with all its attendant distress, pain of body, and mental depression to some unfortunate individuals of those five states."

OUR BEST FARMING LAND UNTOUCHED BECAUSE OF MALARIA

Referring to the Delta region in Mississippi, which lies along the Mississippi River in the western part of the State of Mississippi, extending from the mouth of the Yazoo River north nearly to the Tennessee line, Herrick says that it is the second best farming land in the world, having only one rival, and that is the valley of the Nile.

"Still," says Herrick, "this land today, or at least much of it, can be bought at ten to twenty dollars an acre. Thousands of acres in this region are still covered with the primeval forest, and the bears and deer still roaming there offer splendid opportunities for the chase, as evidenced by the late visit of our Chief Executive to those regions for the purpose of hunting. Why is not this land thickly settled? And why is it not worth from two to five hundred dollars an acre? If it produces from one to two or more bales of cotton to an acre, and it does, it ought to be worth the above-named figures. A bale of cotton to the acre can be produced for thirteen dollars, leaving a net profit of twenty to forty dollars for each bale, or forty to eighty or more dollars for each acre of land cultivated. Moreover, this land has been doing that for years, and will do it for years to come, without the addition of one dollar's worth of fertilizer. Land that will produce a net profit of forty to eighty dollars an acre is a splendid investment at one, two, or even three hundred dollars an acre. Yet this land does not sell in the market for anything like so much, because the demand is not sufficient, for white people positively object to living in the Delta on account of malarial chills and fevers.

"A man said to me not long ago that he would go to the Delta that day if he were sure that his own life or the lives of the members of his family would not be shortened thereby. There are thousands exactly like him, and the only reason that these thousands do not go there to buy lands and make homes is on account of chills and fevers. But there is a time coming, and that not far distant, when malaria in the Delta will not menace the would-be inhabitants. When that time comes it will be the richest and most populous region in the United States."

RAVAGES OF MALARIA EASILY PREVENTABLE

Malaria is a preventable disease. It is possible for the human species to live and to thrive and to produce in malarious regions, but at a very considerable inconvenience and expense. The Italian investigators, and especially Celli and his staff, have shown that by screening the huts of the peasants on the Roman Campagna and by furnishing field laborers with veils and gloves when exposed to the night air, it is possible even in that famous hotbed of malaria to conduct farming operations with a minimum of trouble from the disease. Moreover, Koch and his assistants in German East Africa have shown that by stamping out

the disease among human beings by the free use of medicine, a point can be gained where there is small opportunity for the malarial mosquitoes to become infected. Moreover, the work of the parties sent out by the Liverpool School of Tropical Medicine and other English organizations to the west coast of Africa has shown that by the treatment of malarial-mosquito breeding pools the pernicious coast fever may be greatly reduced. Again, the work of Englishmen in the Federated Malay States has shown that large areas may be practically freed from malaria.

The most thorough and the most satisfactory of all measures consists in abolishing the breeding places of the malarial mosquitoes. In regions like the Delta of the Mississippi this involves extensive and systematic drainage, but in very many localities where the breeding places of the Anopheles mosquitoes can be easily eradicated, where they are readily located and are so circumscribed as to admit of easy treatment, it is possible to rid the section of malaria at a comparatively slight expense.

With a general popular appreciation of the industrial losses caused primarily by the malarial mosquito and secondarily by the forms which do not carry malaria, as indicated in the opening paragraphs, it is inconceivable that the comparatively inexpensive measures necessary should not be undertaken by the general government, by the state governments, and by the boards of health of communities, just as it is inconceivable that the individual should suffer from malaria and from the attacks of other mosquitoes when he has individual preventives and remedies at hand. Large-scale drainage measures by the general government involving large sections of valuable territory have been planned and are practically under way; certain states, notably New Jersey and New York, are beginning to work; communities all over the country through boards of health are also beginning to take notice, while popular education regarding the danger from mosquitoes and in regard to remedial measures is rapidly spreading. But all of this interest should be intensified, and the importance of the work should be displayed in the most emphatic manner, and relief from malaria and other mosquito conditions should be brought about as speedily as possible.

A few excellent examples of anti-malarial work may be instanced.

The latest reports on the measures taken to abolish malaria from Klang and Port Swettenham in Selangor, Federated Malay States, indicate the most admirable results. These measures were undertaken first in 1901 and 1902, and have been reported upon from time to time in the *Journal of Tropical Medicine*.

It seems as though malaria has been permanently stamped out at Klang and Port Swettenham, and this experience in the Malay States should be of value to those responsible for the health of communities similarly situated in many other parts of the world.

MALARIA HAS BEEN STAMPED OUT IN ISMAILIA AND HAVANA

Another striking example of excellent work of this kind is found in the recently published report on the suppression of malaria in Ismailia, issued under the auspices of the Compagnie Universelle du Canal Maritime de Suez. Ismailia is now a town of 8,000 inhabitants. It was founded by De Lesseps in April, 1862, on the borders of Lake Timsah, which the Suez Canal crosses at mid-distance between the Red Sea and the Mediterranean. Malarial fever made its appearance in very severe form in September, 1877, although the city had up to that time been very healthy, and increased so that since 1886 almost all of the inhabitants have suffered from the fever. In 1901 an attempt to control the disease was made on the mosquito basis, and this attempt rapidly and completely succeeded, and after two years of work all traces of malaria disappeared from the city. The work was directed not only against Anopheles mosquitoes, but against other culicids, and comprised the drainage of a large swamp and the other usual measures. The initial expense amounted to

50,000 francs ($9,650), and the annual expenses since have amounted to about 18,300 francs ($3,532).

The results may be summarized about as follows: Since the beginning of 1903 the ordinary mosquitoes have disappeared from Ismailia. Since the autumn of 1903 not a single larva of Anopheles has been found in the protected zone, which extends to the west for a distance of 1,000 meters from the first houses in the Arabian quarter and to the east for a distance of 1,800 meters from the first houses in the European quarter. After 1902 malarial fever obviously began to decrease, and since 1903 not a single new case of malaria has been found in Ismailia.

A very efficient piece of antimalarial work was accomplished in Havana during the American occupation of 1901 to 1902, incidental in a way to the work against yellow fever. An Anopheles brigade of workmen was organized under the sanitary officer, Doctor Gorgas, for work along the small streams, irrigated gardens, and similar places in the suburbs, and numbered from 50 to 300 men. No extensive drainage, such as would require engineering skill, was attempted, and the natural streams and gutters were simply cleared of obstructions and grass, while superficial ditches were made through the irrigated meadows.

Among the suburban truck gardens Anopheles bred everywhere, in the little puddles of water, cow tracks, horse tracks, and similar depressions in grassy ground. Little or no oil was used by the Anopheles brigade, since it was found in practice a simple matter to drain these places. At the end of the year it was very difficult to find water containing mosquito larvæ anywhere in the suburbs, and the effect upon malarial statistics was striking.

In 1900, the year before the beginning of the mosquito work, there were 325 deaths from malaria; in 1901, the first year of the mosquito work, 171 deaths; in 1902, the second year of mosquito work, 77 deaths. Since 1902 there has been a gradual though slower decrease, as follows: 1903, 51; 1904, 44; 1905, 32; 1906, 26; 1907, 23. These results, although less striking than those from Ismailia, involved a smaller expense in money and show surely an annual saving of 300 lives, and undoubtedly a corresponding decrease in the number of malarial cases, which may be estimated upon our earlier basis at something less than 40,000.

THE YELLOW FEVER MOSQUITO UNDER CONTROL

Since the discovery by the American army surgeons that yellow fever is carried by a mosquito, the *Stegomyia calopus*, the disease has been driven out of United States territory.

In what is termed the New Orleans epidemic of 1905 a striking illustration of the value of this recently acquired mosquito-transmission knowledge is seen. The presence of yellow fever in the city was first recognized about the 1st of July, but it was the 12th of August before the Public Health and Marine-Hospital Service was put in complete control of the situation. By that time the increase in new cases and deaths rendered it practically certain that the disease was as widespread as during the terrible epidemic of 1878. There had been up to that date 142 deaths from a total of 913 cases, as against 152 deaths from a total of 519 cases in 1878. The Public Health and Marine-Hospital Service, under Doctor White, took hold of the situation with energy, basing its measures almost entirely upon a warfare against *Stegomyia calopus*. The disease began almost immediately to abate, and the result at the close of the season indicated 460 deaths, as against 4,046 in 1878, a virtual saving of over 3,500 lives.

WORK ON THE ISTHMUS OF PANAMA

The United States Government has very properly used the services of Colonel Gorgas, who was in charge of the eminently successful work at Havana, by appointing him chief sanitary officer of the Canal Zone during the digging of the

canal. In 1904 active work was begun, and Colonel Gorgas was fortunate in having the services of Mr Le Prince, who had been chief of his mosquito brigades in Havana, and therefore was perfectly familiar with antimosquito methods. In Panama, as in Havana, the population had depended principally upon rain water for domestic purposes, so that every house had cisterns, water barrels, and such receptacles for catching and storing rain water. The city was divided up into small districts with an inspector in charge of each district. This inspector was required to cover his territory at least twice a week and to make a report upon each building with regard to its condition as to breeding places of mosquitoes. All the cisterns, water barrels, and other water receptacles in Panama were covered as in Havana, and in the water barrels spigots were inserted so that the covers would not have to be taken off.

Upon first inspection, in March, 4,000 breeding places were reported. At the end of October less than 400 containing larvæ were recorded. This gives one a fair idea of the consequent rapid decrease in the number of mosquitoes in the city. These operations were directed primarily against the yellow-fever mosquito, and incidentally against the other common species that inhabit rain-water barrels. Against the Anopheles in the suburbs the same kind of work was done as was done in Havana, with exceptionally good results.

The same operations were carried on in the villages between Panama and Colon. There are some twenty of these villages, running from 500 to 3,000 inhabitants each. Not a single instance of failure has occurred in the disinfection of these small towns, and the result of the whole work has been the apparent elimination of yellow fever and the very great reduction of malarial fever.

The remarkable character of these results can only be judged accurately by comparative methods. It is well known that during the French occupation there was an enormous mortality among the European employees, and this was a vital factor in the failure of the work. Exact losses cannot be estimated, since the work was done under 17 different contractors. These contractors were charged $1 a day for every sick man to be taken care of in the hospital of the company. Therefore it often happened that when a man became sick his employer discharged him, so that he would not have to bear the expense of hospital charges. There was no police patrol of the territory and many of these men died along the line.

Colonel Gorgas has stated that the English consul, who was at the Isthmus during the period of the French occupation, is inclined to think that more deaths of employees occurred out of the hospital than in it. A great many were found to have died along the roadside while endeavoring to find their way to the city of Panama. The old superintendent of the French hospital states that one day 3 of the medical staff died from yellow fever, and in the same month 9 of the medical staff. Thirty-six Roman Catholic sisters were brought over as nurses, and 24 died of yellow fever. On one vessel 18 young French engineers came over, and in a month after their arrival all but one died.

Now that the relation of the mosquito to yellow fever is well understood, it was found during the first two years under Doctor Gorgas that, although there were constantly one or more yellow fever cases in the hospital, and although the nurses and physicians were all non-immunes, not a single case of yellow fever was contracted in that way. The nurses never seemed to consider that they were running any risk in attending yellow-fever cases night and day in screened wards, and the wives and families of officers connected with the hospital lived about the grounds, knowing that yellow fever was constantly being brought into the grounds and treated in near-by buildings. Americans, sick from any cause, had no fear when being treated in beds immediately adjoining those of yellow fever patients.

Colonel Gorgas and Doctor Carter lived in the old ward used by the French

for their officers, and Colonel Gorgas thinks it safe to say that more men had died from yellow fever in that building under the French regime than in any other building of the same capacity at present standing. He and Doctor Carter had their wives and children with them, which would formerly have been considered the height of recklessness, but they looked upon themselves, under the now recognized precautions, as being as safe, almost, as they would have been in Philadelphia or Boston.

No figures of the actual cost of the antimosquito work, either in Havana or in the Panama Canal Zone, are accessible to the writer, but it is safe to say that it was not exorbitant, and that it was not beyond the means of any well-to-do community in tropical regions.

THE TYPHOID FLY, COMMONLY KNOWN AS THE HOUSE FLY

The name "typhoid fly" is here proposed as a substitute for the name "house fly," now in general use. People have altogether too long considered the house fly as a harmless creature, or, at the most, simply a nuisance. While scientific researches have shown that it is a most dangerous creature from the standpoint of disease, and while popular opinion is rapidly being educated to the same point, the retention of the name house fly is considered inadvisable, as perpetuating in some degree the old ideas. Strictly speaking, the term "typhoid fly" is open to some objection, as conveying the erroneous idea that this fly is solely responsible for the spread of typhoid; but considering that the creature is dangerous from every point of view, and that it is an important element in the spread of typhoid, it seems advisable to give it a name which is almost wholly justified and which conveys in itself the idea of serious disease. Another repulsive name that might be given to it is "manure fly," but recent researches have shown that it is not confined to manure as a breeding place, although perhaps the great majority of these flies are born in horse manure. For the end in view, "typhoid fly" is considered the best name.

In a paper entitled "A Contribution to the Study of the Insect Fauna of Human Excrement (with special reference to the spread of typhoid fever by flies)," published in the Proceedings of the Washington Academy of Sciences, Volume II, pages 541-604, December 28, 1900, the writer showed that 98.8 per cent of the whole number of insects captured in houses throughout the whole country were *Musca domestica*, the typhoid or house fly. He showed further that this fly, while breeding most numerously in horse stables, is also attracted to human excrement and will breed in this substance. It was shown that in towns where the box privy was still in existence the house fly is attracted to the excrement, and, further, that it is so attracted in the filthy regions of a city where sanitary supervision is lax and where in low alleys and corners and in vacant lots excrement is deposited by dirty people. He stated that he had seen excrement which had been deposited overnight in an alleyway in South Washington swarming with flies under the bright sunlight of a June morning (temperature 92° F.), and that within 30 feet of these deposits were the open windows and doors of the kitchens of two houses kept by poor people, these two houses being only elements in a long row. The following paragraph is quoted from the paper just cited:

"Now, when we consider the prevalence of typhoid fever and that virulent typhoid bacilli may occur in the excrement of an individual for some time before the disease is recognized in him, and that the same virulent germs may be found in the excrement for a long time after the apparent recovery of a patient, the wonder is not that typhoid is so prevalent but that it does not prevail to a much greater extent. Box privies should be abolished in every community. The depositing of excrement in the open within town or city limits should be considered a punishable misdemeanor in communities which have not already such regulations, and it should be enforced more rigorously in towns in which it is already a rule. Such offenses are generally committed after dark, and it is often

difficult or even impossible to trace the offender; therefore the regulation should be carried even further and require the first responsible person who notices the deposit to immediately inform the police, so that it may be removed or covered up. Dead animals are so reported; but human excrement is much more dangerous. Boards of health in all communities should look after the proper treatment or disposal of horse manure, primarily in order to reduce the number of house flies to a minimum, and all regulations regarding the disposal of garbage and foul matter should be made more stringent and should be more stringently enforced."

In the opening sentence of the paragraph just quoted attention was called to the activity of bacilli in excreta passed by individuals after apparent recovery from typhoid. Since the paper in question was published, more especial attention has been drawn by medical men to this point, and it has been shown that individuals who are chronic spreaders of the typhoid germs are much more abundant than was formerly supposed.

Dr. George A. Soper recently discovered a striking case of this kind in the person of a cook employed successively by several families in the vicinity of New York City, with the result that several cases of typhoid occurred in each of these families. In a paper by Doctor Davids and Professor Walker, read before the Royal Sanitary Institute of London during the present season, the history was given of four personal carriers of typhoid who had communicated the disease to a number of people. These four carriers were detected in one city within a few months, and from this fact it can be argued with justice that such cases are comparatively numerous. This being true, the presence of unguarded miscellaneous human excreta deposited in city suburbs, in vacant lots, and in low alleyways intensifies to a very marked degree the danger that the food will become contaminated with typhoid bacilli by means of the typhoid or house fly. It is known, too, that the urine of persons who have suffered from typhoid fever often contains active typhoid bacilli for several weeks after the patients have recovered; consequently this also is a source of danger.

THE HOUSE FLY ALSO SPREADS INTESTINAL DISEASES, CHILDREN'S COMPLAINTS, AND CONSUMPTION

It is not alone as a carrier of typhoid that this fly is to be feared. In the same way it may carry nearly all the intestinal diseases. It is a prime agent in the spreading of summer dysentery, and in this way is unquestionably responsible for the death of many children in summer.

In a report by Daniel D. Jackson to the committee on pollution, of the Merchants' Association in New York, published in December, 1907, the results of numerous observations upon the relation of flies to intestinal diseases are published, and the relation of deaths from intestinal diseases in New York City to the activity and prevalence of the common house fly is shown not only by repeated observations but also by an interesting plotting of the curve of abundance of flies in comparison with the plotted curve of abundance of deaths from intestinal diseases, indicating that the greatest number of flies occurred in the weeks ending July 27 and August 3; also, that the deaths from intestinal diseases rose above the normal at the same time at which flies became prevalent, culminated at the same high point, and fell off with slight lag at the time of the gradual falling off of the prevalence of the insects.

The typhoid fly also possesses importance as a disseminator of the bacilli of tuberculosis. In a paper by Dr. Frederick T. Lord, of Boston, reprinted from the *Boston Medical and Surgical Journal* for December 15, 1904, pages 651-654, the following conclusions are reached:

"1. Flies may ingest tubercular sputum and excrete tubercle bacilli, the virulence of which may last for at least fifteen days.

"2. The danger of human infection from tubercular flyspecks is by the ingestion of the specks on food. Spontaneous

liberation of tubercle bacilli from fly-specks is unlikely. If mechanically disturbed, infection of the surrounding air may occur.

"As a corollary to these conclusions, it is suggested that—

"3. Tubercular material (sputum, pus from discharging sinuses, fecal matter from patients with intestinal tuberculosis, etc.) should be carefully protected from flies, lest they act as disseminators of the tubercle bacilli.

"4. During the fly season greater attention should be paid to the screening of rooms and hospital wards containing patients with tuberculosis and laboratories where tubercular material is examined.

"5. As these precautions would not eliminate fly infection by patients at large, foodstuffs should be protected from flies which may already have ingested tubercular material."

The danger of the typhoid or house fly in the carriage of disease has thus been abundantly demonstrated, and yet it is allowed to breed unrestricted all over the United States; it is allowed to enter freely the houses of the great majority of our people; it is allowed to spread bacteria freely over our food supplies in the markets and in the kitchens and dining-rooms of private houses, and, to use the happy phraseology of Dr. Theobald Smith, "when we go into public restaurants in midsummer we are compelled to fight for our food with the myriads of house flies which we find there alert, persistent, and invincible."

Even if the typhoid or house fly were a creature difficult to destroy, the general failure on the part of communities to make any efforts whatever to reduce its numbers could properly be termed criminal neglect; but since it is comparatively an easy matter to do away with the plague of flies, this neglect becomes an evidence of ignorance or of a carelessness in regard to disease-producing filth which to the informed mind constitutes a serious blot on civilized methods of life.

HOW TO KEEP THE FLIES AWAY

If we allow the accumulation of filth we will have house flies, and if we do not allow it to accumulate we will have no house flies. With the careful collection of garbage in cans and the removal of the contents at more frequent intervals than 10 days, and with the proper regulation of abattoirs, and more particularly with the proper regulation of stables in which horses are kept, the typhoid fly will become a rare species. It will not be necessary to treat horse manure with chloride of lime or with kerosene or with a solution of Paris green or arsenate of lead, if stablemen are required to place the manure daily in a properly covered receptacle and if it is carried away once a week.

The orders of the Health Department of the District of Columbia, published May 3, 1906, if carried out will be very effective. These orders provide for the keeping of manure in watertight bins or pits or barrels, protected from flies.

In addition to this excellent ordinance, others have been issued from the Health Department of the District of Columbia which provide against the contamination of exposed food by flies and by dust. The ordinances are excellently worded so as to cover all possible cases. They provide for the registration of all stores, markets, cafés, lunch rooms, or of any other place where food or beverage is manufactured or prepared for sale, stored for sale, offered for sale, or sold, in order to facilitate inspection, and still more recent ordinances provide for the registration of stables. An excellent campaign was begun during the summer of 1908 against insanitary lunch rooms and restaurants. A number of cases were prosecuted, but conviction was found to be difficult.

For one reason or another, the chief reason being the lack of a sufficient force of inspectors under the control of the health officers, the ordinance in regard to stables has not been carried out with that perfection which the situation demands.

Were simple inspection of stables all that is needed, a force of four inspectors, specially detailed for this work, could cover the District of Columbia, examining every stable, after they were once located and mapped, once a week. The

average salary of an inspector is $1,147, so that the total expense for the first year would be something like $4,500. But the inspectors' service is complicated by the matter of prosecution. Much of the time of inspectors would be taken in the prosecution of the owners of neglected premises. Moreover, the health officer has found during the summer of 1908, in his prosecution of the owners or managers of insanitary restaurants, that his inspectors were practically sworn out of court by the multiplicity of opposing evidence. This means that it will be necessary in such cases to send two inspectors together in all cases, so that the testimony of one may be supported by the testimony of the other. This, perhaps, would double the number of necessary inspectors, making the expense of the service something over $9,000.

It is reasonably safe to state, however, that with such an expense for competent service, or perhaps with a slightly added expense, the typhoid fly could be largely eliminated as an element in the transfer of disease in the District of Columbia, and the difficulty which the authorities have had in locating the cause of a very considerable proportion of the cases of typhoid in the District for the past two or three years indicates plainly to the mind of the writer that the typhoid fly is a much more important element than has been supposed. It is a comforting although comparatively insignificant fact and a matter of common observation that in certain sections of the city the typhoid fly has been much less numerous during the past summer than in previous years. The writer is inclined to attribute this to the gradual disappearance of horse stables in such sections, brought about by the rapidly increasing use of motor vehicles.

PUBLIC INDIFFERENCE TO THE TYPHOID FLY IS CRIMINAL

We have thus shown that the typhoid or house fly may carry typhoid fever, Asiatic cholera, dysentery, cholera morbus, and other intestinal diseases; it may carry the bacilli of tuberculosis and certain eye diseases; it is everywhere present, and it is disposed of with comparative ease. It is the duty of every individual to guard so far as possible against the occurrence of flies upon his premises. It is the duty of every community, through its board of health, to spend money in the warfare against this enemy of mankind. This duty is as pronounced as though the community were attacked by hands of ravenous wolves.

As a matter of fact, large sums of money are spent annually in the protection of property in the United States. Large sums of money are spent also in health matters; but the expenditure for protection from flies is very small and is misdirected. There is much justification for the following criticism published editorially in the Journal of the American Medical Association for August 22, 1908, under the caption, "National Farm Commission and Rural Sanitation:"

"The President calls attention to the fact that all efforts to aid the farmers have hitherto been directed to improving their material welfare, while the man himself and his family have been neglected. Nowhere is this more marked than in the attitude of the general government in matters relating to sanitation. It is a trite saying that whereas the government, through the Department of Agriculture, aids the farmer generously in caring for the health of his hogs, sheep, etc., it does nothing for his own health. The government issues notices to the farmer of the injury done to his crops by the cotton-boll weevil and the potato bugs and how to combat them, but the injury the mosquito does in spreading malaria to the people who pick the cotton and hoe the potatoes is not impressed on him. The fact that horseflies may carry anthrax to his cattle is dealt with at considerable length, but the diseases which the house fly spreads to the milk and to the farmer's family attract practically no attention. How to build a hoggen or a sanitary barn is the subject of a number of government publications, but how to build a sanitary privy which will prevent the spread of typhoid, hook worm,

and many other diseases is regarded as of strictly local interest."

But this criticism is not entirely justified, since there was published by the Bureau of Entomology of the United States Department of Agriculture, in 1900, a Farmers' Bulletin, entitled "How Insects Affect Health in Rural Districts,"* in which all of these points mentioned by the editor of the Journal of the American Medical Association have been touched upon, and at the date of present writing 192,000 copies of this bulletin have been distributed among the people. Moreover, a number of years ago a circular† was published on the subject of the house fly, calling attention to its dangers and giving instructions such as are covered in a general way in this article, and some 18,000 copies of this circular have also been distributed. This is an indication that the general government is by no means blind to the people's needs in such matters as we have under consideration, but further work should be done. That the English government is awaking to the same need is shown by the fact that, in the parliamentary vote of the present year in aid of scientific investigations concerning disease, one of the projects supported by the general government was the investigation of Doctors Copeman and Nuttall on flies as carriers of disease.

A leading editorial in an afternoon paper of the city of Washington, of October 20, 1908, bears the heading, "Typhoid a National Scourge," arguing that it is today as great a scourge as tuberculosis. The editorial writer might equally well have used the heading "Typhoid a National Reproach," or perhaps even "Typhoid a National Crime," since it is an absolutely preventable disease. And as for the typhoid fly, that a creature born in indescribable filth and absolutely swarming with disease germs should practically be invited to multiply unchecked, even in great centers of population, is surely nothing less than criminal.

* Farmers' Bulletin No. 155.

† Circular No. 35, Bureau of Entomology, 1891, afterwards reissued in revised form as Circular No. 71.

ENDEMIC DISEASE AS AFFECTING THE PROGRESS OF NATIONS

In referring to the spread of malaria in Greece, the relation of this disease to the rise and fall of national power has been touched upon in an earlier paragraph. The subject is one of the widest importance and deserves a more extended consideration.

The following paragraphs are quoted from Ronald Ross's address on Malaria in Greece, delivered before the Oxford Medical Society, November 29, 1906:

"Now, what must be the effect of this ubiquitous and everlasting incubus of disease on the people of modern Greece? Remember that the malady is essentially one of infancy among the native population. Infecting the child one or two years after birth, it persecutes him until puberty with a long succession of febrile attacks, accompanied by much splenomegaly and anæmia. Imagine the effect it would produce upon our own children here in Britain. It is true that our children suffer from many complaints—scarlatina, measles, whooping cough—but these are of brief duration and transient. But now add to these, in imagination, a malady which lasts for years, and may sometimes attack every child in a village. What would be the effect upon our population—especially our rural population—upon their numbers and upon the health and vigor of the survivors? It must be enormous in Greece.

"People often seem to think that such a plague strengthens a race by killing off the weaker individuals; but this view rests upon the unproven assumption that it is really the weaker children which cannot survive. On the contrary, experience seems to show that it is the stronger blood which suffers most—the fair, northern blood which nature attempts constantly to pour into the southern lands. If this be true, the effect of malaria will be constantly to resist the invigorating influx which nature has provided; and there are many facts in the

history of India, Italy, and Africa which could be brought forward in support of this hypothesis.

"We now come face to face with that profoundly interesting subject, the political, economical, and historical significance of this great disease. We know that malaria must have existed in Greece ever since the time of Hippocrates, about 400 B. C. What effect has it had on the life of the country? In prehistoric times Greece was certainly peopled by successive waves of Aryan invaders from the north—probably a fair-haired people—who made it what it became, who conquered Persia and Egypt, and who created the sciences, arts, and philosophies which we are only developing further today. That race reached its climax of development at the time of Pericles. Those great and beautiful valleys were thickly peopled by a civilization which in some ways has not been excelled. Everywhere there were cities, temples, oracles, arts, philosophies, and a population vigorous and well trained in arms. Lake Kopais, now almost deserted, was surrounded by towns whose massive works remain to this day.

"Suddenly, however, a blight fell over all. Was it due to internecine conflict or to foreign conquest? Scarcely; for history shows that war burns and ravages, but does no annihilate. Thebes was thrice destroyed, but thrice rebuilt. Or was it due to some cause, entering furtively and gradually sapping away the energies of the race by attacking the rural population, by slaying the new-born infant, by seizing the rising generation, and especially by killing out the fair-haired descendant of the original settlers, leaving behind chiefly the more immunised and darker children of their captives, won by the sword from Asia and Africa? * * *

"I cannot imagine Lake Kopais, in its present highly malarious condition, to have been thickly peopled by a vigorous race; nor, on looking at those wonderful figured tombstones at Athens, can I imagine that the healthy and powerful people represented upon them could have ever passed through the anæmic and splenomegalous infancy (to coin a word) caused by widespread malaria. Well, I venture only to suggest the hypothesis, and must leave it to scholars for confirmation or rejection. Of one thing I am confident, that causes such as malaria, dysentery, and intestinal entozoa must have modified history to a much greater extent than we conceive. Our historians and economists do not seem even to have considered the matter. It is true that they speak of epidemic diseases, but the endemic diseases are really those of the greatest importance. * * *

"The whole life of Greece must suffer from this weight, which crushes its rural energies. Where the children suffer so much, how can the country create that fresh blood which keeps a nation young? But for a hamlet here and there, those famous valleys are deserted. I saw from a spur of Helikon the sun setting upon Parnassus, Apollo sinking, as he was wont to do, towards his own fane at Delphi and pouring a flood of light over the great Kopaik Plain. But it seemed that he was the only inhabitant of it. There was nothing there. 'Who,' said a rich Greek to me, 'would think of going to live in such a place as that?' I doubt much whether it is the Turk who has done all this. I think it is very largely the malaria."

In considering carefully this suggestive argument of Major Ross, does it not appear to indicate the tremendous influence that the prevalence of endemic disease must exert upon the progress of modern nations, and does it not bring the thought that those nations that are most advanced in sanitary science and preventive medicine will, other things being equal, assume the lead in the world's work?

Who can estimate the influence of the sanitary laws of the Hebrew Scriptures upon the extraordinary persistence of that race through centuries of European oppression—centuries full of plague years and of terrible mortality from preventable disease?

And what more striking example can be advanced of the effect of an en-

lightened and scientifically careful attention to the most recent advances of preventive medicine upon the progress of nations than the mortality statistics of the Japanese armies in the recent Russo-Japanese war as compared with the corresponding statistics for the British army during the Boer war immediately preceding, or for the American army during the Spanish war at a somewhat earlier date?

The consideration of these elements of national progress has been neglected by historians, but they are nevertheless of deep-reaching importance and must attract immediate attention in this age of advanced civilization. The world has entered the historical age when national greatness and national decay will be based on physical rather than moral conditions, and it is vitally incumbent upon nations to use every possible effort and every possible means to check physical deterioration.

LIFE IN THE GREAT DESERT OF CENTRAL ASIA

By Ellsworth Huntington, of Yale University

IT seems a strange anomaly that the most remarkable ruins of ancient civilization are often closely associated with deserts. In North America the great Aztec and Zuñi ruins lie in the arid regions of the Southwest and of Mexico; in South America the wonderful remnants of the great Inca cities are located in the dry regions of Bolivia, Peru, and northern Argentina. In Africa, likewise, the Rhodesian ruins, the most remarkable in the southern part of the continent, lie near the Kalahari Desert, while in the north the remains of some of the most famous ancient empires border the Sahara from Morocco to Egypt. Asia, too, is no exception, for Arabia, Syria, Mesopotamia, Persia, northwestern India, and western China are all distinguished for their ruins and their deserts.

One of the most interesting examples of the combination of the ruins of a mighty past with conditions of great aridity today is found in the Russian province of Transcaspia, east of the Caspian Sea. Thither in 1903 it was the author's privilege to go as a member of an expedition sent out by the Carnegie Institution of Washington for archeological and geographical research under the leadership of Mr Raphael Pumpelly. During the course of two seasons' work we not only studied the ruins, but gained a fairly intimate acquaintance with the Turkoman inhabitants of the country—its rulers before the Russian conquest, less than thirty years ago. In our study of both the past and the present nothing was more impressive than the inexorable influence which the desert has exercised upon living creatures of every sort.

We entered Transcaspia from oily Baku, crossing the Caspian Sea to Krasnovodsk, and thence going by rail to Askhabad, the capital of the province, and to Merv, the most famous of the ancient cities. From the high, narrow windows of the deliberate train the traveler who elects to sit on the edge of the car seat, and sacrifice comfort to scientific curiosity, may see all of the few simple features which make up the physiography of Transcaspia. After the train has left the opalescent waters of the Bay of Krasnovodsk and has run through the desert for some hours, it comes at length to the Yuzboi, the broad abandoned channel of an ancient river which once flowed from the Sea of Aral or the marsh of Sarikamish to the Caspian Sea in the days when the climate of the country was

more propitious than now, and ancient empires flourished in what is now the desert.

Soon the train begins to run parallel to the mountains of northern Persia, which raise their barren brown flanks through the quivering air 20 or 30 miles away to the south. Between their base and the railway lies a sloping plain of gravelly soil washed down from the mountains by spring floods and fertile only where a rare brook is led abroad in canals to water the earth, or where tunnels, marked by long lines of wells with heaps of debris at their mouths, have been dug for miles into the gravel to rob it of its scanty store of water.

THE OASES OF THE DESERT

On the other side of the railway a great plain of desert sand stretches far away toward the north in the direction of the bleak plateau of Ust-urt and the famed city of "lone Khiva in the waste." Between the desert and the mountains lie the oases of Transcaspia, dusty green beads, large and small, strung on a two-stranded string of shining steel rails. Pleasant, cool, fruitful places they seem to the sun-blackened nomad of the desert, although to the luxurious traveler on the railroad thedusty streets and adobe houses present little that is lovely. Occasionally the house of a Russian official, low, white-washed, and red-tiled, presents a hint of picturesqueness as it stands embowered in fruit trees laden with mulberries, apricots, plums, peaches, quinces, and pomegranates; but the ground below the trees is dry and grassless, and the breath of the desert blights every spot where standing or running water is not found.

On the outskirts of almost every oasis stand the symbols of two types of civilization whose day is past. On the one side a cluster of round felt tents, a flock of fat-tailed brown and white sheep, some kneeling, grunting camels, and a group of Turkoman nomads in long-striped quilted gowns of native red silk and huge caps of sheepskin represent the recent days when the Turkomans cheerfully plundered their neighbors, the mild Persians, or any one else whom sad mischance betrayed into their hands. On the other side huge earthen mounds or lines of fallen walls of sun-dried brick indicate that centuries ago the barren wastes which now lie desolate were the home of a prosperous and numerous race of tillers of the soil.

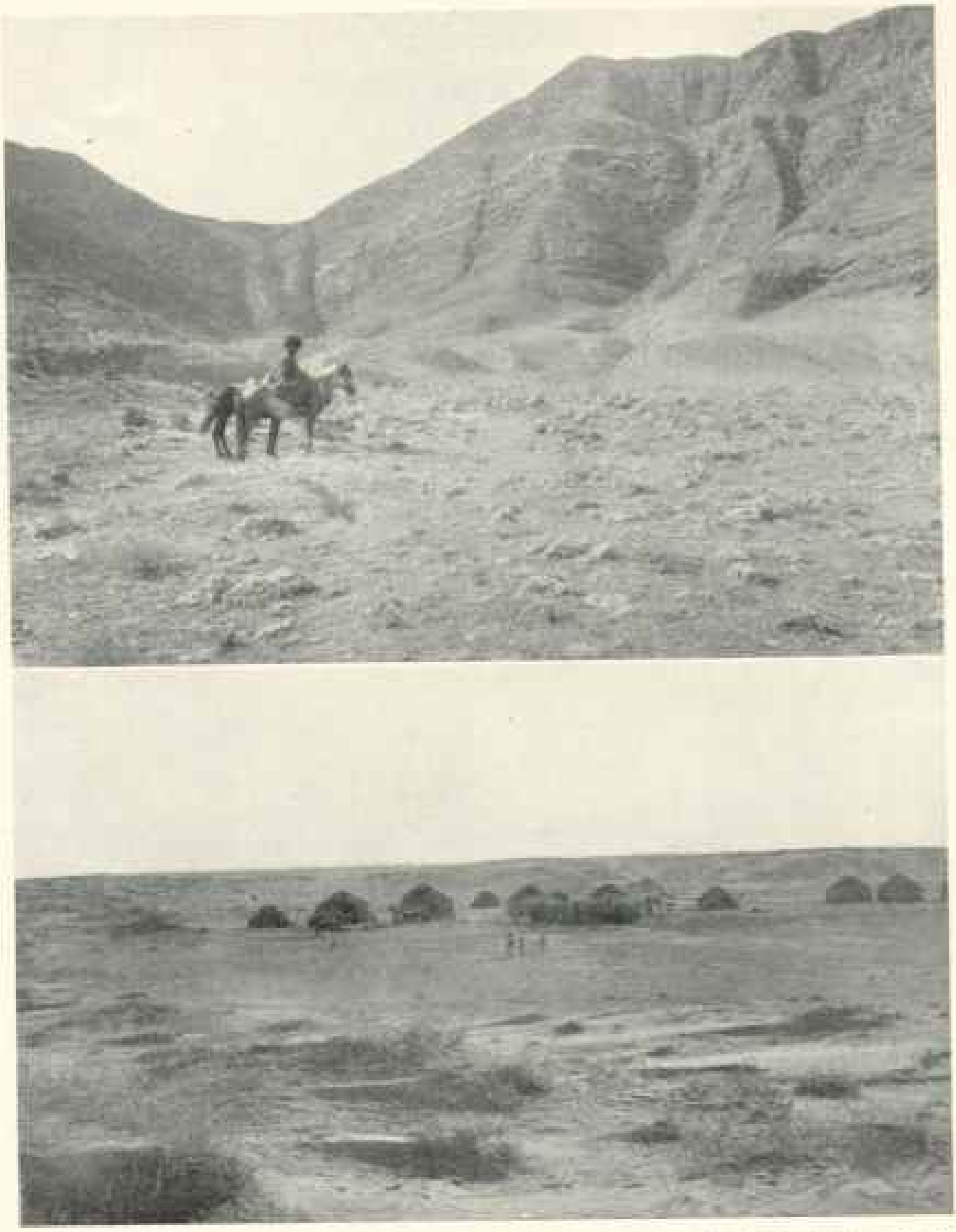
During our stay in Transcaspia we visited the mountains to the south of the railroad, made excursions into the desert to the north, and lived for months among the oases and deserts between the other two regions. Nowhere during all our stay did we feel that we had left the desert behind. On our way to the mountains at the end of May the growth of short, sweet grass which covers the country in early spring had already died and shriveled. The gently sloping plain of gravel at the base of the foot-hills was brown and barren except for dry weeds and little bushes.

Among the mountains themselves the bottoms of the deep canyons were either green with grass among which blue irises were blooming, or else were filled with a jungle of low trees and fragrant rose bushes. Nevertheless a glance upward disclosed bare walls of rock and talus so dry that not a speck of green could be detected. At the heads of the canyons green upland valleys and plateaus appeared, tenanted by pastoral Kurds who leave their stone houses in summer and dwell in tents.

The immediate scenery at these high altitudes of 6,000 or 8,000 feet did not suggest the desert, but from the snow-flecked peaks 9,000 or 10,000 feet above the sea a yellow band on the horizon and a dusty haze in the distant air could be seen proclaiming the great waste of sand a day's journey to the north, and we knew that in a month or two even the mountains would be parched and brown.

THE KURDS AND THE TURKOMANS

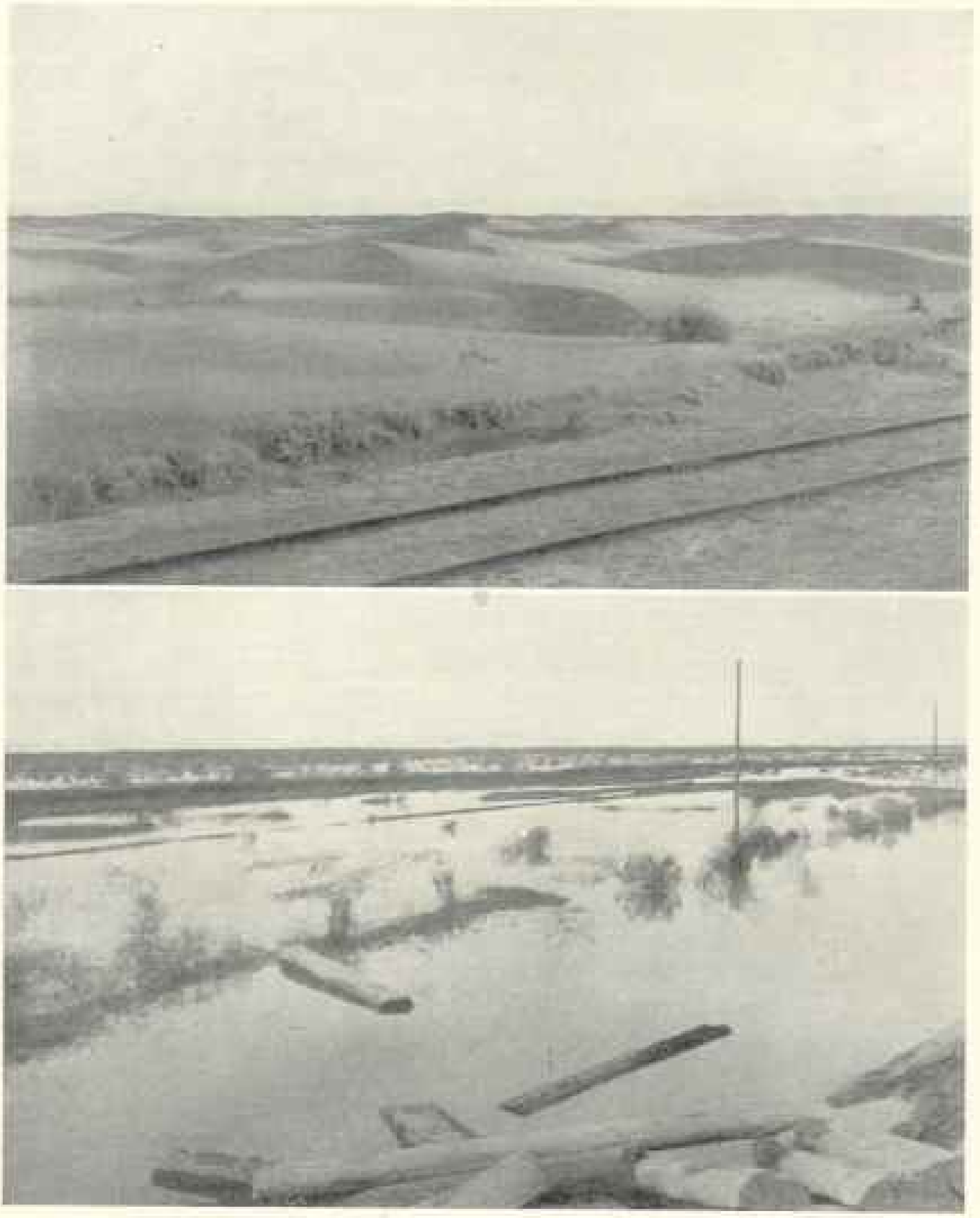
The Kurds, who inhabit the highlands south of Transcaspia are in themselves a forcible reminder of the desert. Three centuries ago in the days of Abbas Shah, the last great king of Persia, the Tartars,



A SAMPLE OF THE MOUNTAINOUS SOUTHERN BORDER OF TRANSCASPIA, SHOWING THE SCANTY VEGETATION AND THE STERILE NATURE OF THE MOUNTAINS

TURKOMAN TENTS ON THE EDGE OF THE TRANSCASPIAN DESERT

who preceded their Turkoman cousins in Transcaspia, seem to have found life unusually hard among the waterless, grassless pastures of sand and gravel. At any rate, they raided the gentle, courteous Persians with unendurable ferocity. On the western borders of his realm lived another race of plunderers, the Kurds, and it occurred to Abbas Shah that the one race might be pitted against the other. Accordingly he transported some 100,000 Kurds to the mountains of Khorasan



SCENES ALONG THE TRANSCASPIAN RAILROAD IN THE MIDST OF THE DESERT

Great fields of sand such as this often lie within only a few miles of scenes of occasional floods like that shown in the second picture. In the sandy places much difficulty is experienced in keeping the sand from drifting over the tracks and preventing the running of trains.

During the floods of May the railroad often suffers severely, sections many miles in length being sometimes washed away.

south of Transcaspia. For a time they put a stop to the raids of the warriors of the desert, but not permanently, perhaps because among the mountains life was easier than in the desert, and there was consequently less temptation to commit robbery when a dry season or swarms of locusts ruined the scanty crops and pasturage.

The Tartars and their Turkoman successors did not often rob the Kurds, for that was dangerous, but until the coming

of the Russians less than a generation ago, their dearest delight was long, hard rides of 80 or 100 miles in a single day on slave-taking raids among the timid Persians. No pity was shown to the poor captives; with chained hands and blistered feet, stumbling and faint, they were driven hundreds of miles at the point of the spear to be finally sold in the slave markets of the rich oases of Bokhara and Khiva.

Far in the interior of eastern Persia, beyond the mountain home of the transported Kurds, the traveler is often surprised by being addressed by native Persians in Turki, the language of the Turkomans, as the writer discovered during a journey which succeeded the one here described. Time and again they tell the same tale: "Years ago in my boyhood I was working in the fields toward sunset, when some one in the watch tower shouted, 'The Turkomans, the Turkomans.' We dropped our work and ran for shelter, but the Turkomans caught us. Six men they killed that day, and fifteen of us they drove to Khiva. There we lived and worked for hard masters twelve years until the Russians came and freed us. God bless the Russians. The Turkomans are fiends."

In spite of their cruel raids the Turkomans are admirable people—brave, generous, and honest, faithful and industrious, and possessing that greatest of virtues, profound respect for women. At least such was the case till recently, although of late contact with Russian civilization is beginning to have the same sad effect which contact with American civilization has had upon the Indians.

A RIDE INTO THE DESERT

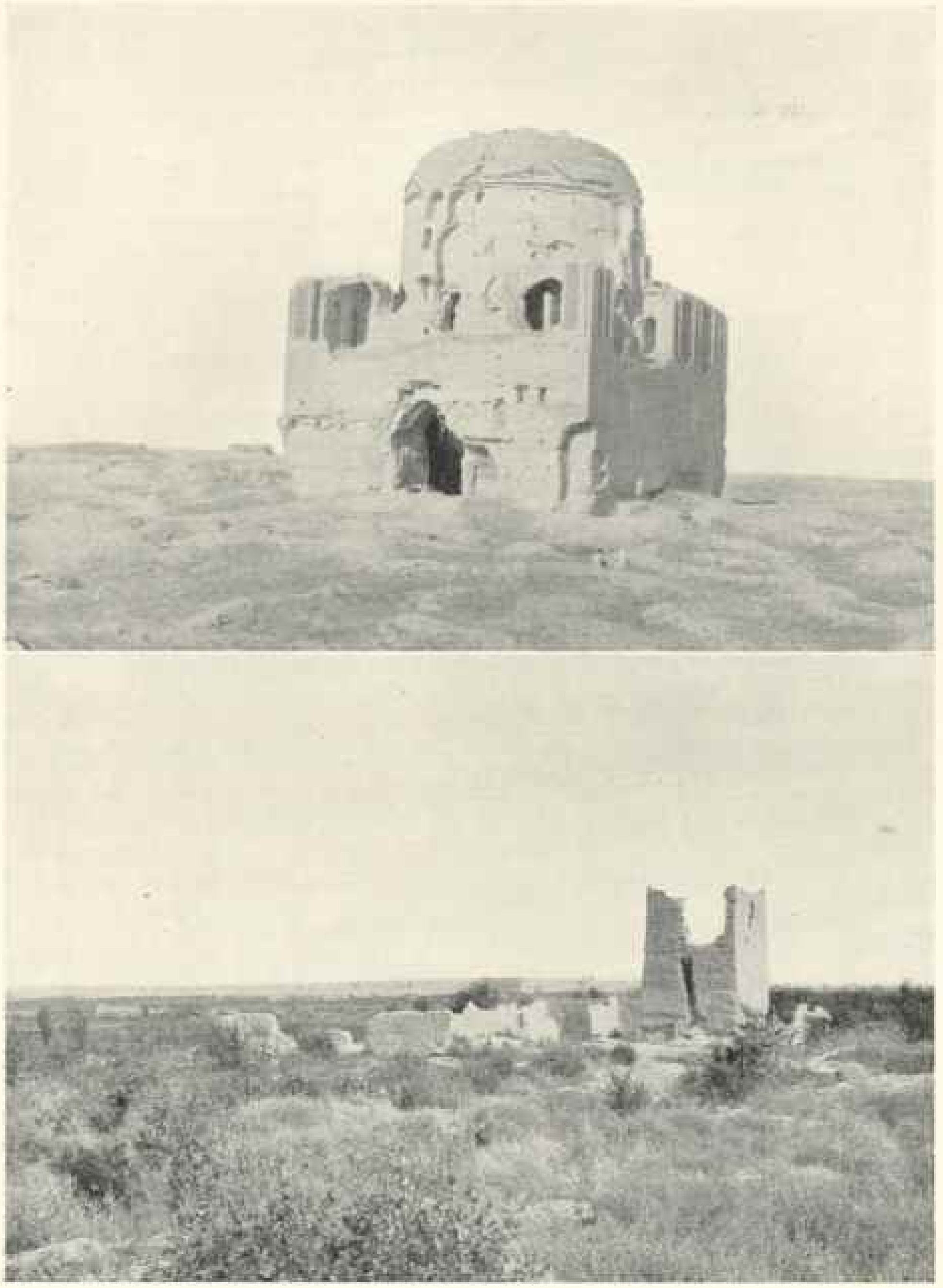
A week's ride out into the sand north of Merv at the end of June gave opportunity to see how friendly the Turkomans are and how terrible is their desert. At first our way led through the unkempt fringe of brown stubble and weed-bordered ditches which surrounds every oasis; then came stretches of clayey plain with just a trace of grass; and finally the sand itself, a vast undulating expanse of dunes, indescribably graceful in their smooth crescentic curves, and strangely beautiful in tint and shading during the cool sunrise hours when the long shadows bring out every slightest hollow or ripple.

As the midsummer sun rises higher the landscape flattens and assumes a garish tint of yellowish gray, inexpressibly wearisome. Strange mirages torment the vision, but never are really deceitful—perchance a group of tents beside a pool of sparkling blue water, or a string of camels pacing slowly along above the horizon in the lower portion of the sky with heads to earth and feet to the unsubstantial floor of heaven.

"By Allah!" remarked the guide on the first day of our journey, "I wish I had brought a thicker robe. I had no idea it would be so hot. The sun beats right through this thin thing, and only the grace of Allah keeps me from being burned to a cinder."

During the heat of the day we rested for two or three hours; that is, we lay down on the burning sand in the shade of a bit of cloth or of our horses—thin, patient animals—and wrote up notes, the bane of the explorer's life, or tried to sleep and forget the heat. The end of the noon siesta was always the worst part of the day. We fairly staggered when we rose to mount our horses; and the still, suffocating heat made us clutch at the saddles to keep from swaying and falling as the dispirited creatures plodded heavily on. Soon, however, a little breeze arose regularly, the horses began to step more lightly, the shadows lengthened, and the world grew interesting.

By sunset we had reached a group of tents, a well, some tamarisk bushes, and flocks of bleating sheep, with here and there a camel from whose gaunt leather sides a few handfuls of last winter's coat of hair still clung. Friendly Turkomans took our horses and gave us cool drafts of the acrid sour milk, which all men love in the desert. In the cool of the evening we sat and talked with our hosts while waiting for dinner of curdled milk, coarse wheaten bread, and the flesh of a young lamb pulled to pieces with the fingers.



RUIN OF AN OLD MOSQUE IN THE LOWER PORTION OF THE MERV OASIS WHERE CULTIVATION HAS NOW BEEN GIVEN UP

RUINS IN THE UPPER PORTION OF THE MERV OASIS WHERE CULTIVATION IS STILL CARRIED ON

In the background may be seen the mud walls of the last of the great cities of Merv

When conversation at length gave place to idle reverie we went to sleep in the open air, regretting the pleasant weariness which made it impossible to remain awake in order to watch the surpassing beauty of the flawless sky and feel the caress of the gentle breeze of the desert.

The purpose of our ride into the desert was the examination of numerous great mounds from 30 to 80 feet high and from 100 to 600 feet in diameter, which are located outside the oasis of Merv. Here in ancient days, when the water supply was greater than it now is, the chief men of the land appear to have lived, raised above the heat of the plain and protected by moats and walls, while around them dwelt the humble peasants whose mud houses have now crumbled into scarcely perceptible heaps covered with countless potsherds. Elsewhere whole villages seem to have been built upon mounds, as they are today in eastern Persia in places of especial danger.

The Turkomans were puzzled when they saw a stranger riding from ruin to ruin, writing, photographing, measuring. "Have you heard what the stranger is doing?" they said to one another, according to the report of the guide. "You know he comes from the west, so he says, from across a lake bigger than the desert. Now these old mounds were built long ago by the Giants whom our ancestors, blessed of Allah, drove far away into the western mountains. There some of the infidels still live. The Americans are infidels. It must be that the Giants are their ancestors, and this man has come here to see where his ancestors lived."

Another matter which puzzled the Turkomans was the fact that I wrote a great deal on horseback. The guide told of their speculations. "It must be," he reported them as saying, "that this is a very religious man. He knows the Koran, or his holy book, whatever it may be, by heart, and as he rides along he writes it down for pleasure."

The means of supporting life in Transcaspia are much more abundant in the oases than elsewhere, but even there they are very precarious. During April and May, 1903, the camp of the Pumpelly expedition was pitched at Anau, a small oasis near Askhabad, the Transcaspian capital. There, with the aid of about 120 Turkomans, we excavated two mounds, the remains of a village of extreme antiquity, founded in the days when the camel, sheep, and pig were still undomesticated and were hunted by the villagers who later tamed them, apparently in the very village into the ruins of which we dug.

A PLAGUE OF LOCUSTS

One day in April a spirit of unrest appeared among our Turkoman workmen, for a whisper went abroad that this was to be a year of grasshoppers. The rumor was only too true, for before many days the green grass and the fields of tender wheat nearest the mountains were full of round, dark spots no bigger than a dollar, and composed of almost microscopic living creatures.

Day by day the spots grew larger, like the spreading of a plague, at first a foot in diameter, then three feet, and soon ten. Little by little, too, the tiny swarming creatures became visible as individuals—genuine grasshoppers, minute, but appallingly voracious. Here and there a Turkoman could be seen with a spade attempting to cover the plague-spots with earth, but in general the grasshoppers were left unmolested.

The faces of the Turkomans grew graver day by day as the creatures increased in size, and the men stuck to their work of digging more faithfully than before, seeming to feel that they must earn as much as possible to support their families in the hard days to come. There was no complaint, no cursing; they seemed to look upon the myriad-mouthed horde of grasshoppers as an affliction sent by Allah, and not to be opposed by ordinary human means.

At length there came a day when the grasshoppers, now nearly half an inch in length, began to move more widely, and broad patches of sere brown stubble could be seen where they had devastated parts of the wheat fields. About the same

A KURDISH WRESTLING MATCH OUTSIDE A MOUNTAIN VILLAGE

The inhabitants are descended from the Kurds brought by Abbas Shah to oppose the Turkomans

A VILLAGE OF TURKOMANS WHO HAVE GIVEN UP THE NOMADIC LIFE IN LARGE MEASURE

The houses are built entirely of mud, even the domes containing no wood whatever

time a new and most welcome factor entered into the situation; rose starlings, northward bound on their annual migration, appeared upon the scene one morning. A pleasant light came into the faces of the Turkomans as they pointed to the great flocks of rosy-breasted, black-winged birds which circled over the plain in troops like blackbirds in America during the fall of the year. They ate voraciously; and thousands, nay, millions, of the pestiferous insects were devoured in a single day.

On the following morning the number

of starlings had increased, and the third day the swarms of birds almost darkened the sky when, in their frequent flittings, a flock passed overhead. That day the headman of the village asked us for contributions to a fund for getting rid of the grasshoppers.

"These starlings," said he, "are the children of a sacred spring among the Persian mountains two days' journey to the south of here. Wherever the water is, there the birds gather. Allah, the Merciful, has sent many birds to us, but they are not enough. We must do something to get more of them. There is just one way to do it. If we can get some of the water and bring it here, the birds will follow it. So today I am collecting money. Tomorrow, by the grace of Allah, I will send Verdi, the Mullah, our most holy man, to get the water. In his hand he must carry a good present, for the water is of no use unless it is taken from the spring and blessed by the holy sheikhs who guard it from pollution."

Three days later the headman was radiant. "See," said he, "how thick the birds are," and truly they were circling over the wheat fields in extraordinary numbers. "Last night our messenger reached the spring, and already the birds have begun to come. Today he will stay there; then it will take him two days to get back, bringing the vessel of water. Wait till the fourth day from now, the morning after he arrives, and see the multitude of birds."

On the third morning the headman looked old and weary, and had scarcely a word of greeting. The birds were gone; not a solitary starling was to be seen. In the night, silently, swiftly, as they had come, so they went, flying northward according to their wont, in response to the changing seasons. No thought of migrations came to the Turkomans. One thing alone they knew—the birds had gone, the grasshoppers remained, and the crops were doomed to utter ruin. Perhaps a little of the unripe grain could be cut for fodder, but nothing could be saved for food for themselves and their children.

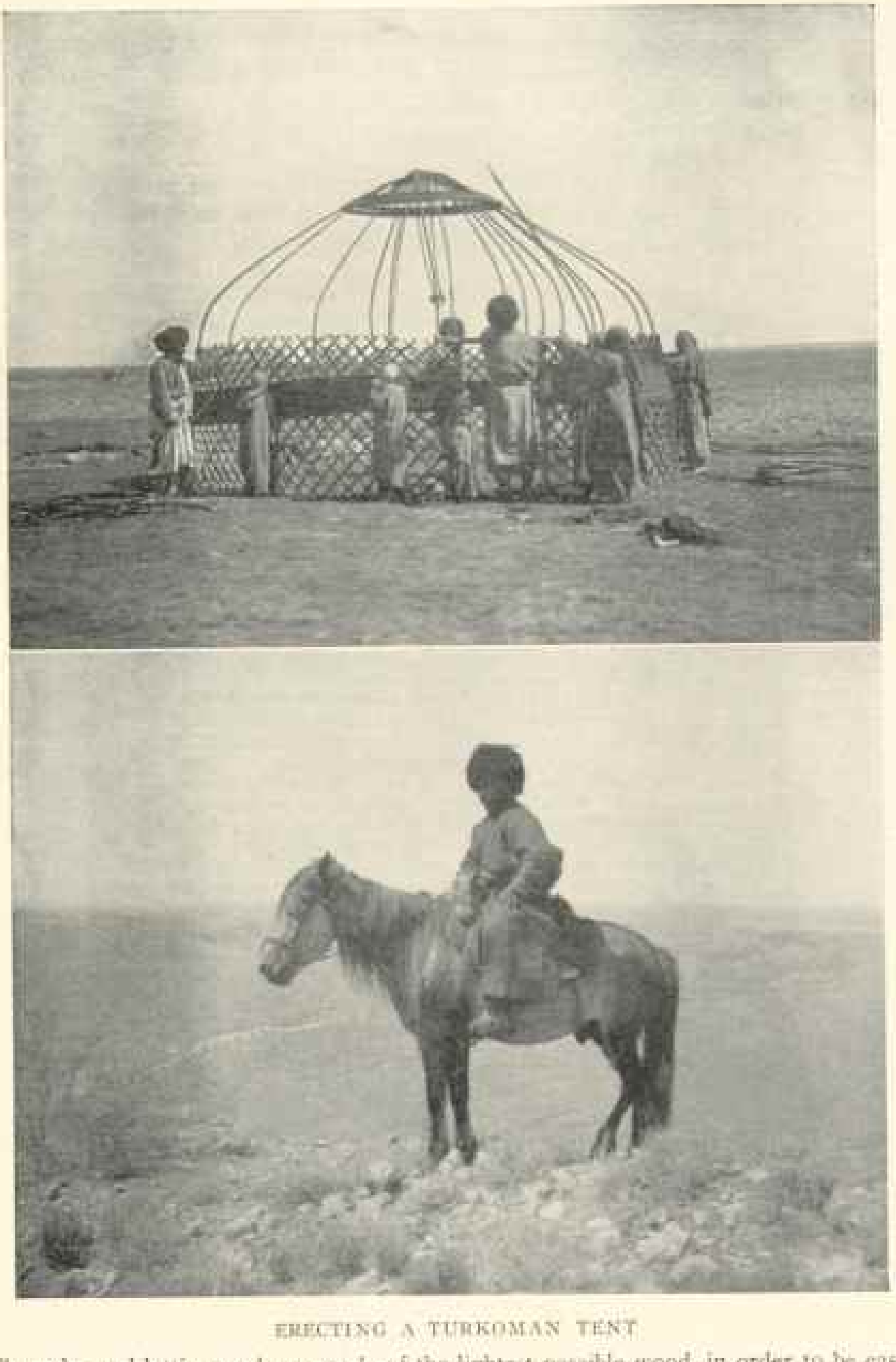
Some one had blundered; perhaps some impious deed had been committed; therefore Allah had refused the further aid of his sacred birds. There was no further talk of a joyful procession to meet the Mullah far from the village and bringing the jar of sacred water home in triumph. The holy man stole into the village dejected and unnoticed, while the villagers thought only of their ruined crops and their families, which would soon be hungry.

THE MARCH OF MILLIONS

The days that followed were like a nightmare. The insects were now full grown, and on a day they all began to move. Northeastward they went toward the desert—slowly, very slowly, but steadily, hopping, hopping, hopping, rarely pausing, never turning to one side. A low rattle filled the air like the steady falling of fine sleet, and everywhere there was a faint, sickening odor. It was impossible to walk without stepping on the creatures.

On the morning when the grasshoppers began to move the writer was at work in a round native tent of felt, with the top, perhaps 30 inches in diameter, open to admit light and air. When the grasshoppers reached the tent not one of them turned aside. Straight up the wall they crawled, and straight across the top until they came to the opening. There they paused a few minutes and then jumped blindly. One after another they landed on the table, which was necessarily placed under the opening for light. Tap, tap, tap, they fell at intervals of a few seconds until it soon became impossible to work. When they righted themselves after falling to the floor, they always turned in the original direction, hopping across the floor, climbed the wall and the inside of the roof of the tent until they reached the opening at the apex, and were able to continue their interrupted journey.

Near our tents flowed a brook about three feet wide, which was used for irrigation. When the grasshoppers reached it they paused a moment, and then, urged



ERECTING A TURKOMAN TENT

The poles and lattice-work are made of the lightest possible wood, in order to be easily transported

A TURKOMAN READY FOR THE TRAIL

Before the coming of the Russians, Turkomans mounted and equipped just as is this man often rode 80 or 100 miles in a day on slave-taking raids into Persia

KURDISH WOMEN AND CHILDREN AMONG THE MOUNTAINS ON THE NORTHERN FRONTIER OF PERSIA CLOSE TO TRANSCASPIA

A GROUP OF TURKOMANS

Notice the various types of sheepskin cap and the coat of sheepskin which the right-hand man wears even in summer.

by the crowds coming up from behind, jumped into the water and struggled for the other bank. The majority reached it after being carried down a few hundred feet. On the bank they rested in swarms until their wings were dry, and then hopped steadily on.

Many of the weaker insects, however, never got across the stream alive. They were carried down to the point where the brook was distributed over the fields, and there were deposited in great heaps, which soon began to emit a most noisome odor.

OUR EXCAVATIONS CHOKED BY THE INSECTS

The coming of the grasshoppers had a disastrous effect upon our work of excavation. The insects jumped into the diggings in hordes, falling over the perpendicular edges in a steady stream. Crossing the bottom of the excavations in their usual persistent manner, they tried again and again to climb the steep walls, only to grow weary before reaching the top, and so to fall back once more. Thus they piled up to a depth of a foot or two in every excavation. At first we tried to have them shoveled out, but the accumulation of a single night could scarcely be removed in a day. As most of our work was finished, we merely shoveled earth into the pits to cover the loathsome, dying mass of insects. Once in the bottom of a deep, round well sunk in exploring the ruins, we found a large snake buried in a seething, squirming, ever-deepening mass of living death from which his writhing head alone protruded.

There was one excavation which we determined not to abandon at once. As quickly as possible, which was not till the end of the second day, we procured cheese-cloth and stretched it across the top of the excavation. The grasshoppers crossed by legions, their shadows darkening the cloth, and the sound of their hopping was like the patter of heavy rain on a roof.

The work of cleaning out grasshoppers was intensely disagreeable. Even in the upper portions of the excavation the insects swarmed everywhere, and it was continually necessary to brush the sticky creatures from hands, arms, head, and neck.

The Turkoman laborers were clad in baggy white cotton trousers of the common full Turkish type, worn without underclothes. To stand in such garments amid the grasshoppers and shovel them into buckets or bags while the creatures crawled everywhere must have been almost unendurable. Every few minutes the men stopped to remove the clinging insects from inside their clothes. Nevertheless not only did those who were at work keep on faithfully, but scores of others, seeing that the grasshoppers had consumed their sustenance for the year, pleaded piteously for an opportunity to earn something to support their wives and children.

The visitation came to an end at length, and the grasshoppers passed on into the desert. The land was left reaped—consumed, as it were, by fire. There was a strange stillness in the air, and though our tents were pitched in what had been the fruitful grain fields of an oasis, we seemed to be in the midst of the great desert.

When the locusts were gone and the Turkomans were left idle, discouraged, and moody, it was easy to see how the precarious conditions of Turkoman life have contributed to the formation of the warlike, plundering character for which the people of the desert are noted. Little groups of malcontents gathered here and there and began to talk against the Russian government. "How shall we live?" they said. "We cannot plunder our neighbors, as our fathers did, for the Great White King has his soldiers everywhere. We have no flocks, for since the Russians persuaded us to settle in the oases permanently, we have kept only a few sheep. If we and our little ones starve, it is the fault of the Russians. Give us the old free days again."

Devoid of genuine foundation as such mutterings may be, they nevertheless cannot be lightly disregarded. Probably the Turkomans are as comfortable today as in the past, and possibly more so, for the Russian rule is far from oppressive; but such a thought is remote from the minds of the Turkomans. Now, as in the past, when pitiless nature causes them to suffer, they strive to fix the blame upon man, and to retrieve their fortunes by inflicting pain upon those whom they deem their enemies. Only the conquest of the desert can free them from the constantly recurring menace of hunger.

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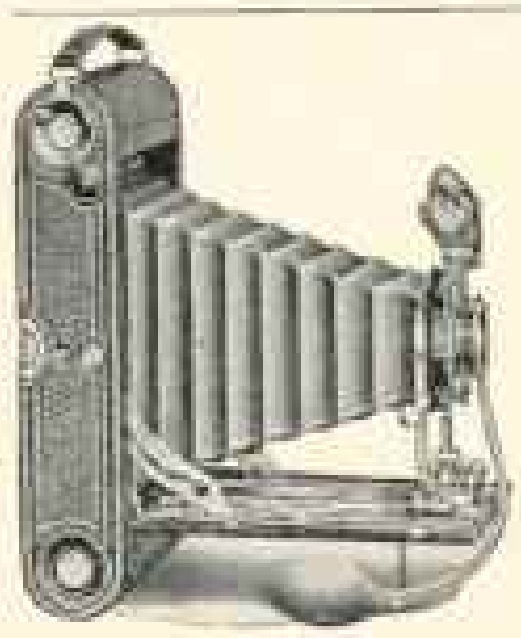

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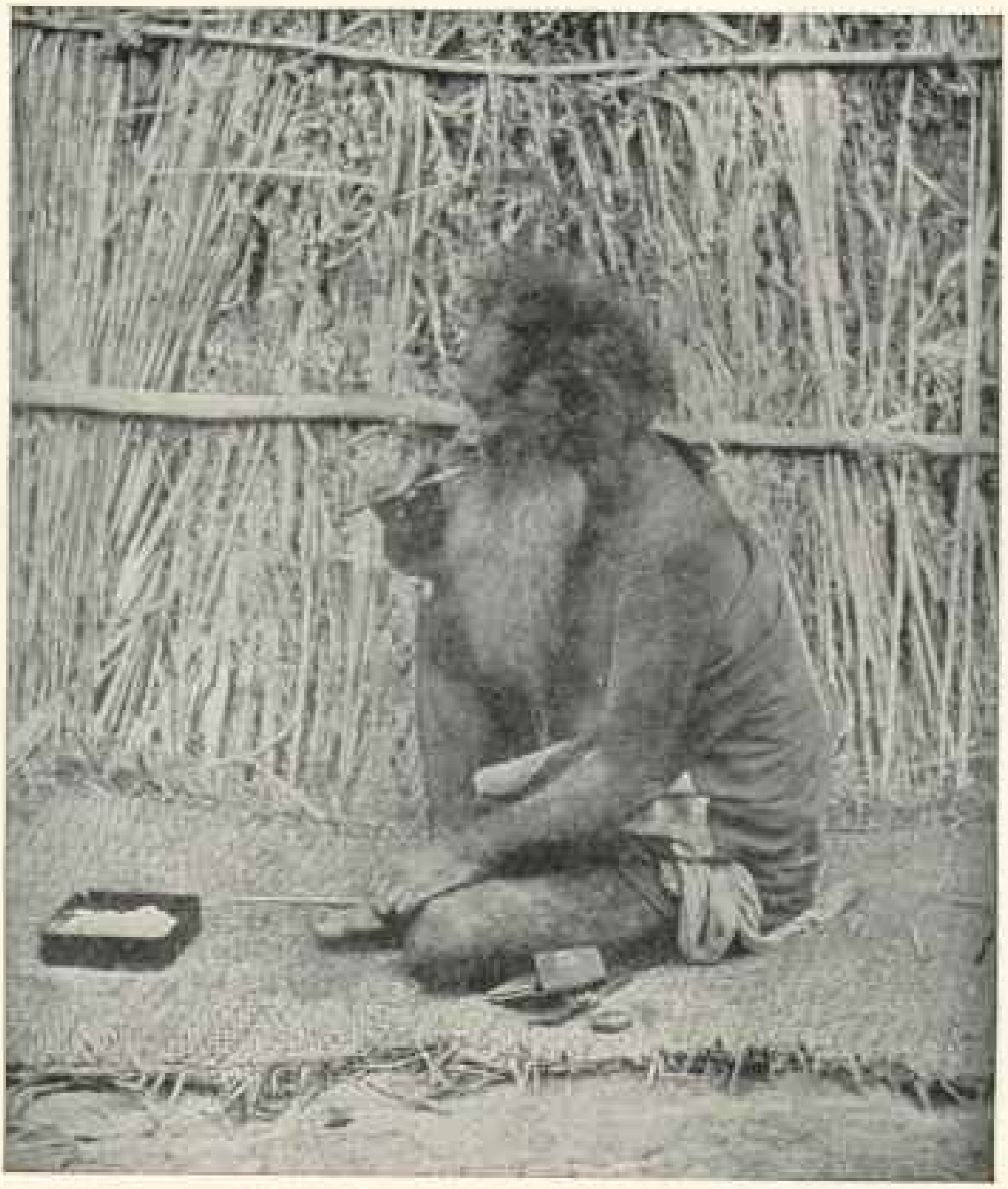

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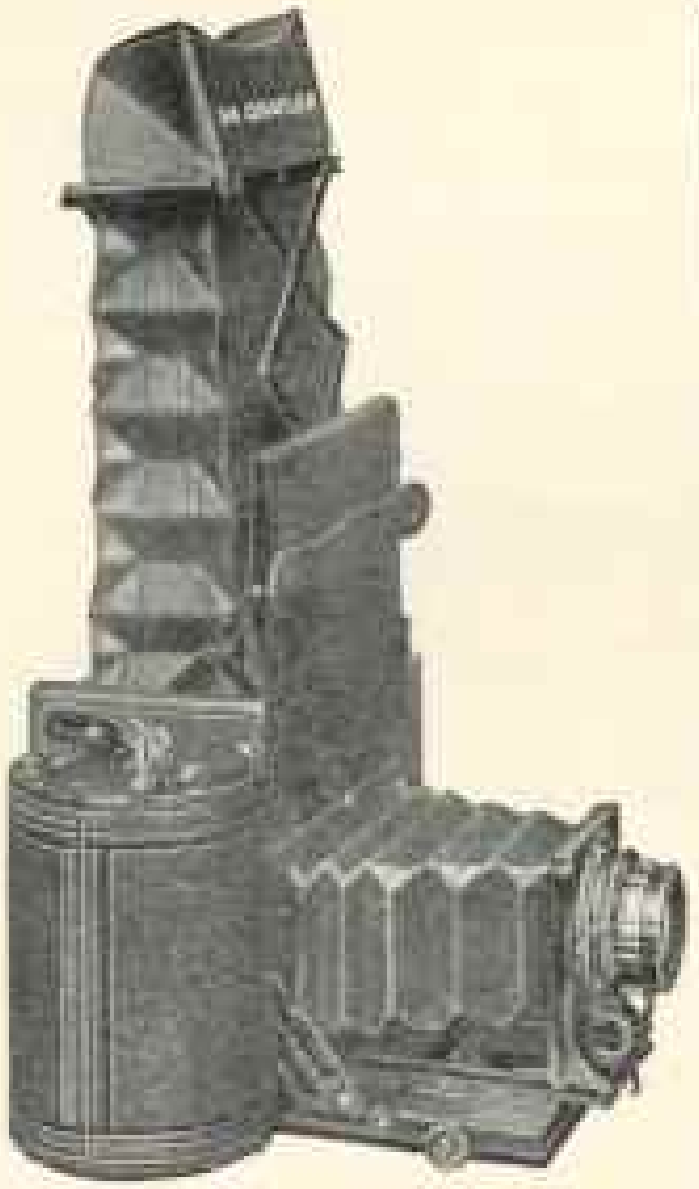

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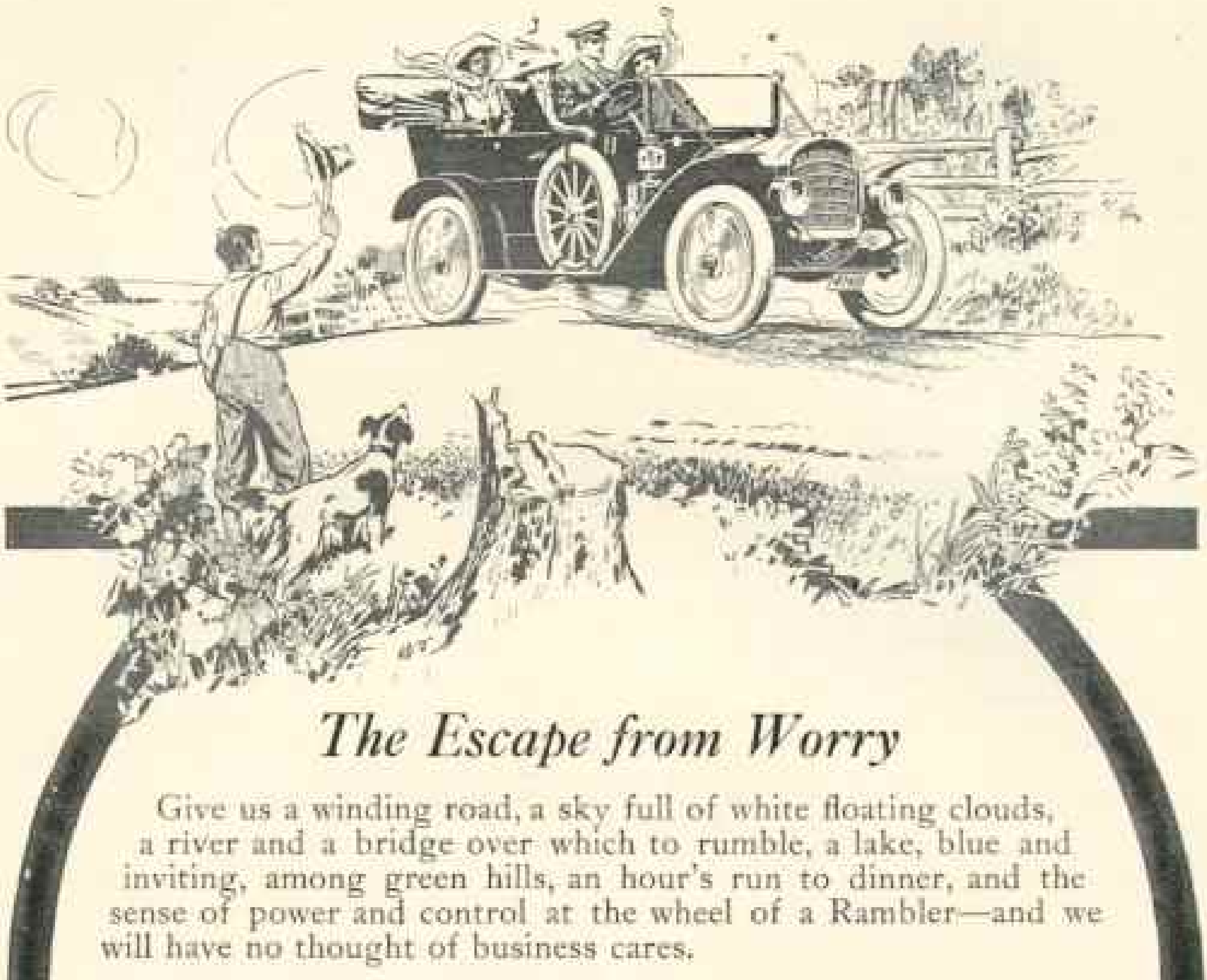

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