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GILBERT H. GROSVENOR, EDITOR

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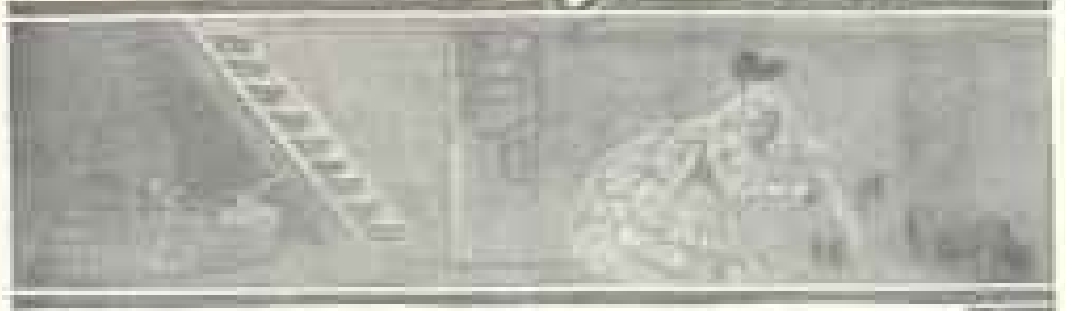

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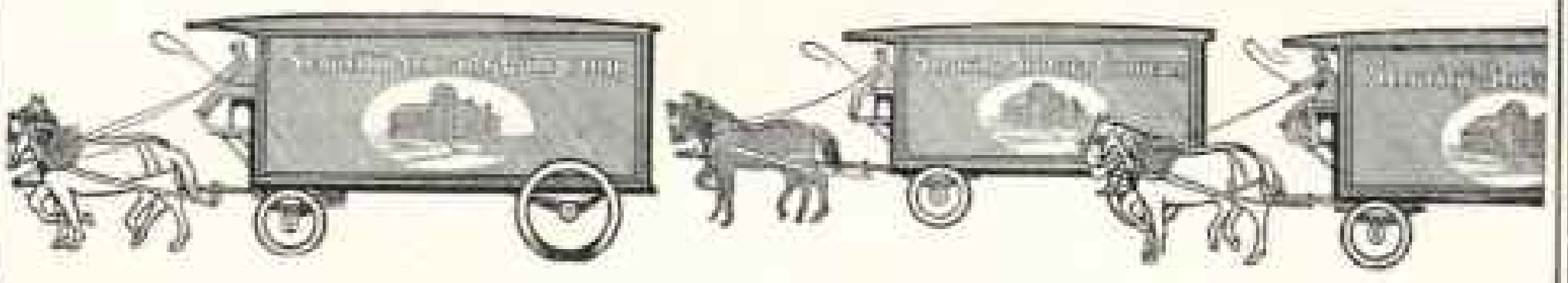

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VOL. XXI, NO. 5 WASHINGTON MAY, 1910

THE NATIONAL GEOGRAPHIC MAGAZINE

# THE HOUSE-FLY

BY N. A. COBB

*With photographs made specially for the National Geographic Magazine by N. A. Cobb*

THE fly referred to in these pages is the one most commonly found in our houses—the *Musca domestica* of Linnæus. At most seasons nine flies out of ten found in houses are of this kind. In some of the paragraphs, however, the statements are inferences fully justified by experiments with very similar species.

Speaking broadly, man has made the house-fly; it has developed along with the human dwelling. If we had no closed-in dwelling places it is doubtful if the house-fly as at present constituted could continue to exist. It thrives simply because we afford it food, protection, and breeding places.

It is a comforting thought that just as we have made the house-fly, so we can unmake it, but it is discouraging to think how long it will take us at the present rate.

Following man into all but the coldest climates, this fly is found in nearly all parts of the world, and its name in many languages denotes the fact that it is an indoor or household insect. In the past it has been looked upon with indifference, or, at most, struck at with objurgation when too familiar. It figures in fable and poetry, not without some degree of praise occasionally. Its reputation as a harmless, innocent, lively, and interesting creature will die hard.

In reality it is one of our worst enemies. Its relations to human health and sanitation are most important, and yet for years all efforts to bring the facts properly to the attention of municipal authorities met with indifference or ridicule. We had become so accustomed to put up with the losses of life and property directly traceable to flies that we no longer had the capacity to grasp the significance of very simple facts—facts demonstrable by almost any one at the expense of a few minutes, or at most a few hours, of observation or experiment. Again, it was so easy to turn the whole matter into what passed for a joke that the gravity of the subject was lost sight of.

Latterly, however, a gratifying change is taking place in public opinion, due no doubt to what has been discovered about mosquitoes. It has been shown that these latter insects are one of the main factors in the production of diseases that frequently have claimed their victims by hundreds, or even thousands, under most

tragic circumstances. No mosquitoes, no malaria. No mosquitoes, no yellow fever.

In sanitary matters the tragedy that appeals to us strongly enough to make us do something worth while must be a tragedy quick in its action and very awful in its results. One is almost tempted to say that if only a disease is insiduous enough it may proceed without opposition, even though we know all about its cause and the means for its prevention. How otherwise can we explain the prevalence of consumption? One hundred yellow-fever victims per week move us more than the regular mortality from consumption that same week, though the latter may be a hundred times the greater.

If consumption laid hold of its victims suddenly and took them off in a few days, what a difference it would make in our attitude toward it! And yet it does far worse. It lingers and tortures its victim, often for years, making life a burden to him and to his friends, a continual source of care and expense, a continual source of sorrow, and, worst of all, a continual menace to all who come in contact with him or his belongings. It does worse, while we too often continue to tread the old beaten track, more or less apathetic, failing to do what we know we ought to do.

However interesting and horrible this psychological aspect of consumption may be, I wish at the present time to do no more than make it illustrate the attitude we have assumed toward flies, which is hardly less interesting and deplorable.

But people are beginning to ask, if the mosquito is so important a factor in human diseases, whether the people who for a generation or more have been calling attention to the house-fly as a distributor of disease may not have a case worthy of attention. The result has been a slow and partial awakening, so that we now have municipalities with sufficient enlightenment and courage to begin the fight against flies. I say courage very advisedly, because it takes courage of an uncommon sort, in matters of this kind, to act up to convictions we know are not shared by the majority of our neighbors. Fighting public indifference is a thankless task, especially when it is accompanied by an undercurrent of half-conscious guilt.

We have been slow to recognize the important part insects play in the spread of disease, because it is difficult to catch them in the act. The insects themselves are small and elusive, and the disease germs even more so. It is a rare occurrence for us to know at what time, or precisely in what manner, we have become infected with the germs of disease. It is almost always a matter of guesswork. If, therefore, any one is skeptical about the dangerousness of flies, and asks to be shown a case in which it can be proved that flies have infected a human being, he sets a difficult task. There is no difficulty whatever in causing flies to come into contact with virulent germs, nor is there any difficulty in showing that they can transfer these germs to healthy animals, and that the animals in consequence become diseased. This has been done and constitutes one of the main proofs of the dangerousness of flies.

There is plenty of evidence that flies, having come into contact with diseased material, have afterwards by their contact with persons or their food *probably* caused the disease that followed. This, however, does not constitute that rigid and satisfactory proof we would prefer. Nevertheless, such histories can now be assembled in numbers that amount to the strongest kind of circumstantial evidence. There are a number of diseases whose annual increase and decrease harmonize with the abundance of flies in precisely the way they would do if flies were the inoculating agency. The circumstances fully warrant us in accusing the fly of transferring almost any infectious disease that occurs in fly-time.

The fly's power to spread disease is a direct function of its powers of locomotion. It can fly considerable distances at a high rate of speed. It is quickly carried long distances by trains, boats, teams, animals, and man.

It is possible to get a good idea of a fly's rate of flight in a number of ways.

Flies come to ships newly arrived in port across considerable stretches of water. This we know, because a few hours earlier there were no flies on the ship. No communication has been had with land. The flies must have come on their own wings. Occasionally we see a fly follow a team or animal, easily keeping up a good pace. The wing muscles of a fly when weighed are found heavier in proportion than those of any bird so far examined. It is difficult to tire a fly out. Test this by trying to keep one constantly on the wing in a room and you will soon find you have no easy task. All this shows the fly to be no mean navigator of the air.

If such an active and adventurous insect as the fly carries disease germs it will quickly spread them far and wide.

Most of our diseases are caused by invisible germs that lodge and grow in our bodies, destroying our tissues or poisoning us with their excreta. These germs may be brought to us from some sick person by whatever is large enough to carry them and has the opportunity. Combine this fact with what every one knows about flies, and we see at once the tremendous importance of flies as carriers of human disease germs.

The result of this simple piece of reasoning is so startling that it is often sidetracked by its own importance. It looks so incredible that we hesitate, distrusting our own logic. It seems incredible that men have gone on doing as they have done, and as they are still doing, if the facts are as they seem. The consequences of our reasoning seem so tremendous we fear there must have been a mistake somewhere. And so we dismiss the idea.

One way to disturb this false security is to interest people in the habits and structure of flies. The more we know about flies the more clear it will become that they are among our worst enemies.

The photographs illustrating this article have been designed with this end in view. Take for instance the view of the fly resting on glass and viewed from below. Look at the feet, and observe that each of them has two claws and two light-colored pads. The fly clings to rough surfaces by means of the claws, and to smooth surfaces by a combined action of the claws and pads. The fly's pads are covered with thousands of minute short hairs, sticky at the end. There is no suction—merely adhesion.

The action of a fly's pads may be illustrated by means of a piece of sticking plaster and a few threads and small weights. Take a piece of sticking plaster half an inch wide and sew through it some short pieces of thread at intervals of half an inch, and knot the threads on the sticky side so that they cannot pull through. Stick the plaster to a dinner plate or other smooth object and it will be found that if a small weight is attached to each thread the plaster will sustain in this way a considerable weight—that is to say, the sum of all the small weights is considerable.

Now, remove the weights and attach all of them to one or two of the threads at one end. The plaster will promptly be torn loose. Acting on a portion of the plaster at a time, the weights can accomplish what they cannot accomplish when distributed along the whole surface of the plaster.

This experiment illustrates roughly how the fly uses and controls its feet. Of course, in my illustration you can see just how the weights release the plaster from end to end. It is very difficult to make this observation on a fly, because the fly's pad is so small, and more particularly because the whole operation takes place in something like the fiftieth part of a second.

Wonderful as the fly's pads are, they have their disadvantages, for stickiness and locomotion are not always strictly compatible. Humorous use is made of this idea in Uncle Remus tales, "The Tar Baby" and "The Outrageous Prank of Brer Rabbit." In one of these Brer Rabbit takes advantage of the stickiness, not only of his feet, but the rest of his anatomy, to strike terror into the souls of the other animals. Raiding Brer Bar's pantry, he accidentally breaks the

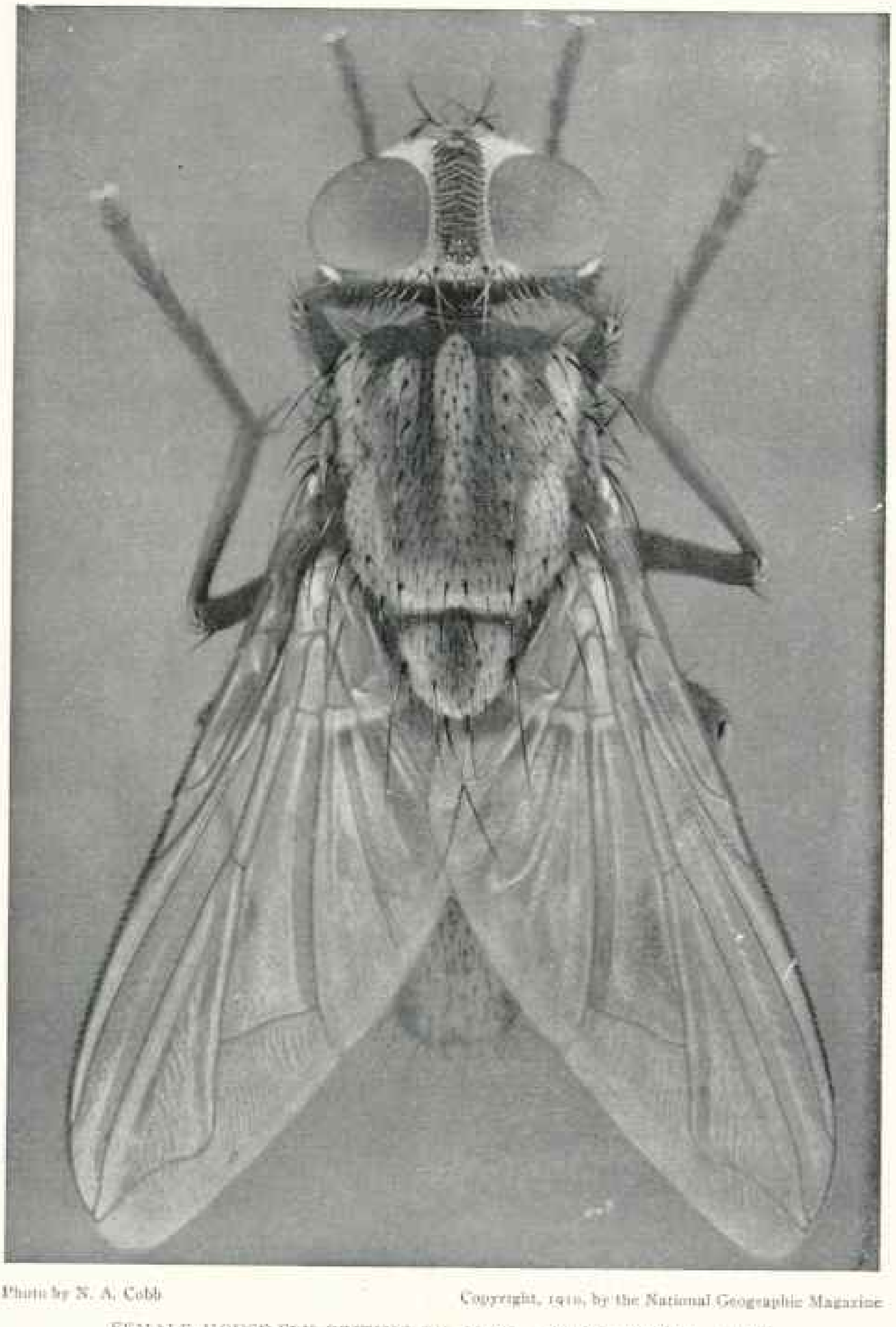


Photo by N. A. Cobb



FEMALE HOUSE-FLY RESTING ON GLASS AND SEEN FROM ABOVE

The house-fly swallows many kinds of germs and spores, and deposits them all day long at intervals of a few minutes in its excreta, the "fly specks." Those germs and spores pass through the fly in less than an hour, and come out in the fly specks alive and uninjured. Flies spread more germs in this way than in any other. The house-fly sticks close to man and is a dangerous agent in the spread of human diseases. Diseases of animals and plants are spread in the same way. The hairs on the back of a fly are not a haphazard arrangement, but correspond in number and location on all house-flies.

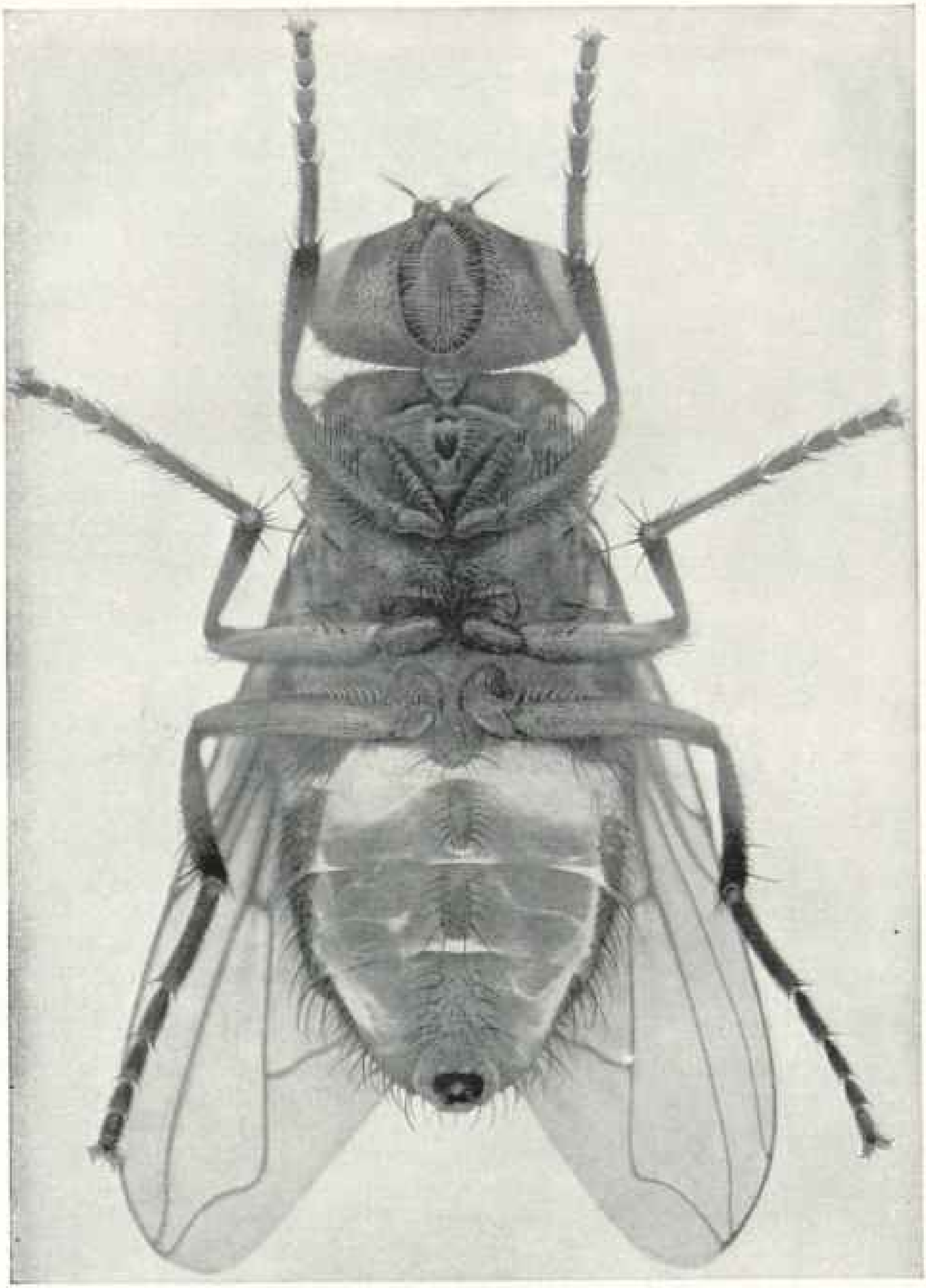


Photo by N. A. Cobb



MALE HOUSE-FLY RESTING ON GLASS AND SEEN FROM BELOW

In addition to two claws, each of the six feet is supplied with two light colored sticky pads. Germs and spores stick to these pads, and are thus carried from place to place with great rapidity, for the fly travels fast and far on its own wings, and on cars, boats, and other moving things. The fly cleans its feet carefully whenever they become contaminated, thus removing many of the germs that would otherwise be spread, but not all.

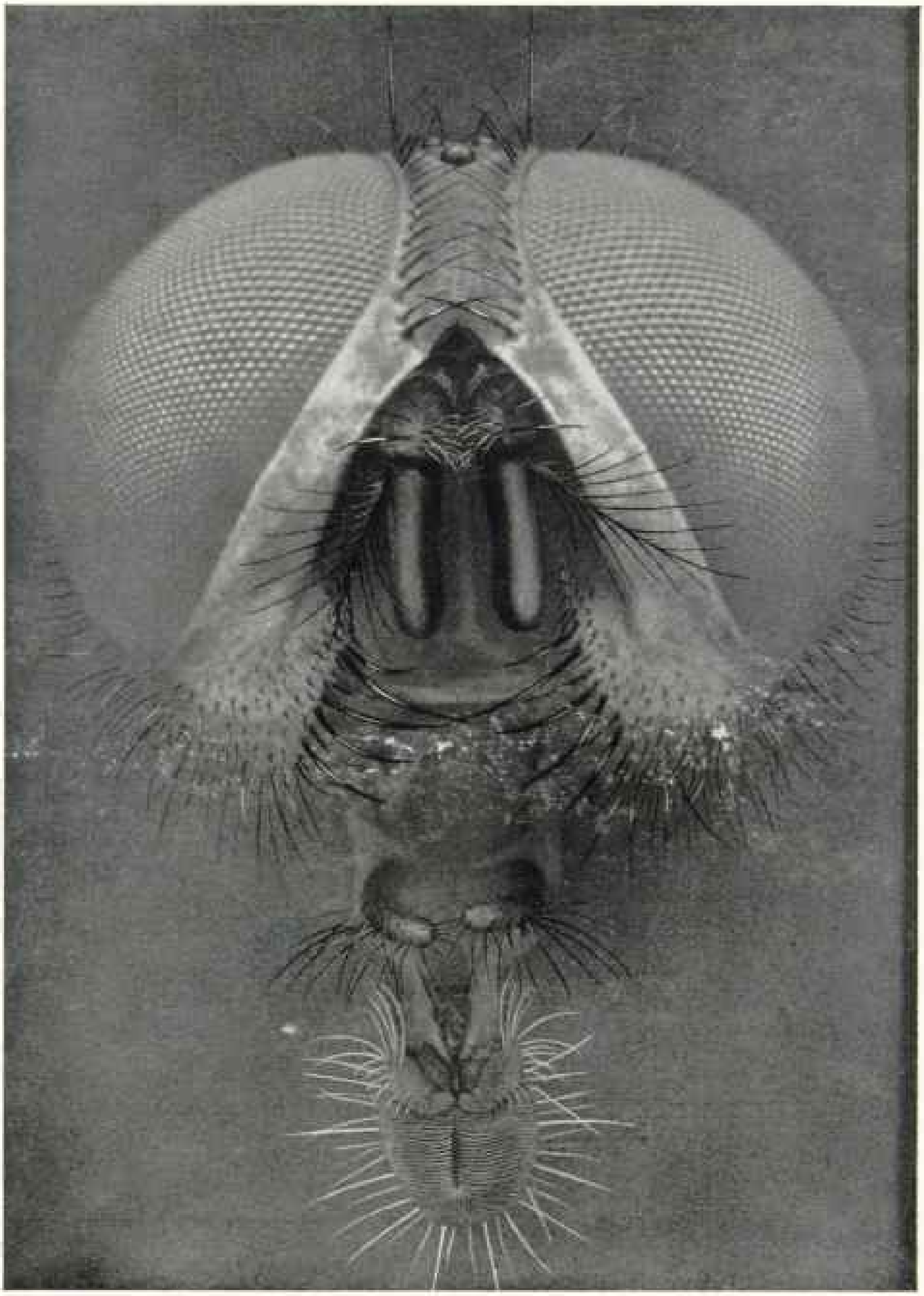


Photo by N. A. Cobb



FRONT VIEW OF THE HEAD OF A HOUSE-FLY

The same head is shown in profile on the opposite page. The fly is one of the most highly organized of insects. The two large areas studded with thousands of facets are the compound eyes. The three simple eyes are seen at the top of the head in the middle. See also top view of the fly. The two large pendant organs with "peacock feathers" on them are the antennæ, or "feelers." A fly can see in all angular directions.

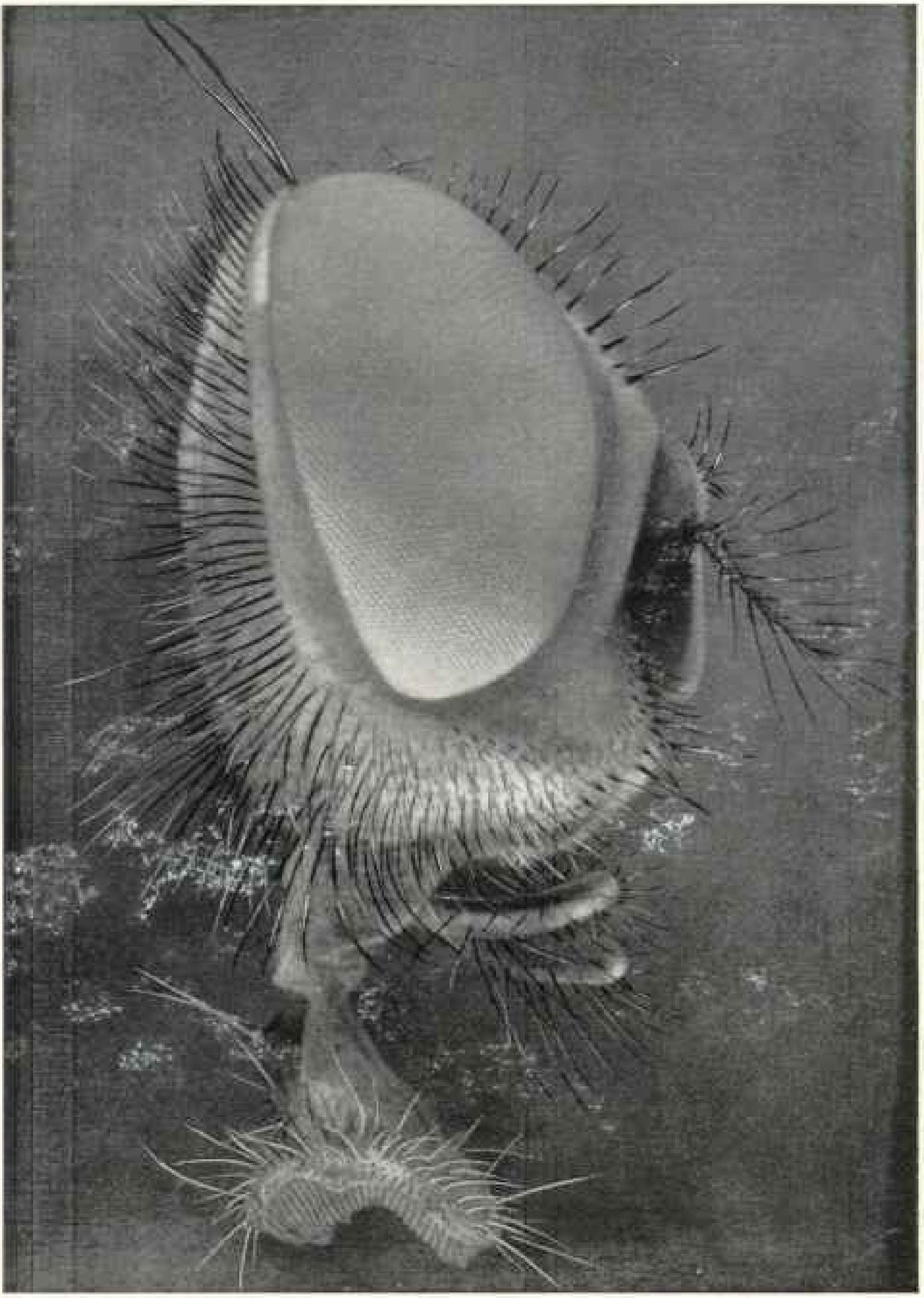


Photo by N. A. Cobb. 

SIDE VIEW OF THE HEAD OF A HOUSE-FLY

The same head is shown front view on the opposite page. The end of the proboscis carries a sieve through which all the food is strained. The meshes of this sieve allow germs and all but the largest spores to pass. The house-fly takes in only liquid food. When the fly eats solid food, it first spues saliva on it so as to dissolve it.

honey jar over himself to such a tune that, as Uncle Remus says, "He wan't jes' bedobble wid it, he was jes' kivered." Brer Rabbit soon discovered that this condition was incompatible with convenient locomotion. Things stuck to his feet in such an unusual way as to suggest to this practical joker what a spectacle he would present if he should roll himself among the sticks and leaves in Brer Bar's yard. Carrying out this idea, Brer Rabbit presents himself to the other animals with the usual side-splitting results.

In the "Tar Baby"—"One day Brer Fox rig up a contraption what he call a tar baby." This sticky puppet placed cunningly in Brer Rabbit's path excites Brer Rabbit's ire, because he "won't say nuffin" in response to Brer Rabbit's overtures. In his efforts to teach him manners Brer Rabbit hits the tar baby, and as the tar baby will not let go, and still persists in "sayin' nuffin," Brer Rabbit hits him with the other hand. This is the beginning of such a tangle between Brer Rabbit and the sticky tar baby that Brer Rabbit is completely entrapped and falls into the hands of Brer Fox.

All his grown-up life the fly has to manage with sticky feet. Imagine our plight if the soles of our feet were sticking plaster, perennially renewing its stickiness! Whoever has experienced the sticky mud of certain regions will recall how the boots ball up and what a conglomeration one drags home from a ramble under such circumstances.

To such inconveniences the fly is constantly subject, and it is this that has bred into him a habit of frequently preening himself, particularly his feet. These are constantly becoming clogged with adhering substances, and this contamination the fly must assiduously remove if his feet are to act properly in supporting him on slippery places. If this contamination is too sticky to rub off the fly laps it off, and it then passes off in his excreta.

Thus it is that all sorts of microscopic particles are moved from place to place on the feet of flies. These particles are rarely of sufficient size to be seen with the unaided eye. Nevertheless, they are constantly present, and the amount of matter thus transferred is relatively considerable on account of the fly's activity. When flies have access to diseased or rotten or foul matter the transfers thus effected are dangerous. All sorts of minute organisms are spread in this way, including diseases of man, animals, and plants. It is impossible to go into details in this place, but it is only right to say that the imagination completely fails to grasp the far-reaching consequences of this transfer of germs and spores on the feet of flies.

Unfortunately, this is not the worst of it. The transfer of germs by means of the fly's feet is a small matter beside that which takes place through its excreta.

The following is the defecation record of a well-fed fly (the fly was fed at 9:23 a. m.):

| *Interval times* | *Notes on spores in the excreta* |
|---|---|
| ---- 9.35 | |
| 8.... 9.43 | |
| 6.... 9.49 | Spores in excreta seen to pass. |
| 3.... 9.52 | |
| 6.... 9.58 | |
| 1.... 9.59 | Spores. |
| 2.... 10.01 | Spores. |
| 4.... 10.05 | |
| 5.... 10.10 | |
| 3.... 10.13 | |
| 3.... 10.16 | |
| 4.... 10.20 | |
| 3.... 10.23 | |
| 3.... 10.26 | Spores. |
| 2.... 10.28 | Found one. |
| 1.... 10.29 | |
| 1.... 10.30 | Spores. |
| 13.... 10.43 | Very many spores. |
| 1.... 10.44 | |
| 3.... 10.47 | Found one. |
| 15.... 11.02 | Very many spores. |
| 9.... 11.11 | |
| 9.... 11.20 | Very many spores. |
| 6.... 11.26 | |

The time lapsing between the movements varied from 1 to 15 minutes and averaged about 4½ minutes.

No wonder that fly specks are common if the fly evacuates once in five minutes all day long! The number of specks in even the best-kept houses is simply appalling. I might be accused of sensationalism if I should publish records in

my possession gained through the use of a little counter which can be used to estimate the number of fly specks on a given area.

We men-folks are much less observant in this matter than our better halves, but even a man, after a short period of training, finds no difficulty in astonishing himself at the abundance of fly specks in situations that show them off to advantage; for instance, on ordinary window panes. No housewife needs to be told that one of the main reasons for cleaning windows is the presence of fly dirt, but even she will, I think, be surprised at the results of actual counts. The fact is we ordinarily notice only the largest and the darkest. The great majority escape notice because they are small or transparent and colorless. Window panes with from 1,000 to 10,000 fly specks per square foot are not at all uncommon. From 10 to 50 per square foot is a common number in what are considered well-kept homes. Spotless glass is rare, except on house-cleaning day.

This is in situations where the dirt can be readily seen. On neutral tinted objects, less often cleaned, fly specks occur in millions. On wall-paper, chandeliers, outside veranda posts, on cornices, ceilings, and window blinds the numbers are almost past computation.

The amount of this fecal matter deposited by flies is of course in proportion to the number of flies. When the flies have access to diseased or rotten or foul matter these feces are dangerous. If there is any infectious or contagious disease in your neighborhood in fly-time, beware of flies!

Flies swallow the germs of typhoid in countless millions while feeding on the excreta of typhoid patients. As a result they spread a thousand times more typhoid germs in their excreta than on their feet. My own experiments have shown that the spores of a variety of diseases pass through various species of flies without appreciable change, and that without doubt certain diseases produce odors that entice flies to swallow the spores so that these latter may be more efficiently spread abroad. The germs are just as virulent after passing through the fly as before.

My experiments show that the greatest variety of spores and microbes can, and normally do, pass through flies and germinate afterwards. In fact, the most delicate spores are little if any injured by the fly's digestion. Among those tried are the spores of some of our commonest and most destructive moulds and spores of nearly all the diseases of sugar-cane and those of numerous other plants. In short, it rarely happens that spores of any kind swallowed by a well-fed fly do not appear in an hour or so in the feces of the fly in an uninjured condition, such that they germinate readily afterward. Finally, as might be expected, examination of the excreta of flies captured in the open shows it to contain a great variety of spores in a living condition.

I find the digestion of the adult fly to consist in the absorption of those substances readily soluble in its weak digestive fluids and the evacuation of all others. In accordance with this principle the fly is an enormous feeder. At a single meal it frequently swallows nearly half its own weight of food. In the course of a day a well-fed fly probably as a rule swallows more than its own weight of food.

During the summer the fly population of any large town must number millions. Comparing this fact with the food habits of the fly, we see at once the importance of the rôle they play in our affairs, more particularly in view of their disease-carrying powers. I venture to think the most powerful imagination fails to take in the vast multitude of conclusions that follow from these simple lines of reasoning.

What has been said is an attempt to show that the house-fly is a character of much greater significance to us than is indicated by his adornment of a fable. He really does have something to do with the turning of the wheel, but it is the wheel of life. He may have little to do with keeping it going, but he certainly sometimes has much to do with stopping it.

The fly does far worse things than get into the ointment, for unless we take care he gets into or onto pretty much everything we eat or drink. Such an occurrence is not simply disgusting; it is more or less dangerous, and the danger lies in the introduction into our bodies of disease germs. This danger is far more real than commonly supposed. There can be no doubt that much sickness is started in this way.

The question is, What ought we to do about it? The answer is simple, and it is that we ought to take greater precautions, both individually and collectively—

First. To fully inform ourselves on this subject by reading and observation.

Second. To prevent the multiplication of flies. Abolish their breeding places. Protect food and refuse so that flies cannot get at them.

Third. To keep flies out of our buildings and streets.

Fourth. To employ all reasonable agencies to destroy flies that come into existence in spite of our other precautions.*

*For further information on the ravages caused by flies see "Economic Loss to the People of the United States through Insects that Carry Disease," by Dr L. O. Howard, August, 1909, NATIONAL GEOGRAPHIC MAGAZINE, pp. 735-749.

# NOTES ON THE DISTANCES FLIES CAN TRAVEL*

By N. A. COBB

EXPERIMENTS INDICATING THE GREAT POWERS OF FLIGHT POSSESSED BY SOME FLIES

IT is very difficult to make the necessary direct observations as to the distances flies can travel and their rate of speed—flies' motions are so rapid. Nevertheless, in the course of time I have been fortunate enough to witness a number of convincing instances. To these I have added the indirect evidence of comparative anatomy. If the fly's wing muscles are unusually bulky, it is a fair inference that its flight will be quick, or long sustained, or both.

I have never succeeded in tiring my flies very perceptibly if they had a free space to move about in. When confined in a room they may be kept on the wing for hours without showing many signs of fatigue. Though they move twenty feet to the experimenter's one, they will often succeed in tiring him out if he undertakes the task of keeping them always on the wing. The instance of the fly starting to cross the Mediterranean Sea is a very striking one. (See page 382.)

Among insects, as among birds, fliers of two very different types are to be found—those that soar and those that fly. Without entering deeply into the question, this division may be said to be about as marked among insects as among birds. The fliers among insects, to which class the flies belong, correspond, however, more nearly to the extreme limit reached in humming birds.

The rate of wing vibration in flying insects is higher than any wing rate among birds. In fact, the difference is so great that it raises altogether new mechanical and physiological questions. In the case of insects these questions have excited the interest and attention of minds of the highest order, as is apparent on looking over the literature of the question.

The flies belong to the quick-action group of flying insects, the principles of

*Abstracted from "Fungus Maladies of the Sugar Cane," by N. A. Cobb.

whose wing musculature appears to have been first explained correctly by Graber. No one has yet, however, fully explained how it is that these insects are able to execute such quick movements. Is it possible that the division of the thoracic muscles into groups, a division that seems to prevail in all the insects that fly in this manner, is a provision by which the muscles act in relays? If we recall the motions that are executed by a single pair of antagonistic muscles, can we recall a single instance where movements are executed at the rate of several hundred per second? I doubt if even in those minute forms where there appears to be the least molecular difficulty—I refer to the cilia of microbes—so high a rate of vibration would be claimed. (I know of no investigations.) Few men can execute more than ten movements per second with any muscle.

It has often struck me when examining the batteries of muscle by which the quick-action insects execute their wing movements, that here is a mechanical and physiological problem that it would be well worth while to investigate.

## ENORMOUSLY POWERFUL WING MUSCLES OF FLIES

Ten flies of the smaller of the two sarcophagous species found common at this Station* were weighed after being chloroformed. They were taken as captured in the middle of the day. No doubt a slight amount of the vapor of chloroform added to the apparent weight of these ten flies, which was 478 milligrams. The central thoracic muscles were removed and weighed, and also the two sets of lateral muscles. The result was 67.5 milligrams for the central and 58.5 for the lateral. Thus we have:

Average weight of fly, 47.83 mg.

Average weight of lateral batteries of muscle, 5.85 mg.

Average weight of central battery of muscle, 6.75 mg.

Total weight of muscles, 12.6 mg.

From which we learn that the weight of the central thoracic muscles is 14.1 per cent of the weight of the fly, and the weight of the lateral thoracic muscles is 12.2 per cent of the weight of the fly, and that together these thoracic muscles constitute 26.2 per cent of the weight of the fly.

The method was to fix the flies in 50 per cent alcohol, dissect out the muscles, soak them in water for several hours, remove the excess of water and weigh the muscles barely moist.

Eight females of the commonest species of *Syrphus* about the Station had their great thoracic muscles removed and weighed, with the following results:

Longitudinal muscles, 12.3 per cent of the weight of the fly.

Oblique muscles, 9.2 per cent of the weight of the fly.

Total, 21.5 per cent of the weight of the fly.

A similar trial with ten males weighing 774 mg. gave as a result:

Longitudinal muscles, 17.12 per cent of the weight of the fly.

Transverse muscles, 12.5 per cent of the weight of the fly.

Total, 29.62 per cent of the weight of the fly.

The males of this species have a greater proportion of muscle than the females. This appears to be generally true of flies.

The wing muscles of a notable flier, *Volucella obesa*, often to be seen, especially in the morning, standing in the air in shady places in Honolulu, were removed and weighed in the same manner as described for the two sarcophagous species. The result showed that the longitudinal muscles constitutes 25.7 per cent of the entire weight, while the oblique sets constitute 22.3 per cent of the entire weight, so that together these muscles constitute no less than 48 per cent of the weight of the insect. It should be noted that all the specimens examined appeared to be males, and the absence of gravid females may in some degree account for the difference between these results and those noted in the case of the sarcophagous flies. How-

*Experiment Station of Hawaiian Sugar Planter's Association, Honolulu.

ever, it could not account for more than a portion of the great difference.

This result is from the examination of ten specimens that in the aggregate weighed 674 milligrams.

WING RATES OF POWERFUL INSECT FLIERS

Records of wing vibrations of a specimen of *Syrphus* that had been in captivity 24 hours, and meanwhile fed on sugar and water, gave, as the average of four tests, 400 per second. The voice of this fly when scared by pressure varied from violin A to the C above.

A second specimen gave 378 as the average of five tests. One test in the same quarter-second gave 341 and 578, the slower being at the beginning of an effort, the faster at the maximum speed attained. These rates, which at first appeared to be the true wing rates, proved ultimately to be subsidiary vibrations.

Wing vibrations of *Volucella*, 298, average of six tests. The tests varied remarkably, being as follows: 228, 253, 275, 282, 348, 405. The latter two are remarkably above the others, and are subsidiary vibrations.

Three tests on a green-bottle fly gave 250, 258, 196. Average, 235.

A large sarcophagous fly, female, as the result of seven tests, gave an average of 246 per second. In the course of these tests rates as high as 400 were observed for short periods of time, but these were probably subsidiary vibrations. The tests ran as follows: 199, 206, 227, 257, 268, 281, 281.

The wing vibrations of one of the large sarcophagous flies held captive, on being chronographed, gave as the result of seven different trials 203 vibrations per second.

Golden dragon fly (*Pantala flavescens*, Fab.), 17 per second, five observations, one individual.

Large dragon fly (*Aræ junius*, Drury), 22 per second, seven observations, one individual.

Tuning-fork tests on the same paper as the above tests gave results as follows: Pitch, A international. 420, 446, 462. Average, 443.

HIGH WING-RATE FLIERS VS. THE SAILERS

The dragon flies are well known to be powerful fliers. Nearly everybody must have noticed the bold flight of these conspicuous insects, which may at times be seen soaring high above the roofs of houses in our towns, and even over the tops of some of our high hills and mountains. We may, therefore, arrive at a more accurate conception of the flight of flies if we compare it with that of these larger insects which come under more common observation.

The relative powers of flight of the fly *Volucella obesa* and the large dragon fly is shown by the usually futile attempts of the latter to capture the former. I have never seen a *Volucella* captured by one of these dragon flies, though the *Volucella* when standing still in the air offers an unusually fair mark. When the dragon fly arrives the *Volucella* is gone. The fact that dragon flies continue to make passes at them may indicate that the flies are sometimes caught.

A golden dragon fly and a *Volucella*, whose weight were to each other as 297.4 to 64.2 (mg.), had wing areas that were to each other as 46.8 to 1.6.

Or, to speak approximately, a dragon fly weighing only four to five times as much as a fly, both being expert fliers of their respective kinds, had a wing area thirty times as great.

A *Volucella* fly and a large dragon fly, whose weights were to each other as 64.2 to 1598.5 (mg.), had wing areas that were to each other as 1.6 to 82.; that is to say, speaking approximately, the dragon fly, while she weighed only 25 times as much, had a wing area over 50 times as great.

A REMARKABLE FLIGHT

I remember once to have witnessed a very remarkable example of the power of flight of one of the larger flies. On a voyage across the Mediterranean from Algiers to Marseilles in company with Prof. W. T. Swingle, I observed a dipterous insect keeping pace with the steamer so accurately that it almost seemed as if it were joined to the boat

by some invisible rigid connection. The boat left Algiers at noon, and as long as there was any light left by which to observe, the insect kept its place steadily. This was in midsummer. The insect never made any attempt to come aboard.

The boat was not particularly fast, her speed being, so far as I could judge, about thirteen knots. When we consider that the insect was all the time supporting itself in the air while the boat merely floated on the water, and thus had its weight supported, the comparison between the two is all the more striking.

# FIGHT THE FLIES

*We reprint herewith a circular recently published by the American Civic Association, which is conducting a vigorous campaign against the fly*

IT is at this time of the year that the house-fly begins to take on life for the ensuing spring and summer; eggs laid last fall will soon begin to hatch. At first he is only a little worm, wriggling his tiny grub-like form in some incubating pile of filth. He is usually found in the manure pile, the outhouse, or the mound of rubbish or garbage in the back yard. In this condition he is easily killed, and it should be the duty of every person to kill him now. The house-fly could not exist if everything were kept perfectly clean and sanitary. Exterminate the fly-worms, do away with its breeding places, and there will be no flies. If we are to fight the flies this summer we should use every agency possible, and the best way to fight them is to prevent their breeding.

The common house-fly is coming to be known as the "typhoid fly," and when the term becomes universal greater care will be exercised in protecting the house from his presence.

Flies kill a greater number of human beings than all the beasts of prey, with all of the poisonous serpents added. They spread disease which slays thousands, while big, powerful beasts kill single victims.

As soon as the fly comes out of his shell he is full grown and starts out in the world to make a living, and if your home is not clean he knows it by the odor. They can discern an odor of filth for miles.

As much as they like filth odors they dislike other odors. Where a bad odor will attract them the clean odor will repulse them. A pleasant-smelling substance—the fragrance of flowers, geraniums, mignonette, lavender, or any perfumery—will drive them away.

He is a frequenter of offal. The fly lays her eggs in the manure pile or other objectionable filth. All the germs—all the imaginable abominable microbes—fasten themselves on the spongy feet of the fly. He brings them into the house and wipes them off his feet. The fly you see walking over the food you are about to eat is covered with filth and germs. If there is any dirt in your house or about your premises, or those of your neighbors, he has just come from it. It is his home. Watch him as he stands on the lump of sugar industriously wiping his feet. He is wiping off the disease germs, rubbing them on the sugar that you are going to eat, leaving the poison for you to swallow.

He wipes his feet on the food that you eat, on the faces and on the lips of your sleeping children. This does more to spread typhoid fever and cholera infantum and other intestinal diseases than any other cause.

Disease attacks human beings only when they are brought in contact with it. For instance, you cannot get typhoid fever unless you swallow the germs of typhoid, and you do not swallow these

germs unless they get on the food you eat or in the liquids you drink, or on the glasses or cups from which you drink.

Not only does he scatter the seeds of disease from his body over your food, but before your fruit and vegetables are placed before you they have been subjected to his filthy habits, either in the kitchen or in the stores, where he flies from the horse dirt in the middle of the street to the tubercular sputum on the sidewalk, and then back to the foodstuffs displayed for sale.

Many diseases which are attributed to milk and water originate through flies. A polluted brook, river, or lake furnishes germs from sewers, and flies in millions settle on the refuse that washes along the water's edge.

Intestinal diseases are more frequent whenever and wherever flies are most abundant, and they and not the summer heat are the active agents in its spread.

There is special danger when flies drop into such fluid as milk. This forms an ideal culture material for the bacillus. A few germs washed from the body of one fly may develop into millions within a few hours, and the person who drinks such milk will receive large doses of bacilli, which may later cause serious sickness.

Therefore, keep the flies away from the milk.

### DON'TS

Don't allow flies in your house.

Don't permit them near your food, especially milk.

Don't buy foodstuff where flies are tolerated.

Don't have feeding places where flies can load themselves with ejections from typhoid or dysenteric patients.

Don't allow your fruits and confections to be exposed to the swarms of flies.

Don't let flies crawl over the baby's mouth and swarm upon the nipple of its nursing bottle.

Clean up your premises inside and out, and then, as much as you can, see that others do the same.

Strike at the root of the evil. The house-fly breeds in horse manure, kitchen offal, and the like. Dispose of these materials in such a way that the house-fly cannot propagate. Screen all windows and doors and insist that your grocer, butcher, baker, and every one from whom you buy foodstuffs does the same.

There is more health in a well-screened house than in many a doctor's visit.

After you have cleaned up your own premises inspect the neighborhood for fly-breeding places. Call the attention of the owner to them and, if he does not remove them, complain to the Board of Health.

Flies breed in horse manure, decaying vegetables, dead animals, and all kinds of filth.

### NOT LESS THAN 95 PER CENT OF THE PESTS ARE BRED IN THE STABLE

All stables should have a manure bin with a door at the side and a wire screen on the top, that the larva deposited in the manure before it was placed in the bin will be screened when hatched, and, as flies seek light and come to the top of the bin, they can be easily killed by burning paper or some other device.

The fly has a thirst only equaled by his hunger; place a dish of poisoned water in the stable and a greater part of the flies hatched there will be killed.

Flies are nature's scavengers, fulfilling the same function that some bacteria do, but become an intolerable nuisance and danger when entering human dwellings and by contamination of food.

The presence of flies is a direct evidence of careless housekeeping and of the existence of filth in some form about the premises, and are more dangerous than the good housekeeper's terror found in bed-rooms.

Remember that wherever absolute cleanliness prevails there will be no flies. Look after the garbage cans. See that they are cleaned, sprinkled with lime or kerosene oil, and closely covered.

Remove all manure from stables every three or four days, and when removed keep in a tight pit or vault, so flies cannot breed in it.

Lye, chloride of lime or blue vitriol water, crude carbolic acid, or any kind of disinfectant may be used.

Keep flies away from the kitchen. Keep flies out of the dining-room and away from the sick, especially from those ill with contagious diseases.

Screen all food. Apply this rule not only to food prepared at home, but to foodstuffs offered for sale, and especially fruits, salads, and all other things which do not require to be cooked.

Prevent consumptives from expectorating where flies can feed upon it.

HOW TO KILL FLIES

To clear rooms of flies carbolic acid may be used as follows: Heat a shovel or any similar article and drop thereon 20 drops of carbolic acid. The vapor kills the flies.

A cheap and perfectly reliable fly poison, one which is not dangerous to human life, is bichromate of potash in solution. Dissolve one dram, which can be bought at any drug-store, in two ounces of water, and add a little sugar. Put some of this solution in shallow dishes and distribute them about the house.

Sticky fly-paper, traps, and liquid poisons are among the things to use in killing flies, but the latest, cheapest, and best is a solution of formalin or formaldehyde in water. A spoonful of this liquid put into a quarter of a pint of water and exposed in the room will be enough to kill all the flies.

To quickly clear the room where there are many flies, burn pyrethrum powder in the room. This stupefies the flies, when they may be swept up and burned.

If there are flies in the dining-room of your hotel, restaurant, or boarding-house, complain to the proprietor that the premise are not clean.

# CAMERA ADVENTURES IN THE AFRICAN WILDS

*Photographs by A. Radclyffe Dugmore. Copyright, 1910, by Doubleday, Page & Co.*

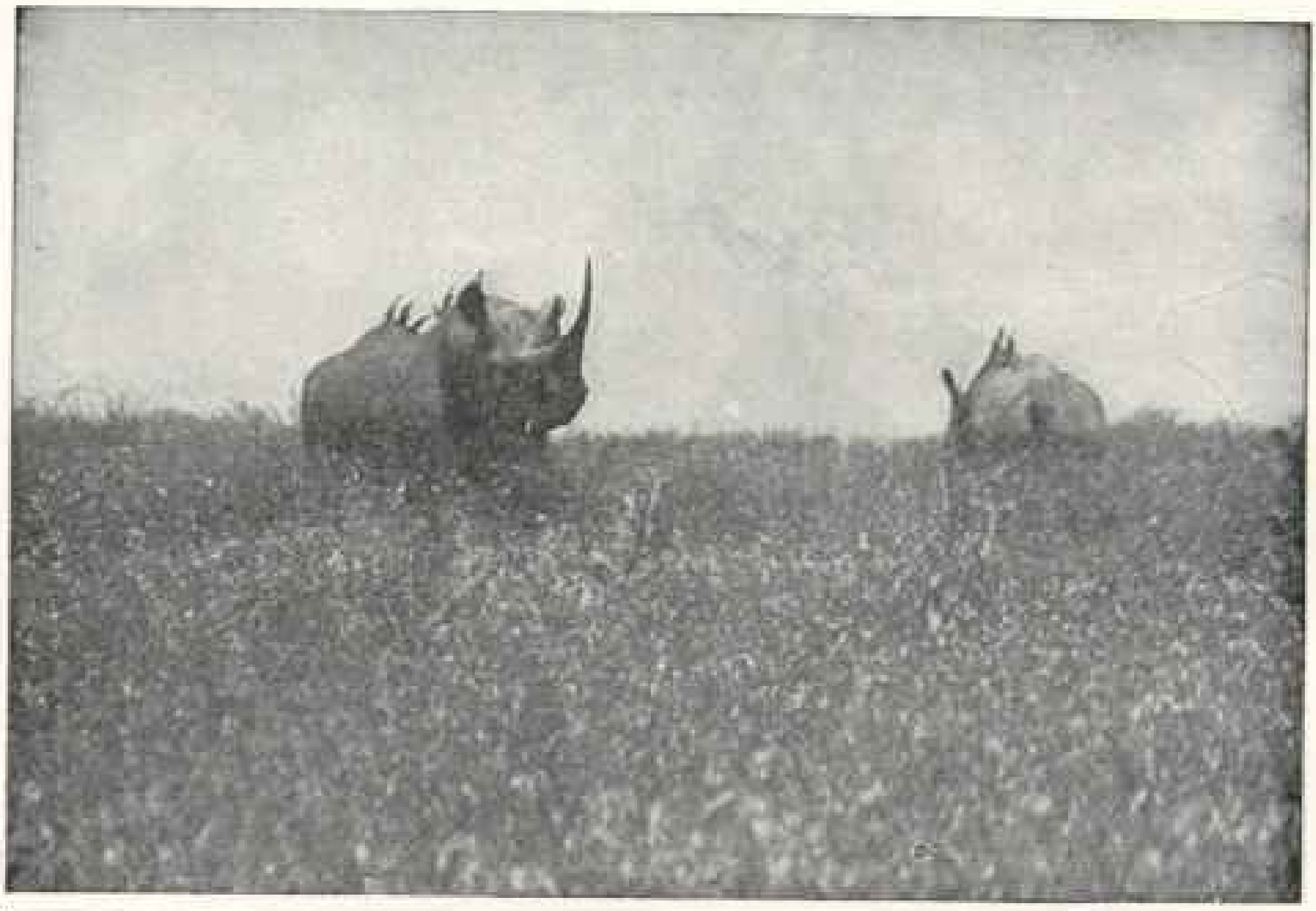
TO stand before a charging rhinoceros, holding a fifteen-pound camera, and to wait deliberately until the beast is only a few feet away before releasing the shutter, knowing all the while that only an unerring bullet from his companion can turn aside the leviathan and save the photographer from being tossed 15 yards, is surely as great a test of physical and moral courage as any soldier would like to undergo. The volume which contains Mr Dugmore's photographs of wild game in Africa and also his experiences in obtaining these photographs, is one of the most thrilling, inspiring, and instructive books published in many years.*

Through the courtesy of Messrs Doubleday, Page & Company, the NATIONAL GEOGRAPHIC MAGAZINE is able to reprint eleven of the one hundred and forty remarkable photographs given to the public by Mr Dugmore. The photographs are far more wonderful and beautiful than those by the German, C. G. Schillings, which excited so much enthusiasm several years ago, and which were described and illustrated in this magazine in August, 1907.

Readers will probably find an interesting debate in the question whether photographing rhinos or photographing lions by flashlight is the more nerve-racking occupation.

Mr Dugmore secured his flashlights of lions in the following manner: He built a small hut of branches, open on one side. Outside the hut he arranged the flashlight and three cameras focused on a dead carcass, a zebra or hartebeest, a few feet away. At night he took his position in the hut and waited for the lions to appear.

* "Camera Adventures in the African Wilds." A. Radclyffe Dugmore, pp. 250, with 140 photos from life. 8½ x 11 inches. Doubleday, Page & Co., 1910. $6.00.

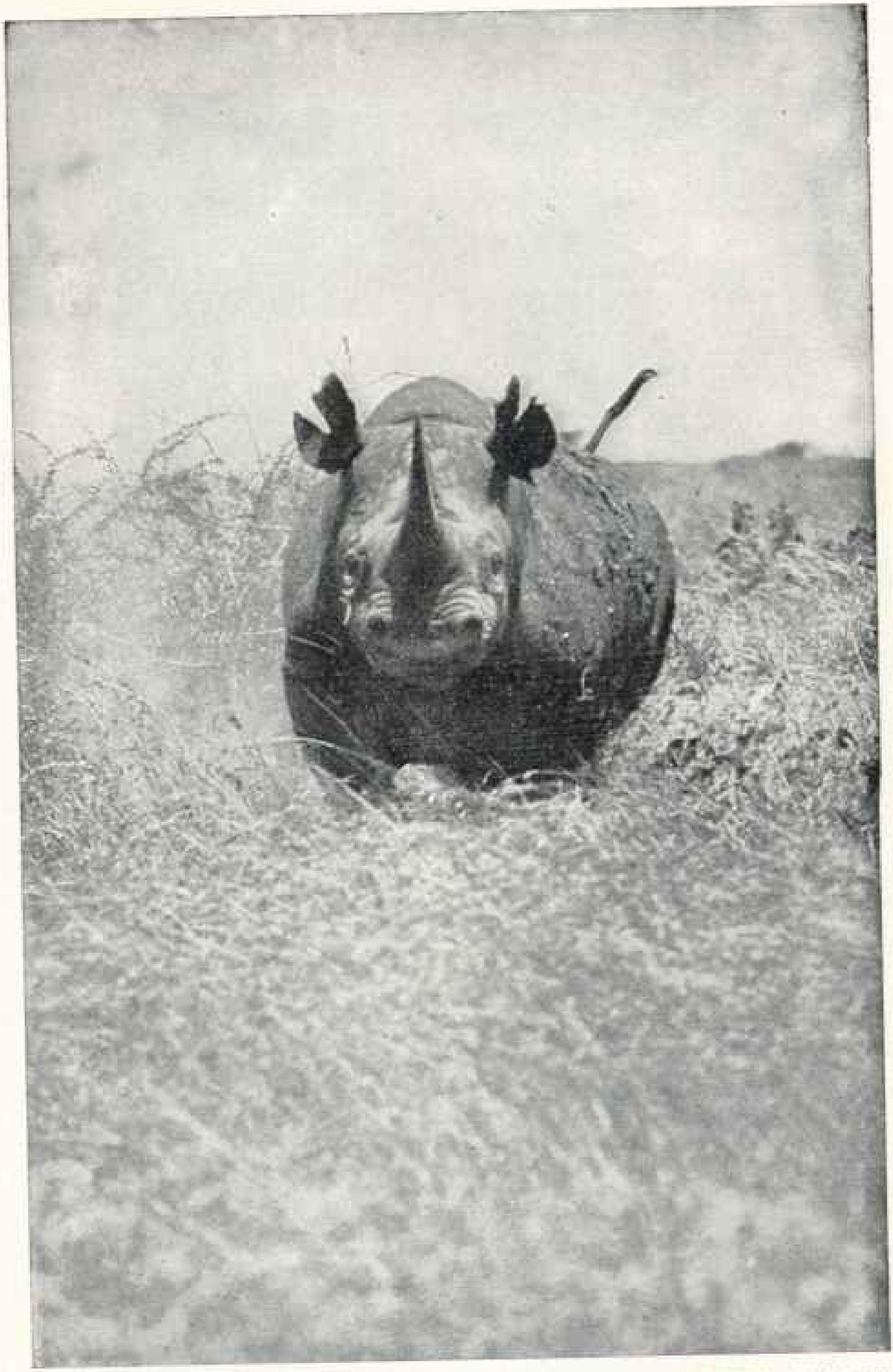


RHINOS FEEDING

Note the birds on their backs. These birds eat the ticks, which infest the beasts. They also act as sentinels, by their fluttering warning their companions of approaching enemies

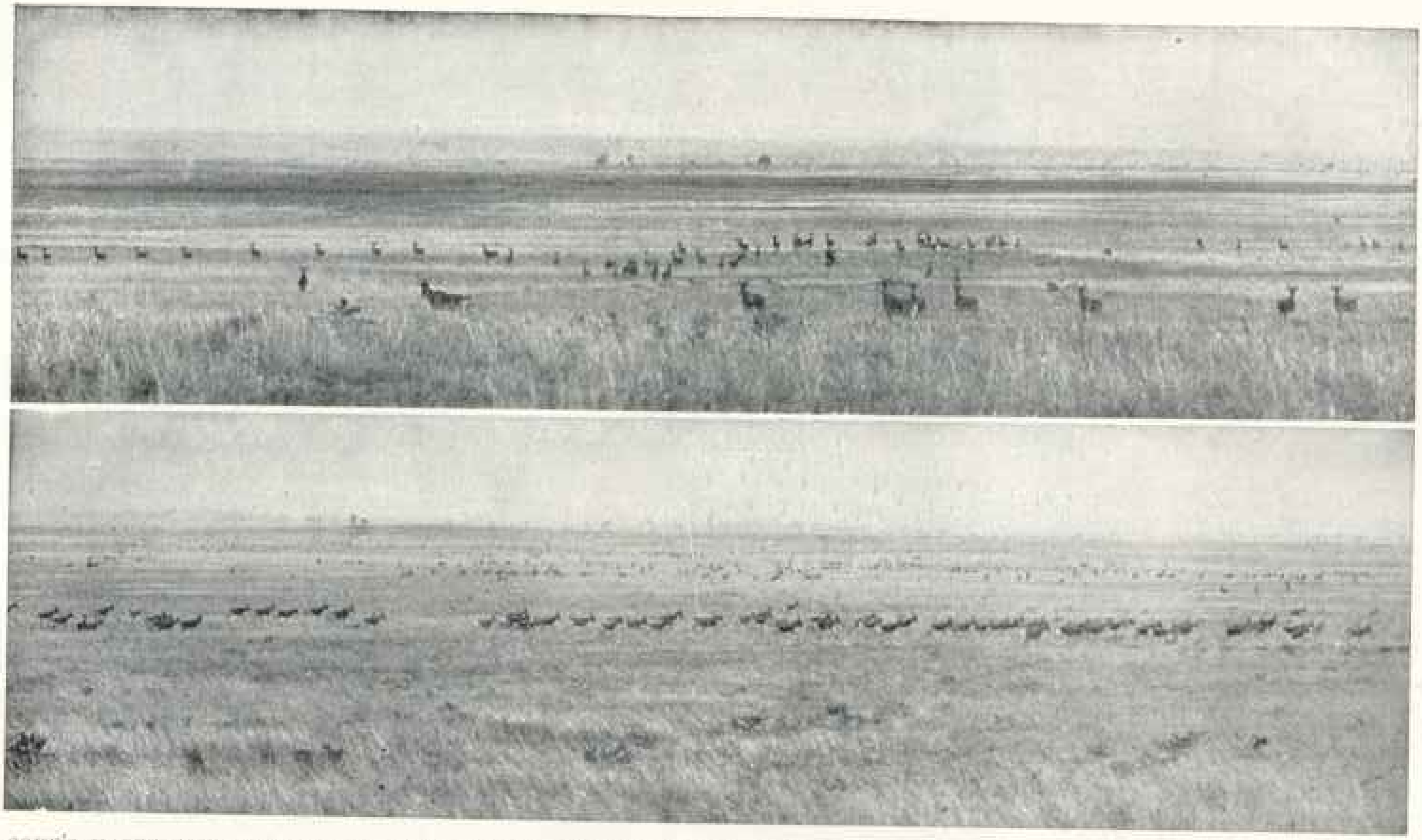
THE LOWER PICTURE IS OF ONE OF THE SAME PAIR IN THE ACT OF CHARGING

The horn is about 24 inches long, and is composed of hair or bristles closely pressed. A rhinoceros' horn's only value is as a trophy, though some are sent to China, where they are pulverized and sold for medicinal purposes.



RHINOCEROS PHOTOGRAPHED AT A DISTANCE OF FIFTEEN YARDS WHEN ACTUALLY CHARGING THE AUTHOR AND HIS COMPANION

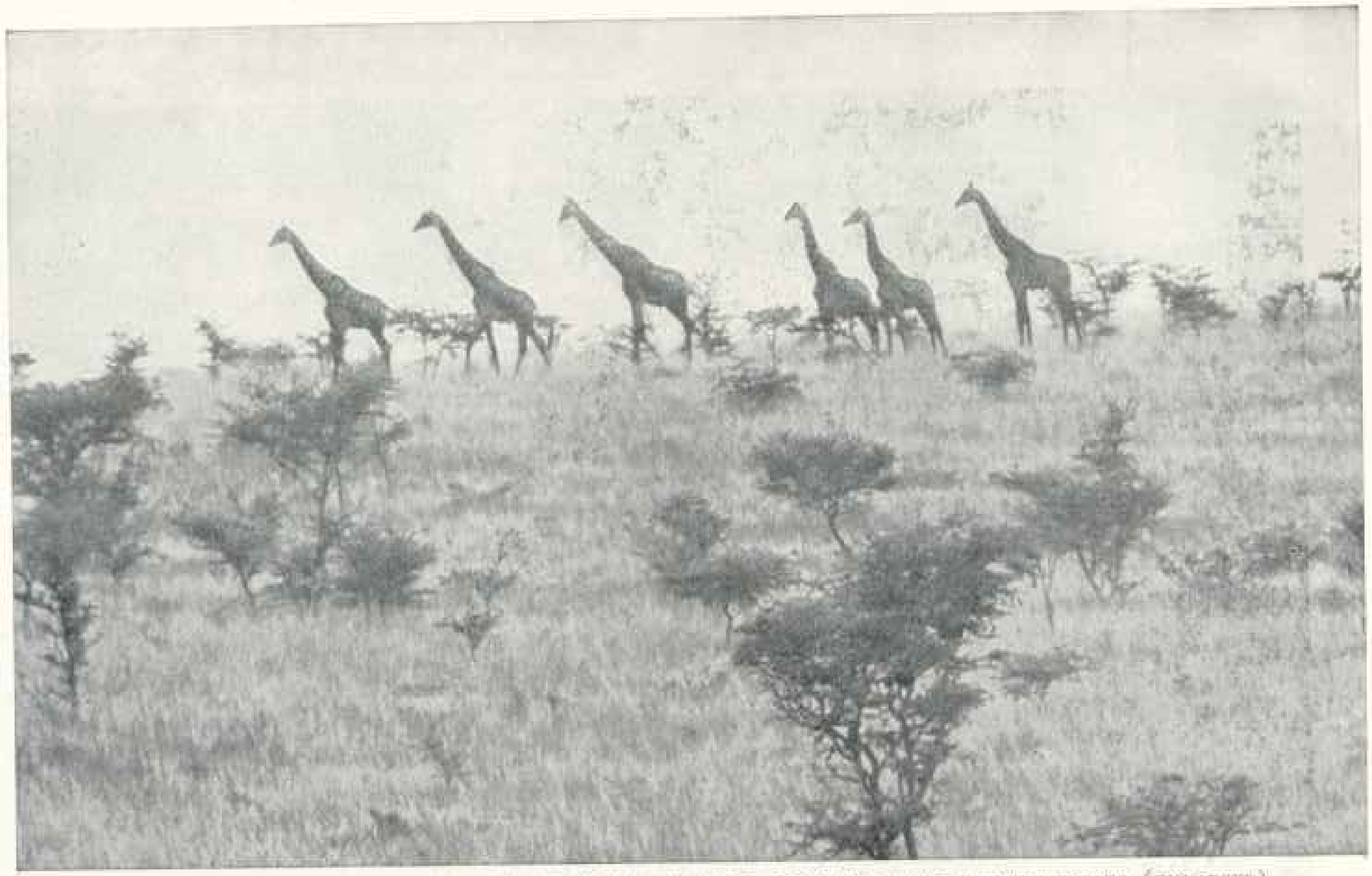
As soon as the exposure was made a well-placed shot from Mr. Dugmore's companion turned the charging beast



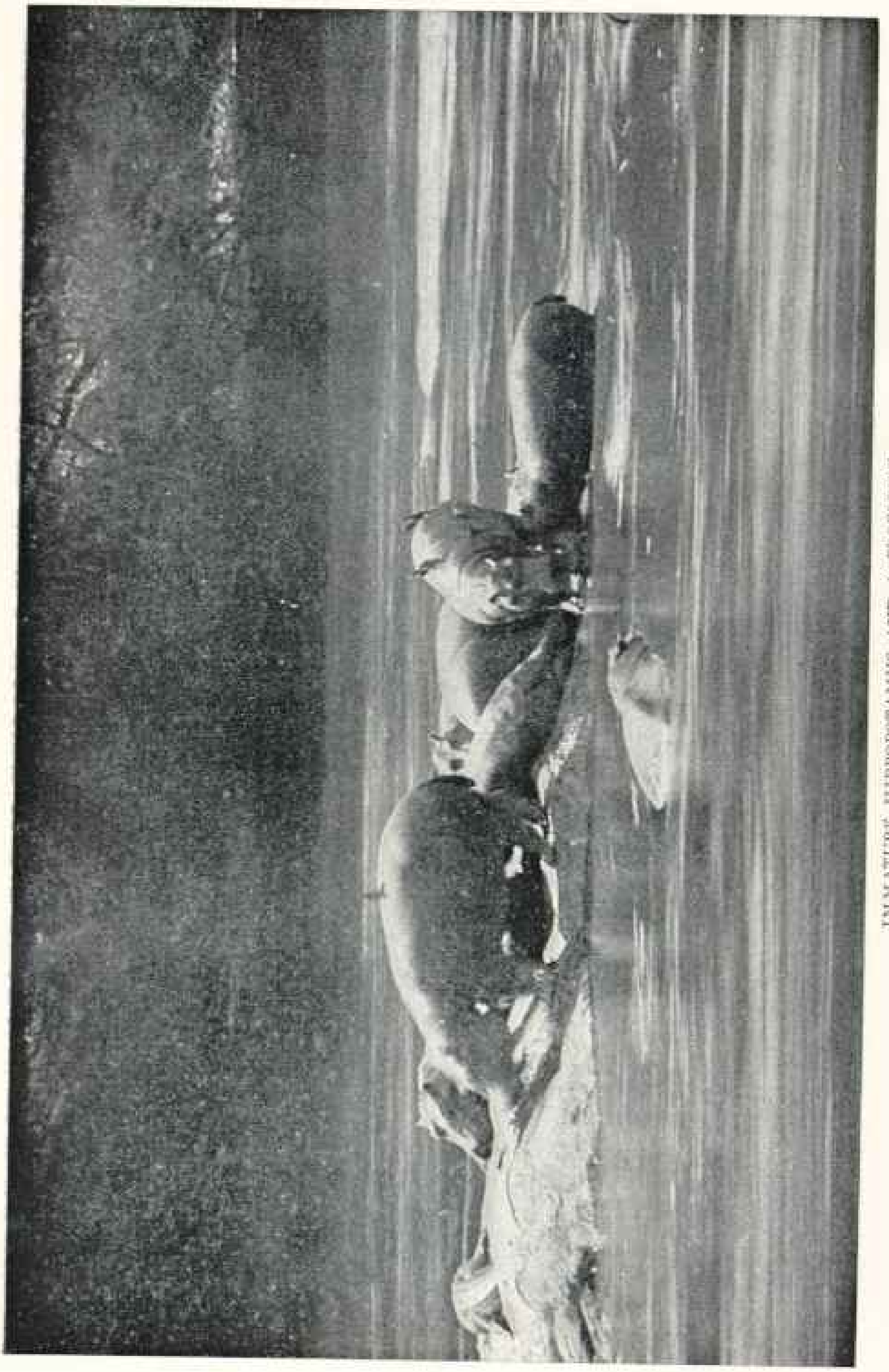
COKE'S HARTEBEEST: THIS PICTURE WILL GIVE SOME IDEA OF THE ABUNDANCE OF THE GAME IN INLAND BRITISH EAST AFRICA

LARGE HERD OF COKE'S HARTEBEEST ON THEIR WAY TO WATER

The people of Nairobi, a fair-sized town and headquarters of the railroad and government, have been compelled to build a double row of fencing around the town in order to keep out the great herds of game. The fence is, however, often broken and a zebra or hartebeest galloping through the streets is a common sight.



HERD OF GIRAFFE PHOTOGRAPHED AT A DISTANCE OF ABOUT 375 YARDS WITH THE TELEPHOTO (ENLARGED)



IMMATURE HIPPOPOTAMUS AND A CROCODILE

The birds seem on the animals' backs eat the parasites—leeches and others—which infest the coarse skin (telephoto made on the Tana River)

"For about two hours I had been straining both eyes and ears, when suddenly, to my astonishment, a huge lion appeared. He was standing close to the zebra when I first discovered him, and I could not understand how he could possibly have come without being seen or heard. Yet there he stood, the king of beasts, the most feared animal in Africa, not twelve yards away."

The lions weigh on an average over five hundred pounds each, and yet their approach was so silent and stealthy that Dugmore always failed to detect their coming until the tearing of flesh and breaking of bones of the bait proclaimed their arrival.

By pressing the electric button the flash was then fired, but the lions would only retreat for one hundred or two hundred yards, where they would make the night hideous with their roaring. It was then the pleasant duty of the photographer to emerge from the protection of his hut, reload his three cameras and the flashlight apparatus, while the chorus of the lions continued. On one night Mr Dugmore secured photographs of twelve different lions.

Mr Dugmore speaks most enthusiastically of the wise precautions taken by the British government to prevent the extinction of game. In addition to the regulations forbidding the shooting of game along the railways, the authorities have set aside about 10,000 square miles as a reserve in which no shooting is allowed. The abundance of game in the free-zone is simply extraordinary.

"We could see countless herds of animals," hartebeest and gazelles, zebra, elands, etc. "Our excitement reached its highest pitch when we discovered a large giraffe standing complacently, scarcely one hundred and fifty yards from the snorting train. How different the huge creature looked in his natural state from those we had seen in zoos or menageries! How different the deep, rich coloring and the dark, well-defined markings from the faded coat of the beast in captivity! This splendid animal, towering above the small trees, after watching us for a few seconds, ambled away to what he considered a safe distance."

The most unpopular of all the animals in British East Africa, says Mr Dugmore, are the zebras.

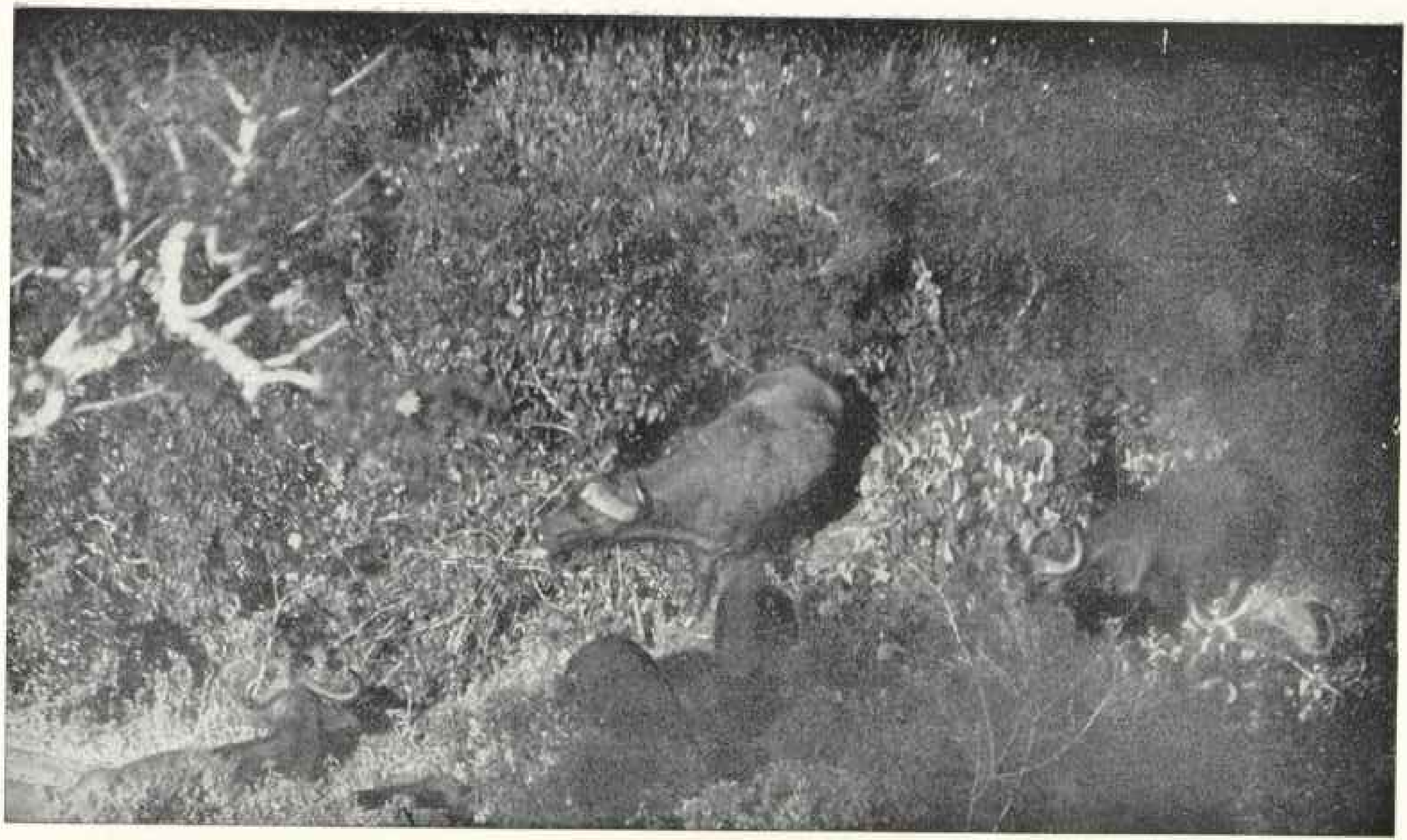
"They looked like painted ponies with their strongly defined black stripes, and were beautiful beyond words. It is curious how they appeal to the new arrival, while, if you speak to the settler of the zebra as being even worthy of notice, he smiles sadly, and commences a torrent of abuse against what he considers one of the worst pests of the country. They would like to see them wiped off the face of the earth, and the handsome creatures are killed in great numbers to be used as food for the native workmen, or even for the dogs. And yet they can scarcely be said to be decreasing except in very restricted areas.

"The cause for this common dislike of the zebra is his objectionable habit of disregarding fences. A herd will stampede, and ten or twenty panels of a barbed wire fence are down like a flash, and then, as likely as not, they will wheel round and repeat the operation at another point. In places where fences are measurable by miles, it is of the most importance that they should be kept in a good state of repair. The destruction of a few panels may mean immense damage to crops, and perhaps the loss of valuable ostriches; hence the settlers' lack of love for the cantankerous, though beautiful, zebra.

"So far no practical use for the animal has been discovered. They are not easily tamed and, generally speaking, are extremely bad-temperad, so that they are most difficult to break or handle, and it is almost certain that they are not worth the trouble, owing to their lack of stamina. Contrary to popular opinion, they are not very fast, and have no staying power."

The huge and clumsy hippo conceals in its immense mouth teeth which sometimes attain a length of over five feet, and yet this gigantic pig eats only grass.

"The beast is frequently shot for its ivory, which is quite valuable. Then,

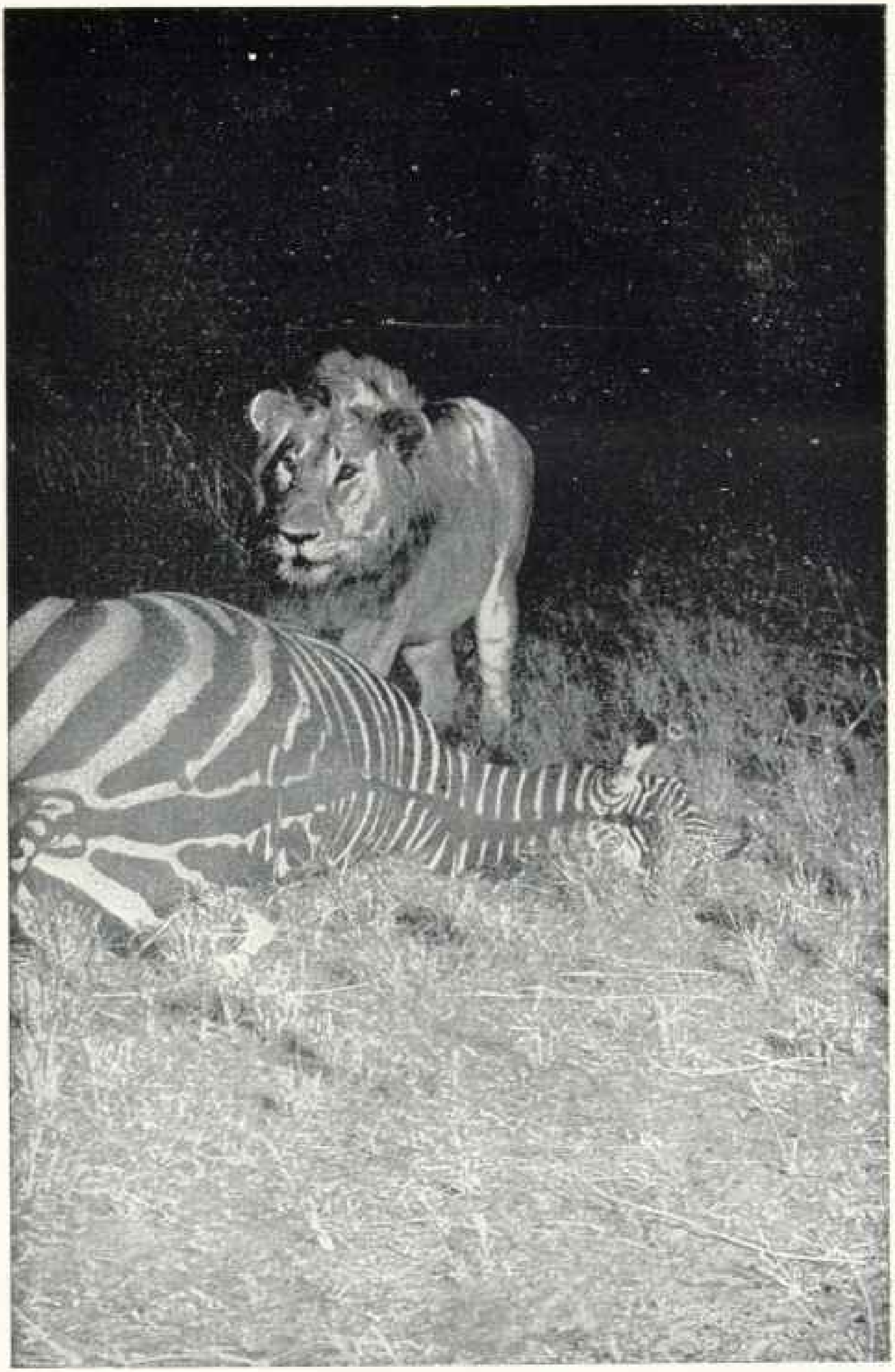


A GROUP OF BUFFALO RESTING AMONG DENSE BRUSH

This telephoto was made when the sun was very low and the wind blowing with such vigor that a time exposure was impossible, hence the blackness of the shadows, where the buffalo can scarcely be detected

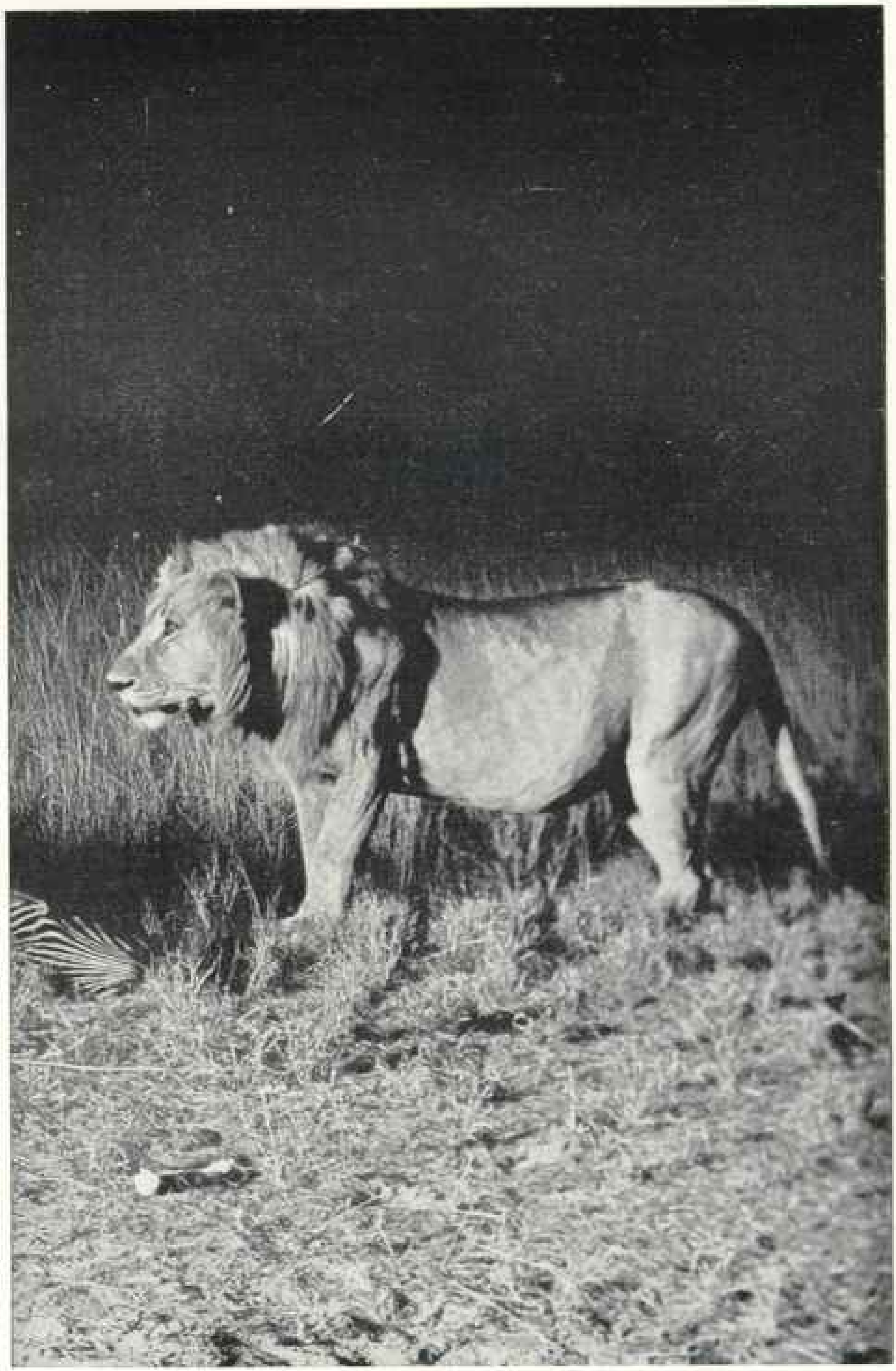
A LIONESS ABOUT TO COMMENCE HER DINNER: THE HARTEBEEST HAD BEEN KILLED BY LIONS DURING THE PREVIOUS NIGHT

This flashlight was made when the animal was ten yards from the author



THE SAME LION AS SHOWN ON THE OPPOSITE PAGE, BUT PHOTOGRAPHED FROM A DIFFERENT POSITION

Zebra is the favorite meat of the lion



FLASHLIGHT PICTURE OF THE KING OF BEASTS

At the moment the photograph was made the lion was twelve yards from the author and his companion, who were on the ground beneath some thorn bush

too, their meat is probably more appreciated than that of any other African animal, the immense quantities of fat being greatly relished.

"Agriculture and the hippopotamus do not go hand in hand, as a single hippopotamus will in one night destroy acres of crops; consequently the animals are not much loved by either the native or European farmers.

"The hippopotamus is usually a nocturnal feeder. He spends most of the day in the water, though he may be frequently seen on rocks or sand bars enjoying his sun-bath. As evening approaches he becomes restless, and usually soon after the sun sets he begins to think of dinner. At this time the herd separates, each individual going, I believe, to his own favorite feeding-ground. Whether they feed every night I am not quite sure, for I have noticed certain individuals keeping to a pool all night, while it is not at all an uncommon thing to see them at night asleep on sand bars.

"Certain landing places are used regularly and, judging from the way the banks are worn down and rocks polished, it would seem as though these places have served for many centuries. How far they will go from their day pool is hard to say, but there is every reason to believe that they will sometimes travel ten or fifteen miles or more before landing. Then when they are ashore they will often go a long way before finding the necessary supply of the grass which forms their food.

"It is scarcely credible that such large beasts (for a full-grown bull will probably weigh over three tons) can find enough nourishment in grass, but of course in porportion to their size they do not require nearly as much food as animals of more nervous temperament and active habits of life."

In addition to the lions, rhinos, hippos, and giraffes, most interesting are Mr Dugmore's photographs and descriptions of the filthy spotted hyena, of hartebeests, tiny dik-dik, elands, warthogs, gazelles, oryx, impala, waterbuck, Grevy's zebra, vultures, marabou storks, and other animals, and of the extravagant vegetation.

Several entertaining chapters are devoted to an account of the little-known country around Meru and the native dances.

"The women do most of the heavy work, and it is no uncommon thing to see a girl of perhaps twelve or thirteen carrying a seventy or eighty pound load of firewood on her back, with a bag of corn or a huge gourd of water on the top of it. These are hung by a strap from the head, which is usually clean-shaven. In front, more often than not, hangs a baby, which complacently sucks at its mother's breast as she walks along. The father marches in front, carrying no more than his spear and knob stick, his body smeared with a sickening mess of red earth and grease.

"The costume of the men is usually a red blanket or a brown cotton cloth hung from one shoulder, while the neck, wrists, arms, ankles, and below the knees are decorated with beautiful little beaded bands of wire. Frequently they dispense with covering of any kind. The women wear a short skirt of leather with or without bead work. It is fastened below the breasts and parts in front, so as to leave the knees free.

"Heavy wire ornaments are usually wound around the legs, arms, and neck, and sometimes immense waistbands of beads and cowries are worn. Ear ornaments are used by both sexes, the women preferring clusters of large beaded rings, or heavy wire. In both cases the lobe of the ear is cut and stretched enormously by means of wooden or bone discs.

"It is curious that the women have the head clean-shaven, or nearly so, while the men do their hair, or wool, in most fanciful ways, usually filling the fine braids with a mixture of their favorite red earth and grease. The people are chiefly agriculturists, their live stock consisting almost entirely of goats, sheep, and poultry. The sheep are rather small, and are the fat-tailed variety; the poultry are also small, and lay eggs not much larger than those of the bantam."

# THE FIRST TRANSANDINE RAILROAD FROM BUENOS AIRES TO VALPARAISO

By Harriet Chalmers Adams

ARGENTINA and Chile were neighbors, but they could not well be sociable with a mountain barrier between. A passage, however, has at last been opened through the towering, snow-clad Andean wall, and enthusiastic crowds in Buenos Aires and in Santiago de Chile have sped departing trains bound for the adjacent territory. The great Transandine Railway is completed.

On the 5th of last April the Transandine tunnel, the final link in the 888 miles of rail connecting Buenos Aires and the Atlantic with Valparaiso and the Pacific, was officially opened on the Chilian side of the mountains at Caracoles station.

It was a fitting day for a Chilian celebration, since it commemorated the anniversary of the patriotic battle of Maipó, dear to the heart of every native of the far south as the greatest and final victory in the war of independence. Many prominent men of the Republic were present, including members of the cabinet, and at the banquet subsequently held in honor of this historic event Argentina's representatives were entertained before their return to their own country on the other side of the tunnel.

Argentina's official opening of the road was postponed until the 25th of May, which is not only Independence Day in the Republic, but also the inaugural date of the Centenary Exhibition.

The chief feature of this most important of international expositions yet to be held in Latin America is, very appropriately, a railway exhibition, agriculture and art taking secondary place. Buenos Aires, the fourth metropolis of the Americas, the second Latin city of the world, the first Spanish-speaking center, is to be the scene, for six months, of a brilliant demonstration of progressive Argentina's marvelous development. Modern, industrial Argentina has been created by her railways, which not only cross the country from the Atlantic to the Andes, but penetrate those semi-tropical lands adjoining the verdant Republic of Paraguay on the north and those bleak, wind-swept pampas on the south bordering the old Patagonian frontier.

### INITIATED BY A MASSACHUSETTS MAN

The story of the Transandine Railway, from its earliest projection by a North American captain of industry to its final completion by an Anglo-American syndicate, is worthy of a prominent place in engineering annals.

William Wheelwright, a native of Newburyport, Massachusetts, was the first to conceive the idea of a transandine road. The plan, which he outlined in 1860, called for the building of a railway from Caldera, on the Chilian coast, eastward through the mountain pass of San Francisco, and thence across the pampas of Argentina to Rosario, a port on the Parana River—a more northerly route than the one finally adopted.

To the indomitable zeal of the Chilian brothers, Juan and Mateo Clark, however, is due the major honor of the actual achievement. When, in 1872, having fulfilled their contract for the installation of a telegraph line across the Andes, they applied to the Argentine Congress for railway concessions from Buenos Aires to the Chilian frontier, they were regarded by many as idle dreamers. Yet one of the brothers, happily, has lived to realize the triumphant fulfillment of his dream.

In 1874 the Argentine concessions were obtained by the Clarks; in 1878 the contract was signed; but many obstacles arose and it was not until 1886 that a company—The Transandine Railway—

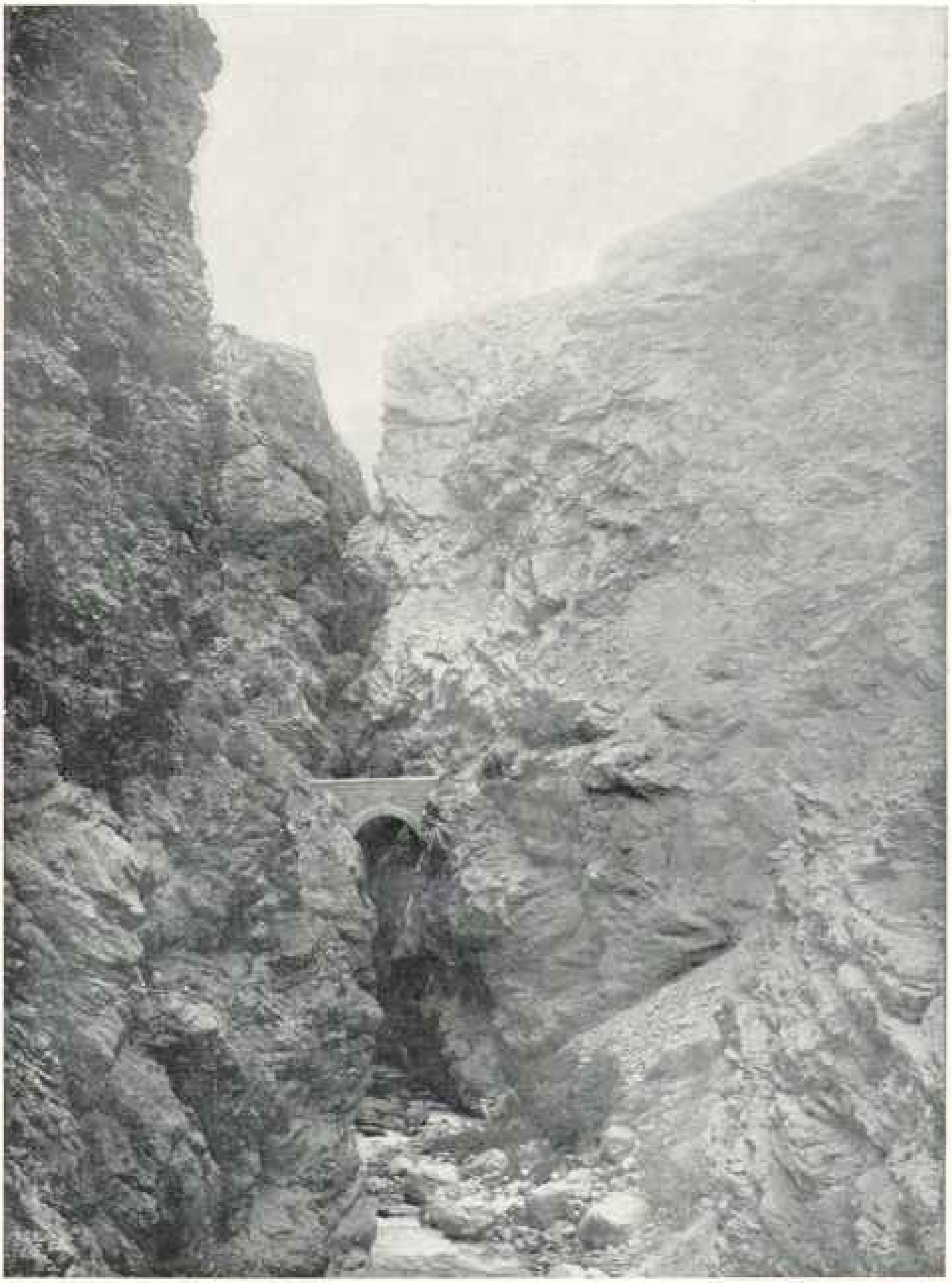


Photo from W. R. Grace & Co.

THE SALTO DEL SOLDADO BRIDGE ON THE TRANSANDINE RAILROAD

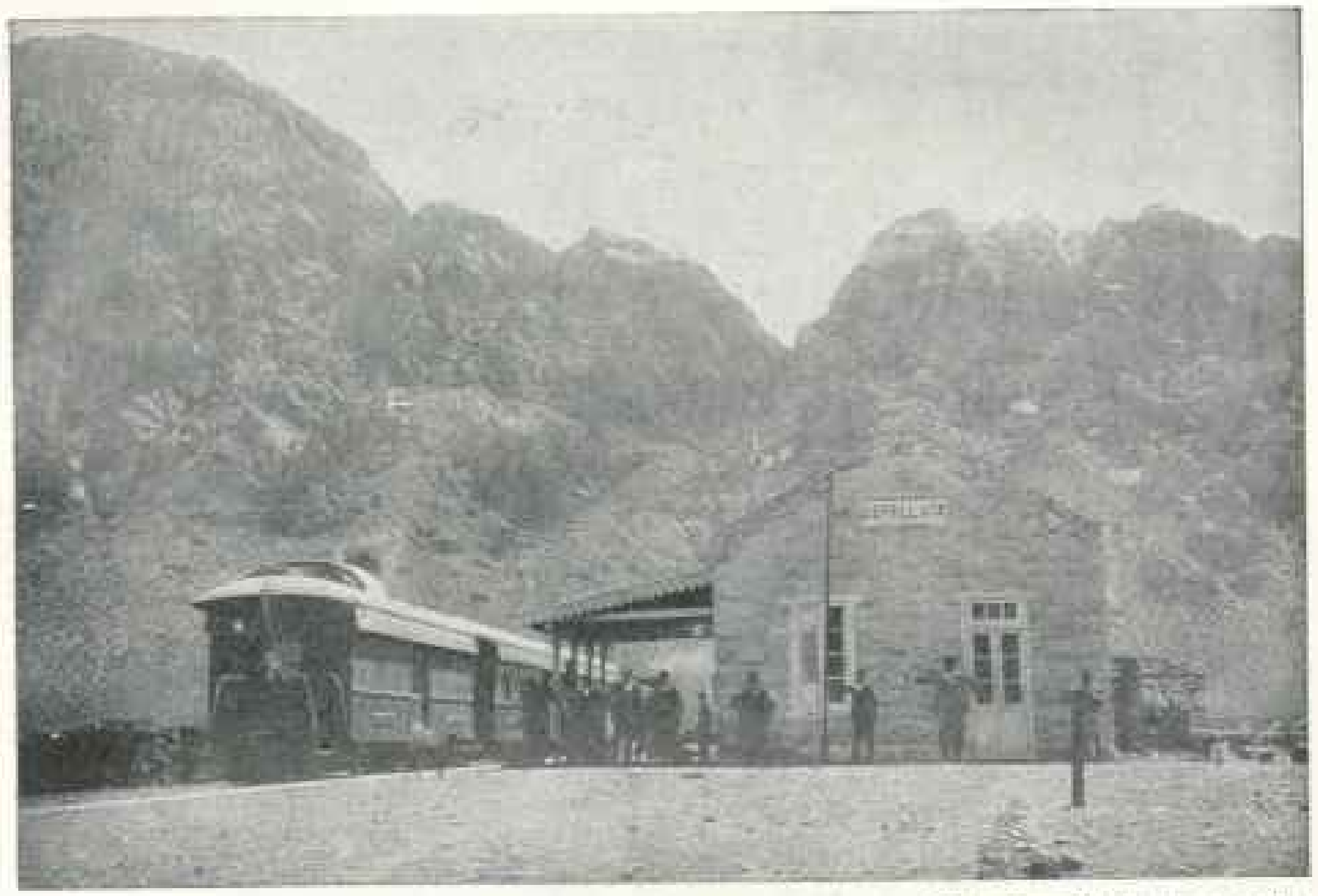


Photo from W. R. Grace & Co.

STATION OF USPALLATA, ARGENTINA

was incorporated to carry out the undertaking. Actual work on the road was at last commenced, and in 1888 the first train left Mendoza, bound westward toward the Andes. The construction now continued steadily until 1891, when work was suspended for eight years.

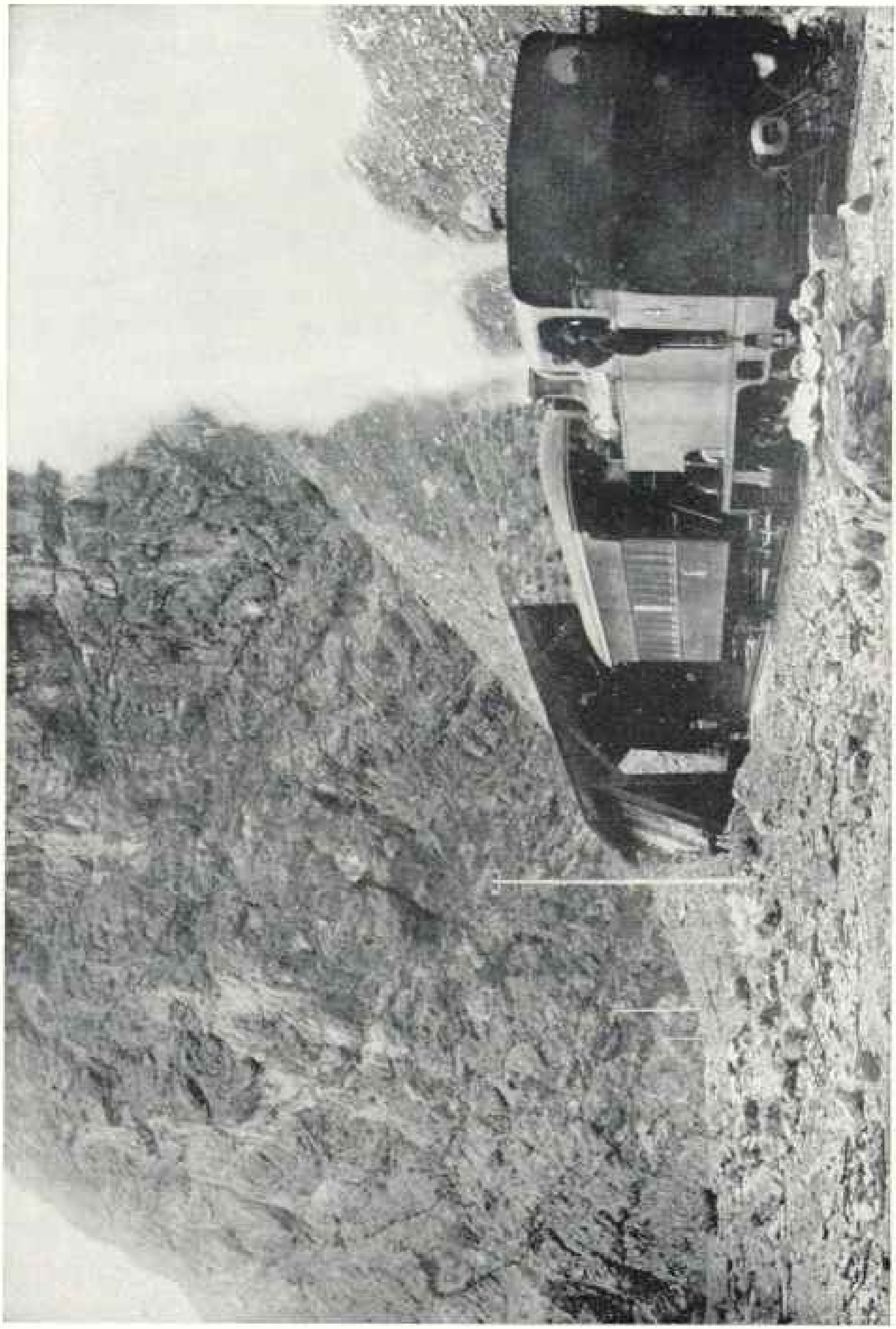
Meanwhile the Clarks had obtained a Chilian concession for a railway from Valparaiso eastward to the Argentine frontier, and work on this end of the line was begun in 1889. Eventually the Clark brothers were obliged, through financial embarrassment, to give up these concessions, and both divisions came under the control of an English company.

In 1899 work on the Argentine side was resumed and steadily prosecuted until the approach of the summit tunnel was attained. Construction on the Chilian side, on the contrary, progressed slowly, and it was not until 1903, when W. R. Grace & Co., of New York and London, were awarded the contract of completing the road, that work at the western end was energetically carried on. In 1906 an agreement was entered into by the companies representing the road on the two sides of the Andes.

### THE SUMMIT TUNNEL: A MARVELOUS ENGINEERING FEAT

It was agreed to pierce the summit tunnel, the final connecting link, by means of the same contractors and under one control and authority. The result has demonstrated the wisdom of this decision.

The drilling of this unique passageway, two miles in length and situated two miles above the sea (although 2,000 feet below the mule trail over the mountain pass of Uspallata—12,605 feet), was a stupendous undertaking. Fortunately, engineering science, and improved appliances for tunneling in particular, has made great strides since those early days when the Transandine was projected—when the piercing of this Cumbre, or Summit, tunnel was reckoned as an in-



SNOW-SHEDS AT THE ENTRANCE OF ONE OF THE TUNNELS OF THE TRANSSIBERIAN RAILROAD

Photo from W. R. Grace & Co.


SKETCH-MAP OF RAILROAD FROM BUENOS AIRES TO SANTIAGO, 888 MILES LONG

superable obstacle in the completion of the road. It was on November 27 of last year that the workmen, approaching from opposite sides of the tunnel, faced the last rocky barrier preventing Argentine and Chilian traffic by rail. It was an old Italian, Felipe Fascio, for many years employed in similar Alpine undertakings, who placed the final fuse of demolition. So came about the conquest of the Andes, and the Buenos Aires-Valparaiso rail route is at last a reality.

It is expected that the "Transcontinental Express" will make the through journey from coast to coast in about 34 hours. Before the completion of the road, when the missing rail gap was covered by diligence and saddle during the summer season (October to May), 3½ days were necessary for the journey. During the winter months of June, July, August, and September, when the Andean snows made passenger traffic at all times dangerous and often impossible, the sea voyage by way of the Strait of Magellan from Buenos Aires to Valparaiso occupied a period of about 11 days. Well-built snow-sheds in the Andean section will now insure safe passage for trains, even under the most unfavorable weather conditions.

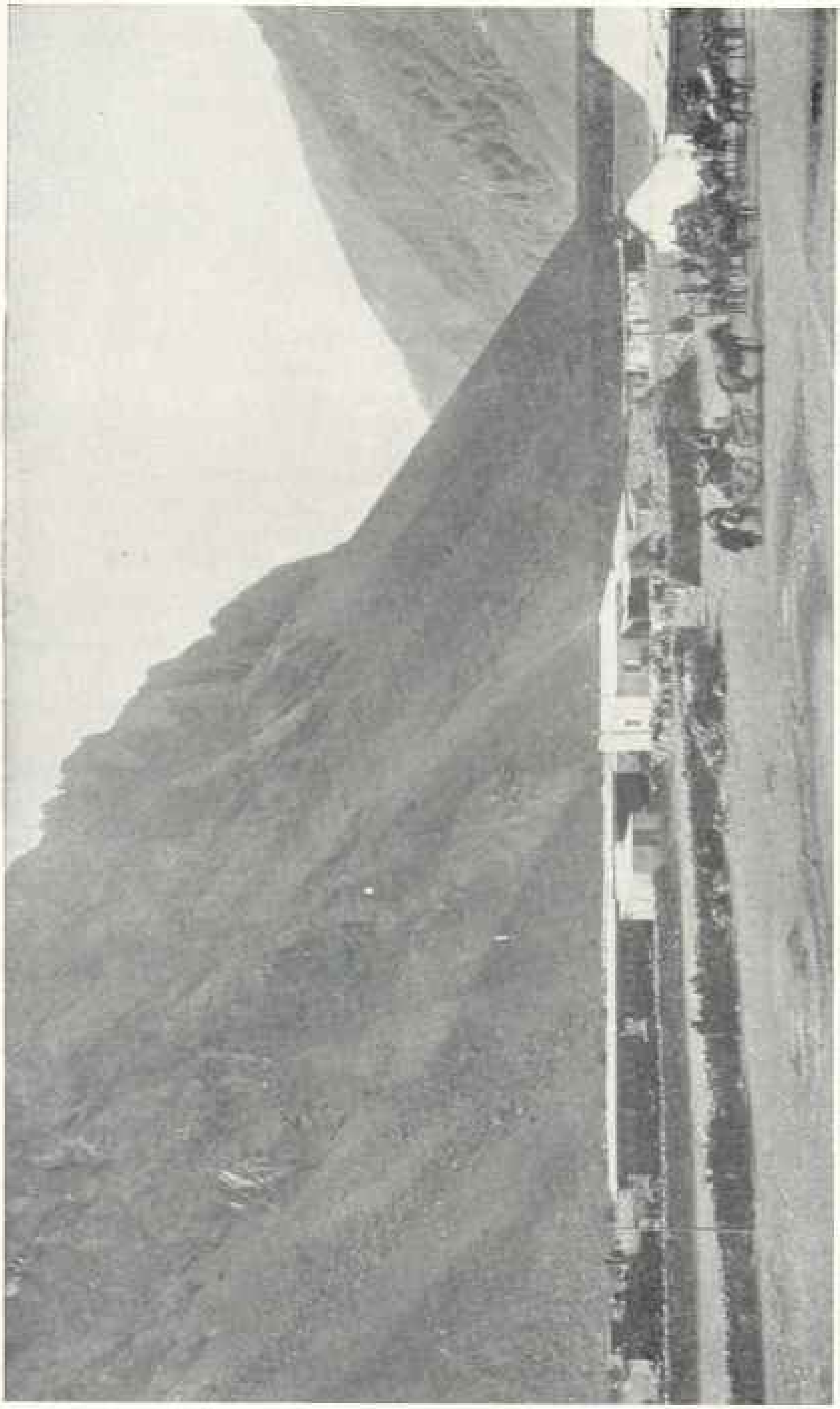
### DIFFERENCE IN GAUGE A SERIOUS INCONVENIENCE

The Transandine Railway is not, as many suppose, one continuous line under one management, a number of companies being associated with the undertaking. "The Buenos Aires and Pacific Railway" (Buenos Aires to Villa Mercedes), "The Argentine and Great Western Railway" (Villa Mercedes to Mendoza), and "The Argentine Transandine Railway" (Mendoza to Argentine frontier) are three distinct organizations, but have, quite recently, come under the management of the first-named company. "The Chilian Transandine Railway" (Chilian frontier to Los Andes) and "The Chilian Government States Railway" (Los Andes to Valparaiso) are each under separate management.

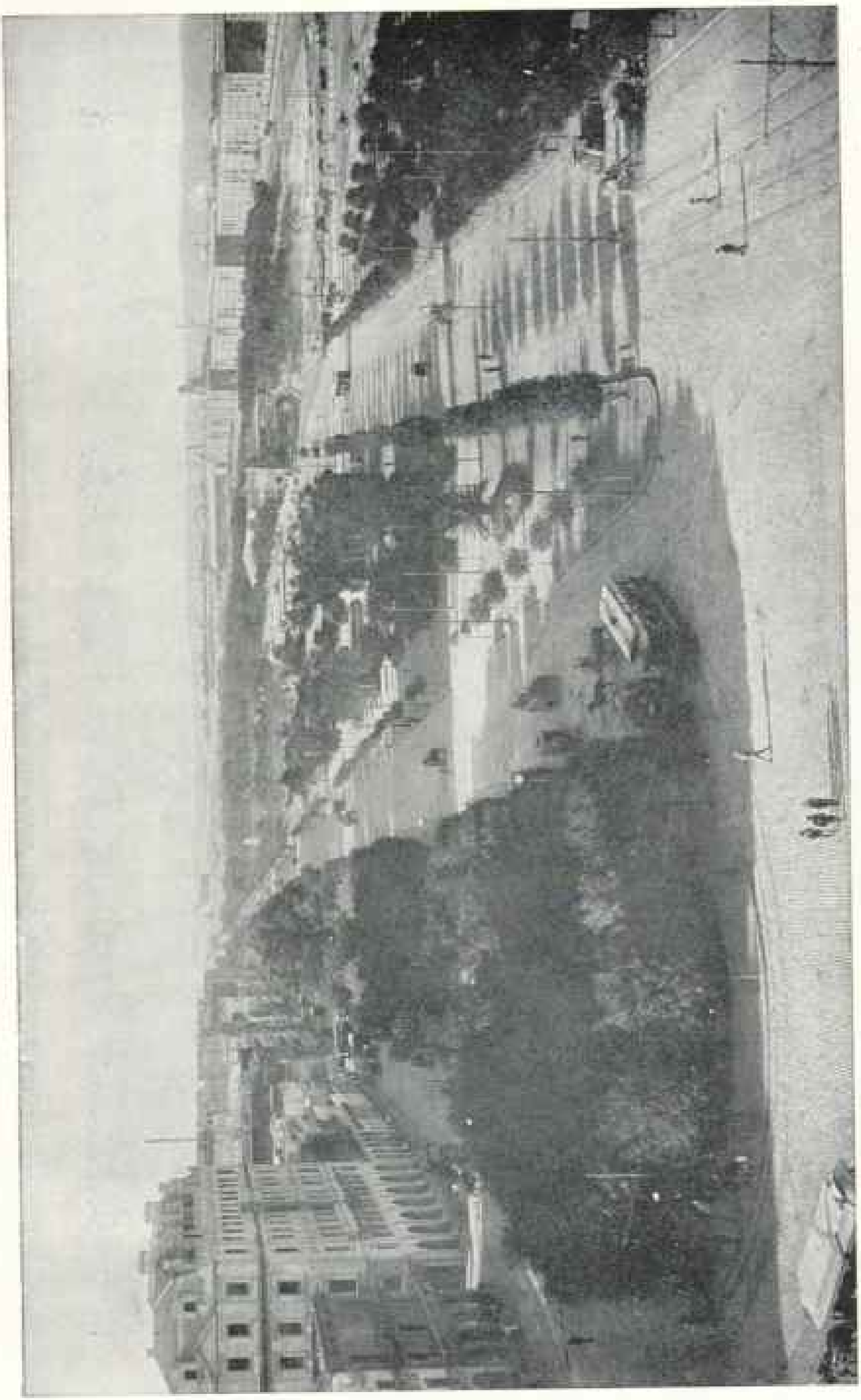
There is one serious drawback in this railway communication between the two oceans, and this is a matter of gauge. "The Buenos Aires and Pacific" and "The Argentine Great Western" are broad-gauge roads, while "The Argentine Transandine" and "The Chilian Transandine" are narrow gauge, and "The Chilian Government States" broad gauge again. This necessitates a transshipment of goods on both sides of the Andes—at Mendoza, the terminus of "The Argentine Great Western," and at Los Andes, where the two Chilian roads connect. These two changes naturally tend to the making of unduly high freight charges as compared to those now ruling on the longer sea route.

### THE POSTMAN OF THE SNOWS

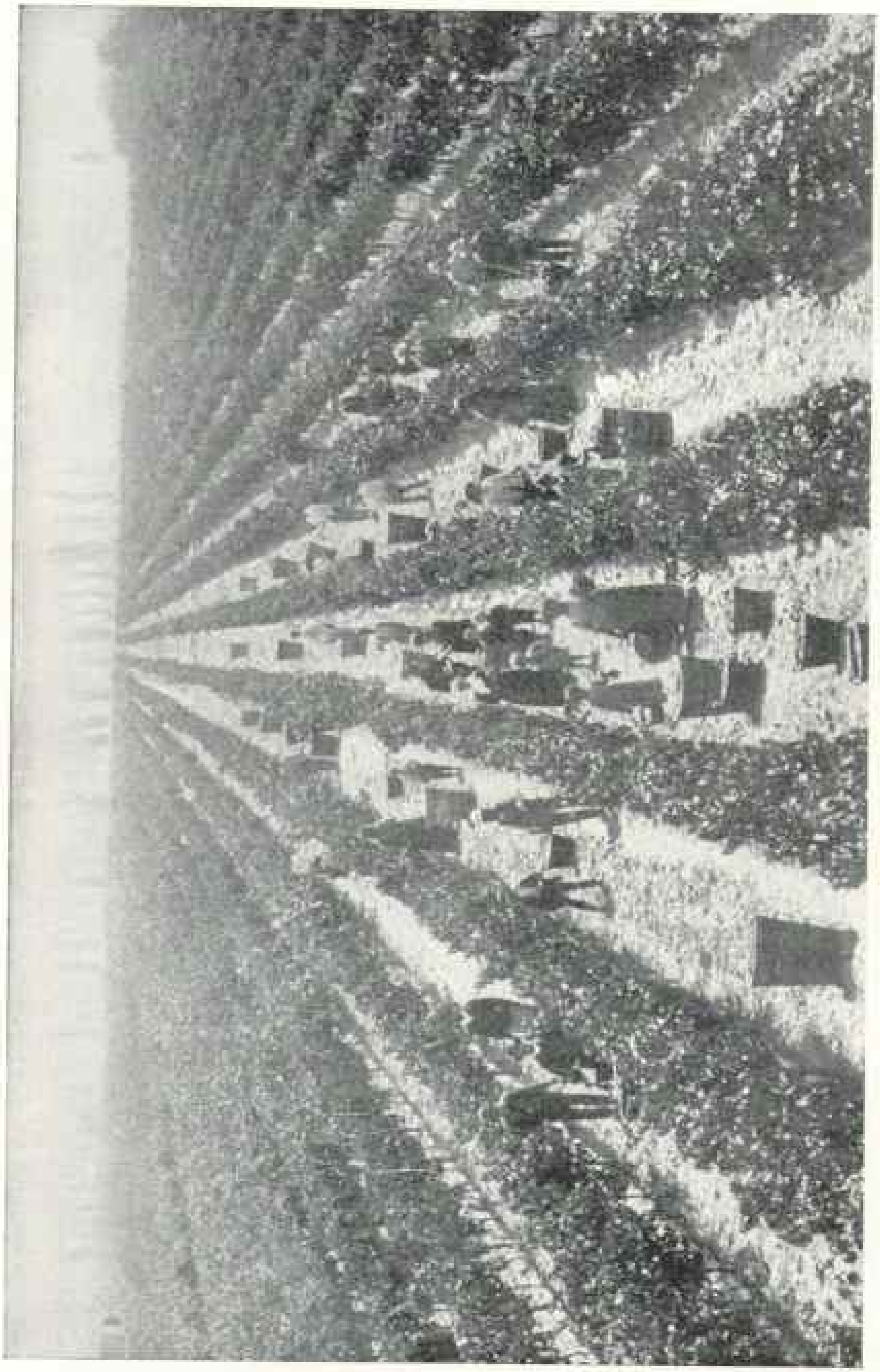
"Across the Andes," meaning the old route via diligence and saddle from Las Cuevas, the former terminus of the railway in Argentina, to the Chilian town of Caracoles, where the traveler again



A STATION ON THE RAILROAD BETWEEN ARGENTINA AND CHILE  Photo from W. R. Grace & Co.



PASEO DE JULIO, THE WATER-FRONT BOULEVARD OF BUENOS AIRES, THE DEAD CAPITAL
Photo from Harriet Chalmers Adams



THE HEART OF THE VINE INDUSTRY, NEAR MENDOZA (SEE PAGE 410)

Photo from Harriet Chalmers Adams

boarded the train, is now an experience of the past.

Of the past, too, are those unsung heroes, the mail-carriers of the mountains, laden with letters and packages marked "Via Cordillera," who braved the bitter cold and the savage snows of the Andean winter. It was about the middle of May, under the old régime, when the stage-coach companies suspended traffic, employees and stock making their way to the lowlands.

Rain and blizzard, sleet and snow, now were masters of the uplands, and avalanches "rushed madly down the mountain sides." No pen picture can describe the hardships and privations endured by the men then entrusted with the mails. The precious burden was carried in leather bags strapped to the back, and a curious foot-gear called the "*tomango*" was worn. It consisted of a sheepskin wrapped around the foot, with the fur next to the skin, this unwieldy hose being bound to the leg by thongs of leather which supported an immense leather sole. A poncho, woolen trousers, a long stick with a steel spike, and a small bag containing rations (dried meat, biscuit, and onions) completed the outfit.

The government has built small stone refuge huts ("*casuchas*") along the trail, and into one of these cheerless shelters the exhausted postman of the snows crept at nightfall, shivering through the dark hours, for there was seldom wood obtainable for fuel. Nature resents man's intrusion into her ice-bound domain, and frost-bites are her usual punishment in the Andes. Only too frequently men lost their way in the newly fallen snow—and the mail never reached its destination.

An American now living in Chile made a winter journey across the Andes last season, and he pays a glowing tribute to these "big children of the mountains," the mail-carriers, who were his companions.

"They are the bravest and sturdiest creatures on the face of the earth and have hearts of gold," he writes. "Their wrinkled, leather-like faces bear the marks of the terrible adventures which they related to me, as we huddled together for warmth under the life-saving oven-shaped shelter during the long, bitter night."

### THE PARIS OF THE NEW WORLD

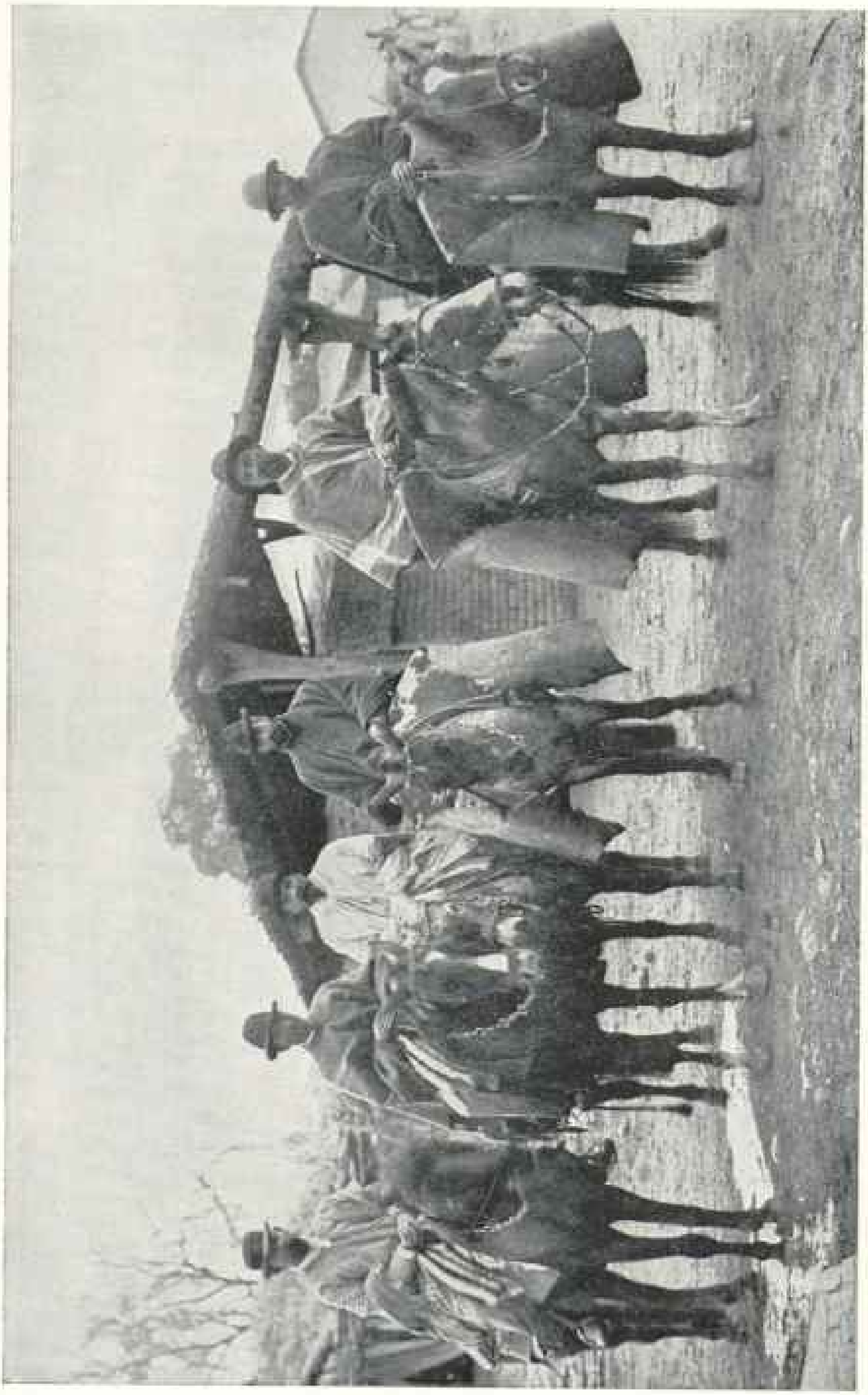
When it is autumn here in North America and we are beginning to think of furs, it is Primavera (first-view), or spring-time, and the peach trees are blossoming in Argentina and in Chile. It is then that the traveler bound across the mountains has a comparatively comfortable journey. We will start from Buenos Aires, traverse the width of Argentina, and cross the Andes into Chile in the old way.

There is hardly a capital in Latin America that has not at some time been labeled "the Paris of the New World." I have visited them all, from Mexico City to Santiago de Chile, from Havana to Panama, and, in my opinion, the title belongs alone to Buenos Aires.

Well built and progressive, artificially beautiful and of cosmopolitan air, the metropolis of Spanish America is a city of which the Argentinos may well be proud. It ranks among the great capitals of the world. The traveler is loath to leave its four miles of splendidly constructed docks, where the flags of every nation wave (save that of the United States of America); its brilliantly illuminated avenues and dazzling cafés; its beautiful Park of Palermo, where the best-gowned women of the South, the pride of the Paris modiste, fascinate the beholder as they drive by in their perfectly appointed victorias. Although founded nearly four centuries ago, Buenos Aires seems as modern as Chicago.

The people who live in this city near the mouth of the Silver River are termed locally *Puerteños*, or "Keepers of the Gate," while those outside the glittering capital, on the vast almost treeless pampa stretching away to the foothills of the Andes, are dubbed *Campoñeros*, of El Campo (the country), or "The Camp."

Buenos Aires is the gorgeous outer



STARTING ACROSS THE ANDES IN THE DAYS BEFORE THE RAILROAD

The curious leggings are sheepskins wrapped around the foot with the wool next the skin. (See page 405)

Photo from Harriet Chalmers Adams

THE COWBOYS OF THE PAMPA

garment, but the heart of Argentina lies beyond the merry throngs, far beyond the fashionable suburbs of Belgrano and Florista, out on the boundless pampa, through which we will journey by rail.

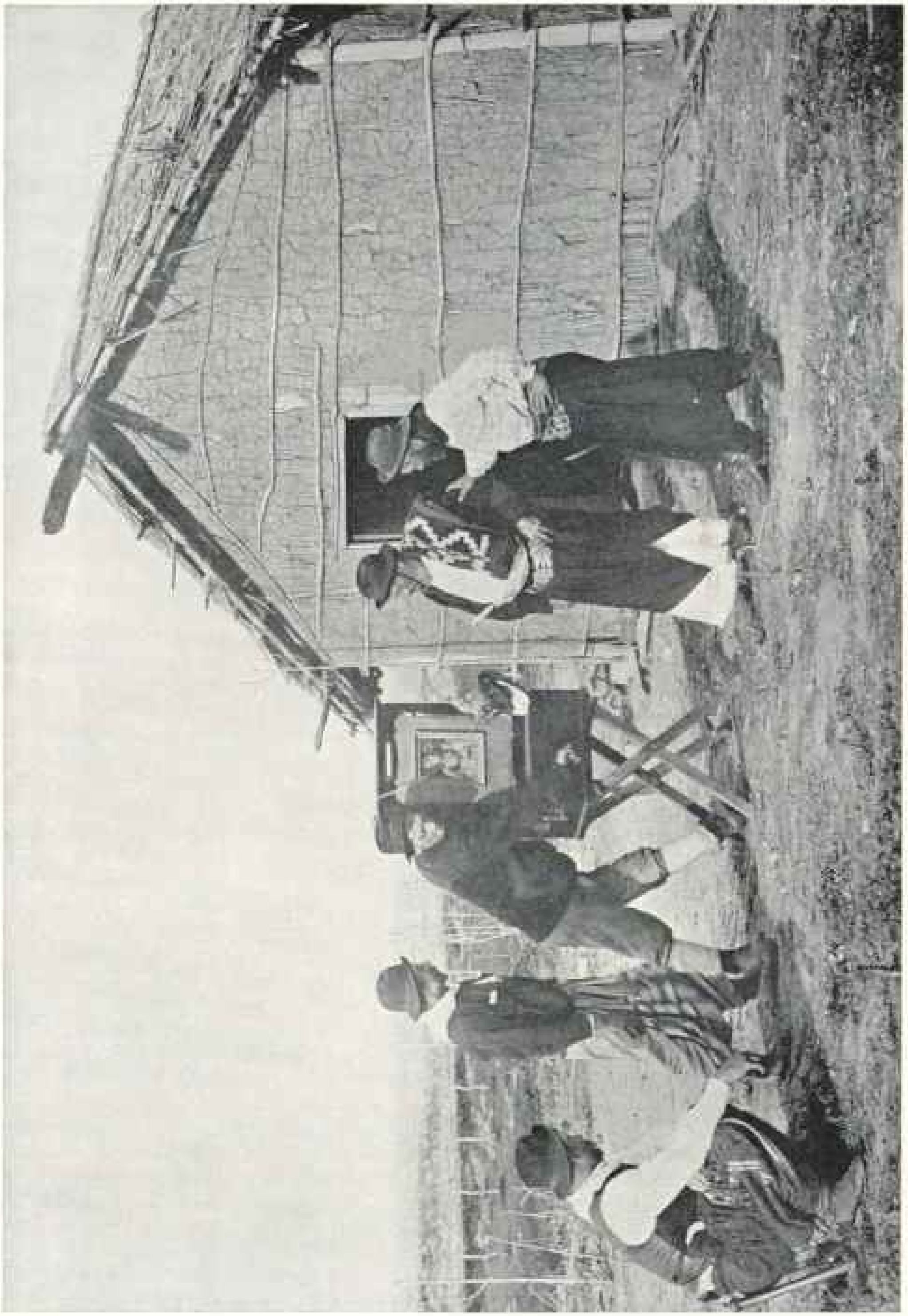
"The International Express" leaves Buenos Aires in the morning, so we have a day's view of the country stretching southward from the railway before the foothills are reached. The longest straight stretch of track in the world (175 miles) lies between Vedia and Mackenna, on this line.

### ARGENTINA EXPORTS MORE FOODSTUFFS THAN THE UNITED STATES

The development of Argentina has been nothing short of marvelous. The Republic is one of the few countries in the world today with advancing trade values. In 1909 there was a yearly gain of $61,000,000 in foreign commerce, and the exports exceeded the imports by more than $94,000,000. The wool and frozen-meat industries have developed rapidly, and when it comes to grains the figures are simply amazing. Two and one-half million tons of wheat and over two million tons of corn went out of the country last year to feed the hungry people of the world. The United States of North America now plays second fiddle to a southern sister in the exportation of foodstuffs. Argentina leads the world in the exportation of grains.

Many of the ranches, or "estancias," in "The Camp" are owned by Britishers. The men who do the work, however, the cowboys of the Pampa, are the *Gauchos*, who are, as a rule, native born. Inferior physically to our cowboys of the West, these men are far more picturesque in costume. They are especially fond of ornamentation—fringed leather and silver trappings, tight boots with silver stirrups, and their saddles are bedecked in a similar fashion. With the encroachment of the railroads and modern civilization, the *Gaucho* is losing much of the old-time charm so long associated with his name, but, with his wild life and his combats, his songs and his dances, he still plays the star rôle in "The Camp."

On our journey across the country we see many of these unique ranchmen at the railway stations. At Rufino, half way to Villa Mercedes, the low-lying land is covered with water, and myriads of ducks, gulls, and other water fowl



CAMP MUSICIAN ON THE PAMPA

Photo from Harriet Chalmers Adams

PLATE FROM HARRIET CHALMERS ADAMS' "THE SPELL OF SOUTH AMERICA"

Plate from Harriet Chalmers Adams' "The Spell of South America"

BORDER OF ARGENTINA AND CHILE

darken the ponds as far as the eye can reach.

After leaving Villa Mercedes we are on "The Argentine and Great Western" until we reach Mendoza, where we change to the narrow gauge of "The Argentine Transandine." If we have anticipated any discomfort, thus far we are agreeably disappointed. We have journeyed in a comfortable "sleeper" and have voted the "diner" excellent.

Mendoza is a hustling little town in the heart of the wine industry. Many Italians come here annually from the mother country to work in the vineyards, returning to Europe when the season is over.

In the past much Chilian wine has found its way across the border, but this export is decreasing with the remarkable development of the wine industry in the Argentine province of Mendoza. The export from Argentina into Chile is mainly that of cattle. Many of the staple commercial products of the two republics are now identical, and it is feared that the producers on either frontier will clamor for protection against one another, now that there is an easier method of transportation. Argentina's important exports of grains, hides, and beef, and Chile's nitrates and copper will be sent abroad by sea as heretofore, but the manufactured goods imported into these countries from Europe and America will probably cross the continent by rail.

### THE CHRIST OF THE ANDES

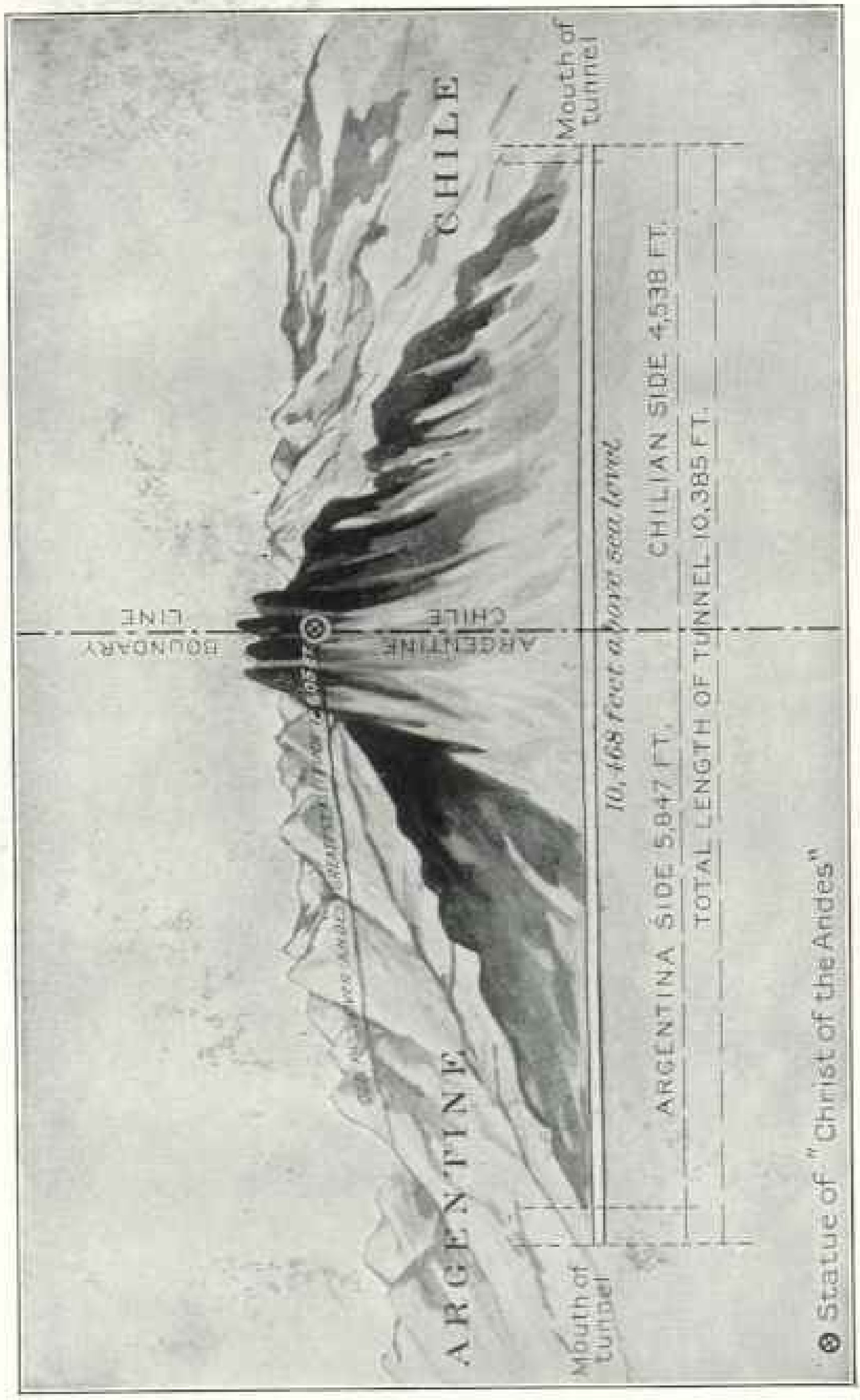
Leaving Mendoza, we begin to climb, and the temperature falls as the altitude increases. At Puente-del-Inca there is a natural bridge spanning the mountain torrent. Here are situated the famous medicinal baths (more accessible to Chilian invalids since the opening of the Summit tunnel). Arriving at Las Cuevas, we leave the train, an army of beponchoed guides and sturdy mules awaiting us. We and our heterogeneous belongings are to be borne by the patient little beasts up over the Cumbre, 12,565 feet above sea-level. Great trunks and hat-boxes bearing flaring European labels, golf clubs, tennis rackets, bags, and boxes of all sorts and descriptions are loaded on panier-wise, and off we all jog on a trot for Chile.

A good-natured crowd of passengers usually, these who cross the Andes, making light of cold and of unaccustomed mounts. It is a different story in the Andean passes farther north, where the occasional wayfarer endures extreme hardships. The Pass of Uspallata has been a highway for so many years that its rugged walls no longer look formidable to the summer traveler.

Less than an hour after leaving Las Cuevas we reach the summit and pause to marvel at the panorama. The guides, meanwhile, arrange saddles and tighten girths for our slide down the Chilian wall. Snow-crowned mountains rise on every side, salient rocky peaks here and there piercing the blue. Dominating the heights, yet ruling through the power of love rather than of might, "The Christ of the Andes" stands on the summit, on the borderland of the two republics.

Cast from the cannon of the two nations, this symbol of peace and fraternity was erected at the time of the border dispute, when the King of England acted as arbitrator. On a gigantic column, surmounted by a globe on which the configuration of the earth is outlined, this colossal figure, 26 feet in height, stands holding a cross in one hand, extending a blessing with the other.

The conception of such a monument came from the hearts of two natives of Argentina, Bishop Benavente and Señora de Costa. It was the splendid woman, Señora de Costa, who, as president of the Christian Mothers' Association of Buenos Aires, undertook the work of securing funds for the creation of the statue. The Argentine and Chilian authorities were later interested in the work and, in March, 1904, three thousand Argentinos and Chilians assembled to witness the unveiling of the monument. The venerable Bishop Benavente himself offered up a solemn mass and blessed the peace flag, which embodies the colors of all the flags of the Americas.



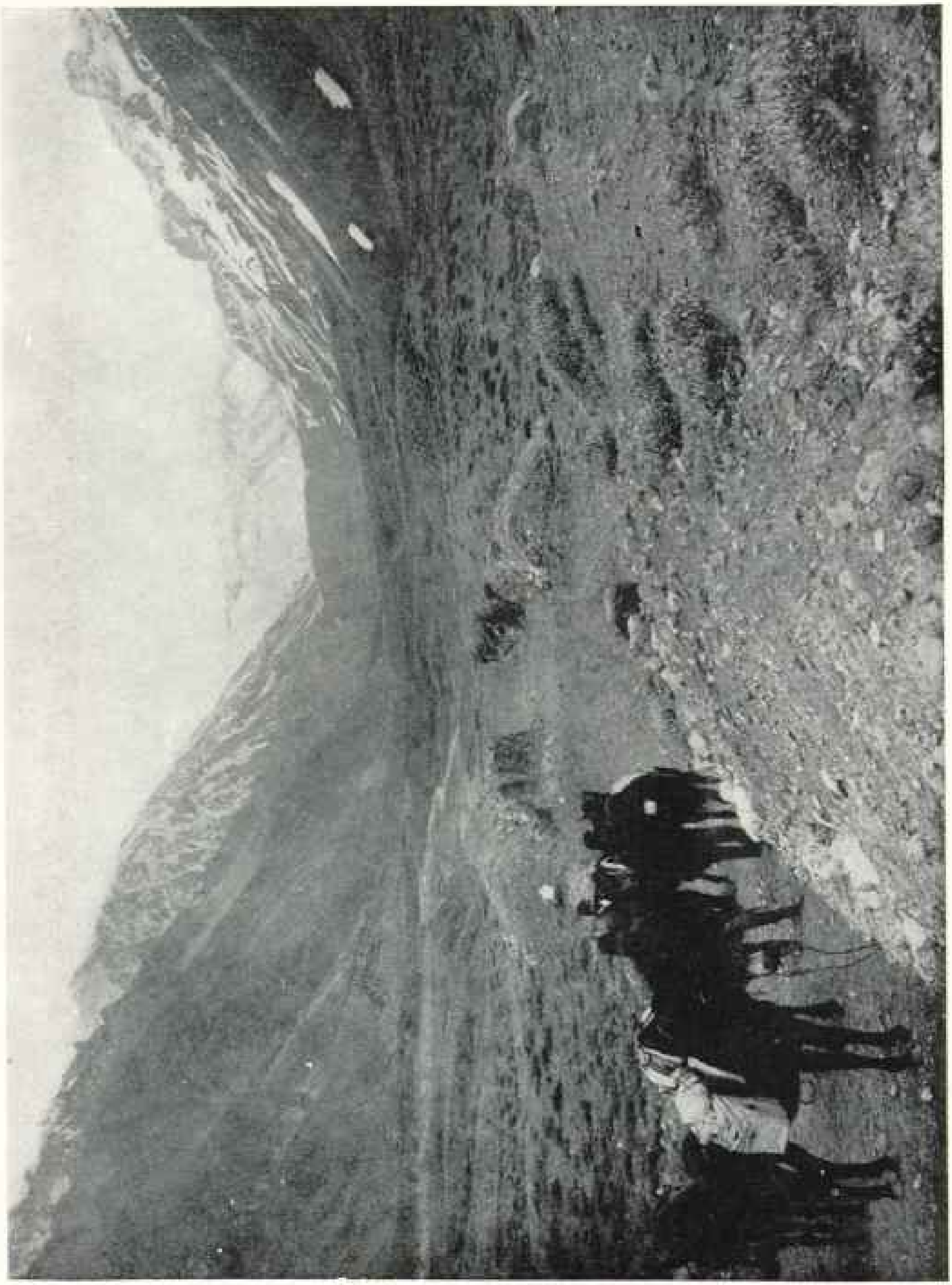

Courtesy of Bulletin of the Bureau of American Republics

PROFILE OF THE TRANSANDINE TUNNEL BETWEEN CHILE AND THE ARGENTINE REPUBLIC

STONE REFUGE-HOUSE IN THE ANDES

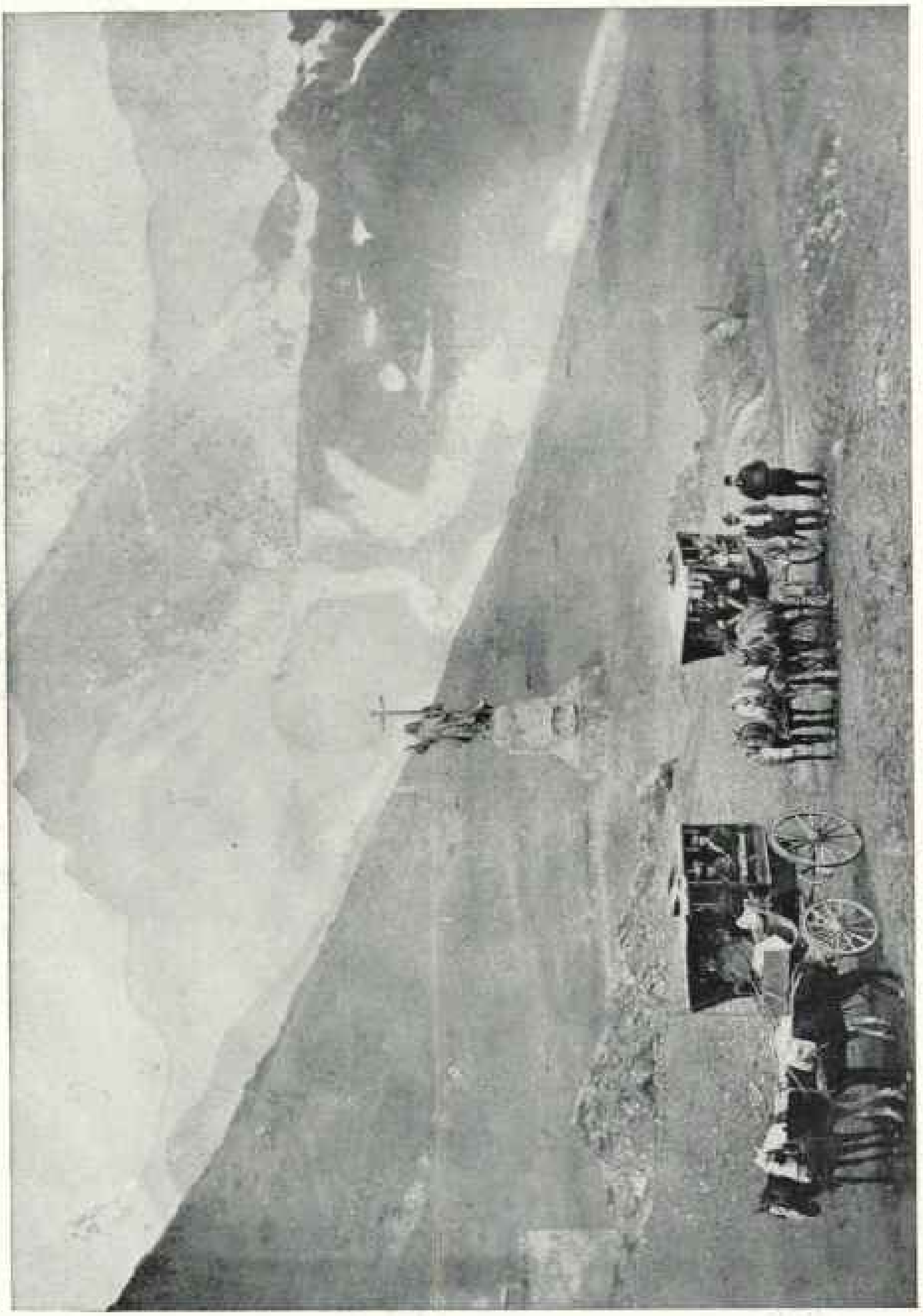
Photo from Harriet Chalmers Adams

Houses of this character have been built at short intervals along the dangerous parts of the highways over the Uspallata and other frequented passes of the Chile-Argentine Andean Range, the first one having been erected in 1791 by Governor Ambrosio O'Higgins. Violent storms sometimes overtake travelers crossing the mountains, and refuge is afforded in these houses until the fury of the tempest abates (see page 405).



IN THE ANDES OF CHILE

Photo from Harriet Chalmers Adams



Photograph from Harriet Chalmers Adams

CHRIST OF THE ANDES, ON THE SUMMIT OF THE CORDILLERA BETWEEN CHILE AND ARGENTINA

(SEE PAGE 410)

The motto on this banner proclaims "Peace to all nations," while the statue's base bears in Spanish the following legend: "Sooner shall these mountains crumble into dust than the people of Argentina and Chile break the peace which they have sworn to maintain at the feet of Christ the Redeemer." Long may this symbol of everlasting love guard and guide the two great sister republics of the far south!

### ON THE CHILIAN SIDE

It is not an exaggeration to say that we slide down to Caracoles, in Chile. The sure-footed little mules following in the rear resemble alighting aeroplanes, their loads projecting like wings. It is a half hour's jog to the little railway station of Caracoles, and we are off for Los Andes. Down steep grade, through tunnels cut out of solid rock, across many a bridge, we fly; down from the forbidding heights into the zone of farms and on to the lovely, verdant valley, where the pretty town of Los Andes nestles in the shadow of Aconcagua, the highest mountain in the Western Hemisphere.

The mountains which guard the Pass of Uspallata are merely little brothers of the giant Aconcagua, which towers 23,300 feet above sea-level. Those who have attained its summit tell of the incomparable view; of the sheer drop of 10,000 feet to the east; of the vast expanse of snow-clad mountains to the north and south; of the declining peaks to the west, diminishing into the green Chilian lowlands, which melt into the far-away sea.

At Los Andes we again change cars for the capital. Santiago de Chile rivals in situation every capital in the New World, with the exception of Rio de Janeiro. The emerald of its surrounding meadows is in sharp contrast to the towering mountains in the background. After sunset Santiago seems of heaven rather than of earth. Then the *Cordillera de los Andes* gleams flame and gold ere a mantle of purple plush envelops the valley. Less dazzling than Buenos Aires, less practical than Valparaiso, Santiago de Chile possesses a dignity foreign to these others, with more of the Old World charm.

Valparaiso we reach by express in a few hours. It is a half Chilian, half Anglo-Saxon city. The British have come to stay in this great South Pacific seaport. The British-Chilian combination, like the American-Chilian, produces a splendid type. Travelers class as the beautiful harbors of the world Rio de Janeiro, San Francisco, Sydney, Naples, Constantinople, and Cork. We add Valparaiso to the list of portal queens.

And so we have crossed the continent in a little over three days. Via the Summit Tunnel we will cross in 34 hours. The Christ of the Andes will always have its pilgrims; the peasants will follow the trail in the footsteps of their fathers; but the traveler will choose the easier route and will forsake the Cumbre and the mule.

### OTHER NOTABLE SOUTH AMERICAN RAILWAYS

In writing of the Transandine, the other important railroads of South America come into view. In Peru are the two highest railways on earth, the Oroya and the Southern Railway. On the Oroya it is possible to climb over 15,000 feet in a single day from the Pacific Ocean to the roof of the Western world. These two roads are a monument to the late Henry Meiggs, a North American engineer. In Northern Peru projected lines cross the Andes and drop down into the Amazonian Valley. In northern Chile railways also ascend to the highlands, and a line nearing completion will connect the Chilian port of Antofagasta and Bolivia's picturesque capital, La Paz, with the northern towns of Argentina.

In Brazil the railways are striking westward from the coast, aiming for Matto Grosso, the rich inland province of the mighty republic. The far-famed interior Madeira-Marmoré road is progressing rapidly. Quaint Quinto is now reached by rail from its port, and Bogatá is connected with its river highway, the Magdalena. Lesser lines in existence

CHILEAN SOLDIERS GREETING THE FIRST TRAIN FROM ARGENTINA ON THE TRANSANDINE RAILWAY

Photo from R. S. Carpenter

and in projection throughout the continent add their note to the "Song of the Ties," and we shall live to see more than one other Transandine railway, although the completed Pan-American road belongs to the far-distant future.

This first transcontinental railway of South America marks a new era in the continent's commercial history, and in our own. With the opening of the Panama Canal we North Americans will have a golden opportunity to win from Germany and England the trade which is ours by the right of contiguity. Through gross lack of understanding of our Southern neighbors, we have lagged behind in the commercial race. European nations have intelligently developed trade with Latin America, but it is only in recent years that we have followed in their wake.

The Transandine Railway sounds the bugle call, not alone of Argentine and Chilian development, but of the growth and prosperity of the entire continent. We owe better acquaintance to our Latin sisters. We owe commercial advancement to ourselves. Ships should carry our flag into Southern waters. We should take first rank in the near future in South American trade.

## THE FIRST TRANSANDINE TRAIN

A MEMBER of the National Geographic Society, Mr E. N. Carpenter, of Wilkes Barre, Pennsylvania, who happened to be in Chile in April, participated in the formal opening of the Transandine Railway, April 5. From his letter to the Society the following is printed:

"The special train left Santiago, Chile, Monday, April 4, with about 150 guests, including cabinet ministers, senators, deputies, and government officials. We were comfortably quartered that night in the railroad hotel at Los Andes, from which point the railroad is one-meter gauge to Las Cuevas, on the Argentine side. The altitude of Los Andes is 824 meters and that of the tunnel, 43 miles distant, 3,200 meters. The rack railroad begins at Rio Blanco, on the Chilian side, and climbs 6,000 feet in the 26 miles to the tunnel.

"Our train left Los Andes in two sections early Tuesday morning, April 5, and, after several brief stops, finally reached Carracoles, at the mouth of the tunnel, where it was made up in one section. We then proceeded into the tunnel, where, at the international boundary, which was marked by a string of colored incandescent lights, we met the train carrying the Argentine delegation from Buenos Aires. Greetings over, both trains returned to Carracoles, where we were received by a body of Chilian infantry, while the band played the national airs of Chile and Argentina. A large tent had been erected in which "almuerzo" was served, followed by speeches by prominent representatives of both countries.

"This over, the Chilian train escorted the Argentine delegation through the tunnel to Las Cuevas, and, after farewells were said, both parties started on their homeward journey, we reaching Santiago late the same night."

# FEDERAL FISH FARMING; OR, PLANTING FISH BY THE BILLION

By Hugh M. Smith
U. S. Deputy Commissioner of Fisheries

IT was nearly forty years ago that the United States Government first awoke to the necessity of conserving the aquatic resources of the country, and began those operations in behalf of fishes, fishermen, and fish-eaters that have now attained such gigantic proportions.

Several of the States had already established their local fish commissions or boards when in 1871 Congress took the initial step toward a national fishery service by the passage of a joint resolution creating the office of commissioner of fish and fisheries.

The early years of the Bureau of Fisheries were devoted to an investigation of the condition of the fisheries of the Atlantic coast, Great Lakes, and other sections; to studies of the interior and coastal waters and their inhabitants, and to exploration of the off-shore fishing banks. The cultivation of useful fishes was soon taken up throughout the country, and quickly attained large proportions. The natural expansion of the work was materially augmented from time to time by acts of Congress, and in a comparatively short time the operations came to have a very wide scope.

From year to year, as the importance of the work has become increasingly evident, additional hatcheries have been built, the capacity of existing hatcheries has been enlarged, the scale of the operations has been extended, and new kinds of fishes have been added to the output.

Today there is scarcely a phase of aquiculture, of the fishing industry, or of biological and physical science as connected with the waters, that does not come within the purview of the bureau.

## CULTIVATION OF FOOD-FISHES

It is conceived to be the better policy to expend a small amount of public money in making fish so abundant that they can be caught without restriction and serve as cheap food for the people at large, rather than to expend a much larger sum in preventing the people from catching the few fish that still remain after generations of improvidence.

Public or government fish-culture in America exceeds in extent and importance that of all other countries combined. However, the neglect of some of the states to provide the minimum protection to certain species inhabiting interstate and international waters has not only negatived the fish-cultural work of the bureau and of the states themselves, but has practically inhibited it by preventing the possibility of securing an adequate supply of eggs, thus making desirable and necessary the placing of interstate and international waters under the jurisdiction of the general government.

At the end of the first ten years of the bureau's existence, the fishes that were being regularly cultivated were shad, carp, chinook salmon, Atlantic salmon, land-locked salmon, rainbow trout, brook trout, and whitefish, in addition to which the propagation of several others had been undertaken experimentally. The list now is six times as long and the annual output is ten times the aggregate for the ten-year period ending in 1881.

The main energies are devoted to the important commercial fishes—shad, whitefish, lake trout, Pacific salmons, white perch, yellow perch, cod, flatfish—and the lobster, which are hatched in lots of many millions annually. More widely popular, however, are the distributions of the fishes of the interior waters which are generally classed as game fishes. Although representing only about 10 per cent of the output of the hatcheries, this feature of the work is very important,

HATCHERY CREW MAKING A PLANT OF SHAD FRY ON A NORTH CAROLINA SOUND

Shad culture in North Carolina is now more successful than in any other State, owing chiefly to the support given the government by the State authorities (see pages 429 and 435)

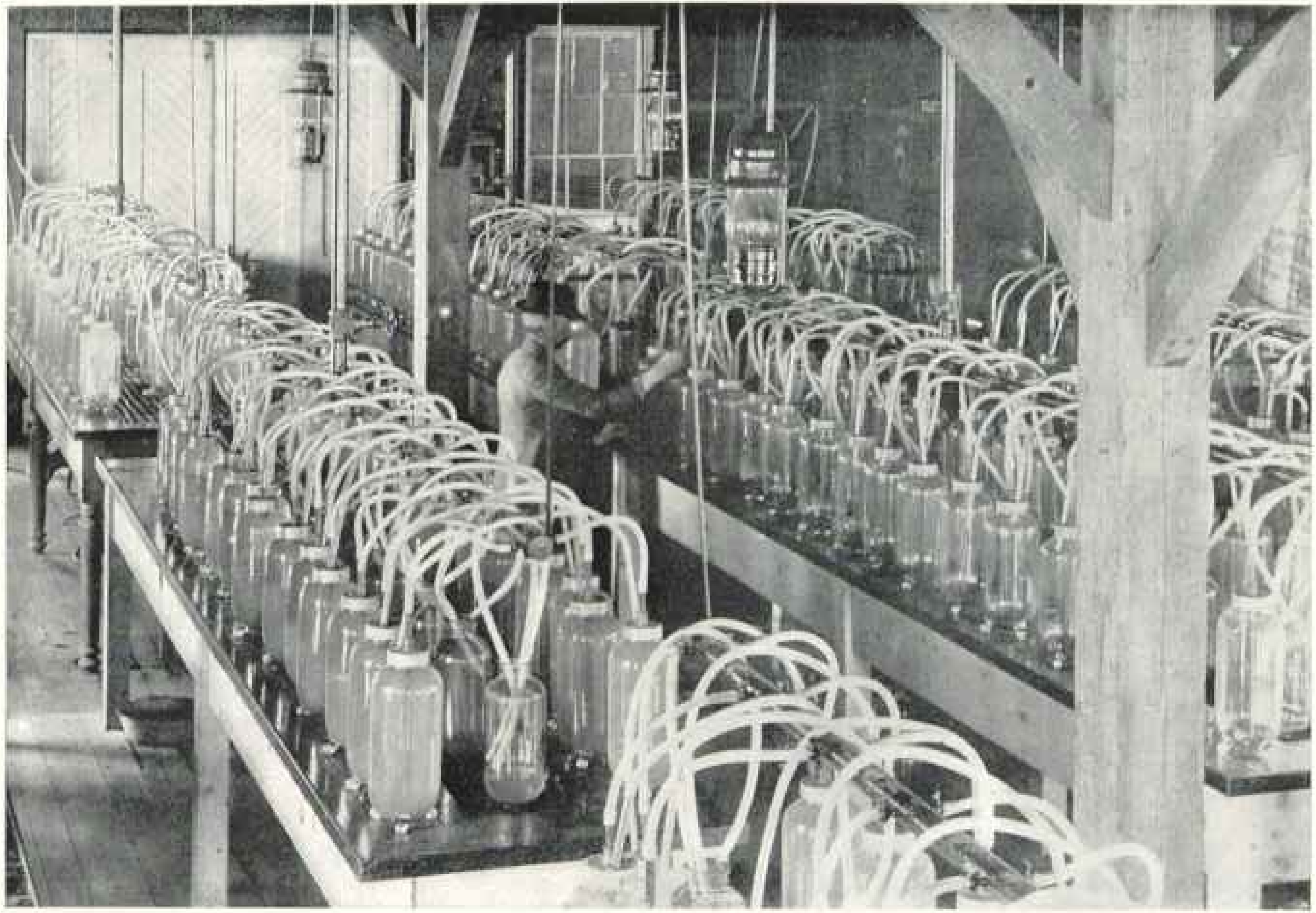
for it supplies choice kinds of fish for public rivers, lakes, and ponds, and for fishing preserves and private ponds and streams in all parts of the United States. The fishes most in demand for these purposes are the land-locked salmon, the different species of trout, the grayling, the basses, the crappies, the sunfishes, and the catfishes, but various others also are handled.

### NATIONAL FISH NURSERIES

Fish-cultural stations are established by special act of Congress, and their location and construction are determined after a careful survey of the available sites in a given state. The usual buildings are the hatchery proper, a residence for the superintendent and his family, and necessary outbuildings. At some stations there may be also power house, foreman's or fish-culturist's dwelling, mess hall, and stable. The superintendent's and other quarters are furnished gratis, but station employees provide their own subsistence.

The only permanent marine hatcheries are in Maine and Massachusetts, where the cod, pollock, flatfish, and lobsters are hatched in immense numbers. Other sea fishes that have in previous years been artificially propagated and may again come under the hand of the fish-culturist are the haddock, the scuppaug, the sheepshead, the sea bass, the mackerel, and the squeteague, some of which were hatched on the steamer *Fish Hawk* in Chesapeake Bay and Florida.

The fish-cultural work on the eastern coast streams was centered at 6 hatcheries and subhatcheries in 1909. At 1 of these the principal species handled is the Atlantic salmon, at 4 the shad, at 3 the yellow perch, at 2 the white perch, and at 1 the striped bass. In recent years the bureau has operated a shad hatchery on the



INTERIOR OF A SHAD HATCHERY IN THE CHESAPEAKE BASIN

The semibuoyant eggs of the shad are incubated in glass jars, from 85,000 to 100,000 eggs being put in each jar. The shad fry emerge in 3 to 10 days and are soon planted (see pages 429 and 435)

Delaware River, and has detailed the steamer *Fish Hawk* for shad hatching in Maine, New Jersey, North Carolina, and Florida. The central station, in Washington, is operated largely for experimental and exhibition purposes.

In order to counteract the effects of the very exhausting fisheries of the Great Lakes, the government has maintained hatcheries for many years, and now operates 6 belonging to the United States and 2 belonging to the State of Michigan. The fishes to which attention is given are those which enter most largely into the catch of the fishermen, namely, the whitefish, cisco, lake trout, and pike perch, the annual output of which now exceeds one and a half billions. Under arrangement with the Canadian authorities, two egg-collecting stations for whitefish, cisco, and lake trout are maintained at points in Ontario.

The hatcheries on the rivers and lakes of the Pacific coast are devoted almost exclusively to the various salmons. In California, where the bureau established a salmon hatchery as early as 1872, there is one central or main station, at Baird, on the McCloud River, with important collecting stations on two other tributaries of the Sacramento. In Oregon a central hatchery at Oregon City, on the Willamette River, has 3 subhatcheries on tributaries of the Columbia, in Oregon and Washington, and 3 subhatcheries on tributaries of the Rogue River, Oregon, in addition to several egg-collecting stations.

The interests of the large salmon fisheries of the Puget Sound region are safeguarded by a hatchery on Baker Lake, on the Skagit River, Washington, and will soon be further aided by several other nurseries for which Congress has made provision. The two latest additions to the western salmon hatcheries are at Yes Bay and Afognak, in Alaska, at which points immense numbers of blueback or sockeye salmon are now being put forth.

### SHAD AND STRIPED BASS IN PACIFIC

A significant feature of artificial propagation on the Pacific seaboard is that in the Columbia basin the hatching of the acclimatized shad has begun on a small scale, and in the Sacramento basin the cultivation of the acclimatized striped bass has commenced under conditions which indicate that more eggs of this species may be obtained in California than in any of the States to which the fish is native.

The hatcheries in the interior regions constitute the most numerous class, and their output reaches the largest number of people. Their operations are addressed chiefly to the so-called "game" fishes, which, while caught mostly by anglers, nevertheless constitute an important element of the food supply. At these stations large numbers of fish are reared to the fingerling or yearling sizes before being released; for this purpose more or less extensive pond areas are required.

A peculiar kind of station which is included in this general class is that devoted to the collection of fishes of various kinds obtained from the overflows in the upper Mississippi Valley. In the lowlands along the streams in this region the spring floods receding leave disconnected sloughs and pools, which either become dry during the summer or, if they remain until the winter, freeze solid, and the immense numbers of bass, crappy, and other desirable-species therein are lost in the ordinary course of events. By seining these waters the bureau obtains large numbers of fish that would otherwise perish, returning some of them to their native streams and distributing others to adjacent waters.

### ENORMOUS OUTPUT OF THE HATCHERIES

The fish-cultural work of the federal government has now attained a magnitude that cannot readily be comprehended, and is increasing at an exceedingly rapid rate. Especially marked has been the increase in the hatchery product during the past ten years, owing in part to the establishment of new stations, in part to the extension of operations at existing stations, and in part to greater efficiency of methods and appliances. The work during the fiscal year 1909 reached larger proportions than ever before, over three

TESTING A LAND-LOCKED OR SEBAGO SALMON AT GRAND LAKE STREAM, MAINE, TO DETERMINE WHETHER ITS EGGS ARE RIPE

billion fish being produced and planted, as shown in the table:

*Summary of Output, 1909*

| Species | Number |
|---|---|
| Salmons | 164,648,170 |
| Trouts | 75,839,430 |
| Whitefishes | 419,665,000 |
| Shad | 57,378,000 |
| Fresh-water basses | 1,599,195 |
| Pike perch | 644,900,000 |
| Yellow perch | 223,661,285 |
| White Perch | 343,262,650 |
| Cods | 184,426,000 |
| Flatfish | 786,026,000 |
| Other fishes | 40,617,180 |
| Lobster | 164,509,000 |
| Total | 3,107,131,910 |

During the fiscal year 1910 another record will be made, and the output will exceed that of the previous year by several hundred million. A very significant point in connection with these figures is that had the government not engaged in this work about 95 per cent of the food-fish shown would never have existed at all, because they would have been sent to market in the form of eggs.

While the bureau does not lay undue stress on mere numbers and considers the vitality of the fish and the conditions under which they are planted as of paramount importance, the foregoing figures

are certainly very suggestive; and as a further statement of the magnitude of the fish-cultural work it may be of interest to record that the aggregate output of the hatcheries from 1872 to 1909 was about 28 billion, of which over 13 billion represents the work of the past six years.

### HOW THE FISH ARE DISTRIBUTED

The first consideration in the distribution of fishes is to make ample return to the waters from which eggs or fish have been collected. The remainder of the product is consigned to suitable public or private waters.

All applications for fish for private waters and many of those for public streams and lakes are transmitted through and receive the indorsement of a United States Senator or Representative. The demand, especially for the basses, crappies, and catfishes, is greater than can be met with present resources.

The supply of particular fishes available for distribution, and consequently the number allotted to individual applicants or deposited in public waters, depends on differences in the methods of taking and hatching the eggs, on peculiarities of the young, and on the facilities for holding the latter at the stations. The area and character of the water to be stocked must likewise be considered.

The water area that would receive a million pike-perch fry would perhaps be assigned no more than 200 or 300 black bass 3 or 4 inches long, or four to eight times that many if the bass were planted as fry. The explanation is in the fact that pike perch can be propagated by the hundred million, while black bass, hatched by other methods or collected from overflowed lands, can be produced only in comparatively small numbers. The bureau does not attempt to assign any applicant more than a liberal brood stock of the basses or sunfishes. With brook trout, which are distributed both as fry and fingerlings, allotments of fry are many times larger than allotments of fingerlings 3 to 4 inches long.

Fishes are distributed at various stages of development, according to the species, the numbers in the hatcheries, and the facilities for rearing. The commercial fishes, hatched in lots of many millions, are necessarily planted as fry. It is customary to distribute them just before the umbilical sac is completely absorbed.

Atlantic salmon, land-locked salmon, and various species of trout, in such numbers as the hatchery facilities permit, are reared to fingerlings from 1 to 6 inches in length; the remainder are distributed as fry.

The basses and sunfishes are distributed from the fish-cultural stations and ponds from some three weeks after they are hatched until they are several months of age. When the last lots are shipped the basses usually range from 4 to 6 inches and the sunfishes from 2 to 4 inches in length. The numerous fishes collected in overflowed lands—basses, crappies, sunfishes, catfishes, yellow perch, and others—are 2 to 6 inches in length when taken and distributed.

Eggs are distributed only to State hatcheries or to applicants who have facilities.

### SPECIAL CARS FOR THE FISH

Fish are delivered to applicants free of charge at the railroad station nearest the point of deposit, and for this purpose is maintained a special car and messenger service, which is one of the most important adjuncts of the fish-cultural work. In the early days baggage cars were employed, but these have now been supplanted by an equipment which not only affords more comfort to fish and attendants, but makes it possible to transport the fish much greater distances and with smaller percentage of loss.

The cars, of which there are now six, are of standard size and are attached to regular express and local passenger trains. Each car has 20 or more large water tanks along the sides in which to carry fish, compartments holding more than 1,000 gallons of reserve water, a boiler-room, and a plant for pumping both water and air into the fish tanks. There are also an office, kitchen, pantries, refrigerator, and six sleeping berths, with other facilities

TAGGING A PENOBSCOT SALMON

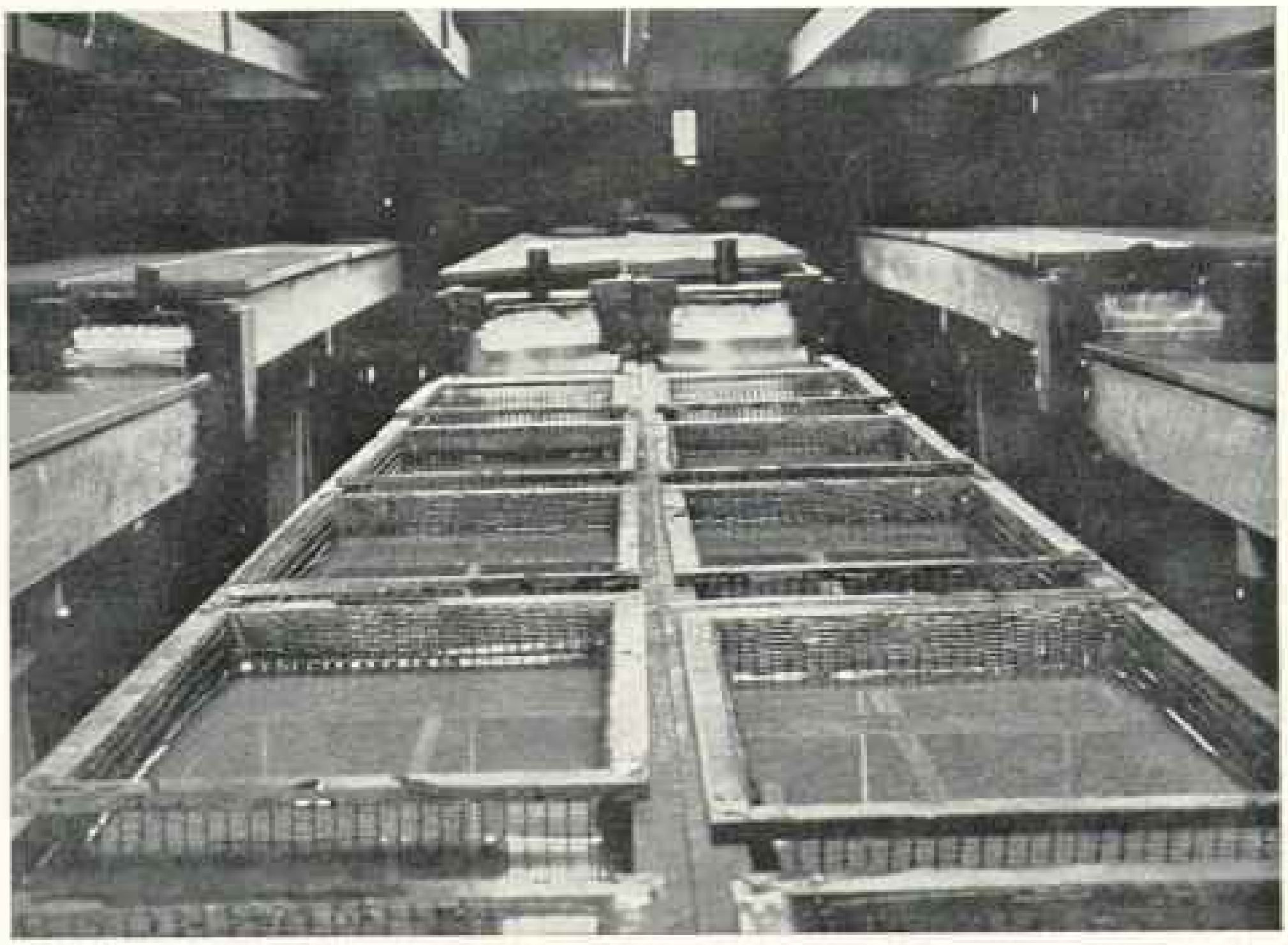
By means of metal tags attached to salmon, which are liberated after their eggs have been obtained, important information regarding the sea life of the New England salmon has been secured when the fish returned to the river to spawn. Similar experiments cannot be made with the Pacific salmon, as the latter fish die after once spawning (see pages 432 and 433).

for the convenience and comfort of the crew of five men (including a cook), who live on the car throughout the year. The government furnishes the cook, fuel, and utensils, but the men provide their own food.

For small shipments of fish and for supplying places off the main railway lines, messengers detached from the cars carry fish in 10-gallon cans in baggage cars. The distributions in 1908 required travel amounting to 83,840 miles by the bureau's 6 cars and 263,196 miles by detached messengers—a total of 347,036 miles—of which 11,826 for cars and 80,816 for messengers were furnished by the railroads free of charge.

## POPULARITY OF THE WORK

There are few enterprises undertaken by the United States Government that are more popular, meet with more general and generous support, and have contributed more to the prosperity and hap-



INTERIOR OF A PACIFIC COAST SALMON HATCHERY

The salmon eggs are incubated in wire baskets arranged in double rows in long troughs

(see pages 421 and 432)

piness of a larger number of people than its fish-cultural work, an evidence of which fact is afforded by the attitude and action of Congress. The comparatively large budget for the various branches of the bureau's work is voted each year without any opposition whatever and the appropriations are increasing yearly. When special needs arise and their merit is presented to Congress, special appropriations can usually be obtained, and government fish-culture is so popular in the country at large and the demand for new hatcheries is so widespread that an extraordinary number of hatchery bills have been introduced and favorably considered in recent sessions of Congress.

The bureau advocates the building of new hatcheries as one of the best and most remmnerative measures that can possibly be undertaken by the federal government, but it rarely has to take the initiative, and on several occasions the establishment of a hatchery has been proposed by Congress before the necessity for it has actually developed.

During each of the recent sessions of Congress, had all the bills providing for new hatcheries become laws, the bureau would have been seriously handicapped in designing and constructing the new buildings and ponds and in supplying competent persons to operate them. In the first session of the Sixtieth Congress there were introduced 101 distinct bills, carrying an aggregate appropriation of $2,142,000 and providing for 74 hatcheries and 4 laboratories in 43 States and Territories.

## SCIENCE AND THE FISH SUPPLY

In making his original plans for the systematic investigation of the waters of the United States and the biological and

physical problems they present, Commissioner Baird insisted that to study only the food-fishes would be of little importance, and that useful conclusions must needs rest upon a broad foundation of investigations purely scientific in character. The life history of species of economic value should be understood from beginning to end, but no less requisite is it to know the histories of the animals and plants upon which they feed or upon which their food is nourished; the history of their enemies and friends and the friends and foes of their enemies and friends, as well as the currents, temperatures, and other physical phenomena of the waters in relation to migration, reproduction, and growth.

In pursuance of this policy the bureau has secured the services of many prominent men of science, and much of the progress in the artificial propagation of fishes, in the investigation of fishery problems, and in the extension of knowledge of our aquatic resources has been due to men eminent as zoologists who have been associated with the work temporarily. Their services have been the services of specialists for particular problems, and through them the bureau has not only been able to give to the public the practical results of applied science, but has contributed to pure science valuable knowledge of all forms of aquatic life.

The small permanent staff of the bureau concerns itself more directly with studies of fishes and their environment, with the conservation of diminishing commercial species, and the development of new or improved methods of increasing the supply. Such lines of work are undertaken as the need appears or as assistance is asked for, and keep the scientific assistants in the field for extended periods each year. Some of the most important work in hand at present concerns aquatic products other than fishes, namely, oysters, fresh-water mussels, sponges, and the diamond-back terrapin, in all of which cases the problem is to find means to offset the results of long-continued overdraft upon the natural supply.

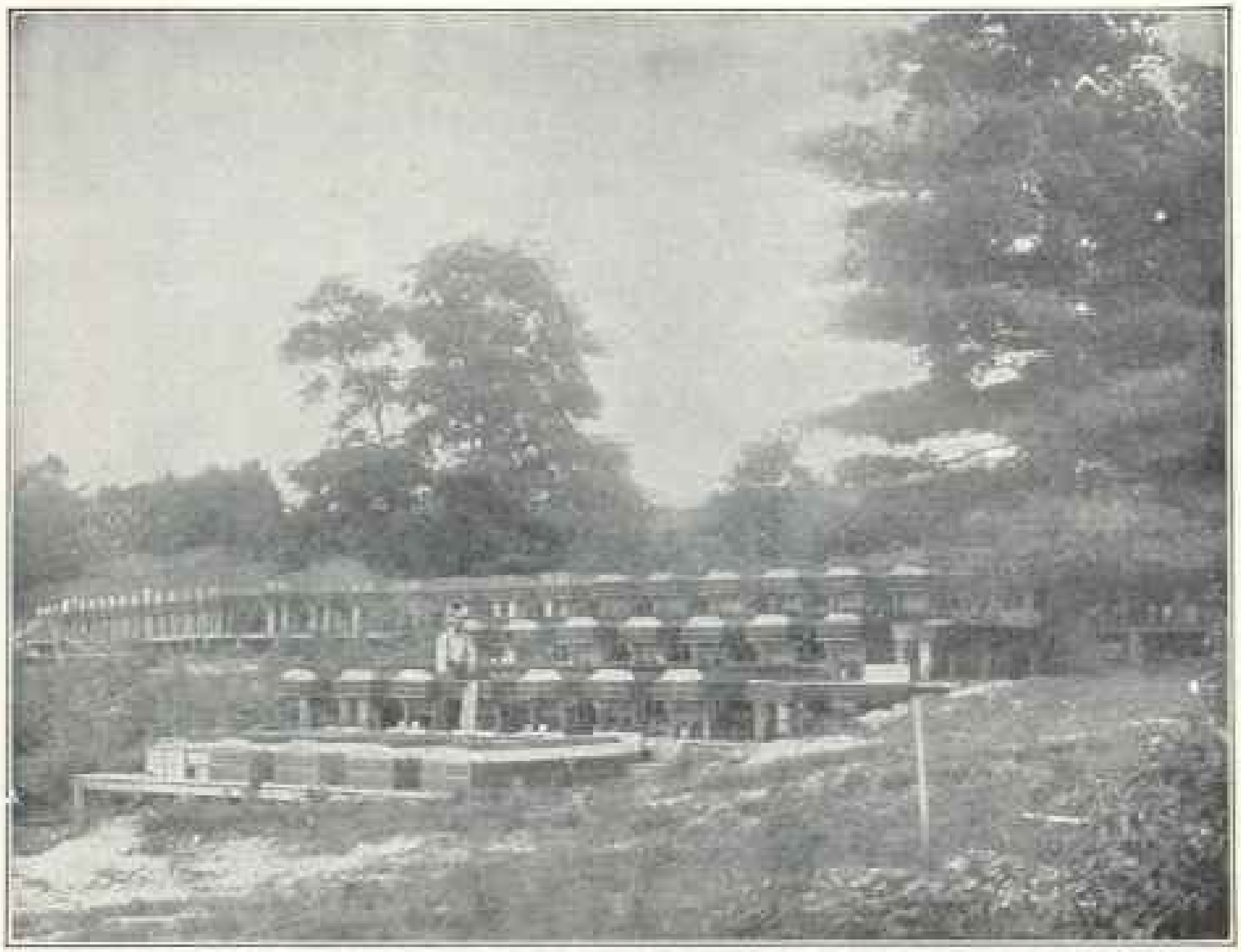
Two seaside laboratories are maintained by the bureau for the prosecution of investigations in pure and applied science. One of these is located at Woods Hole, Massachusetts. It was built in 1883, and is in conjunction with a marine fish hatchery. Here also are extensive wharves, at which the largest vessels may lie, and protected harbors for small craft. A large residence building at this station was for a number of years occupied as the summer headquarters of the bureau, the entire executive and office force being transferred from Washington.

The other laboratory is situated on a small island at Beaufort, North Carolina, and was constructed in 1901. The land for both of these stations was donated by private individuals. In addition to their function in the investigations of the bureau itself, these laboratories are open to the public for study and scientific research. Students and professors in colleges and any other qualified investigators may have the facilities of the laboratories upon request, and these opportunities are largely availed of each year.

### CRUISES OF THE ALBATROSS

For the survey of off-shore fishing grounds, the study of pelagic fishes, and the general exploration of the seas, the bureau has had, since 1882, the *Albatross*, a twin-screw iron steamer, rigged as a brigantine, of 1,074 tons displacement, which was specially designed and built for this work and has contributed more to the knowledge of the life and physics of the sea than any other vessel. The complement of officers and men, numbering about 80, is furnished by the navy; there is in addition a small civilian staff, including a resident naturalist and a fishery expert, to whom the practical work of the ship is intrusted.

After spending several years in the investigation of the fishing grounds of the Atlantic coast of North America, the *Albatross* was dispatched to the Pacific Ocean in 1888 and has since confined her operations to those waters. The vessel has made three extended cruises to the



OPEN-AIR TROUGHS FOR REARING SALMON AT A HATCHERY ON THE PENOBSCOT RIVER IN MAINE (SEE PAGES 432 AND 433)

southern and eastern parts of the Pacific, several cruises to the Hawaiian Islands and Japan, and many visits to Alaska, in addition to numerous surveys on the coast of the Pacific States, all having for their object the investigation of the physics and biology of the regions visited, the determination of their aquatic resources, and the study of their fisheries. In 1907 the vessel began a survey of the waters of the Philippine Archipelago and has just completed that work.

The deepest sounding made by the *Albatross*—near the island of Guam—was 4,813 fathoms; the greatest depth at which the vessel found life was 4,173 fathoms; the greatest known ocean depth is 5,269 fathoms, near Guam, ascertained by the U. S. S. *Nero* while using *Albatross* apparatus.

### WORK IN BEHALF OF THE COMMERCIAL FISHERIES

The first duty to which the Bureau of Fisheries was assigned, namely, the investigation of the reported decrease of food-fishes in New England, necessarily involved the collection of statistics of production, personnel, and capital. Since that time this branch of the work has been conducted without interruption, and in it have naturally been included the various other subjects affecting the economic and commercial aspects of the fisheries. Among the bureau's functions in this field are (1) a general survey of the commercial fisheries of the country; (2) a study of the fishery grounds with reference to their extent, resources, yield, and condition; (3) a study of the vessels and boats employed in the fisheries with special reference to their improvement; (4) a determination of the utility and effect of the apparatus of capture employed in each fishery; (5) a study of the methods of fishing, for the special purpose of suggesting improvements or of discovering the use of unprofitable or unnecessarily destructive methods; (6) an inquiry into the methods

EGGS AND NEWLY HATCHED FRY OF THE LAKE TROUT: NATURAL SIZE

The lake trout ranges from Maine to Alaska and is the largest and most valuable trout in the world. The fish is most extensive in Lakes Michigan, Huron, and Superior (see page 427)

of utilizing fishery products, the means and methods of transportation, and the extent and condition of the wholesale trade; (7) a census of the fishing population, their economic and hygienic condition, nativity, and citizenship; (8) a study of international questions affecting the fisheries; (9) the prosecution of inquiries regarding the fishing apparatus and methods of foreign countries.

### PROTECTING THE ALASKAN SALMON

The fishing interests of Alaska, representing an investment of $10,000,000 and yielding last year a product valued at more than $11,800,000, have received especial attention from the government ever since the territory was acquired, in 1867. The seal fisheries, at first considered the most valuable sources of revenue, were at once placed under protective legislation. Later there appeared a similar need of regulation of the salmon fisheries, which have now come to support industries many times more valuable than the seal fisheries and standing in large proportion to the total fishing interests of the whole United States.

The Alaska salmon-inspection service has thus grown to be one of the most important branches of government fishery work, and it is one of the few instances where the government has assumed legislative powers over fishing.

The protection of the Alaska salmon fisheries has been a difficult problem. The unheard-of magnitude of the resources invited a corresponding recklessness and improvidence. As the canning industry developed, every device that could be used for wholesale capture of fish was put into operation, and gradually all of the favorite streams of the salmon became so blocked with seines, gill nets, traps, and barricades that but a small proportion of the fish could find passage to the spawning grounds, and the future supply was thus most seriously endangered.

The Alaskan aborigines likewise conducted their fishing in a very destructive way, often placing impassable barriers in streams up which salmon were running, and, through ignorance or indifference, leaving the obstructions in place after the full supply of fish had been secured. It was soon apparent that the laws and regulations were inadequate to meet the special conditions prevailing, and were of such a nature as to make their enforcement very difficult.

In 1903 a special commission was appointed to make exhaustive study of the natural history of the salmons of Alaska and to submit recommendations for an improved regulation of the fisheries. As a result a new code of laws is now in effect and promises to prevent the threatened decline in these enormous industries. With increased restrictions as to fishing methods, obstructions in streams, close seasons, etc., the Department of Commerce and Labor is empowered to set aside any streams as spawning preserves whenever such course shall be desirable, all fishing in such waters to be prohibited. A license tax is required on all salmon products: from the payment of this tax, however, all canning and salting establishments are exempted upon condition of their returning young salmon to the streams in the ratio of 1,000 fry to every 10 cases of salmon canned. Five private hatcheries, representing extensive canning interests, were in operation in 1908 and liberated a total of 150,000,000 young fish.

The seal and salmon fisheries have hitherto overshadowed all other aquatic resources in Alaska, not only in commercial value but in revenue to the government. The rental from the fur-seal islands alone has more than repaid the purchase price of the territory, and the tax derived from the salmon fisheries now amounts to about $100,000 a year. Some long-neglected products are gradually coming into importance, however, and the cod, halibut, and herring fisheries especially have undergone remarkable development in the last few years. Since it became a part of the United States, Alaska has yielded fishery products amounting in value to $170,000,000, of which about $50,000,000 was derived from fur-seals, $96,000,000 from salmon,

and the remaining $24,000,000 from all other aquatic products.

### THREE BILLION SHAD HAVE BEEN PLANTED

Much evidence can be adduced to show that the fish-cultural operations of the general government are of direct financial benefit to the country at large. The results in the case of some species have been so striking and so widespread that it would be almost as supererogatory to refer to them as to discuss the utility of agriculture; in the case of other species there can be no doubt of the value of the work, although it may be possible only occasionally to distinguish the effects of human intervention on the fish supply from the effects of natural causes. The outcome of the bureau's efforts to increase the food supply is naturally most evident in the case of small streams, lakes, and ponds, of which thousands have been successfully stocked with the most desirable food and game species.

The leading river fish of the eastern seaboard is the shad. No other anadromous species has been more extensively cultivated and none is now so dependent on artificial measures for its perpetuation. Inasmuch as the principal fisheries are in interstate or coastal waters and the movements of the fish from the high seas to our rivers and back to the high seas place it beyond the claim to ownership which might be urged by the various states were the shad a permanent resident within their jurisdiction, it seemed especially desirable and necessary that this species should be fostered by the general government for the benefit of the entire country. For this reason, and owing to a serious decline that had already set in, the shad was one of the first species whose artificial propagation was taken up by the bureau, and its cultivation is today a leading factor in fishery work, almost every large stream having been the site of hatching operations.

The extent of the work may be gaged when it is stated that nearly 3,000 millions of young shad have been planted by the bureau in coastal streams; and a very significant point is that the eggs from which these fish were hatched were taken from fish that had been caught for market, and hence would have been totally lost if the bureau had not collected them from the fishermen.

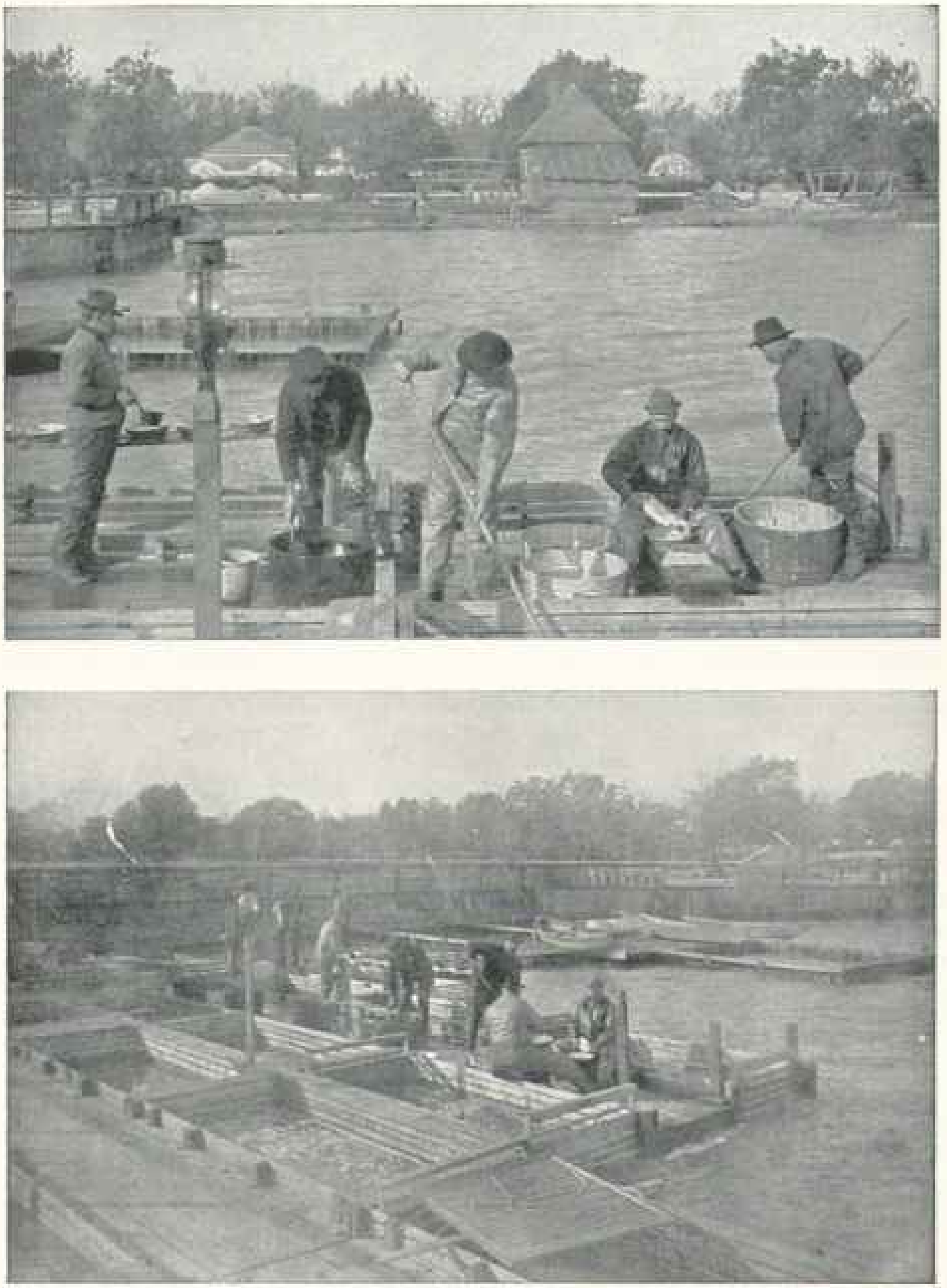
### EXTINCTION OF SHAD IS THREATENED

The great multiplication of all kinds of fishing appliances on the coast, in the bays, in the estuaries, and along the courses of the rivers resulted in the capture of a very large part of the run each season before the shad reached the spawning grounds, and hence the natural increase was seriously curtailed, and in some streams almost entirely prevented. Yet the shad catch increased, and for many years the fishery prospered in the face of conditions more unfavorable than confront any other fish of our eastern rivers.

At length, however, the unrestricted fishing became greedy to an overwhelming extent. The mouths of the rivers and the lower waters through which the shad must pass became so choked with nets that fishing gear farther upstream could make but slender hauls; and for several years there has been a steady decline in catch, which threatens to result in the extinction of the fishery. The bureau has continued its efforts in propagation, but these are curtailed by the factor that is also destructive to the fishery.

When they first enter the streams the shad are not ripe and are useless to the hatcheries, and the spawn-takers must therefore wait for the run farther upstream; but with the recent exhaustive fishing in the salt waters so few fish have escaped that the egg collections have diminished to an alarming extent, being reckoned now in millions where formerly they were hundreds of millions.

Under such conditions it is impossible to propagate enough fish to offset the quantities taken, and the shad fishery is fast being deprived of its one support, while the present meager shad catch, together with the enforced curtailment of propagation, speaks even more convinc-



ARTIFICIAL PROPAGATION OF THE WHITEFISH ON THE DETROIT RIVER

Mature fish, destined for the market, are retained in live-cars and regularly overhauled as their eggs are ripening. After being artificially fertilized, the eggs are sent to the hatchery. This work is very extensive and important, and hundreds of million young whitefish are produced on the Great Lakes each year that would be entirely non-existent except for the government's efforts (see pages 422 and 432).

CATCHING AND SORTING THE BROOD-FISH AT A TROUT-CULTURAL STATION IN THE ROCKY MOUNTAINS

ingly of the value of artificial measures than did the preceding increase.

### WORK ON THE GREAT LAKES

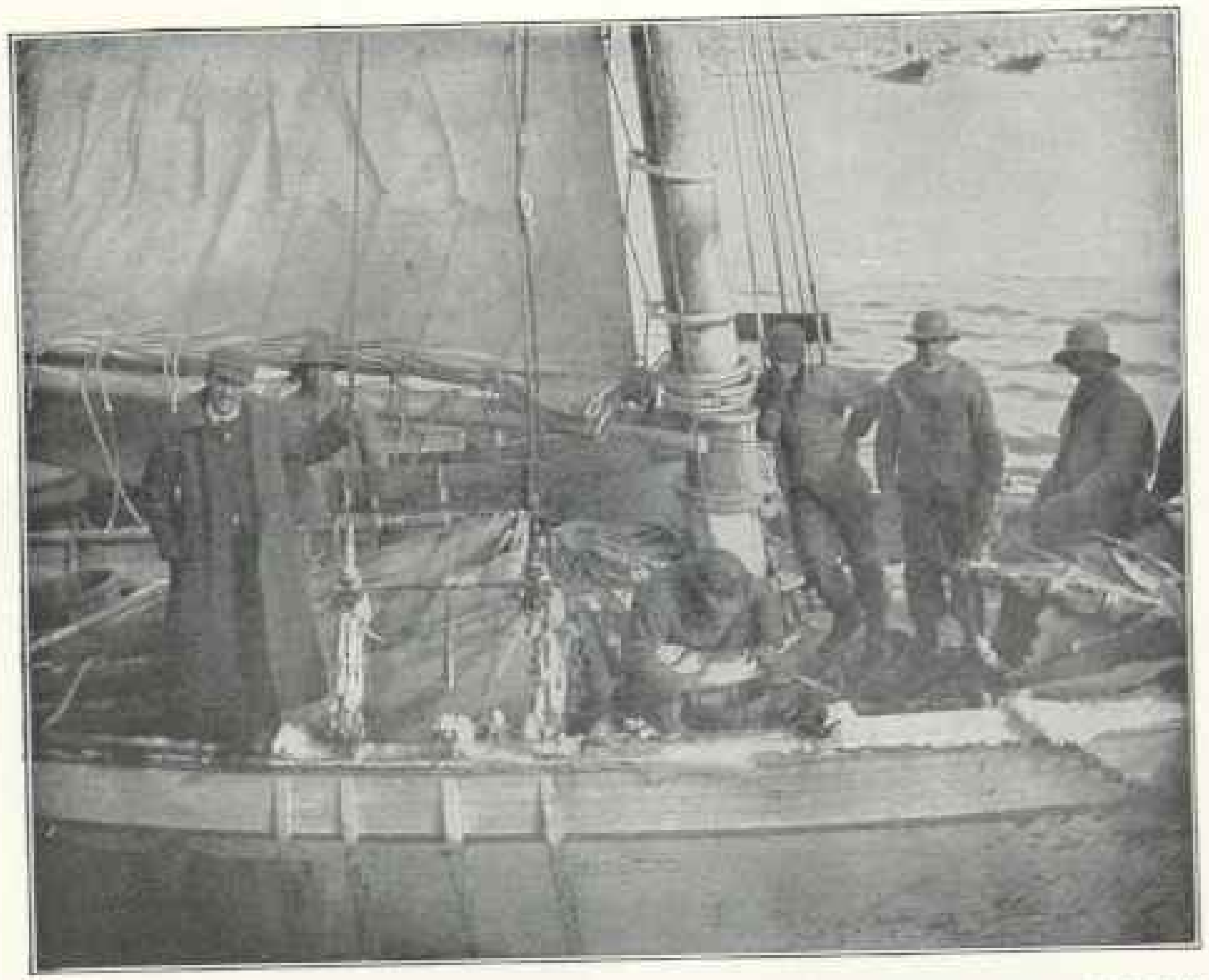
Evidence is not lacking to show that the long-continued and increasingly extensive fish-cultural operations on the Great Lakes have prevented the depletion of those waters in the face of the most exhausting lake fisheries in the world.

The luscious whitefish, the splendid lake trout, the excellent pike perch, or wall-eyed pike, may be hatched in such numbers as to assure their preservation without serious curtailment of the fisheries. The absence of concerted protective measures, however, on the part of the various states interested has the tendency to minimize the effects of cultivation and would seem to justify, if not imperatively demand, the assumption of jurisdiction by the federal government.

### 1,700 BUSHELS OF SALMON EGGS DISTRIBUTED IN ONE YEAR

The long continuance of the Penobscot as a salmon stream for many years after all other New England rivers had ceased to carry this fish is directly attributable to the work of the bureau on that stream. So dependent on artificial measures has been the perpetuation of the salmon supply that it is believed the obliteration of the run and the wiping out of a long-established fishery would ensue within five years after the suspension of fish-cultural operations. Physical conditions in the Penobscot have become so unfavorable for the passage of salmon to the spawning grounds that natural reproduction is now almost if not altogether inhibited, and the only noteworthy source of young salmon is the eggs obtained by the bureau from salmon purchased from the fishermen.

The magnitude of the salmon fisheries of the Pacific States has required very



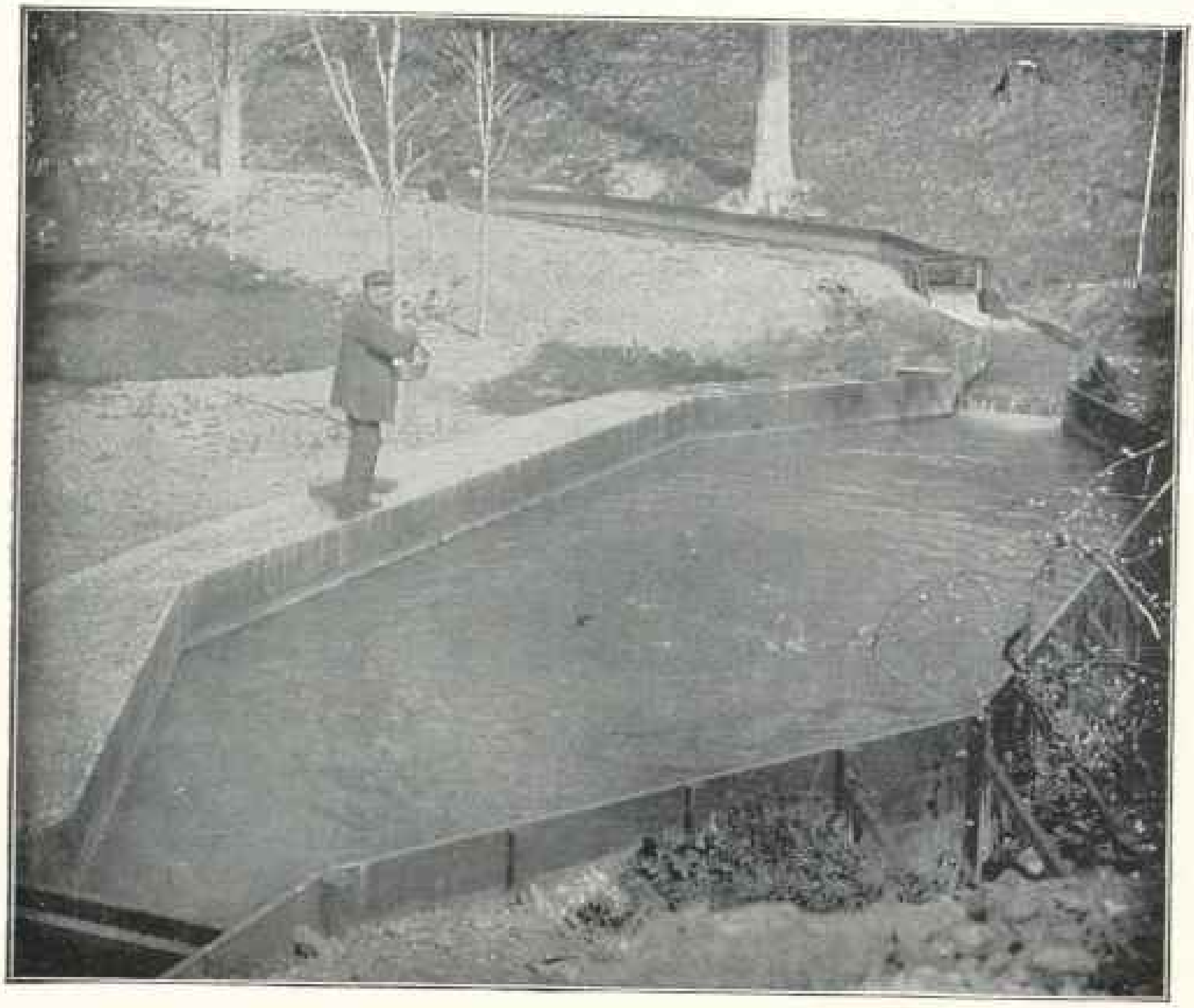
A GOVERNMENT SPAWN-TAKER OVERHAULING THE COD CATCH OF A NEW ENGLAND SCHOONER AND TAKING THE RIPE EGGS (SEE PAGE 435)

extensive artificial measures to keep up the supply. The operations of the bureau, in combination with those of the states, have been gradually extended in both scale and scope until they have now attained a tremendous extent and are addressed to all the species whose cultivation is as yet demanded. The number of Pacific salmon eggs collected by the bureau in 1908 was over 200,000,000, equivalent to 1,700 bushels.

A remarkable fact in the history of the Pacific salmons, of which there are five species, is that without exception all fish which enter any stream on the entire coast die after once spawning, none surviving to return to the sea.

This wise provision of nature to prevent the overstocking of streams has been made foolish by the appearance of man on the scene; he not only catches the salmon in the coast rivers and the lower courses of the rivers will gill nets, seines, and pound nets, in the upper waters with the same appliances supplemented by the fish wheels, and on the spawning grounds with all sorts of contrivances, but in certain sections even carries his foolhardy greed to the extent of barricading the streams so that no fish can reach the waters where their eggs must be deposited.

Natural reproduction, thus so seriously curtailed, is not sufficient to keep up the supply in many of the streams where fishing is most active, for many of the eggs escape fertilization, many more are eaten by the swarms of predaceous fishes that haunt the spawning beds, and many are lost in various other ways during the long hatching period; while the helpless fry and alevins fall a ready prey



FEEDING RAINBOW TROUT IN AN ARTIFICIAL SPAWNING POND AND RACEWAY AT A VIRGINIA STATION

to the same fishes in the upper waters, and the young salmon have to run the long gauntlet of the rivers only to meet new foes in the estuaries, on the coast, and in the open sea.

It is, therefore, no wonder that artificial propagation on a large scale is imperatively demanded in the western salmon streams, and is actively urged and highly commended by fishermen, canners, business men, and the public at large.

The history of the salmon fishery in the Sacramento River, in California, and the recent increase in the catch notwithstanding most unfavorable physical conditions in that stream, afford unmistakable evidence of the value of cultivation.

Some very suggestive, though not altogether conclusive, information relative to the benefits of salmon culture in the Columbia River has been furnished by marking young salmon before releasing them from the hatcheries. The number of marked salmon that returned as mature fish and were captured and reported indicates a very large percentage of survivals and suggests the growing dependence on artificial propagation for the maintenance of the runs.

### NEW ENGLAND COD AND LOBSTERS CONSERVED

In the case of marine hatching operations it is so difficult to prove beneficial results that their utility is doubted by some people. When the bureau began

the cultivation of the cod and the lobster many years ago, it proceeded on the principle that the effects of the fishermen's improvidence could be counteracted by artificial propagation. The ultimate success of cod and lobster culture on the Atlantic coast was therefore confidently expected, and the expectations have been more than realized. Practical results of an unmistakable character were first manifested nearly twenty years ago, since which time a very lucrative shore cod fishery has been kept up on grounds that were entirely depleted or that had never contained cod in noteworthy numbers in the memory of the oldest inhabitants.

There is much unsolicited testimony on this point from many people who have profited from the operations of the Maine and Massachusetts stations. The benefits have not been confined to the immediate vicinity of the hatcheries, but have extended westward and southward along the Middle Atlantic coast and eastward along the whole coast of Maine.

The benefits of lobster culture have been slower in appearing, owing, in part at least, to the less extensive operations and the excessive mortality to which the young are liable; but from all parts of the New England coast there are being received reports of more lobsters, particularly of small size, than have been seen for many years, and there is reason to believe that the long-continued decline of the lobster fishery may have been arrested.

### PROFITABLE FISH IMPORTED FROM EUROPE

Economic results of great value have come from the transplanting of native aquatic animals into waters in which they are not indigenous and from the introduction of fishes of foreign countries into the United States. The supply of food and game fishes of every section of the country has thus been increased and enriched, fisheries of vast extent have been established, and the pleasures of angling have been greatly enhanced.

As this phase of the work has recently been set forth in detail,* it need not be dwelt on here, and it will be sufficient to note that the acclimatized fishes taken and sold in this country now have a value of fully two million dollars a year. Much more important results, however, are seen in the tremendous quantities of such fish annually caught by anglers and for home consumption, whose money value cannot be reckoned. The aggregate results of acclimatization up to the present time, so far as fish caught and sold are concerned, represent at least twenty million dollars to the fishermen and a fifty-fold return on the government's investment.

By far the most important of the exotic fishes is the German carp, of which in 1908 nearly forty-three million pounds were caught in public waters by professional fishermen, and sold for over a million dollars. These fish were the progeny of carp imported by the bureau many years ago and presented in small lots to farmers and others in all parts of the country for the stocking of private ponds and reservoirs. By the overflowing of these waters or the breaking of dams, streams and lakes have become planted with the carp, which is now the most widely distributed fish in the United States.

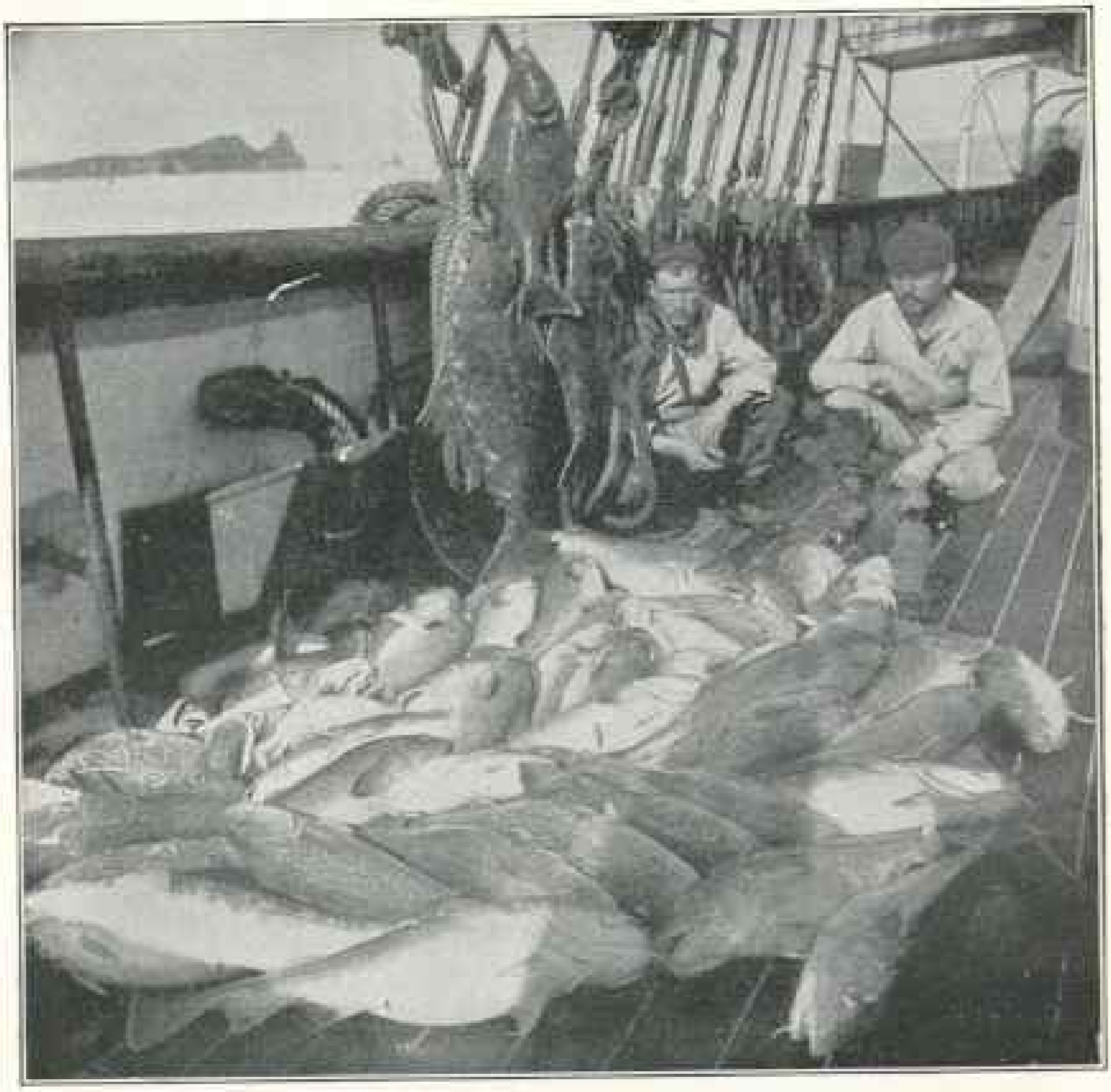
### HELPING THE SHAD FISHERIES OF NORTH CAROLINA

The long-continued and systematic field and laboratory work of the bureau has resulted in a most thorough knowledge of the distribution, abundance, habits, etc., of the fishes and other creatures of the interior, coastwise, and offshore waters of the United States, Hawaii, and Porto Rico—a knowledge which is indispensable to the government in its fish-cultural work and to the various states and insular authorities in their legislative efforts to preserve their fishery resources. The practical results of this work are apparent in numerous specific instances.

* Our Fish Immigrants: The Acclimatization of Native and Foreign Water Animals in the United States. By Hugh M. Smith. NATIONAL GEOGRAPHIC MAGAZINE, June, 1907.

STRIPPING TROUT OF THEIR EGGS AT A STATION OF THE BUREAU OF FISHERIES IN THE ROCKY MOUNTAINS
(SEE PAGES 418-419)

"It is conceived to be the better policy to expend a small amount of public money in making fish so abundant that they can be caught without restriction and serve as cheap food for the people at large, rather than to expend a much larger sum in preventing the people from catching the few fish that still remain after generations of improvidence."



TRIAL FISHING ON THE "ALBATROSS"

While surveying a new "bank" on the coast of Alaska, this experimental catch of cod and halibut was made in 20 minutes. As a result of explorations of the *Albatross* on the Pacific coast, fisheries of great importance have been established, and the Pacific halibut fishery now surpasses that in the Atlantic (see page 496).

Upon two subjects in particular has the bureau expended much energy and at last achieved results by persistently sounding the note of warning. The utmost efforts in artificial propagation cannot save the shad fishery without the aid of laws to permit a certain number of spawning fish to reach the streams, while on the other hand no practicable protective laws can save the oyster supply without cultural work to keep up the beds. The bureau has no power to do more than hatch fish in the one case, devise methods of culture in the other, and cry out the needs of both, and it lies solely with the states to provide for the needs.

North Carolina rose to the emergency of the shad situation a few years ago and sought the aid of the bureau in determining the actual protection required by the shad, the actual condition of the fishery, and the possible remedies for a rapidly diminishing yield. The bureau's recommendations were asked for by the state legislature, and a commission was appointed to draft salutary laws, which have since gone into effect, confining gear to prescribed areas and leaving clear channels for the passage of the fish.

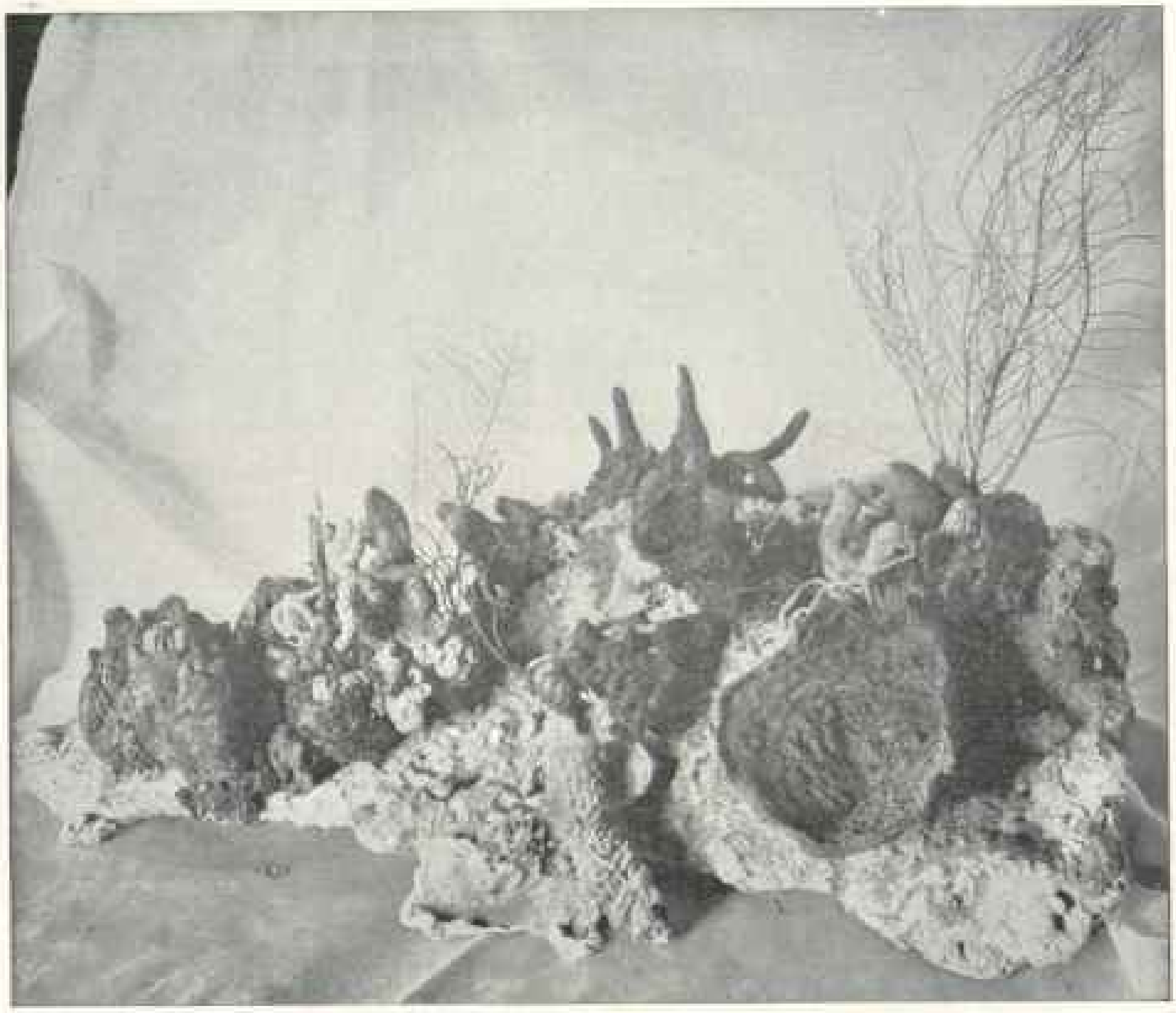
REMOVING SHAD EGGS AT A STATION IN NORTH CAROLINA

Nearly 3,000 millions of young shad have been planted by the Bureau of Fisheries in coastal streams. All the eggs from which these fish were hatched were taken from fish that had been caught for market, and hence would have been totally lost if the bureau had not collected them from the fishermen (see pages 430 and 435).

Immediate results have been seen at the government hatchery in the Albemarle Sound region. The collection of shad eggs in these waters in five years had dropped from 75 million to 6½ million. The next year, which was the first of enforcement of the new laws, the collection was 25½ million, and in 1908 and 1909 the most successful shad hatchery was in this State, the egg collections exceeding 55 million and 60 million, respectively.

## RESCUING THE MARYLAND OYSTER BEDS FROM EXTINCTION

The oyster fishery has had a common history in all of the Southern States, of

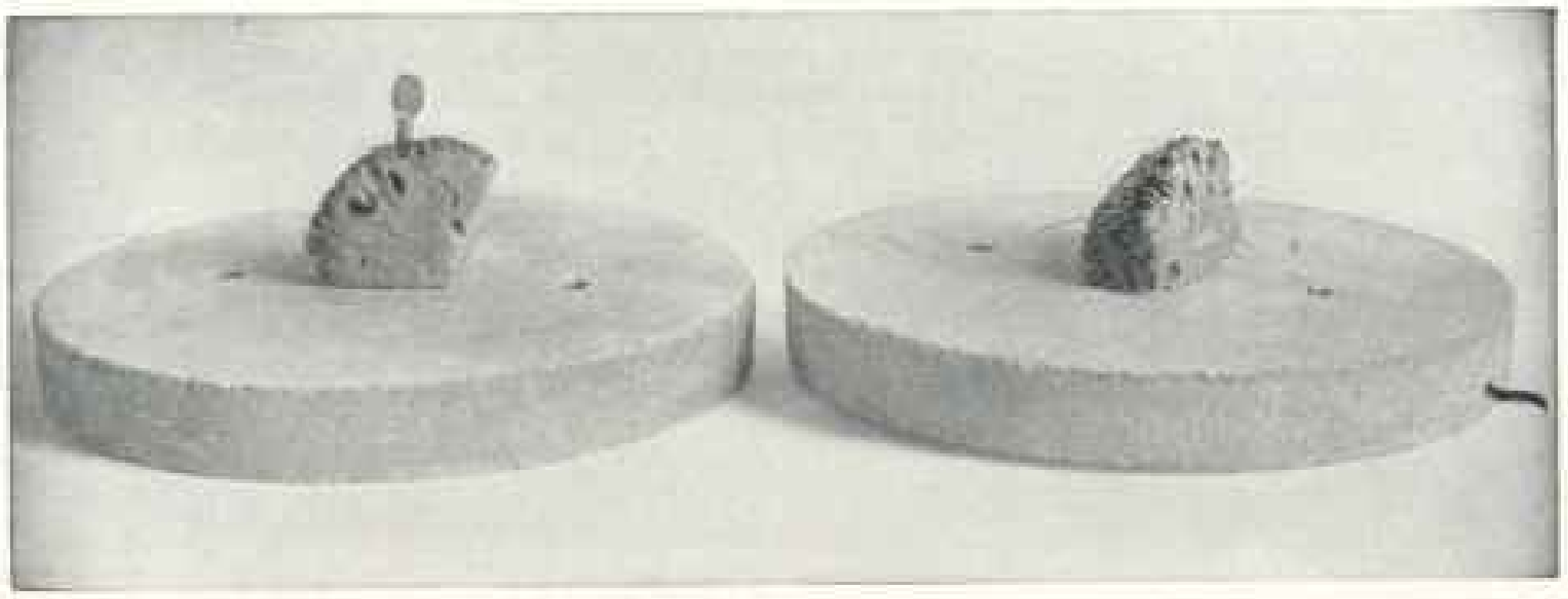


SPECIMEN OF ROCK BOTTOM ON WHICH SPONGES GROW, FROM THE SPONGE BEDS OFF ANCLOTE KEY, FLORIDA

This rock bears 13 species of commercial and non-commercial sponges, besides corals, sea-feathers, starfishes, crabs, and other animals characteristic of the fauna of the sponge beds. One-eighth natural size.

which Maryland, once the foremost in oyster production and one of the last to resort to systematic cultural measures, affords the most notable example. The laws controlling the fishery in Chesapeake Bay have been designed to protect the natural beds, but have not encouraged or protected the oyster planter, and the natural beds, thus practically the sole reliance, in time failed to sustain the tremendous draft upon them. Between 1880 and 1897 the product fell 31.6 per cent; in 1904 it was 39 per cent less than in 1897.

The bureau had for many years pointed out the short-sighted policy that was resulting in the steady decline of the oyster industry, and was at length gratified to find that the state had taken heed of the warning and enacted a comprehensive law favoring oyster planting. The work that has now been undertaken by the Maryland Shell Fish Commission to remedy the alarming condition of the oyster grounds will be the most complete and accurate of its kind. It consists of the survey and delimitation, by the aid of the United States Coast and Geodetic Survey and the Bureau of Fisheries, of all natural oyster beds in Maryland waters, to be marked and set aside as public fishing grounds operated under the



SPONGE CUTTINGS VARIOUSLY MOUNTED ON CEMENT DISKS AND READY FOR PLANTING

existing protective laws. All other suitable grounds will then be reserved by the state to be leased to oyster planters, whose enterprise will be encouraged and their rights protected as was not possible heretofore.

### OYSTERS IN LOUISIANA AND SPONGES IN FLORIDA

Up to 1898 there were few planted beds of oysters in Louisiana waters. Investigation of the oyster grounds by the bureau in that year, however, led to the passage of beneficial laws and proved a general stimulus to oyster culture in that state, as is shown by the fact that some 20,000 acres of bottom were soon under cultivation. In 1906 the state oyster commission again asked the bureau's assistance, and large areas of utilized bottom were examined to determine their productive capacity. The conditions were found to be exceptionally favorable, and experimental plants produced 3½ to 4 inch oysters in quantities of 1,000 to 2,000 bushels per acre, within two years after the cultch was put down.

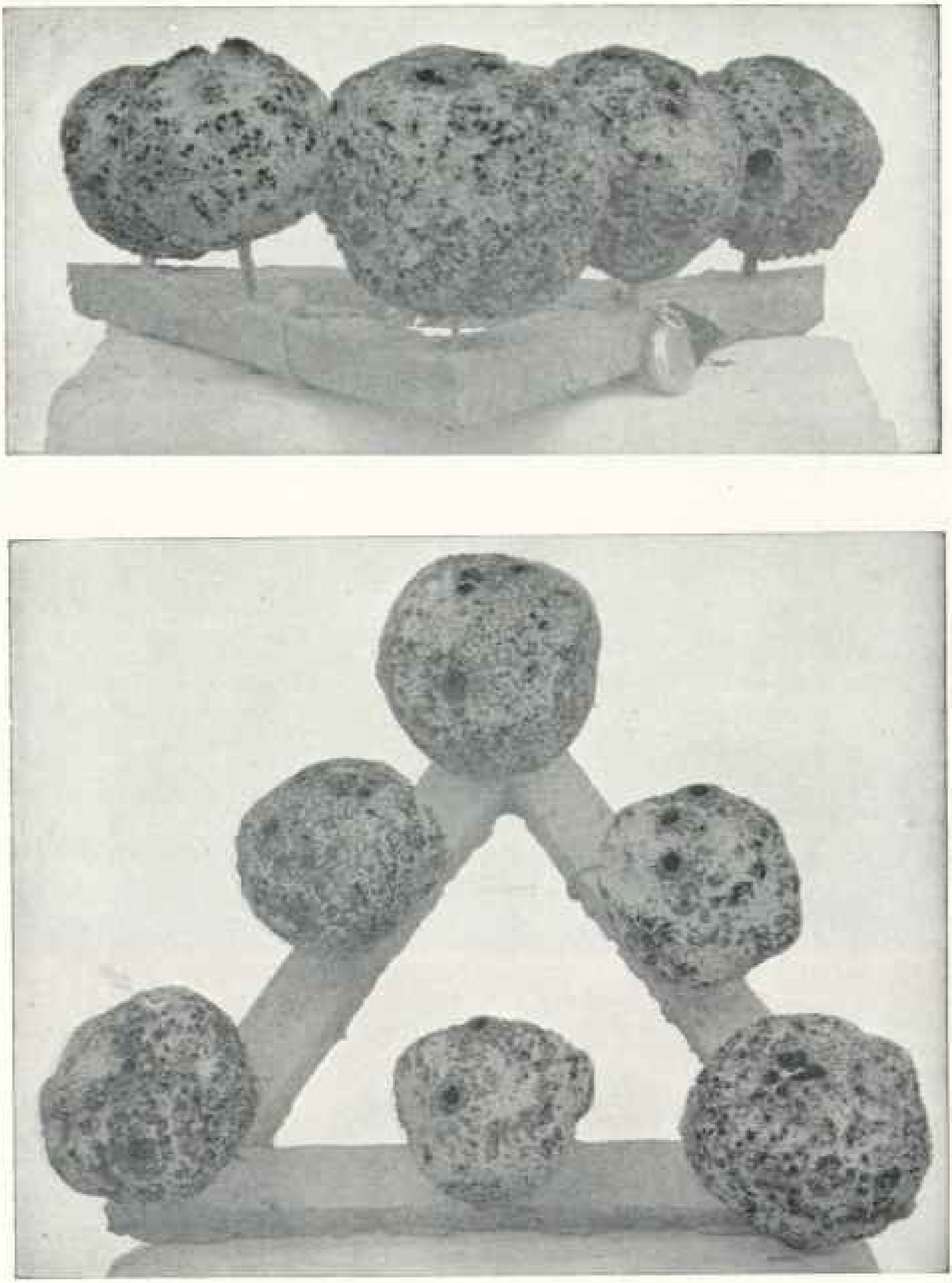
In Barataria Bay, where there had been no oysters whatever, such promising beds were established that several hundred acres of adjacent bottom were immediately leased by prospective planters. Other localities, though they have so far shown no such conspicuous commercial enterprise, may be expected to prove equally productive.

Experiments in sponge culture have been in progress for several years, and have now developed a practical system by which sponges may be produced from cuttings at a cost much less than that entailed in taking them from the natural beds. In view of the more rapid depletion of the natural beds which will undoubtedly result from recent changes in the methods of the fishery, the bureau is convinced that the preservation of the American sponge industry will depend upon cultivation; and as it is estimated that about $1,500,000 worth of sponges were taken in Florida during the past year, the failure of the fishery would be a serious commercial loss to the state.

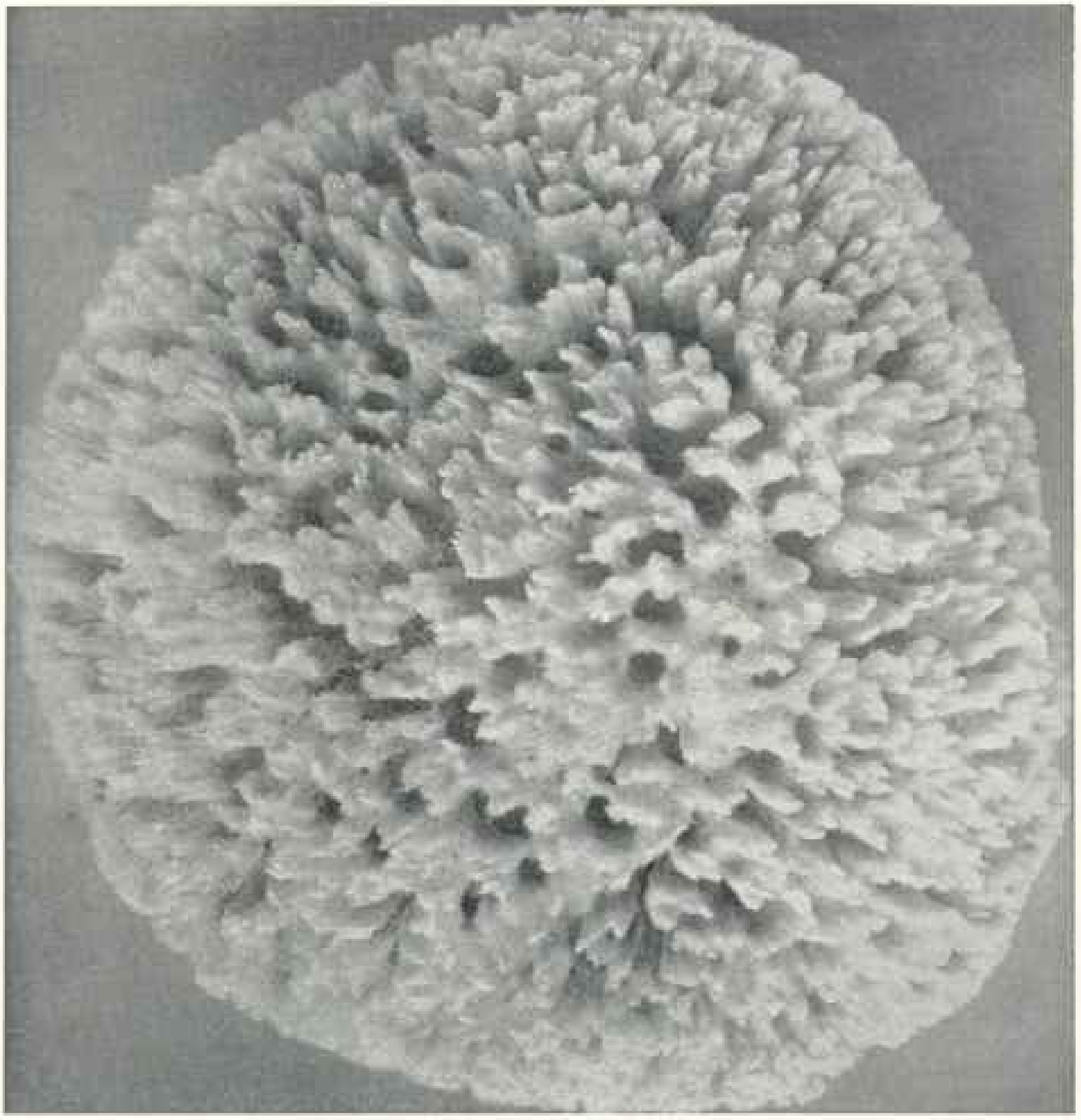
### MUSSELS FOR PEARL BUTTONS

In coöperation with the Rhode Island Fish Commission, the bureau has developed new methods of lobster and soft-shell clam culture which are being applied with success in New England. Experiments with the hard-shell clam are now in progress at Beaufort.

Important work recently undertaken is an effort to establish mussel culture in the Mississippi Valley. The supply of mussels in those waters, on which is based a pearl-button industry valued at about $5,000,000 per annum, with an investment of $6,000,000, is being rapidly exhausted, and the mussel fishermen and manufacturers recognize that without scientific coöperation of the government



SPONGES, PLANTED FROM CUTTINGS AND GROWING ON CEMENT DISKS
(SEE PAGE 440)



SHEEPSWOOL SPONGE, 35 MONTHS OLD

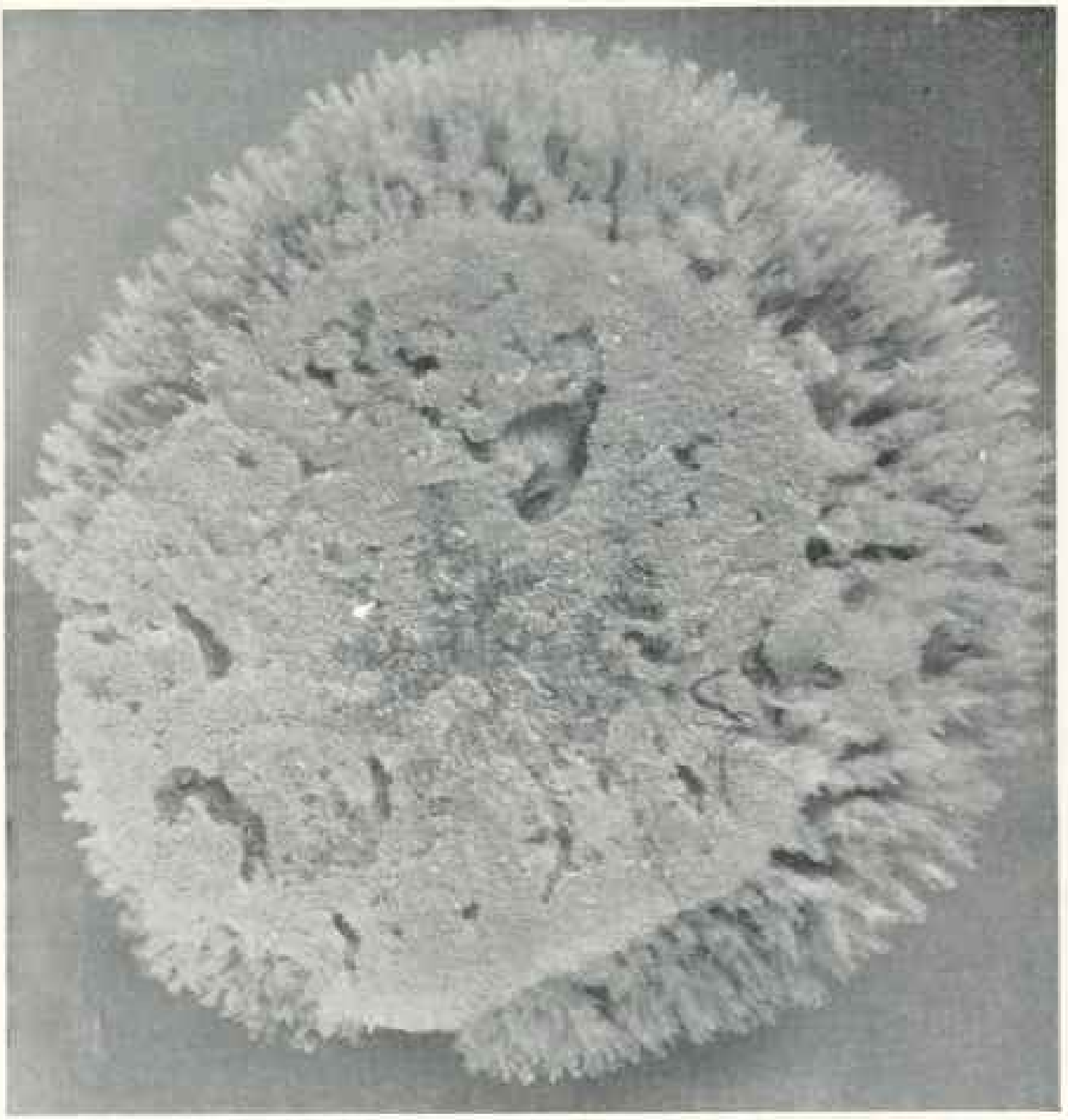
Grown on spindles in Cape Florida Channel from a cutting. Weight, dry and thoroughly cleaned, 1 1/3 ounces. Three-fourths natural size (see page 440)

the business is doomed to early extinction.

The bureau in one season's work has practically, though not conclusively, shown a method by which the pearl mussels can be propagated, and is demonstrating that the work can be carried on at a comparatively small expense in connection with the already established operations in rescuing fishes from the overflowed lands, the fish reclaimed being employed, without injury to themselves, in the dissemination of the larvæ of the mussels.

There have been liberated 25,000 fish, bearing about 25,000,000 young mussels ready to drop and begin their independent existence and already past the stage when they are most subject to fatality.

The work is also capable of application to waters under private control and will probably become a source of respectable revenue to farmers and others whose property embraces streams, ponds, and



THE UNDER SURFACE OF A SHEEPSWOOL SPONGE

Not over 48 months old; grown on a cement disk at Anclote Key from a cutting. Weight, dry and thoroughly cleaned, 15½ ounces. The root or under surface of natural sponges which grow on rough rock bottoms, as on page 499, and which must be torn from the rock, is raw, like the interior of the sponge, and therefore is the weakest and least durable part of the sponge. The root of cultivated sponges, on the contrary, is the strongest part of the sponge, as contact with the flat cement disk on which the cutting is planted develops a close and soft felt, as shown in this illustration.

lakes. The importance of this work is urgently insisted upon by the National Pearl Button Manufacturers' Association, which embraces practically the entire capital invested in the business.

### STUDY OF DISEASES OF THE FISH

In the field of fish diseases great progress has been made in the extension of knowledge of the causes of many of the fatalities which sometimes make a clean sweep of the hatcheries and which heretofore could not be adequately coped with because their etiology was not understood. The services of the scientific staff in this regard have been not only of great benefit to the government, but are highly regarded and frequently availed of by state and private fish-culturists.

Among the direct material aids rendered

A CATCH OF LARGE, FAT HADDOCK IN THE NORTH SEA

By sending its experts to all parts of the world, the government has secured valuable new fish for the country and useful methods for the fishermen. Government fish-culture in America exceeds in extent and importance that of all other countries combined (see pages 429 and 435).

to fish-culture in the past four or five years are the following: (1) Determination of the cause and remedy for the fatal malady known as the "gas disease"; (2) isolation of a bacterial organism producing a fatal disease in trout and discovery of a possible remedy; (3) determination of the cause of a fatal protozoan disease in trout; (4) discovery of a remedy for the diatom disease of lobster eggs and larvæ; (5) studies of the causes for the death of fish in captivity and the determination of a number of cases of responsible peculiarities in the water supply; (6) studies of the character of streams and the effects of various conditions on fishes, which have supplied much information on the subject to the public; (7) determination of the effects on fishes of galvanized iron and other metallic containers used in transportation of fish and fry, and (8) indication of certain undesirable types of vessels for holding fish.

### CANCER IN FISHES AND MAN

One of the recent developments in the study of fish pathology has been the discovery of a widely prevalent cancerous affection of the thyroid gland in trout and salmon under domestication. At certain hatcheries the disease attacks a very large percentage of the fish, many of which succumb in a short time.

While it is not believed that fish cancer may be communicated to human beings through the eating of infected fish, the conditions are serious as regards the hatchery work; for, unless the progress of the disease is arrested and preventive measures are discovered, artificial propagation will become inadequate to meet the present growing needs for fish for stocking purposes.

In the opinion of experts, cancer in fishes, while important in itself, is of very great and far-reaching consequence because of its bearing on the cause of cancer in man, and the vast amount of material thus made available for experiment and investigation throughout the country is thought to afford the best possible opportunity for the elucidation of general cancer problems.

President Taft was doubtless prompted by these considerations to send to Congress a special message in which he advocated an appropriation of $50,000 to enable the Bureau of Fisheries to establish a laboratory for the study of cancer in fishes.

### NEW FISHERIES AND NEW METHODS DISCOVERED BY THE FEDERAL GOVERNMENT

The importance to the fishing interests of the work of the bureau in connection with the economic fisheries is widely appreciated and freely acknowledged. The statistical inquiries of the bureau afford the only adequate basis for determining the condition and trend of the fisheries and the results of legislation, protection, and cultivation. Among the numerous special matters in which the bureau has benefited the fisheries the following may be mentioned:

By bringing to the attention of American fishermen new methods and new apparatus, new fisheries have sometimes been established and new fields exploited.

By the introduction of cod gill nets the winter cod fishery of New England was revolutionized. In a single season shortly after the use of such nets began a few Cape Ann (Gloucester) fishermen took by this means over 8,000,000 pounds of large-sized fish, and as much as $50,000 has sometimes been saved annually in the single item of bait.

By the dissemination of information regarding new fishing grounds important fisheries have been inaugurated. Thus when the abundance of halibut off the coast of Iceland was made known by the bureau, a fishery was begun which yielded from $70,000 to $100,000 annually to the New England fishermen.

The bureau has experimented with various unused or little-used products in order to determine their economic value and to suggest the best ways of utilizing them. Less than fifteen years ago there was practically no market for the silver hake or whiting (*Merluccius bilinearis*), and immense quantities incidentally taken in pound nets and other apparatus were thrown away. The bureau pointed out

the possibility of preparing a marketable salt whiting, and it is a significant fact that in a few years the sales of this fish in New England have increased from about 100,000 pounds to 5,000,000 pounds.

LOSS OF LIFE FROM STORMS DIMINISHED BY A NEW TYPE OF FISHING VESSEL

Owing to the appalling mortality among the crews of the New England fishing vessels, caused in large part by the foundering of vessels at sea, the bureau many years ago undertook the introduction into the offshore fisheries of a type of craft which would combine large carrying capacity and great speed with enhanced safety. By correspondence, discussion in the daily press, personal interviews, exhibition of models, and finally by the actual construction of a full-sized schooner (the *Grampus*) with the requisite qualities, the bureau was enabled to inaugurate a momentous change in the architecture of fishing vessels; so that for a long time the New England schooners have been constructed on the new lines, with a consequent minimizing of disasters and a decided increase in efficiency.

For other fisheries and regions the bureau has likewise advocated improved types of vessels and boats especially adapted to local conditions, and has published plans and specifications embodying the results of studies of the fishing flotilla of the world.

The results of the bureau's efforts in this line, in saving life and property, in increasing the usefulness of the vessels, and in improving the quality of the catch as landed, cannot be estimated, but the beneficial effects may be partly appreciated when it is stated that during the ten years ending in 1883, when the old types of vessels were in use, there were lost by foundering from the port of Gloucester alone 82 vessels, valued at more than $400,000, with their crews of 895 men, while during the ten years ending in 1907 the losses from this cause aggregated only a fourth as many vessels and men.

# OUR COAL LANDS

By Guy Elliott Mitchell

WHAT can the study of fossil shell-fish and ferns have to do with the price of coal? The connection is a closer one than may be supposed, and its explanation shows the intensely practical work of the government geologists in the application of abstruse science to every-day economy.

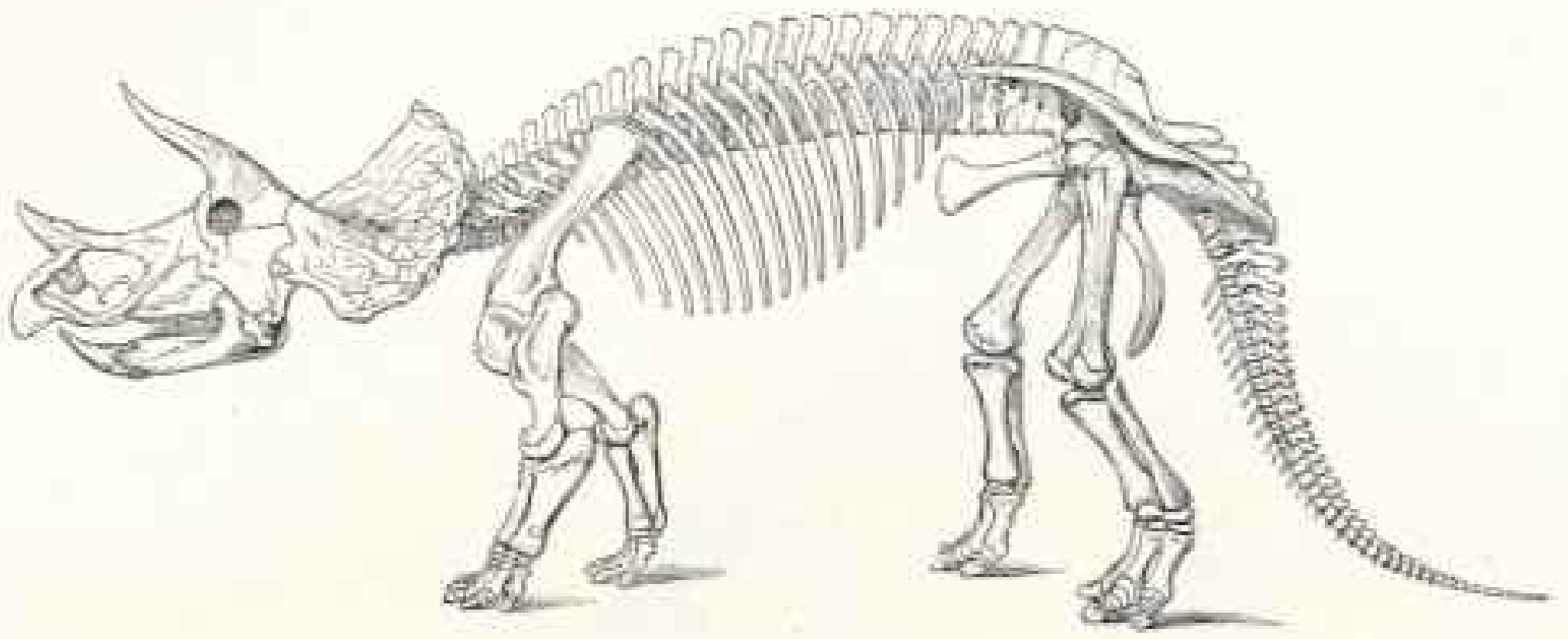
Paleontology is that branch of geology which deals with fossils as they are found in the different rock strata. Their presence easily determines the age of many rock formations which might not otherwise be recognized.

For instance, a certain species of conch may be known to have flourished during the Cretaceous period—too long ago to be estimated in years. During this period vast coal-beds were formed in the western and northwestern part of the United States as a result of the growth of a luxuriant and almost tropical vegetation.

Now here is a most valuable key for the coal geologist. In whatever strata of rocks he finds this fossil conch-shell and its associates he may look for coal of Cretaceous age.

It is due to the previous study of the broad stratigraphic and paleontological problems of the West that Uncle Sam's economic geologists have been able to classify between 35,000,000 and 40,000,000 acres of western coal lands within the short period of 4 years since President Roosevelt withdrew from entry all the government coal lands pending such classification and adequate valuation.

The particular kind of shell shown in the illustration has been of enormous importance in this classification work.



HE POINTS TO COAL

The huge *Triceratops* of the Wyoming Basin, 25 feet long by 10 feet tall, is, where found, a good lead for the coal geologist. His remains, however, are too scarce to be depended upon.

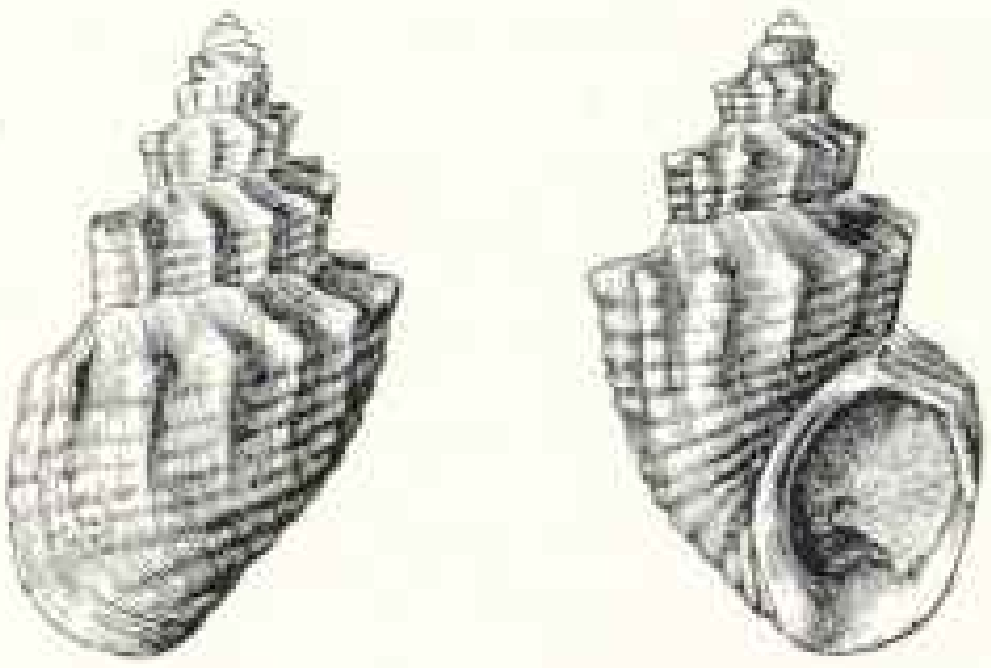
Where the coal geologist finds this conch in a rock formation he knows that no coal beds will be found lower down in the ground. He knows that some coal may be found in the same strata in which the conch lies, but that in the strata immediately above very high-grade coal can be confidently expected. The name of this little helper of Uncle Sam, who was a very abundant resident of the early United States, is *Pyrgulifera humerosa*. He hasn't any American name.

In this coal classification and valuation work, which is the next economic step following the discovery of the coal beds, the geologist comes down out of the realm of high science, with its Pyrguliferas and other things, right into camp with the every-day coal miner and operator. Using the data which the geologists bring in from each field season's work in Wyoming, Montana, Utah, and all the other public coal-land States, the Geological Survey at Washington works out the tonnage on every 40-acre tract of coal land, and, taking into consideration the quality and depth of the coal, places a valuation upon the land.

This valuation ranges all the way from $10 an acre up to several hundred dollars. Some of the land, where the coal seams are very thick, of high-grade coal, or where there are several seams, one over another, has been rated at over $400 an acre.

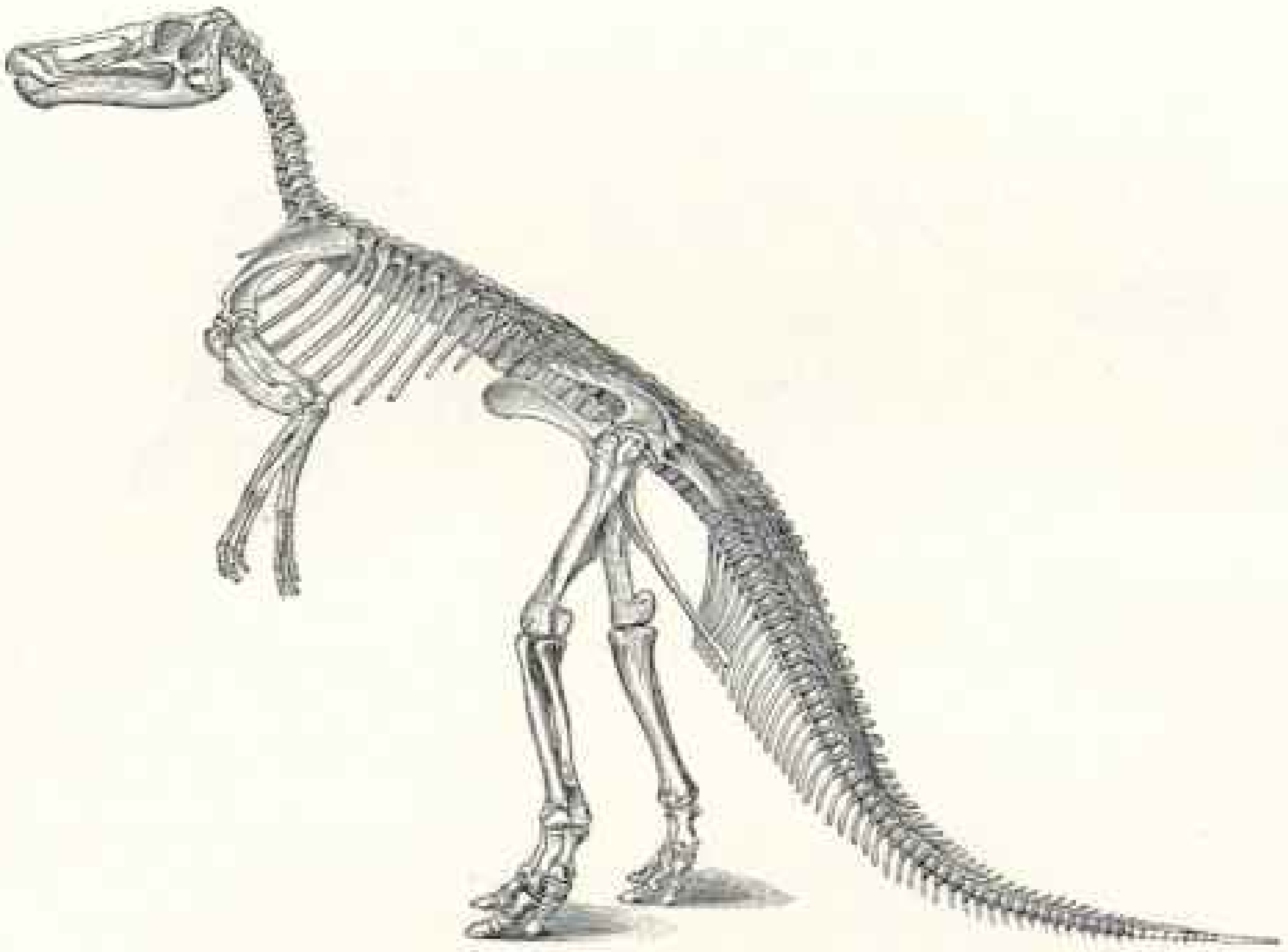
This seems like a big price—$64,000 for a 160-acre tract of coal land which, until the coal-land classification work began, in 1906, was sold at $20 an acre, or $3,200—but, when it is seen what a great amount of coal an acre of such land contains, even the $400 valuation looks small.

Many of the western coal lands are underlain by beds of 40, 50, and even aggregating 100 or more feet of solid coal. An acre of coal 40 feet thick contains 72,000 tons, and the Geological Survey calculates that at least 40,000 tons



FOSSIL SHELL OF A SMALL CRETACEOUS CONCH, PYRGULIFERA HUMEROSA

A most useful geologic key to the western coal beds



ANOTHER SPECTACULAR BUT NOT VERY DEPENDABLE GUIDE TO THE COAL GEOLOGIST: THE GIANT 30-FOOT CLAOSAURUS

He is too infrequent to be counted upon; whereas the little Conch, *Pyrgulifera*, is omnipresent just below the coal formation

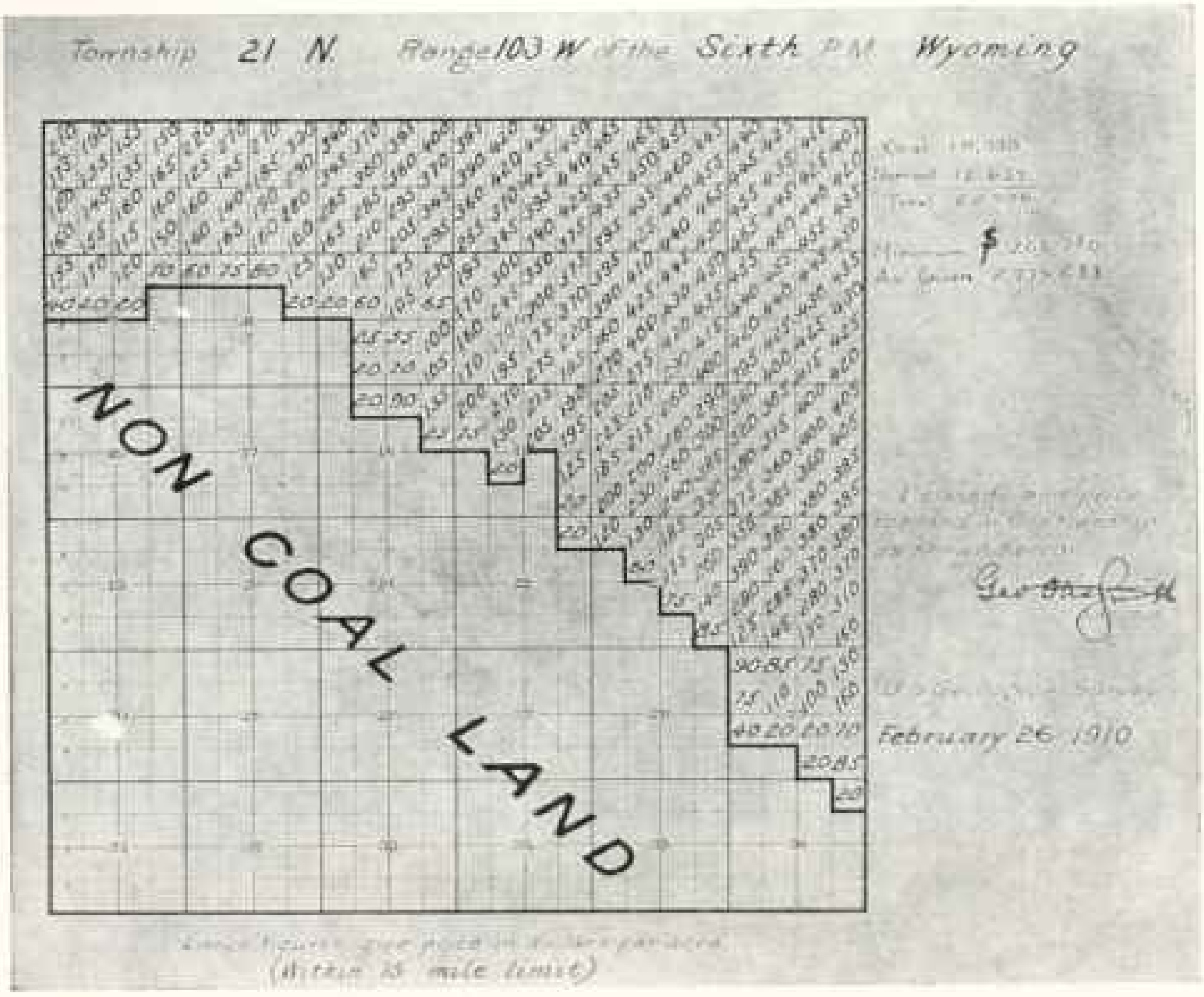
of this can be brought to the surface, thus making the very liberal allowance of almost half for loss in mining. Four hundred dollars an acre for such land would thus be a charge of only 1 cent a ton, certainly not much of a burden on the coal operator or the ultimate consumer.

Under Uncle Sam's new classification and valuation scheme, the public coal lands are now handled in a thoroughly business-like manner, and in sharp contrast with the old happy-go-lucky methods under which coal land was sold at a fixed and very low price, without regard to its real value, or even disposed of under agricultural or other laws at a nominal rate.

The coal-land law provides that coal land shall be sold at not less than $20 an acre if lying within 15 miles of a railroad, or $10 an acre if beyond that limit. Until 1907 this price had been regarded as the only price, but it was then decided that the figures named were clearly *minimum*. Since then the coal lands have been classified and valued by the Geological Survey at approximations of their commercial worth. During 1907-1908 valuations were fixed as high as $75 an acre.

In April, 1909, the Department of the Interior inaugurated a valuation plan based on the estimated tonnage of the coal deposits.

Since coal occurs in beds or seams, it is a comparatively easy matter in most instances for the geologists to estimate the tonnage with a fair degree of accuracy. An acre of coal one foot in depth contains approximately 1,800 tons, and 1,000 tons is allowed by the Survey as recoverable. The valuation regulations take into account thickness of beds, depth, whether




A WYOMING TOWNSHIP PARTIALLY UNDERLAIN BY COAL, CLASSIFIED AND VALUED IN 40-ACRE BLOCKS

Price range from $20 an acre to $465 an acre. Acreage of coal land in this township, 10,339 acres, valued at $2,770,688; average $268 per acre

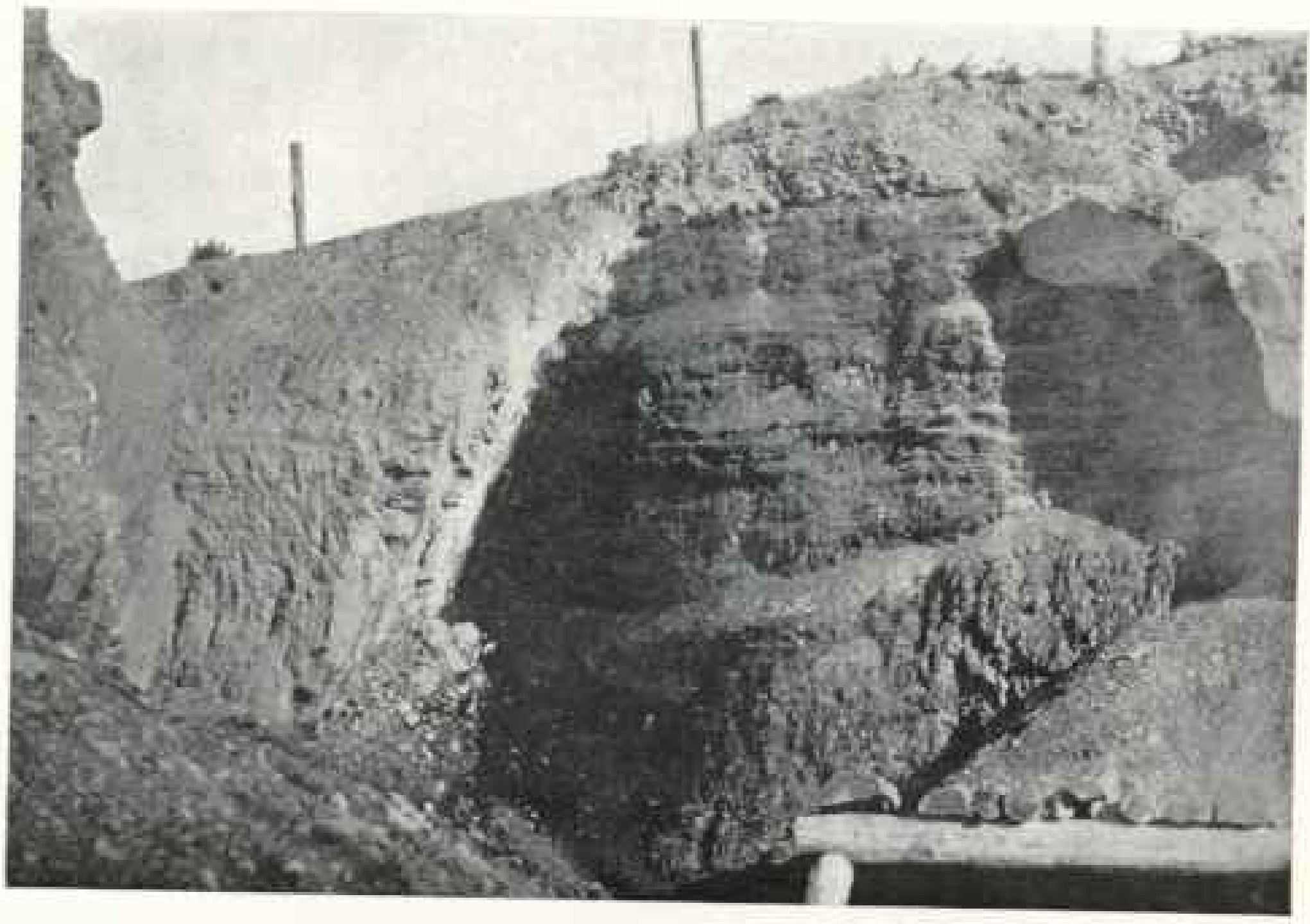
one or more beds, and quality of coal. Under these regulations a maximum valuation of $300 an acre is allowed for virgin fields where the tonnage estimates are based solely on geologic conclusions, while in fields where mines are already developed and the prospective purchaser knows exactly what he will get there is no limit to the values which may be fixed.

Under these new regulations the area classified as coal land by the Geological Survey up to May 1, 1910, a period of 13 months, has been valued and the sale price fixed at $232,308,000—an average rate of a little over $52 an acre. This acreage would, if sold at the minimum price fixed by law, yield but $76,169,000. Here is a gain, therefore, of $150,000,000 in coal-land values representing a little over a year of coal classification work.

The values of the coal lands, as fixed by the Survey, of course vary greatly; they run all the way from the minimum price up to as high as $465 an acre in certain lands in Wyoming. Each 40-acre tract is separately classified and valued.

In one Wyoming township, a plat of which is shown on this page, the value of the land classed as coal under the present regulations is $2,770,688. At the minimum price it would bring only $206,780.

During the single month of April ap-



A 30-FOOT COAL SEAM AT HANNA, WYOMING

A new coal field has recently been discovered in Arizona which probably contains more coal than has been mined to date from all the coal mines in the United States (see page 451)

proximately 350,000 acres of coal land were valued at $22,000,000, which is three times the value of the same area at the minimum price. At the present writing, May 24, the coal valuations for May, 1910, have already run $36,000,000.

The question may be asked whether, with 30,000,000 or 40,000,000 acres of coal land in the West now in private ownership, there will ever be a demand for these government coal lands at $200 or $400 or possibly a much higher figure per acre. The answer is that the lands are actually being purchased, and, moreover, these prices are very conservative.

The big coal companies themselves, such as the Union Pacific and the Rocky Mountain Coal Company, are today leasing coal lands from other parties and working them on a 10-cents-a-ton royalty basis, and thus actually paying in royalties several times what the government would charge the entryman as a cash price for similar coal lands.

At the Salt Lake City land office alone, during a single month, $200,000 worth of coal-land sales were made and 50 declaratory statements filed for purchase of additional coal tracts, aggregating probably another $200,000, or a total for a month's coal business in one land office of $400,000.

The government coal classification work has not yet been nearly enough completed to allow for even an estimate at what the total valuation figures will be, but a little rough guessing may prove of interest.

It is estimated by the Survey that there are approximately 50,000,000 acres of public coal lands, located principally in Wyoming, Montana, Colorado, Utah, and New Mexico. Of these it is believed that 30,000,000 acres are underlain with what may be termed fine coal.

Assume that the average valuation which will be placed on these lands is $50 an acre, which according to the rec-

ord of present valuations appears to me conservative, and that on the remaining 20,000,000 acres an average valuation of $25 is placed. This would give a round figure of $2,000,000,000—a sum almost too big to contemplate.

If these figures of acreage and valuation are thought too extravagant, it may be remarked that the coal figures are constantly expanding, and that every year's geologic work by the government adds additional areas to our coal map.

### IMMENSE COAL FIELD RECENTLY DISCOVERED IN ARIZONA

Thus, in congressional testimony the other day, Director Smith, of the Survey, mentioned a new coal field in Arizona, not previously included in any coal estimates, which he stated probably contained a tonnage equal to all the coal mined in the United States since the discovery of the first mine.

Two good results from this coal valuation work are, first, that the receipts from the coal-land sales go into the Reclamation Fund, for the irrigation of desert lands by the government and the creation of homes—for every acre of coal land sold at, say, $300 a farm of 10 acres may be reclaimed from the desert by irrigation and a home created—and, second, that the placing of a good-sized price on the land will prevent monopoly of the western coal supply. It precludes the purchase of the lands for mere speculation—holding them indefinitely without mining developments. The management of his big coal-land properties is one instance at least where Uncle Sam is acting the part of the wise landlord in the interests of the people.

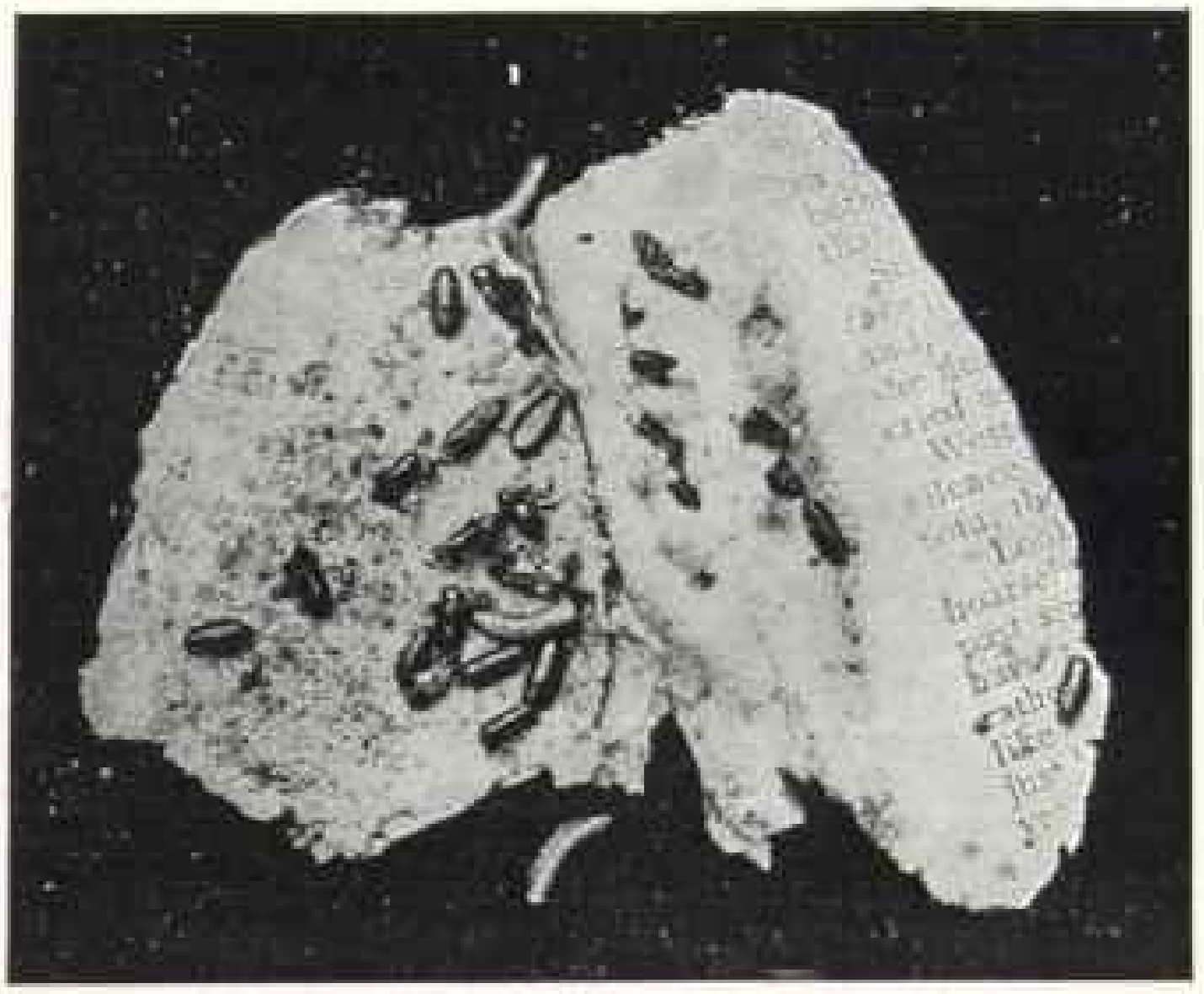
Now follow this work another step. The Geological Survey valtues the coal lands not only according to tonnage per acre, but according to quality of coal. There are all grades of coal, ranging from brown lignite—only a step removed from peat—to anthracite, produced under enormous pressure and friction, and the fuel-testing work of the Survey determines the number of heat units and the energy values of coals of the various beds.

Further than this, the government has inaugurated a practice with respect to its own coal purchases which will doubtless before long become the rule in private coal buying, namely, paying for coal on the basis of its heating value—the *British thermal unit* basis.

The Geological Survey samples all Uncle Sam's coal purchases and makes tests which show what the coal will do practically. If the coal falls below a certain standard a deduction is made in price; if it exceeds that standard a higher price is paid.

The present practice of coal purchase is to a considerable extent buying a pig in a poke—you get the weight but you don't know the quality. The new practice is eminently fair to both producer and consumer.

Government purchases alone amount to $10,000,000 annually, and the public saving by this exact method of purchase amounts to hundreds of dollars daily. Applied to the country at large it would represent millions of dollars a year.



FLY LARVÆ AND PUPÆ IN WASTE PAPER (ASH-PIT REFUSE), NATURAL SIZE

Photographs by Robert Newstead; by courtesy of the Liverpool School of Tropical Medicine

Egg of house-fly greatly enlarged, showing the segments of the larvæ through the cuticle

PRIVY VAULTS, SWARMING WITH FLIES, ADJOINING KITCHEN DOOR

These conditions, inviting disease and insuring the pollution of food, are practically duplicated in hundreds of towns besides Pittsburg, in which this photograph was taken

# FISHES THAT CARRY LANTERNS

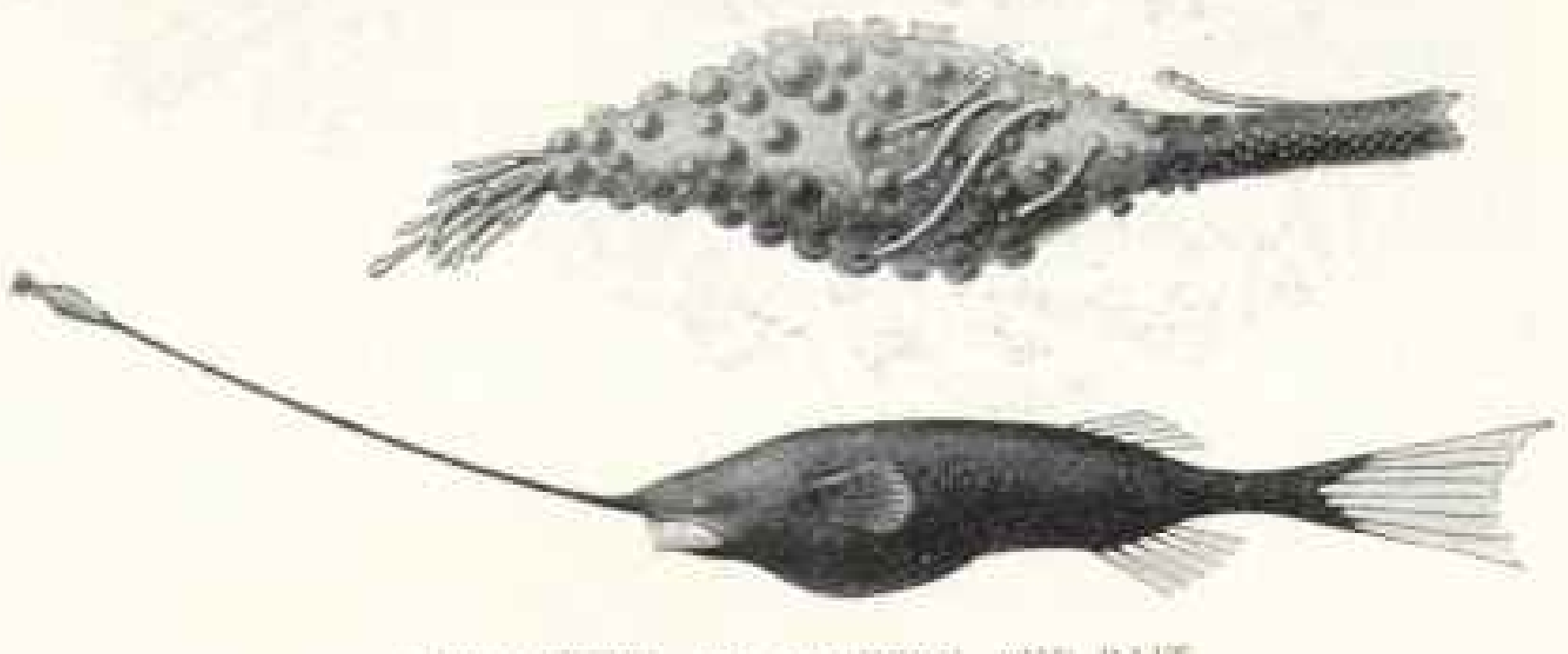
SEVERAL years ago this Magazine published a description of the angler fish, well known along the New England coast because of a device by means of which it lures and catches other fish.* This device consists of filaments or tendrils resembling seaweed, which are attached to the head.

When the angler is hungry it hunts out a convenient place in shallow waters, where its color and markings make the fish indistinguishable from the sea-bottom. Here it lies quietly, often as if dead, while its floating filaments, kept in motion by the tide, decoy other fish, which never discover their mistake until too late to escape from the angler's merciless jaws.

This angler fish is the only one of its kind frequenting the shallow seas of northern Europe and North America, but there are many other related species inhabiting the deep seas of almost all parts of the globe, as well as lurking in the tropical groves and in the sargasso meadows of the Atlantic Ocean. These relatives of the angler are the subject of a bulletin by Theodore Gill, "Angler Fishes, Their Kinds and Ways," recently published by the Smithsonian Institution, and from which these notes are obtained.

The most extraordinary of all the anglers are those that carry lanterns to see with.

"Some stout-bodied anglers resorted to deep and deeper waters, where the light from the sun was faint or even ceased, and a wonderful provision was at last developed by kindly nature, which replaced the sun's rays by some reflected from the fish itself. In fact the *illicium* (a prolongation of the spine) has developed into a rod with a bulb having a phosphorescent terminal portion, and the 'bait' round it has been also modified and variously added to; the fish has also had superadded to its fishing apparatus a lantern and worm-like lures galore.



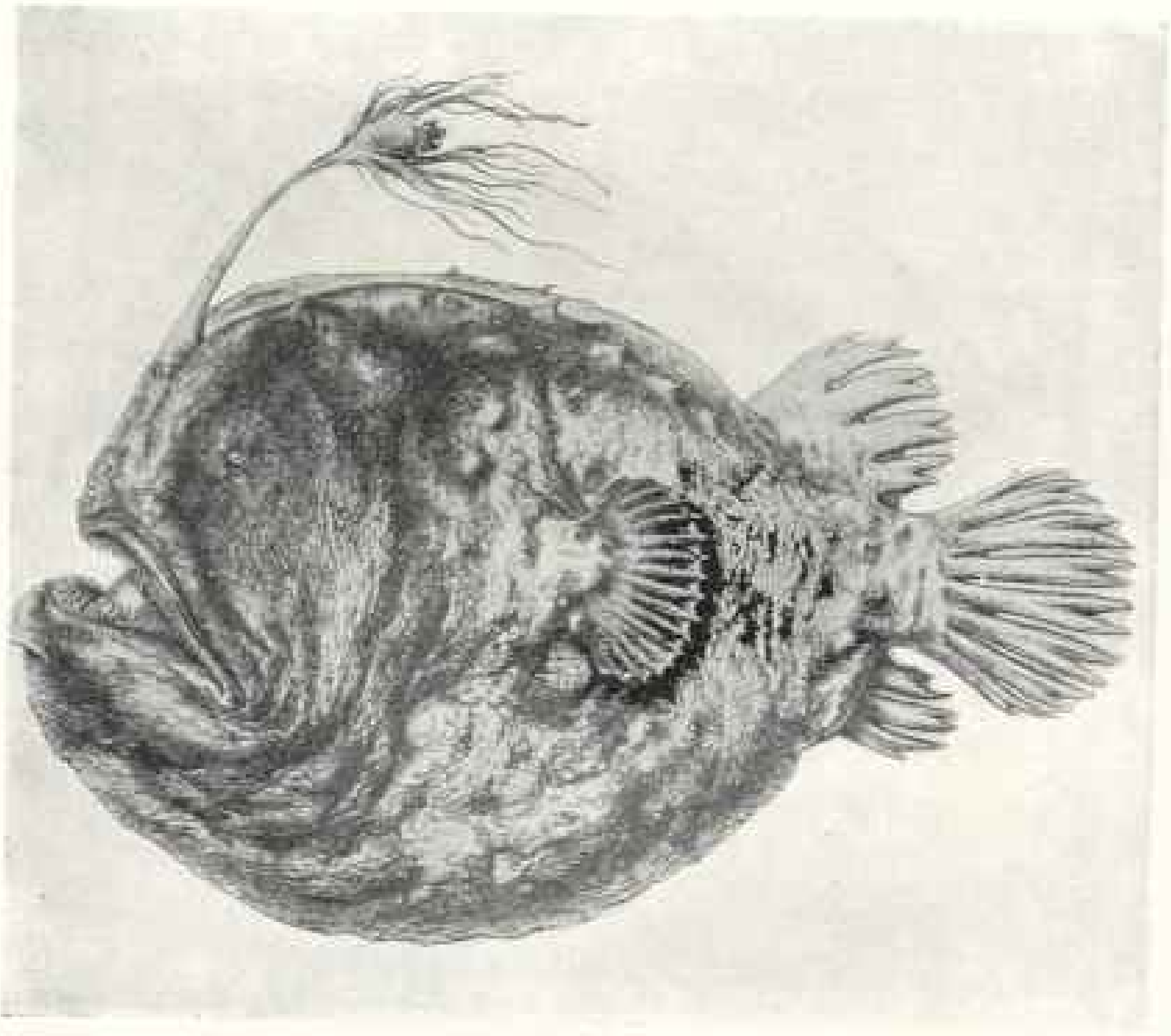
A FISH WITH ITS LANTERN AND BAIT

This tiny fish was dredged in the Indian Ocean at a depth of more than a mile (7,200 feet). The bulb-like upper figure is an enlargement of its torch. The fish is 1½ inches long (excluding the rod and bulb). It swims with the rod and torch pointed straight forward.

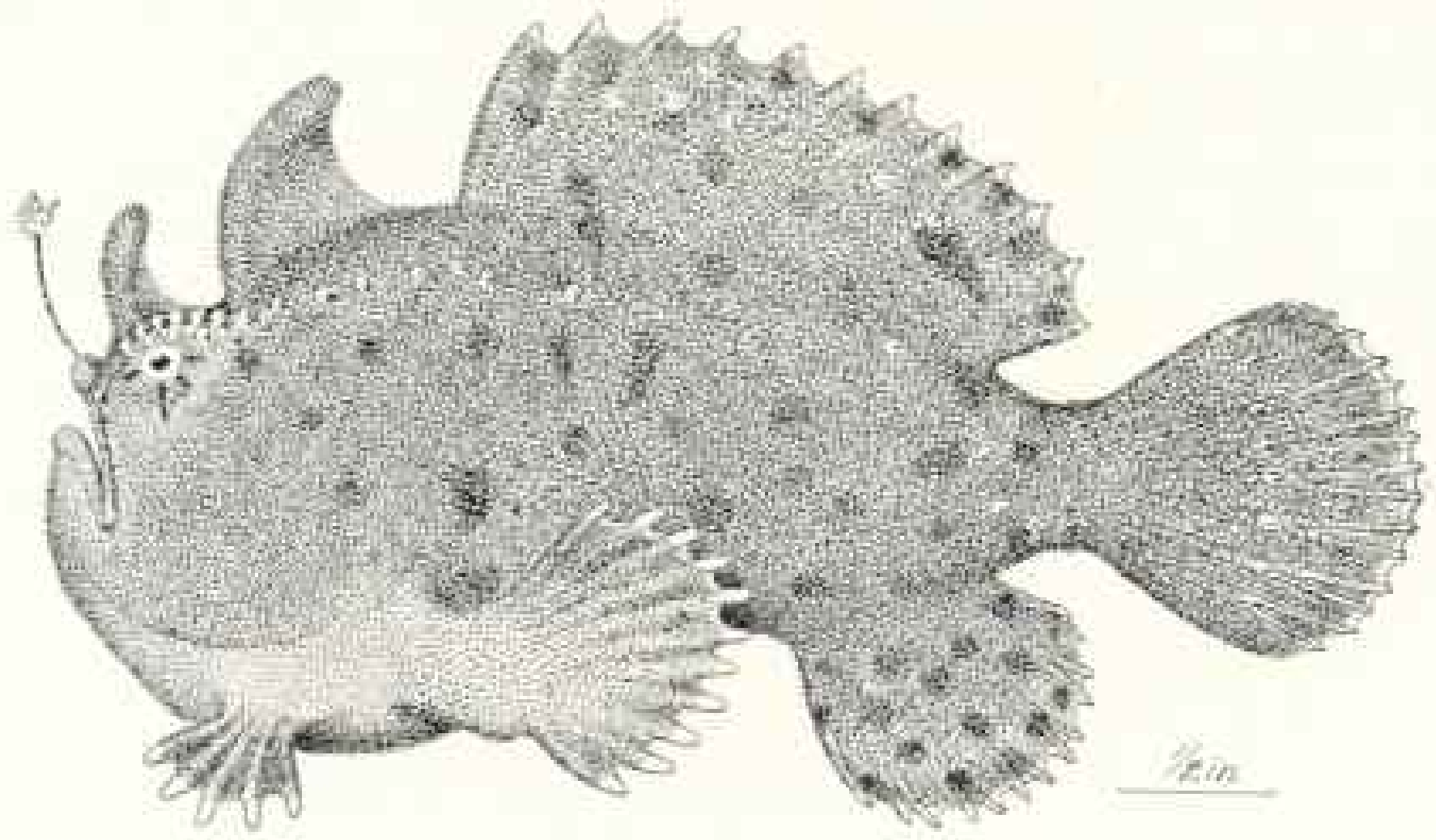
"How efficient such an apparatus must be in the dark depths where these angler fishes dwell may be judged from the fact that special laws have been enacted in some countries against the use of torches and other lights for night fishing because of their deadly attractiveness. Not only the curiosity of the little deep-sea fishes, but their appetite is appealed to by the worm-like objects close to or in relief against the phosphorescent bulb of the anglers."

As may be inferred from the size of

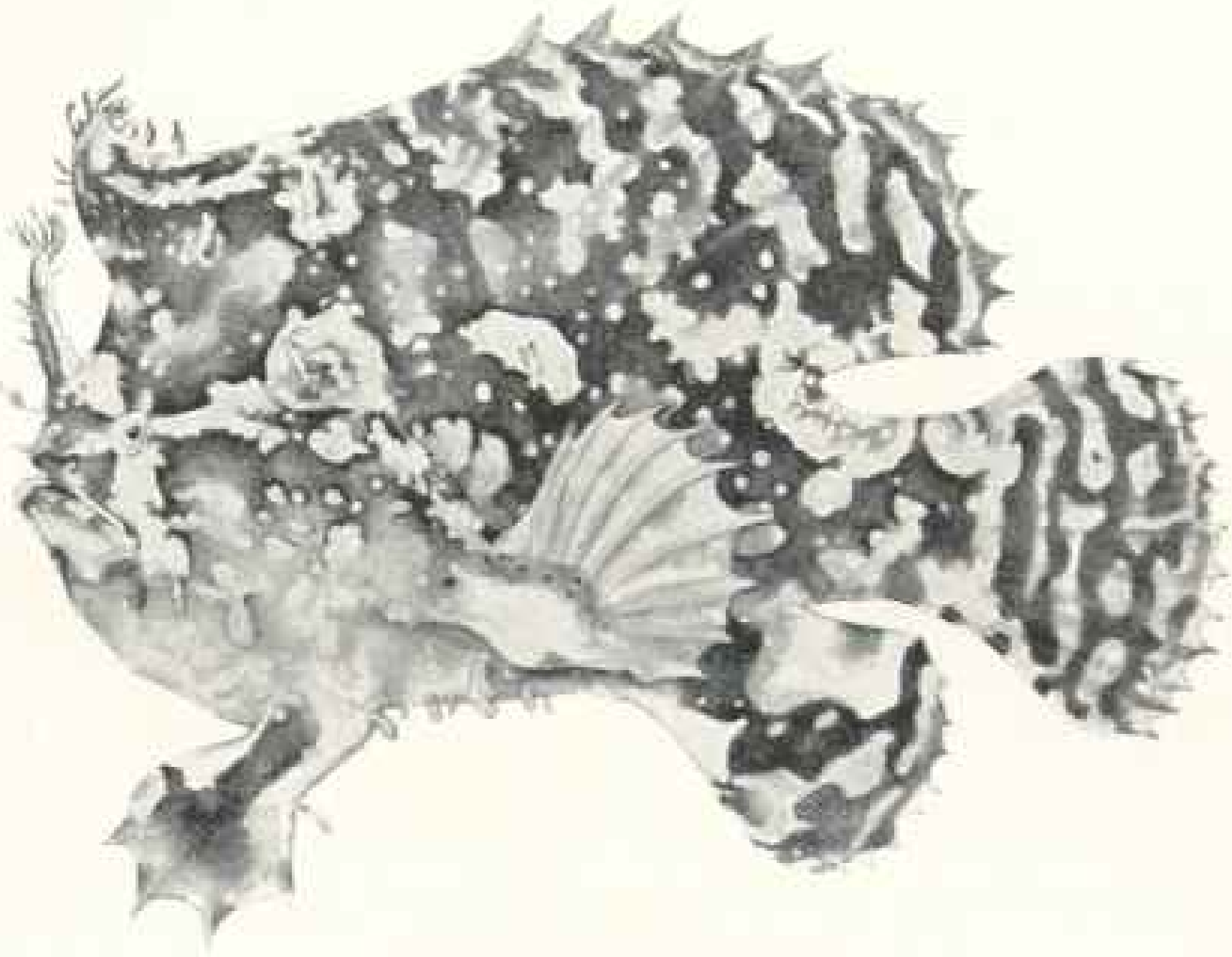
* See "The Purple Veil," by H. A. Largelamb, pp. 335-341, NATIONAL GEOGRAPHIC MAGAZINE, 1905.



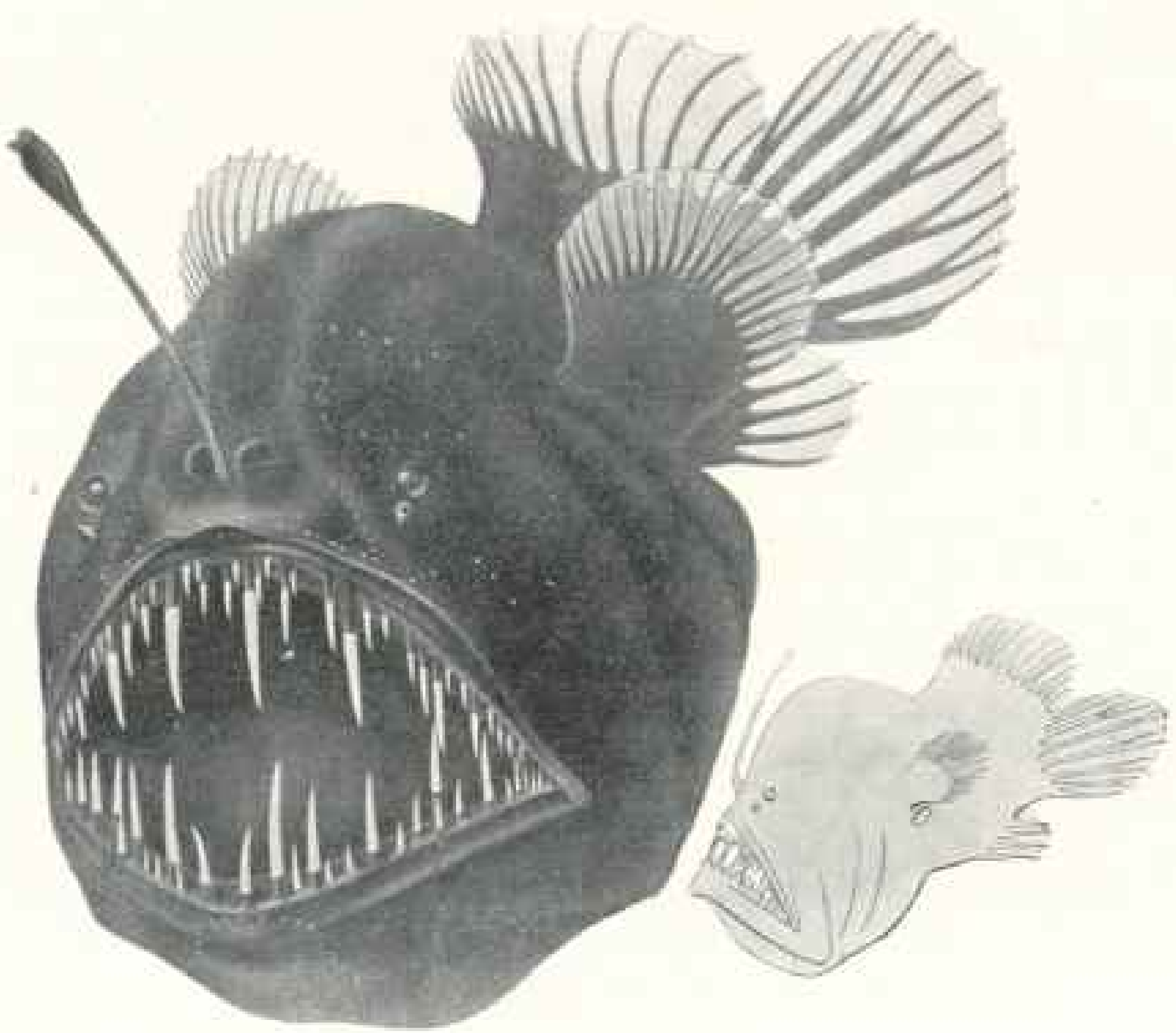
AN ANGLER FISH: NOTE THE FILAMENTS OR BAIT WHICH LURE OTHER FISH



ANOTHER SPECIES OF ANGLER: A SEA TOAD OF THE WEST INDIES



A FROG FISH OF THE SARGASSO SEA



ANOTHER SPECIES OF THE ANGLER, EQUIPPED WITH A DIFFERENT KIND OF BAIT

the mouth and teeth of the fish shown on page 455, certain species are ravenous predatory fishes, which may sometimes seize and swallow fishes much larger than themselves. For instance, a specimen obtained by Mr J. G. Johnson, at Madeira, was less than 4 inches long (3.8 inches), but it had actually engorged a fish about twice its own length (7½ inches). The extensibility of the jaws and connected parts, as well as the dilatability of the œsophagus, stomach, and integuments, enabled the captor fish to accomplish this feat. So completely had the captor ingested (but not digested) its victim that "it was tempted to take a bait," and was thus secured for ichthyology.

Another species of the angler are the sea toads, which are inhabitants of tropical seas (see page 454). The brilliant scarlet and other colors which render the sea toads so conspicuous when seen in the jars of a museum collection are quite in harmony in their natural home and assimilate the fishes to the brilliantly colored coral animals and the other organisms, in the midst of which they lurk in wait for prey.

Most of their lives are spent in coral growths. Selecting a fitting place, such as a fissure just wide enough to get into and hold on to, a fish may assume an oblique or vertical position, sometimes looking downward, sometimes with head upward. It then uses its pectoral fins to obtain a good purchase on the rock, and can thus remain stationary indefinitely, waiting till its victims come sufficiently near to be seized.

Closely akin to the sea toads are the frog fishes, which are mostly inhabitants of the "sargasso seas," or "sargasso meadows," in mid-ocean. The sargasso sea is an egg-shaped area in the latitude of Florida, beginning some 400 miles east of Jupiter, and extending thence easterly for 1,700 miles to about the 30th meridian. It is characterized by an unusual quantity of seaweed, also known as "sea-grape," "sea-lentil," etc., which grows luxuriantly on the surface of the sea.

Although floating on the high seas, and thus at the mercy of the winds and waves, nevertheless, those agents operate in such a manner, in conjunction with the currents, that for year after year and century after century nearly the same areas of the ocean are covered by this peculiar plant. The sargasso meadows appear to occupy the same position at the present time as in the days of Columbus, who first described them.

Amid the seaweed thrive most of the species of swimming crabs, cuttle fishes, and other fishes which are found along the shores of continents and islands. Flying fishes of different kinds are also tenants of these fields, although they may rarely show themselves in the air. All these are lured and caught by the frog fish. A single frog fish, whose stomach contents were examined by Mobius, was found to have taken in four fishes, one of which, a pipe fish, over 5 inches long, was coiled in the stomach; a small cuttle fish, and a small portunid crab. All these were still in a recognizable condition.

Another peculiarity of the angler family is the remarkable "nest" which the fish constructs to protect its eggs.

"The eggs are discharged in a jelly-like mass, which, on contact with the water, become immensely distended and form buoyant raft-like receptacles, which float at or near the surface till the eggs are hatched. The rafts are swollen to an enormous size in comparison with the mother fishes, those of the common angler sometimes reaching a length of 36 feet and those of the frog fish a couple of feet.

"The egg raft, after full expansion in the water, is a soft jelly-like mass, quivering to the touch, but withal rather tenacious, moderately uniform in the width, and tapering abruptly and blunt at the extremities. It is also rather thick, with blunt edges. The entire mass is thickly permeated with eggs, which appear to be in several irregular layers. After some days, and when the eggs have matured, the jelly probably dissolves and embryos are apparently thus liberated."

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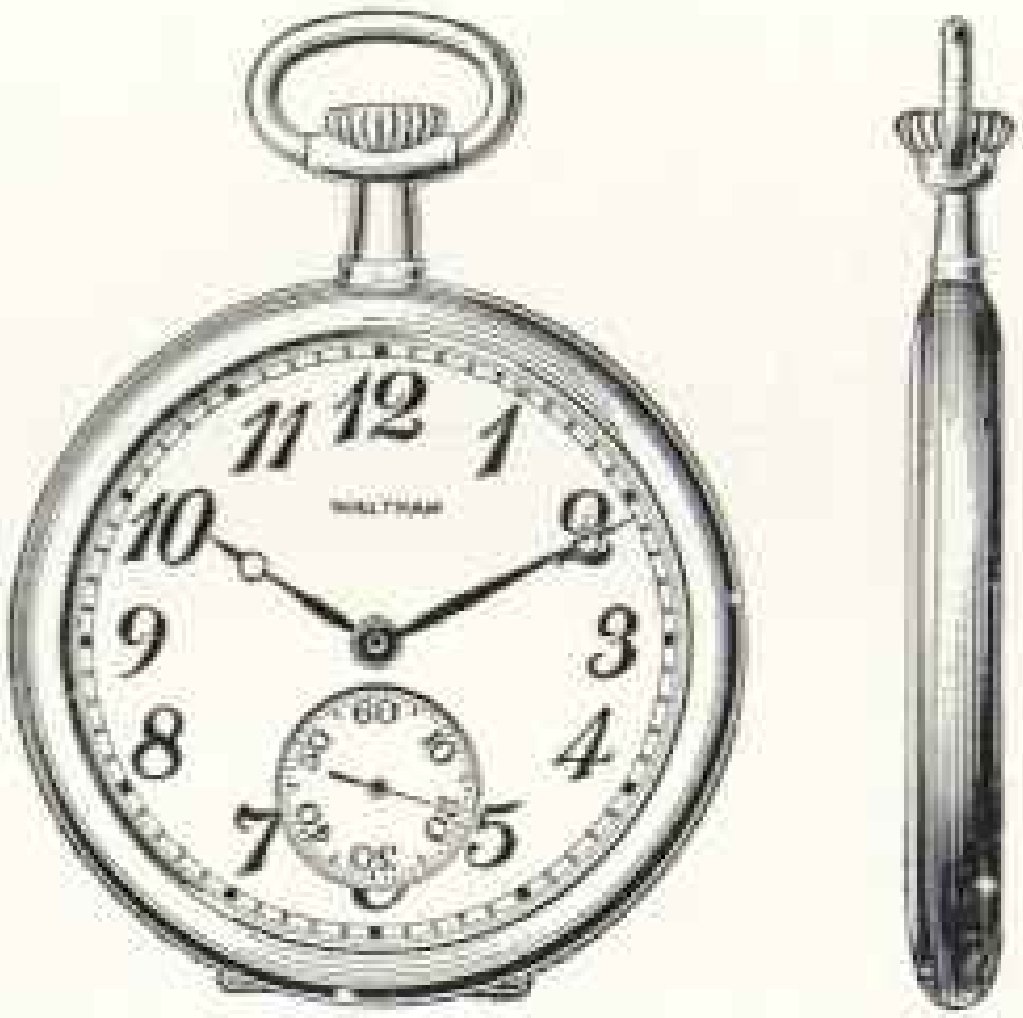


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