

to his need to hide or to make wide circuits in order to avoid the larger towns. It was now the February of northern France, and there was sometimes a little snow, but more often a drizzling rain. He had suffered much from cold; but as he strode along, with a mind more at ease, he took pleasure in the sunshine. A night wind from the north had dried the roads. It was calm, cold in the shadows, deliciously warm on the sunlit length of yellow highway. He had lost time,—quite too much,—but he still hoped to reach Musillon before that man with the wart arrived. If so, he would see Despard, warn him as to Grégoire, and, with this claim, and their old partnership, on which he counted less, he might get his passport altered, and lose himself somewhere. If he had to remain in the town, he must see, or be presumed to have seen, that sick father, and must be promptly adopted if by cruel circumstances

he became unable to journey far enough from Paris to feel secure. The distorted face of Amar haunted him—the man who, to save his own life, would not even make believe to forgive. He had no power within him to explain a man like Amar; and because the Jacobin was to him incomprehensible, he was more than humanly terrible. What possessed that devil of a marquis to turn up? And was he now at his château? And why had Achille Gamel set down Normandy in the passport? And why had he himself been fool enough to fill up the vacant place for the name of his destination with that of the only small town he could recall in that locality? He had been in haste, and now a net seemed to be gathering about him. He must go thither, or take perilous chances. He was moving toward a fateful hour.

"Toto," he said, "let us laugh; for I like not the face of to-morrow."

(To be continued.)

SUBMARINE PHOTOGRAPHY.

BY PROFESSOR LOUIS BOUTAN,
Lecturer on zoölogy at the Sorbonne.¹

THE FIRST ATTEMPTS.



WHEN one follows the line of the railway which runs from Paris to Barcelona, and has crossed the plains of Béziers and Narbonne, covered with vineyards, one catches sight, beyond Perpignan, of the Pyrenees, which bar the horizon. The train now penetrates the mountains, the lower slopes of which push into the sea, and one runs through their high walls by means of tunnels, so that the traveler is plunged at one moment into obscurity, to emerge the next into the brilliant sunshine of the Southern sky.

In this part of France the Pyrenees resemble a gigantic hand laid out flat on the surface of the earth, each finger of which, formed by a mountain-spur, dips its tips into the sea. Between these fingers lie isolated bays, with cities and villages on their shores. Such are Argelès, Collioure, Port Vendres, and Banyuls-sur-Mer.

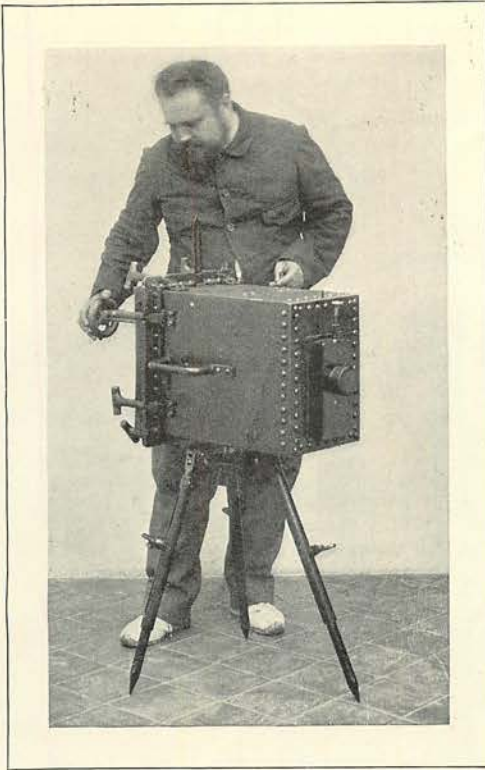
It is at the last-named place that Professor Henri de Lacaze-Duthiers founded the Arago Laboratory, which is now a part of the University of Paris. The laboratory is supported by the French government, and is well supplied with all necessary apparatus, including aquariums furnished with continual streams of sea-water, a steamboat, various sorts of fishing-craft, a workshop, etc.; and all these are placed gratuitously at the disposal of zoölogists, of whatever nationality they may be.

The director of the laboratory has long been in the habit of inviting naturalists to make use of the scaphander in order to study marine animals in their native element. Some years ago, acting on his advice, I familiarized myself little by little with the employment of this apparatus.

I soon found out that the bottom of the sea, especially near the coast, is not flat and monotonous, as one might imagine it to be. On the contrary, it is very uneven, and pre-

¹ In response to an inquiry from us, Professor Boutan informs us that he was the first person to make submarine photographs. He was born in 1859, and is a doctor of sciences of the University of Paris. In 1880, at the time of the Melbourne Exposition, he was sent on a mission to Australia by the French government.

He was maître de conférence at the University of Lille in 1886, and was sent on a mission to the Red Sea in 1890. He has published works upon gasteropods and on reptiles. In 1891 he was maître de conférence at the University of Paris. The submarine views here presented were taken by Professor Boutan.—EDITOR.



PROFESSOR BOUTAN AND HIS APPARATUS FOR SUBMARINE PHOTOGRAPHY.

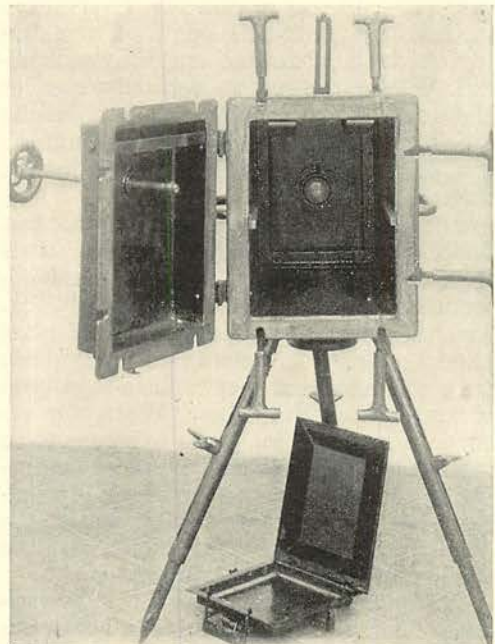
sents most picturesque and varied landscapes. If one happens to have descended on a sandy beach, one sees, as far as the eye can reach, a submarine meadow covered with long grasses, all bent over in the direction in which the current is running. Here and there deep ravines cut up the green surface, while farther away are noticed steep masses of rock formed by fallen blocks or stony precipices. Every boulder is covered with its dress of seaweed, and in the crevices between swarm a whole fauna of invertebrates.

The strangeness of these submarine landscapes made a very deep impression on me, and it seemed a lamentable fact that they could not be reproduced in any other way than in a description which, however exact, was necessarily imperfect. I was filled with the desire, therefore, to bring back from these submarine explorations a more tangible souvenir. But, however good a diver one may be, it is scarcely possible to make a drawing, or even a sketch, under water. I then resolved to try to see if I could not obtain a photograph of this hidden region. As it is not difficult to take a landscape in the open air, why, I asked myself, could I not succeed

in making a photograph at the bottom of the sea? Though it is quite certain that water is a much denser medium than air, still, as the eye can distinguish objects in the midst of water, there should be, I argued, no insuperable obstacle in the way of a photographic plate receiving an impression under the same conditions.

The idea of photographing what I saw under the sea came to me, therefore, quite naturally. But when I tried to pass from the dream to the reality I experienced some difficulties. I first had constructed a rather imperfect apparatus, composed of an ordinary photographic chamber inclosed in a metal case provided with glass and made water-tight. It was with this instrument that I tried my first experiments.

At the start the results obtained were not what I had hoped for; though I took advantage of the most favorable conditions, and observed the most minute care, my efforts were fruitless. When I developed the plates which had been exposed under water, I obtained only shapeless images, irregular undulations, which in no wise reproduced the landscape on which I had turned the objective. The plates, which were only slightly affected by the light coming from the submerged objects, were uniformly beclouded, as if the action of the light had been produced equally over their whole surface. On this account, the landscapes which I had



INTERIOR VIEW OF PROFESSOR BOUTAN'S APPARATUS.



THE DESCENT AT BANYULS-SUR-MER.

sought to reproduce presented an extremely vague outline that was unsatisfactory in every way. It was in vain that I varied the method employed. The length of time during which the plate was exposed was modified. I used the most sensitized plates, or those called "isochromatic." But the results obtained were always the same: a uniform cloudiness still enveloped the indistinct images.

I began to despair of overcoming this first difficulty, when the thought occurred to me to place colored glasses in front of the objective in the interior of the water-tight box. The use, in outdoor photography, of glass plates of various colors has long been tried, and excellent results have thus been obtained in certain cases. When, for example, a mass of deep-green foliage is to be reproduced, this foliage, instead of appearing on the negative as a dark heap of a uniform hue, is brightened by this means, the details come out more distinctly, and the whole presents even a certain relief.

It is found that the rays emitted by variously colored objects other than leaves are weakened in traversing the glass plate, while, on the contrary, those emitted by green

masses preserve in great part their intensity. Thus, by lengthening the exposure, you obtain, in the greens, a picture which is much better in its details. The knowledge of this fact suggested my first trying green-colored plates. By this means I hoped to obtain a clearer image of the seaweeds, which contain in abundance the green principle of chlorophyl. Although the result obtained was not so bad as before, it was not, however, entirely satisfactory. The outline of the objects was perceptibly clearer than in the previous experiments, but the cloudiness was still there. I then tried a whole series of other colors, and, as a physicist before whom I had laid the difficulty had theoretically predicted, it was the blue which produced the best results.

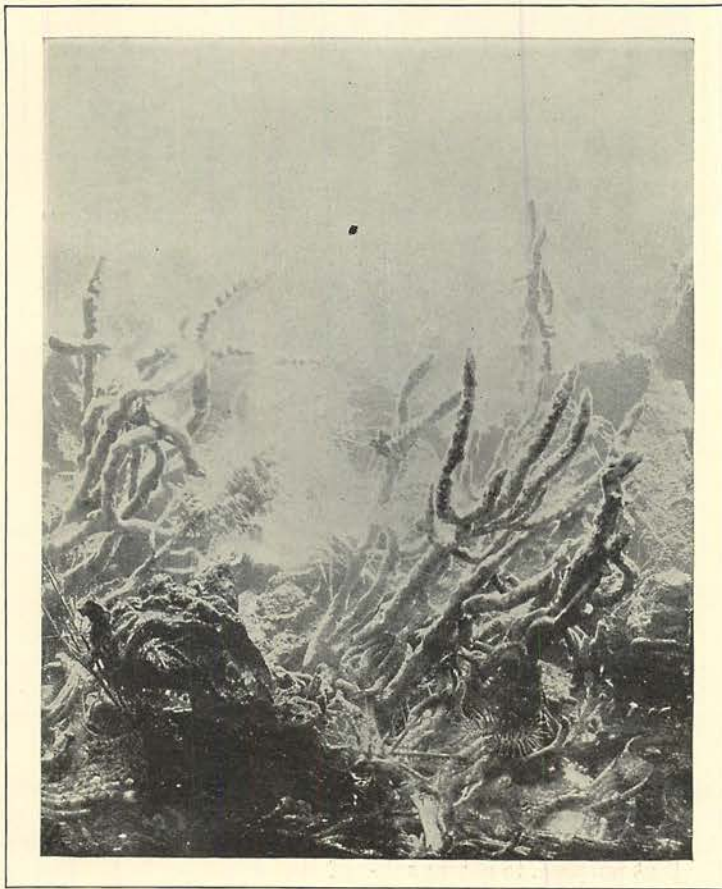
By interposing in front of the objective a perfectly homogeneous blue plate, I succeeded in producing a series of negatives, with the outline of objects clear-cut, and with great delicacy of detail. The cloudy appearance was quite eliminated, at least in the foreground. But there still lingers in the background of the proofs a slight mistiness, due to the medium being denser than air, which I have never been able completely to

remove. This peculiar cloudiness of the background, this sort of mist which settles over distant objects, seems to me to be the characteristic feature of submarine photography.

Almost all the photographs which accompany this article were taken in the little cove of Troc, on the coast near the laboratory. This bay, which is very much exposed to the north wind, is beaten and cleaned by the billows during a large part of the year. But when the south or southeast breezes set in, the water becomes perfectly calm throughout this little inlet, which then looks as if it were a lake. In France the most favorable time for taking these views is June, July, and August.

Here is the *modus operandi* of taking a

down into the water at the point chosen for the operations. Once at the bottom, and at the desired depth, I signal to the captain to send me down the different parts of the photographic apparatus. The iron stand is let down at the end of a rope, followed by the photographic box and a cast-iron weight for steadying the whole. Then I look about me in order to select the exact spot to be photographed, which having been done, I leisurely set up the stand, and place the box on it, waiting for the disturbed water to become clear. A new signal is now given to the captain by means of the safety-rope which he holds in his hand. This signal tells him that the exposure has begun. I now wait patiently till a return signal from above tells



MASS OF SPONGES. FROM A PHOTOGRAPH TAKEN AT A DEPTH OF SIX AND A HALF FEET.

submarine photograph at the Troc cove. Our boat being solidly anchored to the bottom, and held in a fixed position by a number of hawsers fastened to the rocks on shore, I put on the diver's costume, and go

me that it is time to stop. It will be easily understood that it is quite impossible, or at least very difficult without some special arrangement, to carry in a diving-bell a watch which can give the length of an exposure.

PRESENT STATE OF THE QUESTION.

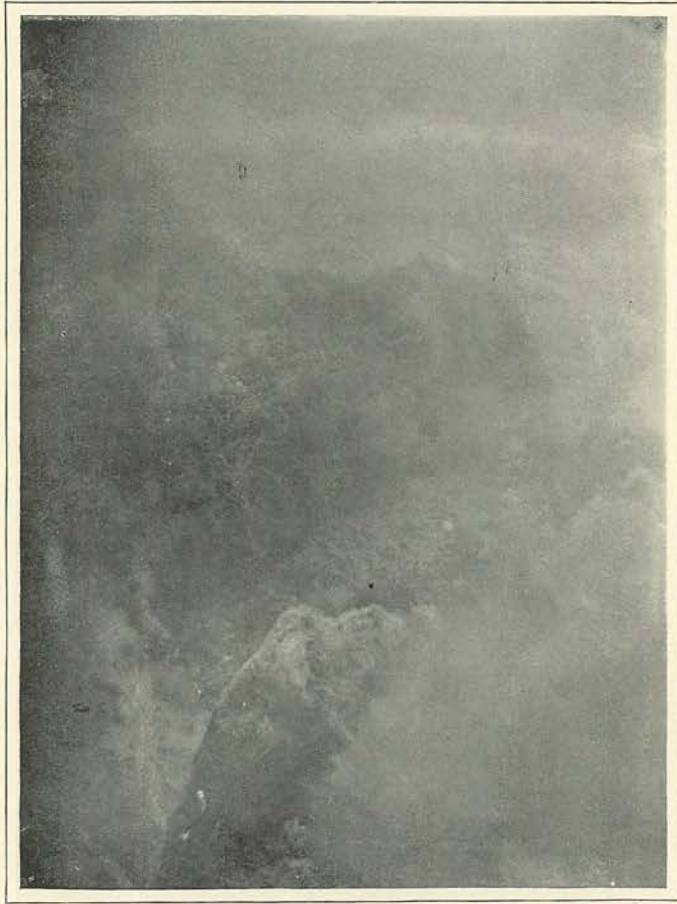
It would take too long to describe in detail the new apparatus which I used this last year; but a glance at the accompanying photographs of the model which gave me the best results will afford the reader a clearer idea of it than the most minute description.

After the different experiments made at

clear image, because the submarine landscape which one wishes to photograph, and the animal life which peoples it, are not still.

Submarine photographs may also be obtained by means of artificial light, magnesium or electricity. But the proofs so far obtained are not so clear as one would wish, which is evidently due to the imperfections of the apparatus employed.

In order to obtain a final and successful



INSTANTANEOUS SUBMARINE PHOTOGRAPH BY MAGNESIUM LIGHT DURING A STORM.
DEPTH, THIRTEEN FEET.

the Arago Laboratory at Banyuls-sur-Mer, it may now be safely affirmed that it is possible, with the aid of objectives specially constructed for that purpose, to obtain submarine photographs when the diver is several meters under water.

When no artificial light is used, submarine photographs require a rather long exposure, the time often extending to twenty-five minutes, and depending on the depth of the water. Under these conditions it is, unfortunately, impossible to obtain an absolutely

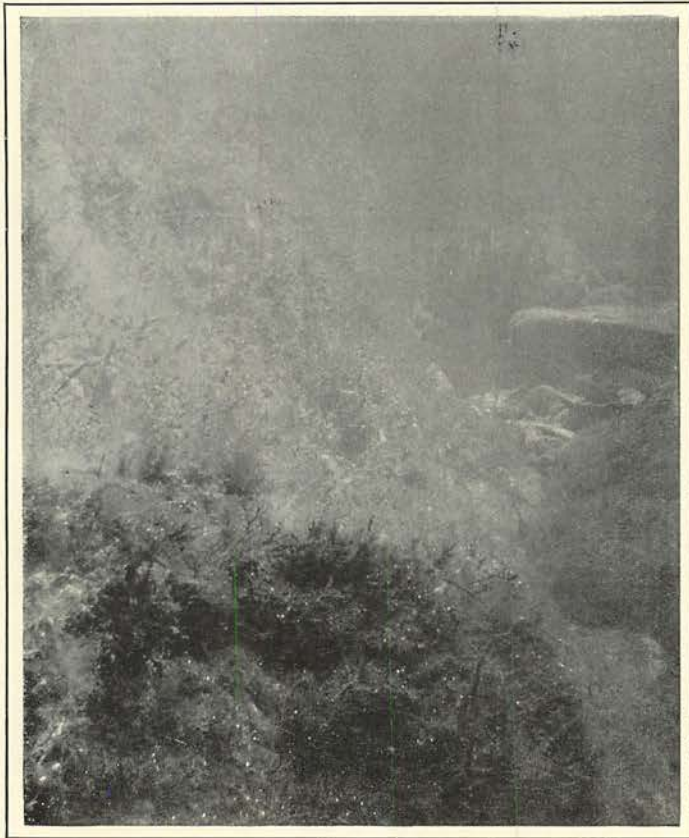
result in submarine photography, and to produce pictures as clear as those secured on land, it is necessary to find the exact formula of the objectives to be used in the water, a medium which is much denser than air, and the index of refraction of which is different. Another *sine qua non* is an exceedingly powerful light, capable of bringing out the smallest details of the object or landscape to be photographed.

But under no conditions will it ever be possible to photograph under water such a

wide extent of surface as on land, and the submarine horizon will always be limited to about one hundred meters. This is due to physical reasons against which we are powerless. When rays of light pass through too great a thickness of water they are absorbed by the liquid, so that they are extinguished before reaching the objective when they come from too distant an object. But, notwithstanding this grave imperfection, the future of scientific submarine photography is of considerable importance, as I shall now try to show.

can go down into them, as the tremendous pressure of the water renders this impossible. For a long time, therefore, it was imagined that the bottom of the sea was one vast extent of mud, without the presence of living things; but numerous scientific expeditions finally proved that such was not the case, and that a multitude of curious and even fantastic animals were to be found there.

The product of even a single catch, including many sharks, as made by us at the Arago laboratory, convinced me that at a depth of eight hundred meters the bottom



SLOPE COVERED WITH ALGAE. DEPTH, SIXTEEN AND A HALF FEET.

THE FUTURE OF SUBMARINE PHOTOGRAPHY.

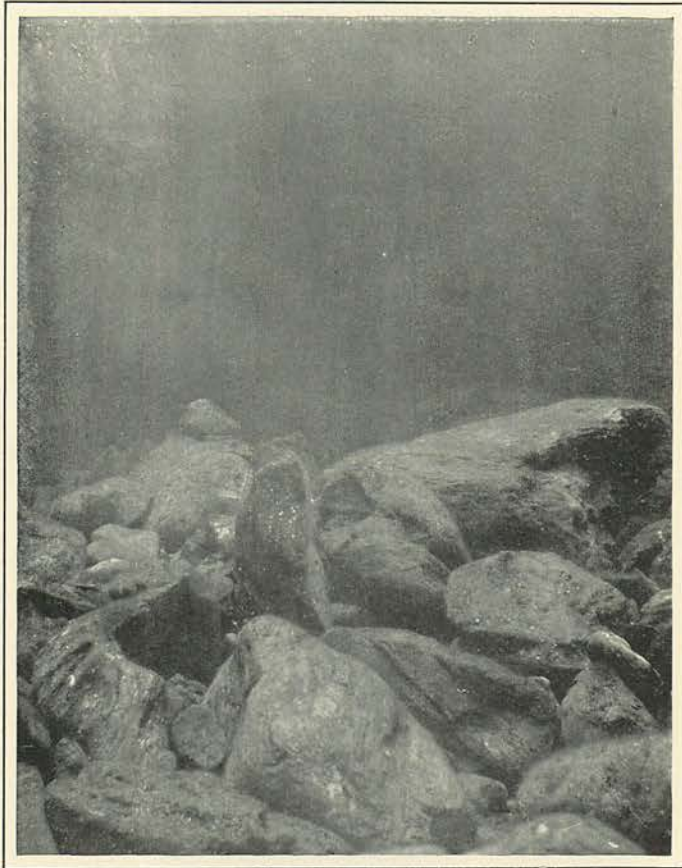
THE extent of the surface of the earth covered by water is vast, since it far surpasses that of the dry land. What do we know of this part of the globe hidden by the seas and oceans? Very little, it must be admitted. Except along the immediate edge of these immense bowls which can be explored in diving-bells, the means which naturalists have at their disposal for examining these depths are most rudimentary. Nobody

of the ocean is full of life. All these big sharks (*Centrophorus ganulosus*) are carnivorous. In order to live, these animals must eat other animals; so there must be many other animals whence these come, although we know almost nothing about them.

As regards the sea, the naturalist is in much the same situation as would be an inhabitant of the moon who could live in ethereal space, but could not breathe the air which envelops our earth. Let us suppose that this voyager from the ethereal

regions should come in contact with our atmosphere. He would float above the highest strata without being able to penetrate them, separated from the earth by the gases which surround it. What must he do if he wishes to know something of what exists below the layers of cloud which hide our globe from his view? He would do as our naturalists have done—construct dredges and nets, and, having weighted them, would let

Up to the present our naturalists have done hardly more than this. Though it is quite true that the apparatus used is as perfect as possible, and that the most illustrious students of nature have displayed in their labors an ingenuity which I should never dream of calling into question, at bottom the proceeding is the same in both cases. They drag rudimentary instruments blindly through the depths of the seas.



VIEW OF ROCKS. DEPTH, SIXTEEN AND A HALF FEET.

them down like the anchor of a balloon, and try and pull them along the surface of the earth. Do you think that with such primitive instruments he would obtain very precise ideas of the terrestrial globe? Every agile animal would flee before the apparatus, which, if it did not get irretrievably caught in some oak, rock, or lofty factory chimney, might bring back, after having scraped for some time along the surface of the earth, bits of leaves, pebbles mingled with soil, etc., all of which, however, could give only a very vague idea concerning the constitution of the globe.

What a change will come over the situation the moment it becomes possible to let down to the bottom of the ocean a photographic apparatus provided with a powerful artificial light! Although this camera will not be able to bring back pictures of wide extent, may it not succeed in satisfactorily photographing one hundred square meters of space? And will not such photographs contain a most precious fund of information?

Everything leads one to believe that it will soon be possible to construct photographic apparatus which will accomplish its work successfully at any depth of water. But

without going so far as this, and without launching forth into hypotheses which have not yet been realized, it may be asserted that submarine photography can already produce useful results.

In the immediate vicinity of the coasts, the photographing of landscapes, the interiors of grottoes, animals caught in their medium, furnishes the student useful and precious in-

formation; and, from an industrial point of view, one may see how it can be employed practically. Suppose, for instance, a ship to be at the bottom of the sea. How are we to know its exact position, and to determine the extent of the damage which it has suffered? A good submarine photograph would be more valuable to the engineers than all the information which divers could furnish.

HIS GRACE THE DUKE.

BY THOMAS BAILEY ALDRICH.



AS the Duke of Suffolk no friends? If an English duke is without friends, or what pass for such, who on this earth can expect to have any? An English duke is a very great personage—even to democracy on this side the water. Our most reluctant doors turn quickly on their hinges at his faintest knock. If he chance to occupy our guest-room for a night, a glamour hangs over the apartment forever. We sow bitterness in the heart of Mrs. Leo Hunter by incidentally remarking, "Yes; this is where we put the duke." Beauty strews the roses of her cheek, if one may say it, at his feet. A very great personage, indeed, with revenues (sometimes) that have their fountainhead in the immemorial past; the owner of half a dozen mossy villages, or perhaps a fat slice of London; a sojourner in spacious town houses and ancient castles stuffed with bric-à-brac and powdered lackeys. In his hand lie gifts and offices, and the mouth of the hungry placeman waters at sight of him; the hat of the poor curate out of situation lifts itself instinctively. His Grace is not merely a man of the moment, but a precious mosaic of august ancestors, a personality made almost sacred by precedent. He stands next to the throne, and if he but smile on the various human strata below him, who is not touched by his condescension?

Is it not a remarkable circumstance, then, or does it not at least seem remarkable, that the Duke of Suffolk, as I shall presently show, has no friends? Yet, however incredible it may appear on the surface, the matter is simple and rational enough at bottom; for I am speaking of that last Duke of Suffolk who, in Bloody Mary's time, was always getting himself into trouble, and finally lost his head

in more senses than one. Strangely enough, he is still extant, though in a much altered fashion. His revenues have taken wing; his retainers are scattered; and there is not a courtier or a dependent alive who cares a farthing whether my lord smiles or frowns. Were this poor, dismantled old duke to make even an excellent jest,—a thing he never did in the course of the sixteenth century,—there is not a sycophant of his left to applaud it. In all the broad realm of England there is none so poor to do him reverence. Spacious town houses and haughty castles with defective drainage know him no more. His name may not be found in the London directory, nor does it figure in any local guide-book that I have ever seen, excepting one. His Grace dwells obscurely in a dismal little shell of a church in the Minories, alone and disregarded. From time to time, to be sure, some stray, irrepressible Yankee tourist, learning—the Lord knows how—that the duke is in town, drops in upon his solitude; but no one else, or nearly no one else. The tumultuous tide of London life surges and sweeps around him; but he is not of it.

On the 23d of February, in the year 1554, Henry Grey, Duke of Suffolk, the father of a nine days' queen, and the ingenious architect of his own calamity, was led from his chamber in the Tower to a spot on Tower Hill, and promptly decapitated, as a slight testimonial of the Queen's appreciation of the part he had played in Northumberland's conspiracy and some collateral enterprises. Thus, like Columbus, he got another world for his recompense.

This is known of all men, or nearly all men; but not one in a thousand of those who know it is cognizant of the fact that the head of the Duke of Suffolk, in an almost perfect state of preservation, can be seen to this day