not cut up their wall space into windows. The result is the architecture of simplicity and rest; and it goes very well with a country that pauses, for miles, in a trance of sky and mountain and plain, and forgets to put in the details.

The practical builders are as successful as the lazy builders, for they build with the same directness. The ranch buildings of the West, like the old Eastern farm-houses, are good in this way. There is no nonsense about them. If the buildings belong to a show ranch there will be ample opportunity for the exercise of a trained intelligence in the adaptation of historic styles that were inspired by similar sites and conditions.

The houses of these great desert landscapes should convey the idea of monotonous and concentrated living. Sun and wind beleaguered fortresses, they should never look as if they cared in the least what an outsider thought of their appearance. They should wrap themselves in silence and blind-walled indifference, as a bathless, breakfastless Mexican smokes his cigarette against a sunny wall of a morning, wrapped to the ears in his dingy serape. It is not presumed to offer this somewhat squalid suggestion to the ranch gentry, but to their humble neighbors of the railroad outpost, the cattle-feeding station, and the engineers' camp, who have winters as well as summers to provide for.

It may be added that the best houses in the West, those best worth describing, like the best people, are not the ones that are typical.

* * *

THE POISON OF SERPENTS.

MY first encounter with a venomous serpent occurred when I was but a lad and had been wading the waters of the Clarion, in McKean County, Pennsylvania. Heavily laden with a noble string of trout, I set foot on a slippery bank to leave the stream on my homeward way when my guide suddenly caught me by the shoulder and jerked me back so violently that I fell in the shallow water. As I struggled to my feet in alarm, the old lumberman pointed quietly to a "hurrah's nest"[1] half-way up the slope — on it was coiled a large rattlesnake. But for the man's quickness I should have been struck in the face or the throat. We soon killed the snake, and as I sat on the bank, thoughtfully examining the fangs of this skillful apothecary that knew the use of hypodermatic injections so long before we took the hint, I felt the awakening of an interest in the strange poison I had so nearly tested on my own person. Few men of my age and occupation have been more in the woods than I, yet only once since this adventure have I seen a crotalus in my many wanderings in the Eastern States. I found a small "rattler" dead on the road near Cape May Court House, New Jersey: a cynical friend settled my doubts as to what had killed it by suggesting that it might have bitten a Jerseyman.

This heroic animal, which never flees, which warns of danger all who come too near, has nearly gone from our woods and plains. As a cause of death it hardly figures in the census; and even in Florida its mortal foe, the hog, is making such ruthless war upon it that before long a snake is likely to become as rare as the viper is to-day in English forests.

In the West, on the sage deserts, I have seen the ground-rattlesnake in large numbers. No one dreads it much, and bites are rare. Deaths from our Eastern or our North-western snakes are also very infrequent, nor were fatal accidents of this nature ever very common anywhere in North America. For this there were several reasons: our poisonous snakes are not excessively numerous, their poison is much less active than that of the cobra and the Bungarus of India or the vipers of Guadeloupe, and during a large part of the year they bury themselves to escape cold. Our troops must in war have trampled heedlessly through countless miles of swamp and woods, and yet there is no return among our war statistics of a single case of death from snake bite.

Compare this with the terrible account Fayrer gives us of the loss of human life from snake poison in India, where dislike of the hog and superstitious reverence for the cobra combine to make the management of this question difficult. Very imperfect returns, excluding Central India, gave in 1869 the deaths from snake bite as 11,416 for a population of 120,972,263, and subsequent and fuller statistics place this vast mortality still higher. Little has been done by the Indian Government to lessen the constantly recurrent annual loss of life. Rewards for cobra heads proved of slight use, and no continuous or systematic means have been used to enable the able staff of army or civil surgeons to study the subject of snake bites as it should long since have been studied.

Some years went by before I was able to

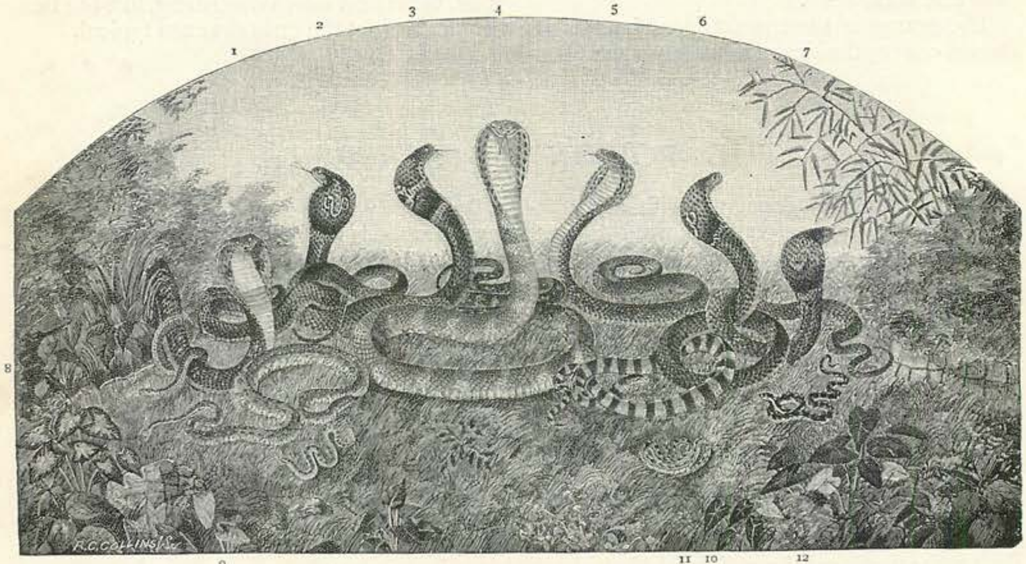
[1] A mass of leaves left by a freshet in the crotch of the divergent branches of a bush.

gratify my never quite forgotten desire to know more of this interesting poison. One day, however, a man offered me a small lot of snakes, and just then I learned of a supposed antidote invented, it was said, by the famous French herpetologist, Bibron. In fact he never did invent an antidote, and how the queer mixture of iodine and corrosive sublimate got his authoritative name is still a mystery. I began in 1859 to study the matter, and soon found that the antidote was worthless, and that no one knew much about snake venoms. Not quite a hundred years previous Fontana wrote on the poison of vipers an immortal work, and nearly another century before him there were written two quaint books, one by Redi, 1664, and one by Charas, 1673. Both of these little volumes are still worth reading. Charas's belief in the value of volatile salt of the ashes of calcined vipers as a remedy for viper bite is an instructive exhibition of a form of medical idiocy not without modern illustrations.

My own researches were carried on in the intervals of a life of great occupation, and were published in 1862 by the Smithsonian Institution. About 1872, unaided by Government, in a climate where heat makes all labor difficult, and at a cost in the way of money and mortal risks which few can comprehend, an Indian surgeon, now Sir Joseph Fayrer, created on this subject a vast mass of material knowledge which without reward he gave to the Government of India. The illustration on this page was meant for a frontispiece to his splendid volume, but was for some reason unused and came to me as a gift from Fayrer. The snakes, drawn from life by pupils of the Government schools, are here grouped so as to show at a glance all the typical Indian poisonous serpents.

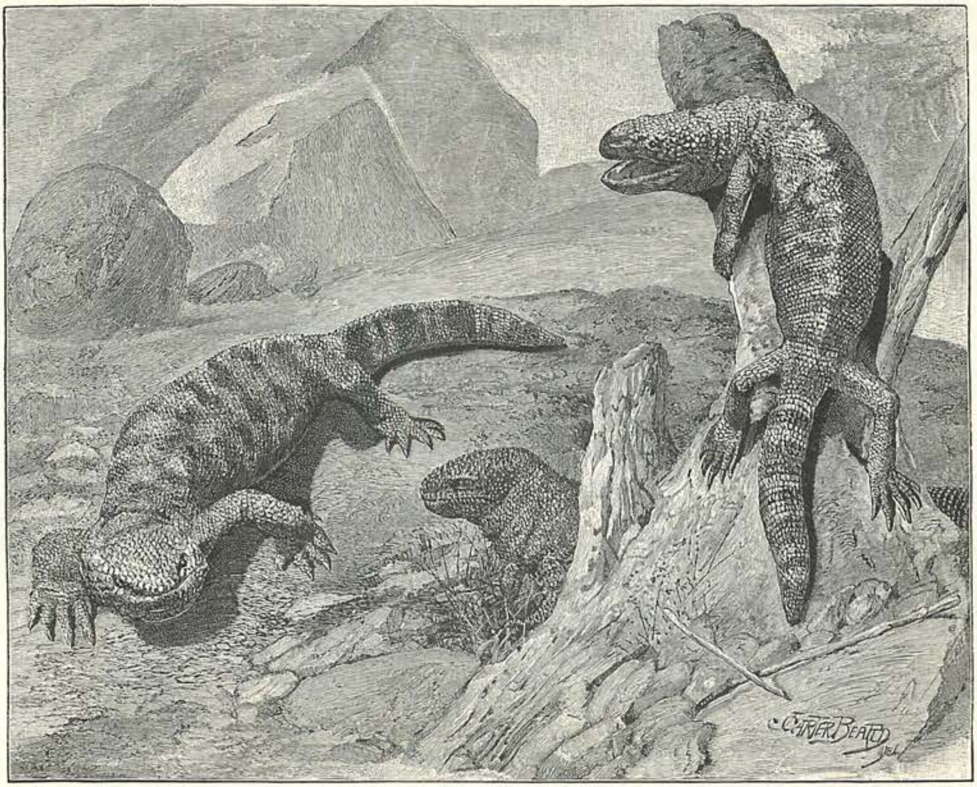
Twenty-four years after my first essay, the Smithsonian published[1] the results of another four years of additional work on the problems which had interested me in my early life. Much of what I did in 1859 to 1862 needed no reëxamination, but new questions had arisen, and novel and accurate methods were now at our disposal. Moreover, I had been haunted for a year or more by the idea that serpent poisons might not be simple but complex, not one thing but a mixture of two or more, and that this might explain the causes of the difference between rattlesnake and cobra bites, and possibly give the clue to methods of successful treatment. When a maggot like this gets into the brain of a man accustomed to want to know why, it breeds a variety of troublesome pleasures. In my case it drove me once more to the laboratory, and caused me to seek the skillful aid of Dr. Edward T. Reichert, now Professor of Physiology in the University of Pennsylvania. Together we solved many perplexing problems. As some of these have for the general reader an unusual interest, I purpose to restate here a few of our results, since our large Smithsonian memoir is not likely to come before many of the readers of THE CENTURY.

It has occurred to me that in telling my story it might be well to show in popular shape how the work was done, as well as its results. To make it clearer, I must first explain the



TYPICAL INDIAN POISONOUS SERPENTS. (FROM A PAINTING BY ANNODA PROSACT BAGCHEE.)
1, Ophiophagus Elaps; 2–7, inclusive, Varieties of Cobra; 8, Trimesurus Carinatus, coiled around No. 1; 9, Daboia Russellii; 10, Bungarus Fasciatus; 11, Bungarus Cornutus; 12, Echis Carinata; one unknown.

1 "Researches on Serpent Poisons," by S. Weir Mitchell, M. D., and Prof. E. T. Reichert.



GILA MONSTERS — POISONOUS LIZARDS.

mechanism which enables the serpent to use its poison.

We have in America as venomous serpents the several species of rattlesnake, the water moccasin, the copperhead, and the beautiful coral snake, the little elaps of Florida, too small with us to be dangerous to man.

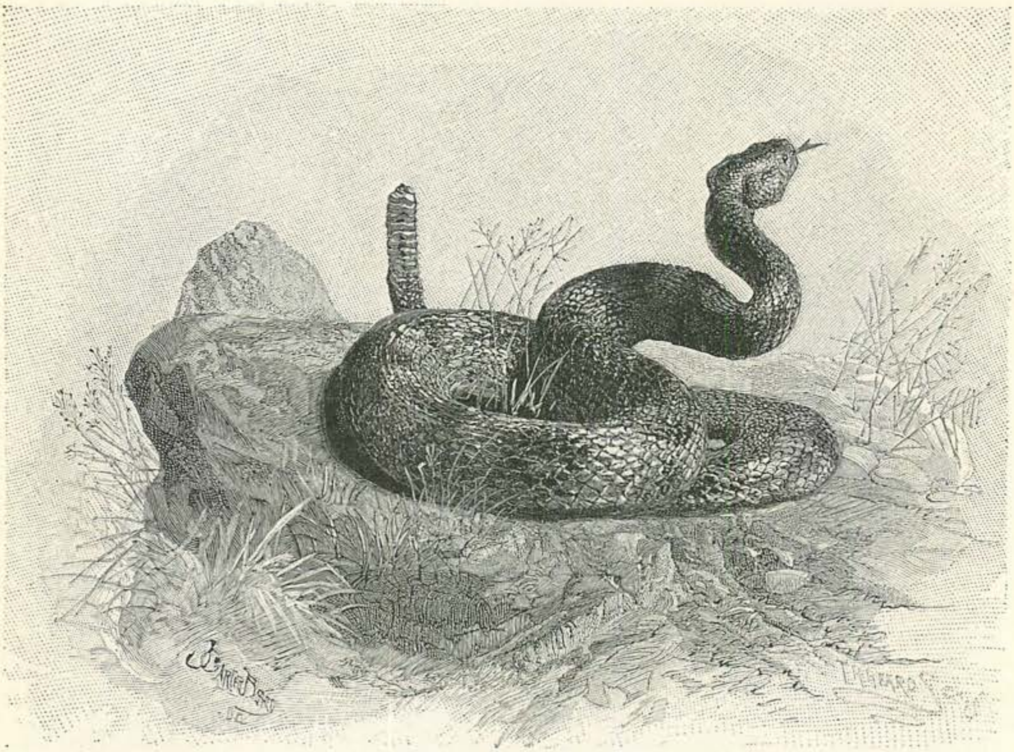
India is preëminently the home of the poisonous snakes, of which there are no fewer than fifteen genera. The cobra is most abundant, but the *Ophiophagus elaps* is the most dreaded, and attains at times the length of fourteen feet. Unlike the cobra and the crotalus, this serpent is viciously aggressive, and will pursue a man with activity.

Among the vipers the daboya is entitled to rank as a poisoner close to the cobra, and the crotalidæ are represented by a number of snakes which are somewhat less effective slayers than the cobra. While these genera are too sufficiently abundant on land, the Indian seas also abound in species belonging to the family of hydrophidæ. These serpents are agile and dangerous, but as yet no one seems to have made any examination of their venom, nor directly experimented to learn anything of its relative hurtfulness. Poisonous water-snakes are found in abundance on the shores of South America, and used to be thrown up in numbers into the paddle-wheel covers of the old side-wheel steamers. I never had the good luck to get a living specimen.

The centipede and the scorpion rank high in the popular mind as poisoners, but they are gentle apothecaries compared to the serpent.

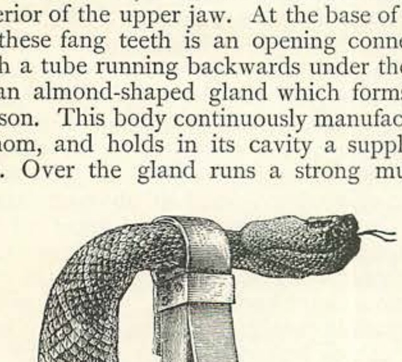
We are in America the privileged possessors of the only other animal at all approaching the poisonous snakes in lethal vigor: it is a lizard, the Gila monster (*Heloderma suspectum*) of Arizona. This strange creature is the only poisonous lizard known. I have heard of but one death in man from its bite, and for a long while it was looked upon by all except the Indian as harmless. Sluggish, inert, well armored with a tough, defensive skin, a feeder on birds' eggs and on insects, it is most difficult to induce this good-humored and most hideous reptile to bite at all. When once it takes hold, no bulldog could be more tenacious. The odor of its poisonous saliva is exactly like that of magnolia buds. Its bite causes no local injury, and its venom is a deadly heart poison.

All of the great family of thanatophidiæ have substantially the same mechanical arrangements for injecting their venom. When not in action the two hollow teeth known as fangs lie pointing backwards, wrapt in a loose



RATTLESNAKE COILED TO STRIKE.

cloak-like cover, a fold of the soft skin of the interior of the upper jaw. At the base of each of these fang teeth is an opening connected with a tube running backwards under the eye to an almond-shaped gland which forms the poison. This body continuously manufactures venom, and holds in its cavity a supply for use. Over the gland runs a strong muscle, which is ordinarily employed to close the mouth by lifting the lower jaw, to which it is made fast. A little circular muscle around a part of the duct keeps it shut and prevents waste of venom.

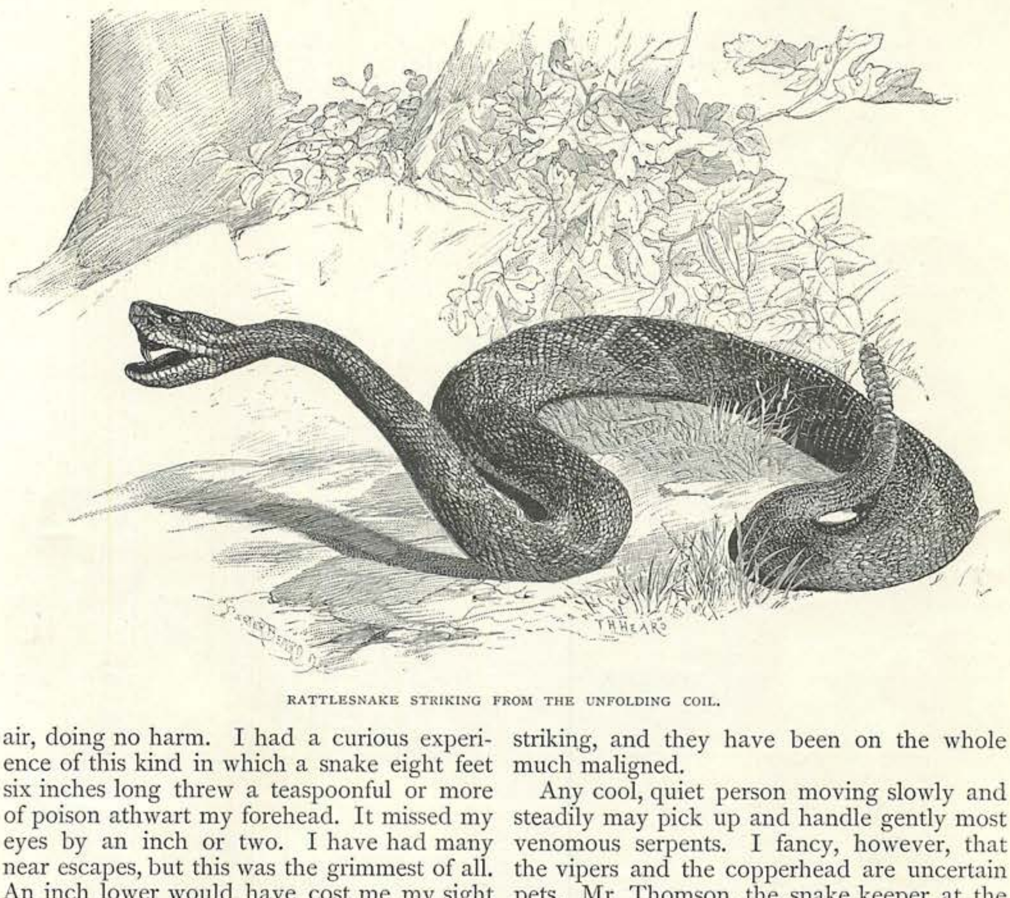


A SNAKE STAFF.

Let us observe what happens when the rattlesnake means mischief. He throws himself into a spiral, and about one-third of his length, carrying the head, rises from the coil and stands upright. The attitude is fine and warlike, and artists who attempt to portray it always fail. He does not pursue, he waits. Little animals he scorns unless he is hungry, so that the mouse or the toad he leaves for days unnoticed in his cage. Larger or noisy creatures alarm him. Then his head and neck are thrown far back, his mouth is opened very wide, the fang held firmly erect, and with an abrupt swiftness. for which his ordinary motions prepare one but little, he strikes once and is back on guard again, vigilant and brave. The blow is a stab, and is given by throwing the head forward while the half-coils below it are straightened out to lengthen the neck and give power to the motions which drive the fangs into the opponent's flesh; as they enter, the temporal muscle closes the lower jaw on the part struck, and thus forces the sharp fang deeper in. It is a thrust aided by a bite. At this moment the poison duct is opened by the relaxation of the muscle which surrounds it, and the same muscle which shuts the jaw squeezes the gland, and drives its venom through the duct and hollow fang into the bitten part.

In so complicated a series of acts there is often failure. The tooth strikes on tough skin and doubles back or fails to enter, or the serpent misjudges distance and falls short and may squirt the venom four or five feet in the air, doing no harm. I had a curious experience of this kind in which a snake eight feet six inches long threw a teaspoonful or more of poison athwart my forehead. It missed my eyes by an inch or two. I have had many near escapes, but this was the grimmest of all. An inch lower would have cost me my sight and probably my life.

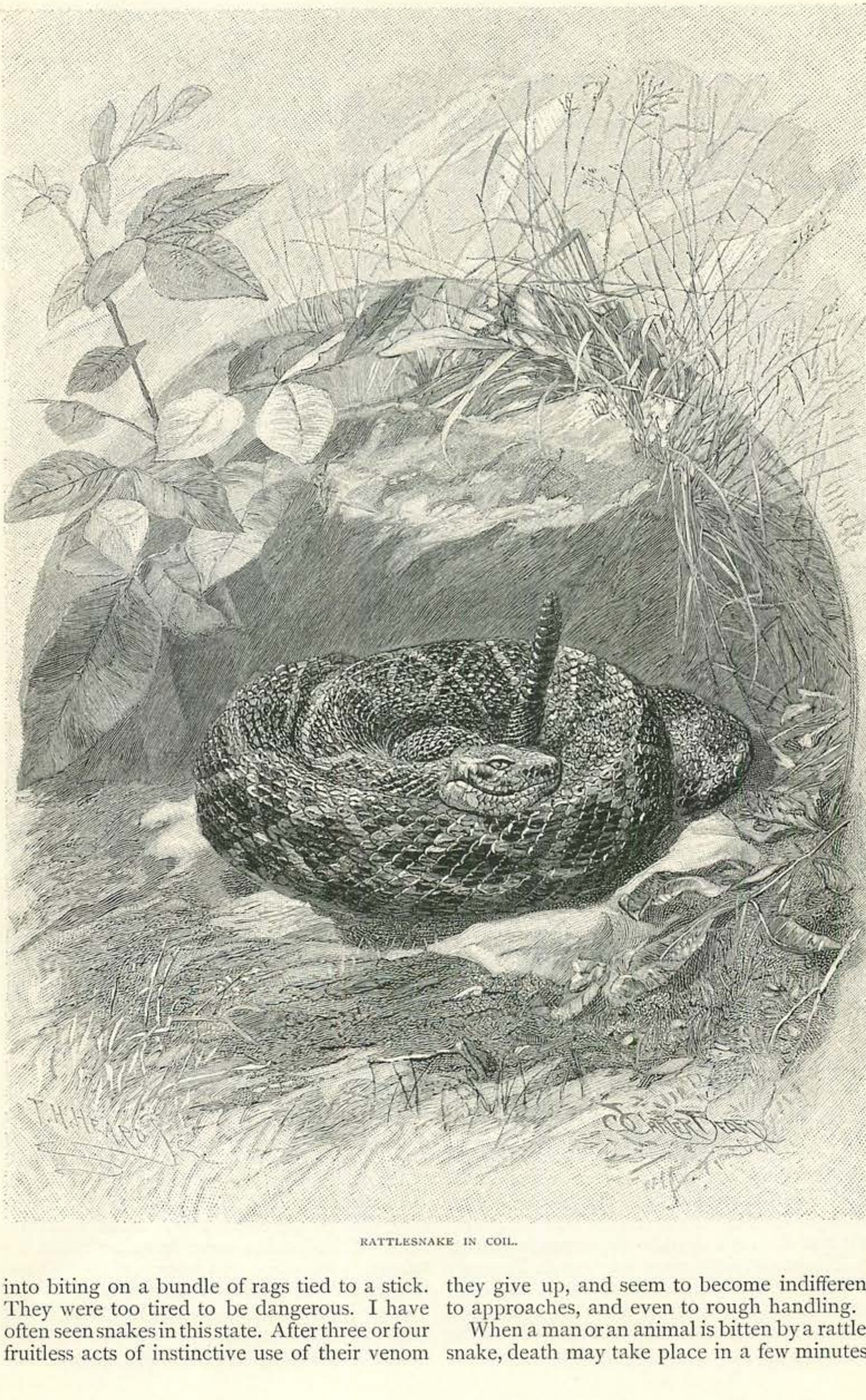
A snake will turn and strike from any posture, but the coil is the attitude always assumed when possible. The coil acts as an anchor and enables the animal to shake its fangs loose from the wound. A snake can rarely strike beyond half his length. If both fangs enter, the hurt is doubly dangerous, because the dose of venom is doubled. At times a fang is left in the flesh, but this does not trouble the serpent's powers as a poisoner, since numberless teeth lie ready to become firmly fixed in its place, and both fangs are never lost together. The nervous mechanism which controls the act of striking seems to be in the spinal cord, for if we cut off a snake's head and then pinch its tail, the stump of the neck returns and with some accuracy hits the hand of the experimenter — if he has the nerve to hold on. Few men have. I have not. A little Irishman who took care of my laboratory astonished me by coolly sustaining this test. He did it by closing his eyes and so shutting out for a moment the too suggestive view of the returning stump. Snakes have always seemed to me averse to striking, and they have been on the whole much maligned.



RATTLESNAKE STRIKING FROM THE UNFOLDING COIL.

Any cool, quiet person moving slowly and steadily may pick up and handle gently most venomous serpents. I fancy, however, that the vipers and the copperhead are uncertain pets. Mr. Thomson, the snake keeper at the Philadelphia Zoölogical, handles his serpents with impunity; but one day having dropped some little moccasins a few days old down his sleeve while he carried their mamma in his hand, one of the babies bit him and made an ugly wound. At present the snake staff is used to handle snakes.

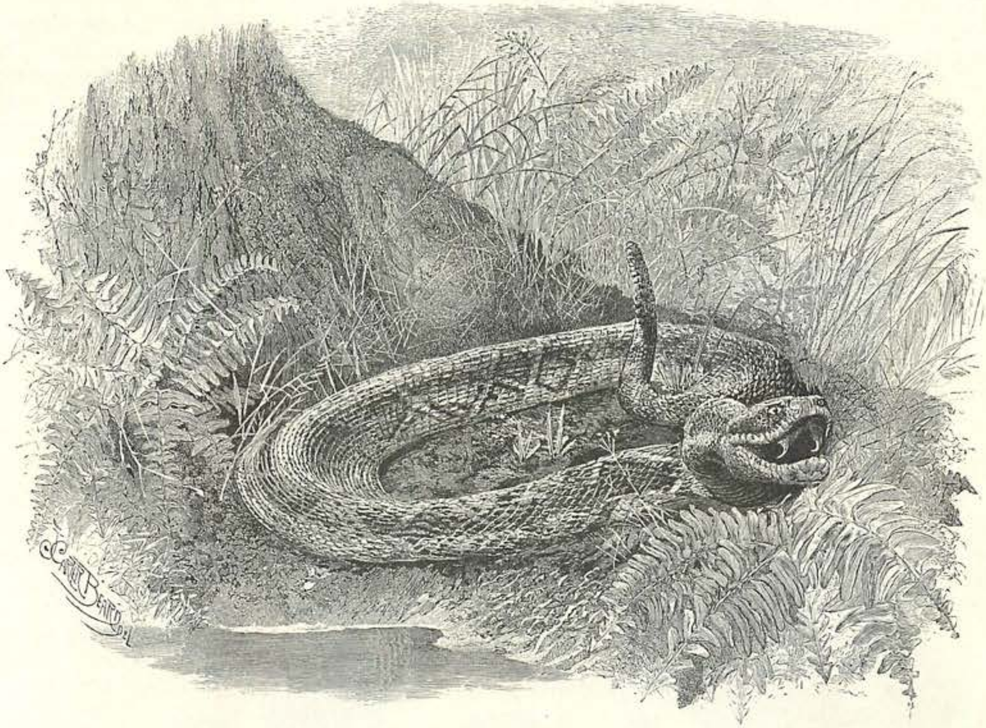
I saw one October, in Tangiers, what I had long desired to observe — a snake charmer. Most of his snakes were harmless; but he refused, with well-acted horror, to permit me to take hold of them. He had also two large brown vipers; these he handled with care, but I saw at once that they were kept exhausted of their venom by having been daily teased



RATTLESNAKE IN COIL.

into biting on a bundle of rags tied to a stick. They were too tired to be dangerous. I have often seen snakes in this state. After three or four fruitless acts of instinctive use of their venom they give up, and seem to become indifferent to approaches, and even to rough handling.

When a man or an animal is bitten by a rattlesnake, death may take place in a few minutes.



RATTLESNAKE SURPRISED.

It has followed in man within a minute, but unless the dose given be enormous, or by chance enters a vein, this is very unlikely. The bite is, however, popularly believed to be mortal, and therefore every case of recovery gives credit to some remedy, for it is a maxim with physicians that the incurable and the easily relievable maladies are those which have most remedies assigned to them.

Usually the animal struck gives a cry, and very soon becomes dull and languid. The heart, at first enfeebled, soon recovers, the respirations become slower and weaker and more weak, paralysis seizes the hind legs, the chest becomes motionless, and at last death follows, usually without convulsions. Observe how little this tells us. Mere outward observation gives us but slight explanatory help. If the animal should chance to survive over a half-hour, the part bitten swells, darkens, and within a few hours the whole limb may be soaked to the bone with blood, which has somehow gotten out of the vessels and remained fluid in place of clotting. What is at first local by and by becomes general, and soon the blood everywhere ceases to have power to coagulate. Then leakages of the vital fluid occur from the gums or into the walls of the heart, the lungs, brain, and intestines, and give rise to a puzzling variety of symptoms, according to the nature of the organ thus disordered. These phenomena make the second stage of poisoning, and with them there is, in finally fatal cases, a continuous and increasing damage to the nerve centers that keep us alive by energizing the muscles which move the chest walls and so give rise to the filling and emptying of the lungs.

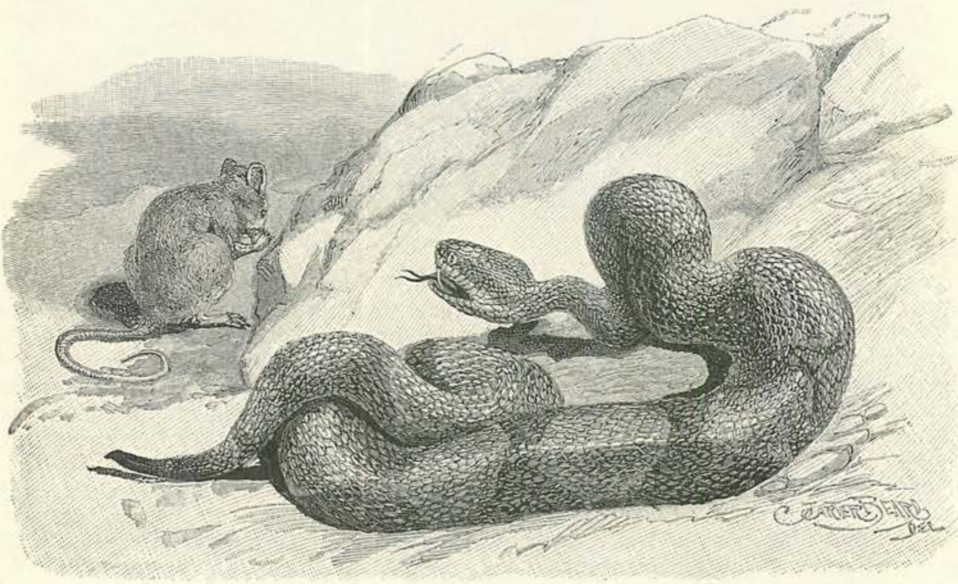
When a physiologist speaks of a nerve center he means by this a group of minute nerve cells, and such a group he is apt to call a ganglion, labeling it with the name of the distant organ or the function to which it gives energy. Much alike in appearance, one ganglion keeps the chest in motion, one influences the heart, one regulates the temperature of the body. When we throw into the circulation a poison, it comes into contact with all of these numerous governing centers; but it does not trouble all of them alike. It has, as a rule, a fatal affection for one only, or far more for one than for another. Why venom should, as if by choice, almost instantly enfeeble the ganglia which keep us breathing, none can say. By and by it also in turn disturbs other groups of nerve cells, but its deadliest influence falls on the respiratory mechanism. The nerve cells thus attacked undergo no visible change; yet some mysterious alteration is present. Probably they lose power to give out their waste products and to re-absorb from the blood the material needful to sustain their local life and activity. At all events the evil done is grave, and when the dose of venom is large, death becomes certain, the animal bitten perishing by slow suffocation.

The deadly apothecary does not succumb to his own drugs. I have over and over injected under the skin of a rattlesnake its own venom or that of a moccasin, or of another crotalus; but in no case have I seen a death result. Why should this be? Other and non-venomous snakes die readily of venom poisoning. The many noxious compounds man carries in his liver, gastric glands, or thyroid gland are fatal if they enter the blood in large amount. There is, indeed, scarcely an organ of his body which is not a possible source of poison to him, the sole question being as to his constant competency to rid himself of the fractional doses ever passing into and out of his blood and to secure himself against certain products which are not meant at any time to pass out of the issues of certain organs of the body into the hurrying currents of the circulation.

But to all creatures save itself the venomous serpent is noxious in varying degrees. Certainly the cobra surpasses as a poisoner all of our American snakes. In India other serpents are more dreaded. With us the rattlesnake leads for capacity to kill, and the copperhead and the moccasin come in order after him. The popular verdict puts the copperhead above the crotalus, but it is wrong, as the above classification rests on careful comparisons of the relative poisoning power of these snakes.

The popular notion of the immunity of some animals has little foundation. Cold-blooded creatures die slowly from snake bite, and the hog escapes only because he does not get seriously bitten. His bristles, tough skin, and clever mode of attack save him. Little pigs are often bitten and die like other creatures. We have never been able to poison plants with snake venom.

TOP. FRONT. PROFILE.



COPPERHEAD.

Practically speaking, there is something more to be said as to the question of relative toxicity. The size of the serpent, the time which has elapsed since it has bitten, determine also the extent of the damage it can do. A snake which has lately bitten two or three times is ill provided with poison, but captive snakes long undisturbed are apt to inflict fatal wounds.

The serpents used in our recent research were brought chiefly from Florida by the potent aid of the Smithsonian Institution, and the dried venom of the cobra was procured from India through the assistance of her Majesty's Indian Government, and more largely by the private aid of Vincent Richards, Esq. The living snakes reached us in coffee-bags secured by strings, the sacks having been placed in a perforated box. When they came we opened the case, undid the strings and tumbled the poisoners into a box some five feet deep. There they lived very well if provided with water; and coiled in corners, or piled in numbers one on another, they lay sluggish and inert until danger threatened. There were half a dozen of these snake cages in our laboratory and at times they contained a hundred snakes, each genus or species having its own box. If disturbed, the rattlers were apt to start a chorus which was somewhat appalling to strangers.

When we desire to collect venom, we use the snake loop. With it a serpent is caught by the neck and lifted up to the top of the box. The lip of a saucer is then slipped into the snake's mouth. Angry at this liberty, it lifts its fangs, which catch on the inner edge of the saucer, against which the serpent bites furiously again and again. As it does so a thin yellow fluid squirts out of the perforation near to the needle-like end of the fangs. We slacken the loop, let the snake fall into a box cage, and seize a second, and a third, until we have all the venom we desire. It is innocent-looking enough. In water a drop of it sinks, whitening as it falls. It has no smell and no taste. A boiling heat clots it as it does white of egg, for, like that body, it is albuminous in its nature. If we dry it with care there is the same resemblance to egg albumen in its shining, yellow scales. Once desiccated it keeps well, as it does also in glycerine or in alcohol.

When I first studied this strange poison I thought of it as a single albuminous body. As such it had always been regarded since it had been proved by Prince Bonaparte to belong to the albumens. When once I chanced to think that venom might be a complex fluid, holding in solution more than one poison, reasons for such a belief multiplied, and so excited my interest that, in 1882, with Professor Reichert's aid, I began to put my theory to the sharp test of experiment.

To prove in the outside laboratory what the inside mental laboratory has comfortably settled is not always easy, and many months of careful research were required before the answer came to us. I will try to make clear our methods and results. When a little of the venom is placed in sufficient water it dissolves readily. If now we heat the solution a coagulation takes place, just such as happens when white of egg hardens on boiling. If by means of a filter we separate this substance clotted by heat, it is found to be innocuous. The clear fluid which passes through the filter is, however, poisonous, but does not cause much *local* effect. As a whole the poison has been damaged by heat, presumably because one or more of its ingredients had been injured by heat. The next step is to learn if the substance made solid and inert by boiling cannot be separated in some other way and in such a form as will leave it also poisonous.

All soluble substances are divisible into two classes, one of which will pass through an animal membrane into a current of pure water and one of which will not. Those which can so pass are said to be dialysable, and the filter is known as a dialyser, and the process is called dialysis. We dissolve some of the poison in water and put it in an inverted funnel, the wide mouth of which, being covered with a thin animal membrane, is placed in distilled water. Under these circumstances the water goes through the membrane and dilutes the fluid above it and certain substances pass out to the water.

The matter which thus finds its way out to the water is said to be dialysable. When examined it proves to be poisonous — to be uncoagulable by heat, and to be the same as the matter left unaltered when we boil the diluted poison for a few moments. This substance resembles the albuminous matter which is formed when gastric juice digests white of egg; and as the material so obtained is called peptone, we named our product which passed through the dialyser to water *venom peptone.*

As the thinner water enters the dialyser and the peptone goes out, within the vessel there falls down a white substance, which is easily redissolved if we add a little common salt. It falls out of solution because the salts belonging to venom and which keep the white matter dissolved are, like all saline substances, dialysable and pass out along with the peptone. This white precipitate has certain likenesses to the albuminous bodies known as globulin, and of which there are several kinds in our bodies. That which thus falls out of the solution of venom we named *venom globulin.* It was to be had also in a simpler way. When we add plenty of pure water to clear fresh venom the water added makes the whole fluid relatively less salt and a white matter falls down. When this is separated and examined it proves to be the same as that left within the dialyser. Other matters of like nature but less important are found in some snake venoms, but essentially all examined by us contained at least two albuminous matters.

Mix these two in pure water with a little common salt and you practically reconstruct

WATER MOCCASIN.

a venom—the other ingredients are of less moment.

If we put *venom peptone* under the skin of a living animal it behaves much as boiled venom does. The local injury it causes is at first slight. Little or no blood oozes forth, but, if the animal survive, in an hour or two a watery swelling is seen, the tissues soften as if they were melted or dissolved, a horribly swift putrefaction occurs, and the tissues near and far swarm with the little rod-like bodies known as bacteria, which are the essential accompaniment and cause of putrefaction. Meanwhile the breath-sustaining centers become weak, and cease to respond by rhythmical effluxes of energy to the various excitations which stimulate the muscles so as to cause them to move the chest. The animal dies from failure to breathe. Internal bleeding is rare and slight, nor are the changes in the blood at all remarkable.

Venom peptone is present in cobra poison, and in that of the rattlesnake. In the Indian serpent it constitutes, however, nearly the whole of the toxic albumen present, there being but two per cent. of the other element in question. The *venom peptone* of the cobra is also a far more active agent than the substance which corresponds to it in the venom of our crotalus, although chemically we can see but little difference between the two; since *venom peptone* passes with ease through membranes, and hence is rapidly absorbed, cobra poison may not always be swallowed with impunity, whereas it is possible to feed a pigeon on crotalus venom day after day and see it live unhurt.

While rattlesnake venom owes a part of its activity to *venom peptone*, its peculiar virulence and destructiveness belong chiefly to *venom globulin*, of which it has relatively nearly twenty-five per cent.—fifteen times as much as in cobra. *Venom globulin*, like the peptone poison, at first and briefly enfeebles the heart, but next attacks the respiratory centers, and finally paralyzes the spinal ganglia. When separated and redissolved in a weak and saline solution with water it is a most potent poison; and besides its influence on the centers which sustain life, it has, soon or late, distinctive effects on almost all the tissues which somewhat resemble the changes seen in certain maladies, such as yellow fever; yet that which in them exacts days is brought about from globulin poisoning within an hour or less. At the spot where we inject globulin the vessels give way and pour out blood which cannot clot, and this change by and by occurs here and there throughout any or every organ of the body, so that at last the blood becomes what physicians call diffluent, and may remain until it decays, free from the clots usually seen in the healthy fluids when drawn and allowed to stand.

Thus it is that, because the cobra has little *venom globulin* and the rattlesnake much, the local appearances of the bite in either are readily recognizable. Then, also, as the Indian snake has much *venom peptone* and our serpent little, the former kills more surely and sooner, and does not cause the blood to stay fluid, so that in most cases the general phenomena would also enable us to say which snake had bitten. Certain other Indian snakes give us symptoms like those caused by the bite of our crotalidæ, and probably will be found to resemble them in the composition of their venoms. While we can thus separate and analyze the influence of the two poisons found so far in all venoms examined by us, neither alone occasions the tremendous and perfect effects seen when both are combined by mischievous nature in a suitable solution. Nor, indeed, is the poison ever quite so effective after it has been once dried and redissolved for experimental use.

There are vegetable poisons which possess power to destroy life by enfeebling the respiratory nerve centers; but we know of no poison save snake venom which has the ability to ruin in a few minutes the capacity of the lesser vessels to keep the moving blood within their guarding walls. Our every function — nay, life itself — depends on the blood being so restrained. If by accident a drop or two of normal blood escape from a small vessel, instantly the blood clots and tends to cork up the tiny tear through which it came. Venom not only seems to rot the vessels, but it also makes the blood fluid, and so facilitates the hemorrhages of which it is the primary cause. To study this singular process of destruction closely a small animal was so completely etherized as to cease to feel pain, and a loop of its intestinal cover called the peritoneum was examined with the microscope. The spectacle of the blood globules driven swiftly through transparent capillaries, the smallest of vessels, is a constant source of wonder to him who sees it. *Venom peptone* in solution disturbs this local flood stream but little. *Venom globulin* exhibits its effects with difficulty, and solutions of dry venom cause but slight and tardy results. If, however, we touch the thin membrane with *fresh* rattlesnake poison, in a few minutes the delicate little cells, which are like a thatch on the inside of the capillary vessels, seem to be roughened, and become less transparent. Then, abruptly, here and there a drop of blood oozes out. Presently the fanlike expansion of the minute vessels we are watching begins to look like a bunch of red grapes, as these tiny blood points increase in size and number, until at last the whole field of view is covered with escaped blood. It is then a question of time as to how long it will be before the same disintegration of vessels, and the same loss of power in the blood to clot, occur in hundreds of places remote from the spot first poisoned.

If after poisoning an animal we examine the blood cells at intervals, we find that they very early lose their usual flat, disklike aspect, and become smaller and round. They also acquire for a time a singular stickiness and elasticity, so that they adhere in masses, and when compressed spindle out, and then run together anew when we cease to subject them to pressure.

The power of venoms to hasten and favor putrescence must have something to do with the symptoms which occur when death takes place after a long interval, as a day or two, or when slow recovery occurs. This tendency is an indirect effect. If we sterilize venom,— that is, subject it to dry heat until all germs are destroyed,— and leave it then in contact with sterilized soup guarded from the germs afloat in the air, no putrefaction ensues; but if to this sterilized broth we add venom not so deprived of bacterial germs, putrefaction is hastened at a rate never seen under other circumstances.

Now, as bacteria are always present in fresh venom, enough enter a wound to account for the fact that animals envenomed swarm within an hour or two with the organisms which cause putrefaction. Their rate of increase is inconceivably great, and seems to be favored by the poison, which provides them with some mysterious conditions of growth. Thus it is that the blood, the nervous centers, the vessels, are all in turn attacked by these fearfully destructive poisons, and that at last putrescent changes may be added to the causes of a multiform group of perplexing phenomena.

The general reader will ask what good has come out of these clearer views as to the mechanism of this poisoning. Our own labors and the brilliant work of Fayrer, Lauder-Brunton, Wall, and Vincent Richards have certainly brought us somewhat more plainly to understand that which happens. What gain is there for man? As yet there is little, except that, while a few years ago we were merely groping for remedies, to-day we are in a position to know with some definiteness what we want and what we do not want.

Let us see what the actual present gain is. If we mix any venom with a strong enough solution of potassa or soda we destroy its power to kill. A solution of iodine or perchloride of iron has a like, but a lesser capacity, and so also has bromohydric acid; but by far the best of all, as was first shown by Lacerda, is permanganate of potash. If this agent be injected at once or soon through a hollow needle into the fang wound, wherever it touches the venom it destroys it. It also acts in like destructive fashion on the tissues; but, relatively speaking, this is a small matter. If at once we can cut off the circulation by a ligature and thus delay absorption and then use permanganate freely, we certainly lessen the chances of death; yet, as the bites occur usually when men are far from such help, it is but too often a futile aid, although it has certainly saved many lives. The first effect of venom is to lessen suddenly the pressure under which the blood is kept while in the vessels. Death from this cause must be rare, as it is active for so short a time. Any alcoholic stimulus would at this period be useful; but, despite the popular creed, it is now pretty sure that many men have been killed by the alcohol given to relieve them from the effects of snake bite, and it is a matter of record that men dead drunk with whisky and then bitten have died of the bite. For the consequences to the blood and to the nerve centers which follow an injection of venom there is, so far as I am aware, no antidote; but as to this I do not at all despair, and see clearly that our way to find relief is not by stupid trials of this sort and that, but by competently learning what we have to do. Moreover, we are in a position at present to say what not to do, and there is a large measure of gain in being able to dismiss to the limbo of the useless a host of so-called antidotes.

Venom is an albuminous complex substance, and although in its effects so unlike the albumens which make our tissues and circulate in the blood, it is yet so like these in composition that whatever alters it destructively is pretty sure to affect them in like fashion. Hence the agents which do good locally at some cost to the tissues are worse than valueless when sent after the venom into the circulating blood. Yet, possibly, we may hope to find remedies which will stimulate and excite the vital organs which venom enfeebles. In this direction lie our hopes of further help. Anything which delays the fatal effect of the poison is also a vast advantage in treatment, because there are agencies at work which seem to be active in renewing the blood and repairing the damage done to the tissues, so that recoveries are sometimes remarkably abrupt. It is possible that free bleeding followed by transfusion of healthy blood may prove efficient.

I am often asked what I would do if bitten while far from help. If the wound be at the tip of a finger, I should like to get rid of the part by some such prompt auto-surgical means as a knife or a possible hot iron affords. Failing these, or while seeking help, it is wise to quarantine the poison by two ligatures drawn tight enough to stop all circulation. The heart weakness is made worse by emotion, and at this time a man may need stimulus to enable him to walk home. As soon as possible some one should thoroughly infiltrate the seat of the bite with permanganate or other of the agents above mentioned. By working and kneading the tissues the venom and the antidote may be made to come into contact, and the former be so far destroyed. At this time it becomes needful to relax the ligatures to escape gangrene. This relaxation of course lets some venom into the blood-round, but in a few moments it is possible again to tighten the ligatures, and again to inject the local antidote. If the dose of venom be large and the distance from help great, except the knife or cautery little is to be done that is of value. But it is well to bear in mind that in this country a bite in the extremities rarely causes death. I have known of nine dogs having been bitten by as many snakes and of these dogs but two died. In India there would have been probably nine dead dogs.

S. Weir Mitchell.