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SNAKE-BITE AND ITS ANTIDOTE.

Cutting from: Forest and Stream,  
N. Y., 1888, ~~XXX~~, p. 307, 327, 349, 369,  
386, 412, 431.





## SNAKE BITE AND ITS ANTIDOTE.—I.

Experiments With *Crotalus* Venom and Reputed Antidotes, with Notes on the Saliva of *Heloderma* ("Gila Monster").

BY H. C. YARROW, M.D.

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IN 1664, Francisco Redi, an Italian, of whom Huxley says he was "a man of the widest knowledge and most versatile abilities, distinguished alike as a scholar, poet, physician and naturalist," published the first work extant upon the nature of serpent venom. It was called "*Osservazione Intorno alle Vipera*," and was printed at Florence. In this rare book are corrected many of the popular superstitions and fallacies prevalent at that time. Although little was added to our actual knowledge of the properties of venom and its composition, still the author is entitled to the credit of having been the pioneer in this class of literature. From Redi's time up to the present day, a multitude of observers in this country and abroad have given to this subject much patient study and research, with a view to discover some means by which the suffering and deaths due to serpent venom might be averted.

In 1672 there was published in Paris a volume of 245 pages by Moysé Charas entitled "*Nouvelles Expériences sur la Vipère*," which contained a reply to certain strictures upon his work made by Redi, and it is interesting to note the many curious remedies suggested by this writer, who appears to have placed great faith in what he calls the "*sel volatil de la vipère*," a preparation made by distilling chopped-up vipers, old and young. In 1702 Dr. Richard Mead—afterward physician to George II. in 1827—published an account of his investigations upon the subject of snake poisoning, which is interesting although not of much practical value.

From 1702 for sixty odd years nothing of consequence was published, but in 1767 at Lucca appeared the great work of Felix Fontana, entitled "*Ricerca Filosofica Sopra il Veneno della Vipera*," a work so important that it has been translated into several languages. As an example of the amount of work done by this industrious and learned Italian, it may be mentioned that he performed over 6,000 experiments, employed over 3,000 vipers, and had bitten more than 4,000 animals. His most important discoveries were, first, with regard to the actual position of the poison gland, which is above and behind the fang, Mead and James having declared that the venom was contained in the fang sheath; second, that the venom of a viper was not hurtful to the reptile itself if injected beneath the skin, or if a bite was inflicted by one of its own species; third, that venom was harmless to cold-blooded animals such as leeches, slugs, snails and some harmless serpents; fourth, that viper venom is poisonous to all warm-blooded animals, and fifth, that venom was not absorbed by mucous membranes. It is interesting to note that the conclusions of this distinguished naturalist have been verified repeatedly by later observers.

In 1777 M. Sage, of the Academy of Sciences at Paris, published a pamphlet recommending the use of ammonia in snake bite, which plan of treatment, however, was not original with himself, as it had already been recommended by Jussieu. It was based upon the theory that the active principle of the venom was an acid salt, but Fontana, who later on performed a number of experiments with it, condemned ammonia as useless, if not hurtful. With regard to the acidity of venom, Mr. Vincent Richards states that at first it is acid, but soon becomes neutral, and this fact has been verified by the writer.

In 1796 Dr. Patrick Russell studied the subject of serpent poisoning, and the results are embodied in a book which was published by the Court of Directors of the East India Company. He performed a number of experiments with Indian serpents, and brought into notice the famous Tanjore pill, the principal ingredient of which is arsenic, in which it may be added he seems to place but little reliance, as he recommends in addition either immediate amputation or the ligature. Dr. Russell, it is claimed, was the first to show the error of the popular belief that the mungoose is proof against the venom of the cobra. It is true that if this little animal is left alone with a cobra he is invariably victorious, but if bitten by

the snake he inevitably succumbs. It is a curious fact, vouched for by Mr. Vincent Richards, that after the conflict the victorious mungoose gnaws out the cobra's fangs. Dr. Russell's book is interesting as marking some onward progress in the study of venom, but it can hardly be considered as a very valuable contribution to knowledge.

In 1799 a Mr. Boag in studying methods of treatment in snake poisoning, advocated the use of nitrate of silver and nitric acid baths, as well as the salts of mercury, but curiously enough, he seems to place great reliance in human saliva as an antidote, probably because it was recommended by Seneca and the elder Pliny. Arsenic he unhesitatingly condemns as being as dangerous as the venom. He believed that death after snake bite resulted from an abstraction of oxygen from the blood, and to overcome this he proposed a speedy oxygenation of the system by artificial respiration, and other methods of procedure. This gentleman made a number of experiments to prove his theory, all of which were unsuccessful.

In 1801 Mr. John Williams advocated the claims of ammonia as an antidote and gave a history of several cases, which he believed had been saved by this agent, and, in 1809, Dr. Macrae, who was bitten by a cobra, stated that his recovery was due to thirteen spoonfuls of ammonia which he swallowed.

Mr. Breton, in 1825, published the results of a series of experiments with serpent venom, but he was evidently mistaken in his statement that "an innoxious snake can be killed by the venom of a poisonous snake."

In Vol. II., 1826, of the "Medical and Physical Transactions of the Calcutta Society" may be found an article by Dr. Daniel Butler on snake bite, in which he recommends the administration of opium, brandy and sulphuric ether in cobra poisoning, his treatment being founded upon the theory that the heart and arterial system are principally affected, an hypothesis now known to be untenable, as we know that the principal action of cobra poison is upon the respiratory centers. He also recommends the use of the ligature, dry cupping and suction of the wounds, and gives the history of several cases.

Dr. Davy, in 1839, published an account of some experiments with the poisonous snakes of Ceylon, but his studies possess little, if any, practical value.

From this period until 1860 nothing of importance was published regarding antidotes to serpent venom, although it should be mentioned that various papers on the subject of reptiles and their venom had been published from time to time by such observers as Dr. Barton, Mangili, Prince Lucien Bonaparte, Bernard Gratiolet and others. Brainard and Green recorded their researches in 1853, the former publishing a separate essay in 1854.

In 1860 the Smithsonian Institution accepted for publication a work which has become classic, and which appeared in January, 1861. It was entitled "Researches upon the Venom of the Rattlesnake, with an Investigation of the Anatomy and Physiology of the Organs Concerned," by S. Weir Mitchell, M.D.; and this quarto of 117 pages has done more to advance our positive knowledge of *Crotalus* venom than any previous publication. The conclusion reached by Dr. Mitchell, as a result of his studies so far as antidotes were concerned, was that none of those in reports were reliable. About the same time that the work already mentioned was passing through the press, a paper by the same author, entitled "On the Treatment of Rattlesnake Bite, with Experimental Criticisms upon the Various Remedies now in Use," appeared in the *North American Medico-Chirurgical Review*, 1861, V., 269, and gave the results of numerous experiments with so-called antidotes, and in summing up the author recommends no special plan of treatment, but advises the ligature, or excision, or both, with the administration of stimulants; in short, the general symptoms are to be treated according to the indications.

Another essay by the same author appeared in the *New York Medical Journal*, 1868, entitled "Experimental Contributions to the Toxicology of Rattlesnake Venom," and in this Dr. Mitchell corrected some of his views published in previous papers.

Following the essays of Mitchell in 1872 came the magnificent folio work of Dr. Joseph Payrer of Calcutta entitled, "The Thanatophidia of India," being a description of the venomous snakes of the Indian peninsula, with an account of the influence of their poison and life, and a series of experiments, London, 1872. This work, beautifully illustrated with thirty-one imperial folio plates drawn from life by native artists, is a veritable monu-





ment of patient research, and a most valuable contribution to our knowledge of the effect of the venom of the different poisonous snakes, with which India is so abundantly supplied. Unfortunately, so far as mitigating the loss of human life is concerned, the author is obliged to admit that no plan of treatment can be absolutely relied upon, as he tested every known or asserted antidote. In treating a case of serpent bite he would employ ligature, excision and general treatment. A number of other papers have appeared from time to time, all more or less valuable, by such well-known authors as Dr. Shortt of India, Harford of Australia, Brunton and Fayrer, Vincent Richards and others, but in none of them is an account of any discovery of a physiological or chemical antidote to serpent venom, once it is diffused through the circulation.

In 1881, however, Dr. J. B. de Lacerda, director of the physiological laboratory of the National Museum of Rio de Janeiro, electrified the scientific world by announcing to the French Academy of Sciences that he had discovered in *Potassa permanganas* an absolutely reliable chemical antidote to the venom of the *Bothrops*, a poisonous South American genus of serpents. In the experiments which were made upon dogs, the venom dissolved in water was injected beneath the animal's leg, and in from one to two minutes afterward a one per cent. solution of permanganate of potassa was thrown into the wound made by

the syringe. In other cases the permanganate solution was thrown directly into a vein, and out of thirty cases only two of the animals succumbed to the effects of the *Bothrops* venom. In some instances the permanganate was not employed until the characteristic symptoms of poison manifested themselves. He formally expressed himself that in this salt we possess an absolutely reliable chemical antidote.

It was not to be supposed that such astonishing results could be accepted without further experiments by various persons, and in 1882 Dr. G. Badolini, of Bologna, repeated Lacerda's experiments and signally failed. Mr. Vincent Richards, of Calcutta, who had been a member of the Snake Poison Commission in India, having learned of de Lacerda's studies, at once instituted a series of experiments to verify if possible the statements made, publishing his conclusions in the *Indian Medical Gazette*, Calcutta, XVII, 1., 57, 85. He is of opinion that the salt is not, strictly speaking, an antidote, but that it may prove of service in neutralizing the venom while in the tissues, but is of no service if the poison has been absorbed into the general circulation. In his over one hundred experiments he used solution of cobra poison and permanganate solution varying in strength, and from his well-known careful method of working, great reliance may be placed in his statements. His remarks in summing up will be given further on.

Theodore Aron, one of Prof. Binz's assistants at the University of Bonn, also experimented in 1882 with the permanganate as an antidote to cobra poison, publishing his results in the *Centralblatt für Klinische Medizin*, Bonn, 1882, No. 31, Nov. 18, and states that he saved some animals by its uses, but he seems to attach much more value to the use of a solution of chloride of calcium, for out of twenty-two experiments with this salt, he saved seventeen of the rabbits which had been inoculated with the venom. He also used alcohol, caffeine, atropine and bromine as antidotes, but all failed.

In April, 1882, Dr. Couty, who had assisted Dr. de Lacerda with his experiments in Brazil, sent a communication to the Academy of Sciences of Paris, in which he stated that, after having made experiments himself, he was obliged to conclude that the permanganate had no antidotal effect upon serpent venom; when in the circulation all of the animals inoculated died. De Lacerda, in answering the statement of his former colleague, mentions that a rupture of friendly relations had taken place between himself and Dr. Couty, and explains why the latter had failed, when he himself had almost invariably succeeded. Space will not permit of this being repeated here.

It is but fair to state in connection with the credit given to de Lacerda that Dr. Armand Gautier of Paris, about the same period, in experiments with cobra and rattlesnake poison, came to the conclusion that a solution of caustic potassa acted as an antidote to the venom, and his memoir was read before the Academy of Medicine July 26, 1881.

In 1884 Dr. de Lacerda published in Rio de Janeiro an 8vo. volume of 200 pages entitled *Leçons sur le Venin des*

*Serpents du Brésil et sur la Méthode de Traitement des Morsures Venimeuses par le Permanganate de Potasse*, in which he reiterates his opinion regarding the antidotal value of the permanganate and states that his discovery is "a veritable scientific and humanitarian conquest of which the happy results have been verified a thousand times, not only in Brazil but throughout the world." In closing he says: "It is not for my country alone that I have written these pages, for I hope they will be read in many parts of the globe. It is for this that I appeal to the competent men of all countries begging them to correct any fault or errors I may have made, and to fill up the gaps that may exist in this book." The writer would state that these few sentences of Dr. de Lacerda instigated him to perform the experiments which will be given hereafter.

Much attention, of late years, has been attracted, especially in the British colonies, to the so-called discovery by Dr. Geo. B. Halford of *Liq. ammonia* as an antidote to serpent venom, and while the intravenous injection of this liquid may have originated with him, the substance is one which has been repeatedly tried and failed, even so far back as the time of Fontana. Halford's theory appealed so strongly to the popular mind that in Melbourne, Australia, hundreds of hypodermic syringes were sold to the settlers, who fully believe they held in their hands an absolute antidote to the bites of venomous serpents. Sir Joseph Fayrer and numerous observers have found it entirely useless in cobra poisoning, and Mitchell states that as a stimulant it is far inferior to alcohol. It is only fair to Dr. Halford to state that he reports a number of apparently authentic cases of snake bite in which the patients recovered after ammonia had been injected into the veins. The writer may add that in his experiments with the *Liquor ammonia* the results were astonishingly disastrous. These experiments will be related in another part of this paper.

The action of the venom of the copperhead (*Ancistrodon contortrix*) has been studied in 1883 by Dr. Isaac Ott, of Easton, Pa., and finally has appeared the magnificent study of venoms by Dr. S. Weir Mitchell and Dr. Edward T. Reichert, published as one of the "Smithsonian Contributions to Knowledge." So far as the writer knows, with the exception of a few unimportant papers, the subject of serpent poisoning and antidotes has in this review been brought up to date.

(TO BE CONTINUED.)

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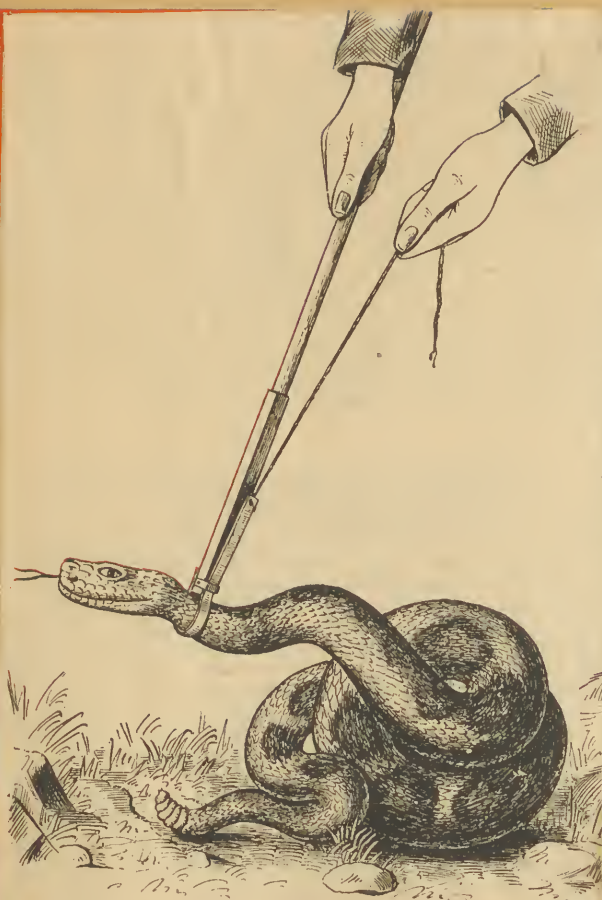
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AFTER reading de Lacerda's views regarding the antidotal effect of the permanganate of potassa in cases of serpent bite, the writer was so firmly convinced of its merits that, during his travels in the Western States and Territories, he invariably carried with him, with a blind and unquestioning faith, a hypodermic syringe and some permanganate of potassa, prepared in case of serpent bite to promptly administer according to de Lacerda's directions, but his confidence was weakened to a certain extent by the results of the experiments of Vincent Richards, Fayrer and others, and, to verify if possible the different statements, he determined to experiment himself with the permanganate, and as will be seen from the recorded notes below, was forced to the conclusion that this salt was of little or no value, at least in poisoning from *Crotalus* venom, if de Lacerda's suggestions only are followed. It was not intended at first to take up the subject of other so-called antidotes, but a good supply of serpents having been obtained by the National Museum, by whose co-operation the experiments were performed, it was thought advisable to continue the investigation still further. In addition to this reason, quite a number of persons, hearing of the experiments, have from time to time sent various reputed antidotes or have suggested certain methods of cure.

The venom used was obtained from several healthy specimens of the northern rattlesnake (*Crotalus horridus*) in the manner recommended by Weir Mitchell.







The snake is seized a short distance behind the head by means of a staff, having at its end a thong of leather passing over the end and through a staple, and this is tightened or loosened, as occasion may require, by means of a string extending up the handle. The cut copied from nature clearly shows this simple instrument. It has been found necessary not to confine the snake's head too tightly, as otherwise it cannot be induced to strike. The head being secured, a stick having its end covered with absorbent cotton is pressed against the snake's mouth, and it is teased until sufficiently irritated to strike its fangs into the cotton, which receives the venom and obviates any danger to the fangs, as it has been found in allowing snakes to strike against a saucer the fangs are frequently broken off. Generally a snake will strike three or four times very viciously, and then relapse into sullen apathy. We have in vain endeavored to procure venom from our snakes by pressing over the poison glands, but this has been unsuccessful except in one instance unless the snake was chloroformed, and if this is done the reptile generally succumbs within a few days. This fact is mentioned as it has been learned through the public prints that some experimenters in a neighboring city have succeeded in squeezing out the venom while the snake was active.

The quantity of venom obtained from different individuals varies greatly. From a large rattler weighing perhaps three or four pounds, our first attempt resulted in securing about fifteen drops of venom after the reptile had struck three times; but if the process is repeated every day or two but a very small quantity is obtained. The smaller snakes gave a much smaller quantity. The cotton after having received its charge of venom was removed from the stick and washed out carefully in glycerine, and by measuring the quantity of this substance first, and then after the venom had been added, we were able to tell accurately the strength of the solution, which consisted of eight drams of chemically pure glycerine and one dram of the venom. This is the preparation which was used in all the experiments, and is called glycerine-venom. One fact should be stated as bearing upon the popular belief that snakes, if kept from water, are not poisonous. It was found that by keeping the rattlers

without water for a week or two the quantity of venom was materially smaller than when we allowed them free access to water, and that the color of the venom, which was yellowish-green when no fluid was supplied, became much lighter in color when they had freely drunk. We have never been able to induce our rattlesnakes to eat, although they have been tempted with a variety of food, but water they consume largely.

When the present supply of rattlers was first received, it was a very easy matter to grasp any one of them behind the neck with the snake staff; but experience has taught them that they must do something against their will, and now it is quite difficult to secure them; and even when secured it is difficult to make them strike; in fact, one specimen is now so tame that it may be handled with impunity, and it is the writer's belief that a rattler, if carefully and tenderly handled, will not bite the hand that grasps it. It is believed the Moqui Indians are aware of this, and it enables them to handle with impunity the venomous snakes used in their fearful dance, so well described by Capt. John G. Bourke, U. S. A. Many persons suppose that the fangs of a rattler once removed, the reptile is harmless for all time, or that at least a year is required to replace the fangs. This is an error, for the writer has in his possession a rattler in which the fangs were twice replaced after an interval of three weeks only. As the rattler doubtless knows when the contents of the poison gland is exhausted, as is evidenced by his refusal to bite after two or three efforts, he probably also knows that it is useless to show fight when the fangs have been removed, and this has been practically tried on one of our snakes. She continued to coil and rattle, but no matter how much teased and irritated, makes no attempt to bite.

An interesting fact has been noticed during the course of our experiments, and one which it seems important to record. It is, that the rattler does not invariably use both fangs in striking, the muscular movements of either side of the jaw being quite independent of the other, and quite at the will of the reptile. The practical bearing of this point is that, occasionally in snake bite, but one puncture will be found, and some doubt might exist if this was really due to the serpent's fangs or not. Another point of interest lies in the fact that if only one fang is plunged into the tissues, the patient will not have received so large a dose of the venom as if both teeth had been used, and a more favorable prognosis can be made.

#### EXPERIMENTS WITH PERMANGANATE OF POTASSA.

This was the first substance used in the experiments, and de Lacerda's directions were carefully followed with the exception that chemically pure glycerine was used as a menstruum to preserve the venom, instead of distilled water. The writer is aware that de Lacerda claims that if glycerine is used to hold the venom in solution, the permanganate is rendered inert, but this is not the case, as in our experiments it has been found that a 5 per cent. solution of the salt if added to the glycerine and venom solution neutralizes its poisonous effects; moreover, if a ligature is placed around the leg of an animal and a certain quantity of glycerine-venom is injected below the ligature, followed by a solution of the permanganate, no poisonous effect is produced by the venom. This effectually disproves de Lacerda's statement. It should be mentioned that in all the experiments tried with the various reputed antidotes, different quantities of these were always first injected into the animals on the day preceding the test with the poison, in order to ascertain if the remedy itself was capable of producing mischief or death.

In order to ascertain the amount of glycerine venom required to destroy a pigeon, the following experiment was made Oct. 21, 1887.

Oct. 21, 1887—11:45 A. M.—Injected pigeon in the lower part of left breast with 3 minims of glycerine-venom solution.

11:48 A. M.—Pigeon commenced to tremble and had difficulty in opening the eyelids.

11:55 A. M.—All voluntary motion ceased. 12 M.—A good deal of tumefaction was noticed around the part injected.

12:05 P. M.—The pigeon has recovered partial muscular movement and the eyes appear brighter.

12:15 P. M.—The pigeon has again lost muscular power.





12:35 P. M.—The pigeon gave two slight flutters, a few gasps and was dead. A post mortem was made before rigor mortis set in, and it was found that the whole of the left breast was ecchymosed and congested with dark blood, and the heart was filled with venous blood.

It was thus discovered that three minims of the venom solution was sufficient to destroy a large healthy blue rock pigeon in less than one hour, the strength of the solution being eight drams of glycerine to one dram of the *Crotalus* poison.

Oct. 22—11:43 A. M.—Injected pigeon with 5 minims of venom solution in the left breast.

11:45 A. M.—Injected 17 minims of 1 per cent. solution of potassa permanganate in left breast.

11:54 A. M.—Convulsive movements of the pigeon's head was noticed.

11:55 A. M.—Injected 17 minims more of the permanganate solution, as the bird was getting very feeble. Opisthotonic spasms took place.

12:15 P. M.—The pigeon died without a struggle.

In this experiment the permanganate solution was injected twice in the immediate vicinity of the venom injection. It should not be forgot'en that the 1 per cent. solution of the permanganate is the one recommended by de Lacerda.

Oct. 25—12:45 P. M.—Injected a large healthy English rabbit in the left thigh with 5 minims of the venom solution, followed at once, without removing the hypodermic needle, with an injection of 25 minims of the 1 per cent. permanganate solution.

12:50 P. M.—Rabbit began to show the effects of the venom; respiration very much quickened; heart beats fast and is weak; animal indisposed to movement.

1 P. M.—Rabbit drank a little water, but was breathing short and fast.

1:10 P. M.—Part injected quite swollen and ecchymosed, but otherwise the animal seemed to be better.

1:40 P. M.—Rabbit was eating, and appeared to be doing very well.

3 P. M.—Rabbit seems perfectly well with the exception of a stiffness of the leg injected.

Oct. 26—12 M.—Rabbit appears perfectly well with the exception of a slight lameness and some swelling of the injected limb.

Oct. 27—Rabbit found dead in the cage. Post mortem: Heart contracted, lungs, liver and kidneys congested, bladder full of urine, intestines full of faeces. In the vicinity of the point of injection was found a large abscess, and the surrounding tissue and whole limb was ecchymosed, and had sloughed deeply. The liver, lungs and mesentery were studded with parasitic cyst worms still living. Decomposition was well advanced in the affected leg.

In the next experiment it was decided to use a smaller dose of the glycerine-venom, the subject being a large healthy English rabbit.

Oct. 27—11:45 A. M.—Injected rabbit in left thigh with 3 minims of venom solution, to which was added 10 minims of water without withdrawing the hypodermic needle; this was followed at once with an injection of 25 minims of 1 per cent. permanganate solution.

11:50 A. M.—Respiration and heart's action much increased, with a curious backward movement of the animal.

11:55 A. M.—Complete loss of motion in leg, with considerable tumefaction of part injected. Animal averse to motion even when irritated.

12:30 P. M.—Animal moves more freely, and seems better, although there is much more swelling and discoloration in the vicinity of the point of injection.

3 P. M.—Animal appears to be doing very well.

Oct. 28—12 M.—Great tumefaction of leg and thigh, œdema of rectum. Punctured and let out large amount of bloody serum. Animal has eaten, but is averse to movement.

3 P. M.—Animal very sick, unable to stand; all motion of hindlegs lost; is very weak.

Oct. 29—10 A. M.—Rabbit was found dead in its box, excessive hemorrhage having taken place from the wound. Post mortem: Great infiltration of blood in the leg and surrounding tissue. Much decomposition and sloughing.

It was now determined to try the effect of placing a ligature around the leg of a fowl before injecting the venom, with the following result:

Nov. 2—Hen injected in left thigh with 3 minims of venom solution with 10 minims of water added.

12:40 P. M.—After a ligature had been placed two inches above the place of injection, without withdrawing the needle, 25 minims of 1 per cent. permanganate solution was injected.

12:50 P. M.—The ligature was removed.

1:15 P. M.—No effect.

1:25 P. M.—Hen draws up the leg injected and stands on the other.

Nov. 3—Fowl apparently in fair condition, but there is much greenish discoloration of the leg and softening of the tissues contiguous to the joint where the venom was injected, abscess forming. Is quiet and stands upon both legs, but does not use the left leg.

Nov. 4—Fowl in about the same condition as yesterday; greenish discoloration more marked, but not extending so far into the surrounding tissue. Part quite soft and feverish.

Nov. 5—Fowl suffering no inconvenience from the injection; discoloration of the part subsiding; very little swelling.

Nov. 6—No result.

Nov. 7—Discoloration and swelling of part injected have entirely disappeared and the fowl has entirely recovered from the effects of the venom.

It will be seen from this experiment that the permanganate had a decided antagonistic effect to the venom, doubtless because the ligature confined the latter to a limited area, and prevented it being carried into the general circulation. In the next experiment the venom solution and permanganate were mixed together and used with the result as noted below.

Nov. 3—12:10 P. M.—Injected into the right leg of a fowl 3 minims of glycerine-venom, 5 minims of water and 30 minims of 1 per cent. solution of permanganate, mixed in vessel and allowed to remain together two minutes. Solution of permanganate changed at once to a color resembling solution of dragon's blood.

Nov. 4—Fowl appears to suffer no inconvenience from the effects of yesterday's injection. Slight swelling and discoloration, and only a slight increase of temperature.

Nov. 5—Fowl as well as ever.

Nov. 7.—Discoloration of and swelling of the part injected has disappeared, and the fowl is in a perfectly healthy condition.

With a view to still further determining the beneficial effect of the ligature, the following experiment was tried with a large dose of the venom and of the permanganate:

Nov. 10—12:45 P. M.—Injected 10 minims of venom solution into right leg of hen below ligature, followed at once by 25 minims of 2 per cent. sol. of potassa permang. Ligature allowed to remain on three minutes. The tissues near puncture were well kneaded. (This chicken was injected before with 3 minims of venom and 1 per cent. sol. permanganate.)

2:30 P. M.—Fowl inclined to stand still, otherwise no other symptoms noticed.

Nov. 11—11 A. M.—Fowl not inclined to move around, but sits down; not much swelling or inflammation of the part injected, but a little darkened in color; eats well.

2:30 P. M.—Fowl appears to be much better than she was this morning; eats and drinks as usual.

Nov. 12—11 A. M.—Fowl slightly lame in the leg injected; part swollen, with greenish discoloration; eats and drinks well.

2:30 P. M.—Fowl in same condition.

Nov. 13—No result.

Nov. 14—Fowl entirely recovered.

It was thought advisable to try the antidotal effect of

a much stronger solution of the permanganate, giving a small dose of venom, the result being as follows:

Nov. 21—12:18 P. M.—Injected 3 minims of venom solution into left leg of hen, followed at once by 25 minims of 5 per cent. permanganate solution.





through same puncture without removing the canula.

12:22 P. M.—Leg drawn up and trembling; respiration quickened, and chicken lying down—can hardly be made to stand up and oscillates backward and forward, feathers ruffled.

3 P. M.—Chicken will not stand, loss of motion of leg injected.

Nov. 22—11 A. M.—Chicken somewhat better, can use the leg injected a little, but still inclined to lie down. Much swelling and greenish discoloration of the leg.

Nov. 23—Hen in about the same condition as yesterday. Will not stand up.

Nov. 25—10 A. M.—Hen found dead; much swelling and sloughing of the leg injected.

This same experiment was repeated upon other fowls and upon rabbits, the result being death.

It should be remembered in this connection that de Lacerda claims that in nearly every case in which he used a one per cent. solution of the permanganate the animal recovered, and moreover he claims that the antidotal effect is produced even if a considerable period of time has elapsed after the injection of the venom. In our experiments we have shown that even a five per cent. solution is of no value, and the reputed antidote was used immediately after the injection, in fact so soon as the venom was injected the barrel of the hypodermic syringe was immediately unscrewed from the needle which was allowed to remain imbedded in the tissues, the syringe was rapidly filled with the permanganate and the injection was then made. Sometimes less than half a minute was consumed in the whole operation.

(TO BE CONTINUED.)

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Curator Department Reptiles, U. S. National Museum.

LET us now examine the testimony of others as to the efficacy of the permanganate as an antidote to serpent venom. The first to repeat de Lacerda's experiments was his former assistant Dr. Couty, who declared in the *Compt. Rend. Acad. des Sc.*, Par., 1882, April 24, that the permanganate was not an antidote, and that a favorable opinion upon its merits should be reserved until further experiments had been tried.

M. Vulpian, in *Compt. Rend. Acad. des Sc.*, Par., 1882, March 6, 613, states that he endeavored to repeat de Lacerda's experiments with the permanganate of potash and had come to the conclusion that an intravenous injection of some centigrams of permanganate can have no influence upon venom after it has been taken up by the circulation, particularly as it is decomposed after a few instants, and in case an effective dose be given, death might result from the antidote. In fact he says it is difficult to explain how the bites of *Bothrops* were cured in Brazil by the permanganate unless such bites are not always mortal. In his *resumé* he says there can be no doubt but that the permanganate can only be useful after recent bites, for if one or several hours elapse no antidotal effects can be produced. He also states that it would be wrong to rely upon this drug in cases of bites of other venomous reptiles in which the bites are often, or more rapidly mortal.

Dr. G. Badaloni reports in the *Lancet*, London, 1883, I., 768, that from his experiments with the permanganate he is led to believe it is of no avail in cases of poisoning from viper bite. Mr. Vincent Richards, of Calcutta, who

used permanganate in a great number of experiments regarding its antidotal power over the cobra venom, has reached the following conclusion:

I. "That in dogs no appreciable symptoms of cobra poisoning followed the hypodermic or intravenous injection of a watery solution of from two to seven centigrammes of cobra poison, when previously mixed with from one to three decigrammes of permanganate of potash, though, under ordinary circumstances, such quantities hypodermically injected are more than sufficient to produce fatal results." This statement simply proves that the salt renders the poison inert when mixed to-

gether in a vessel, not in the body of an animal, and our own experiments show a similar condition.

II. "That when similar quantities of a watery solution of cobra poison were hypodermically injected into dogs and were followed either immediately or after an interval of four minutes (the longest interval I have yet sufficiently tested), by the hypodermic injection with the same part of a watery solution of permanganate of potash (one to six decigrammes) no appreciable symptom of cobra poisoning resulted." This experience of Mr. Richards differs entirely in its result from ours, as is shown by the notes given above.

III. "That when glycerine was used instead of water, to dissolve the dried cobra poison, the permanganate of potash appeared to have no power over the virulence of the virus." This statement, it is thought, has been disproved by our own experiments already related.

IV. "That after the development of symptoms of cobra poisoning the injection of permanganate of potash, whether hypodermic or intravenous, or both, failed to exercise any influence upon the symptoms."

V. "That permanganate of potash possesses no prophylactic properties, since death followed the hypodermic injection of 3½ centigrammes of cobra poison in watery solution in the case of a dog which had been hypodermically injected a few hours previously with 8 decigrammes of the agent in solution."

VI. "That it would appear to be absolutely necessary that the permanganate be to efficacious should come into actual contact with the cobra poison."

VII. "That although no symptoms of cobra poisoning followed the injection of cobra poison and permanganate of potash, sloughing of the part injected sometimes followed." Sloughing we found to be extremely rare in our cases, as will be seen from the notes, in fact a 5 per cent.

solution of the permanganate injected several times into the leg of a rabbit had no appreciable effect.

VIII. "That up to the present time it has never been experimentally shown that any agent has either the power to neutralize the cobra poison lying in the tissues, nor to prevent death when four minutes had elapsed from the time of injection of the poison to that of treatment."

IX. "That if permanganate of potash has such power to destroy so subtle a poison as that of the cobra it is probable that the hypodermic injection of the agent in the bite of a rabid animal, would destroy the virus which causes that terrible disease hydrophobia."

The writer would remark that as early as 1870 he treated three cases of persons bitten by rabid animals with applications of a solution of permanganate of potash after incision of the bites had been performed; none of the patients had *rabies canina*.

Sir Joseph Fayer states in his address to the Medical Society of London, speaking of Richards's views, as follows: "I agree with Richards that so far as it goes it is a good local application and as such ought to be used; or, in its absence, tannic acid or *liquor potassæ* might be resorted to with the same object; but as a constitutional remedy, as a physiological antidote, it is powerless, like all others that have been tried and failed to do good." Dr. de Lacerda himself, although he attributes the highest value to it as a chemical antidote, both as a powerful oxidizing agent and by the action of the potash, says, as to the idea of finding a physiological antidote for snake poisoning: "I entirely agree with you that it is a Utopia; although I found that *liquor potassæ* practically answered the same purpose as permanganate of potash, it did not decompose the venom, but merely destroyed the tissues in which the venom was lying, thereby preventing its absorption; and it was subsequently discharged with the slough. This was proved by the fact that when the venom and *liquor potassæ* were mixed and injected subcutaneously, no constitutional effect followed; but if the same mixture was diluted with water and injected into a vein or into the peritoneal cavity of an animal, symptoms of cobra poisoning were soon manifest, and the animal died."

As opposed to the opinion of the persons quoted, we have on the affirmative side of the question only de Lacerda's statements and cases, and one or two others. The first is mentioned by Dr. de Fourier in the *Journal de Hygiène* for Sept. 22, 1882, in which a case is mentioned of an individual having been bitten by a very large serpent





supposed to be poisonous, to whom a solution of the permanganate was given internally and hypodermic injections were also employed; the patient recovered. Another case is related by Dr. E. Borjes, in the *Polyclinic, Philadelphia*, 1883, I., 57, in which the patient was bitten by a rattlesnake. Four hours after the bite one-half grain of permanganate of potash was injected subcutaneously and two grains were given internally every hour. Ammonia was applied to the wound and the patient recovered.

Before leaving the subject of the permanganate, it may be well to state de Lacerda's hypothesis of the action of this salt as he himself communicates it in a letter to Dr. Fayrer: "Passing now to the essential point of the discussion that took place in the Medical Society. I will give in a few words how I comprehend and how I judge that the efficacious effect of permanganate of potash should be comprehended. You yourself, by experiments made in 1869, recognized that permanganate of potash mixed with the venom took from it its noxious properties. Certain conditions of the experiments led you, however, to deny the efficacy of this chemical agent in the cases in which the venom had been inoculated in the tissues. As you know, however, I have demonstrated by numerous experiments and innumerable clinical facts that the neutralization takes place even in the midst of the tissues, which makes this substance a chemical antidote of great value. The permanganate of potash acts upon the venom, destroying it in two ways: first as a powerful oxidizing agent, second by the potash that forms the base of the salt, passing a current of nascent oxygen through a concentrated solution of the venom, which loses entirely its noxious properties. This experiment, which I have repeated many times, gave me always the same result. Let us suppose now, then, an individual is bitten. If injections are made in the place of the bite from five to ten minutes after the inoculation of the venom, this is promptly neutralized *in situ* and the individual runs no further danger. A great number of facts have been observed like this in Brazil. If aid is given late, hours after the bite, when the tumefaction of the wounded part is very pronounced and the phenomena that indicate the entrance of the venom into the circulation have already declared themselves, injections repeated in various parts of the wounded members parting from the wounds made by the fangs of the reptiles still give very good results. Nor is it difficult to explain the good results in this case. The venom as I have said acts first locally and only enters the general circulation after the lapse of a certain time, and by portions. The permanganate of potash meeting in the tissues with the venom, which is little by little diffusing itself, neutralizes it in the various points when it has been diffused and thus stops the source of supply. The entrance of new and successive portions of the venom into the general circulation being thus impeded, the organism takes charge of the elimination of what has already been introduced and which was insufficient to compromise the life of the individual."

It is only fair to add that the poison of the *Bothrops* is much less venomous apparently than that of the cobra and *Crotalus*, and this may account for the good results obtained by Dr. de Lacerda, but we should not forget also that Mitchell makes the statement that at least seven-eighths of patients (bitten by the *Crotalus*) recover, and that the mere fact of their surviving can assuredly be no test of the value of any particular form of treatment.

Dr. E. R. Sisson, of New Bedford, Mass., sends to the Tampa (Fla.) *Journal* this report of his successful treatment of a dog bitten by a rattlesnake:

"On March 1 my pointer Joe was bitten by a rattlesnake. It being my custom, while hunting in Florida, to go prepared for an emergency of this kind, and being present at the time of the accident, I lost no time in applying the treatment.

"First, I pressed the wound to make it bleed as freely as possible; then I sucked it; after this applied five drops concentrated spirits of ammonia to the open wound, immediately following by ten drops of the fluid extract of jaborandi hypodermically, holding it in the puncture for two minutes. After making these local applications to destroy the action of the poison on the blood. I gave 1oz. of whisky with a drop of the ammonia internally every hour. After this, stopped the ammonia and gave whisky and milk. Six ounces of milk to six teaspoonsful of whisky, decreasing gradually the whisky for the first twenty-four hours, as the circulation and strength improved, when I stopped it altogether, and gave 6oz. of beef

tea, making the tea of Liebig's extract, usual strength, alternately with the same quantity of milk, once in six hours. This course was followed for sixty hours, when the animal voluntarily took small pieces of fresh beef. From this time on his improvement has been continual, having hunted the dog twice within the last three days, with all his usual vigor, and no loss in the strength of his nose.

"This is my first experience in the treatment of a rattlesnake bite, and I give it to sportsmen for what it is worth.

"No treatment, in my opinion, will amount to much in such a case, where the circulation is involved, unless applied immediately and continued regularly for at least seventy hours or more, with rest and freedom from all excitement.

E. R. SISSON, M.D."  
Dr. Yarrow advises us that Lieut.-Com. William P. Randall, U. S. Navy, also vouches for the above.

### SNAKE BITE AND ITS ANTIDOTE.—III.

Experiments With *Crotalus* Venom and Reputed Antidotes, with Notes on the Saliva of *Heloderma* ("Gila Monster").

BY H. C. YARROW, M.D.

Curator Department Reptiles, U. S. National Museum.

WERE it not for the fact that many persons still believe in the antidotal efficacy of ammonia in snake bite poisoning it would not have been thought worth while to experiment with this agent any further, and a number of observers from the time of Fontana to the present day have proved not only its absolute uselessness, but have also shown that under certain conditions of administration it is dangerous to life. Weir Mitchell says that in one case he thinks he actually destroyed a dog with the means which was meant to save him, and our experiments, it is thought, will show a similar condition of affairs. To Dr. Halford has been attributed the method of cure of venom poisoning by ammonia, but this is an error, as has already been shown in this paper, and if further proof is wanting it may be found in the *Medical Times and Gazette*, London, 1873, ii., p. 216, which gives the translation of a letter written by Felix Fontana to Mr. Gibelin dated Florence, July 1. 1782, in which he states he experimented upon lambs and rabbits, using from twenty to forty drops of ammonia injected into jugular vein, none recovered. He also states that twelve experiments may not be sufficient to show the absolute inability of ammonia as an antidote, but they show it is not a specific. In his work on poisons, p. 3, he says in reference to its use externally or internally, "It is then a fact proved that ammonia is entirely useless whether applied simply to the bitten part or whether taken internally, and there is even reason to suspect that it was hurtful."

Inasmuch as Dr. Halford revived an interest in the ammonia plan of treatment it seems only fair to give a resumé of his plan of treatment which will be found in his pamphlet entitled, "New Treatment of Snake Bite," by G. B. Halford, Melbourne, 1869, p. 16, in which he recommends the bite to be cut out, and when symptoms of drowsiness or sickness come, inject ammonia ten drops to twenty of water into vein (adult dose) with hypodermic syringe pointed toward heart (does not mention care to be taken to avoid air entering vein). Gives a number of examples. Speaks of injecting ammonia into right and left ventricles of heart, carotids and jugulars, the dog being under chloroform. Half dram liquor ammonia B. P. sp. grav. 0.959 every fifteen minutes or so for several hours. Dogs not injured but were finally killed as chest had been opened.

He again discusses the subject in the *Medical Times and Gazette*. London, ii., p.p., 90, 170, 224, 323, 461, 575, 712, and gives a number of apparently well authenticated cases.

Average length of time it takes to kill dogs with cobra bite according to Halford is 3h. 23m.; *Haplocephalus curtus* 2h. 15m.; fowls by cobra 18m. Some die in much shorter time.

Fayrer found that the injection of ammonia into the veins of healthy dogs was followed by grave consequences such as convulsions and marked muscular prostration, and no immunity was produced when the animals were bitten by cobras. He thought the ammonia treatment hastened death, and Healey (G. D.) and Rees (W. C.) report a case of snake bite in the *Australian Medical Journal*, 1874, XIX., p. 49, in which ammonia was injected





into the veins and brandy given internally, which resulted in death.

In our own experiments, believing that the venom, or at least a part of it, remained in the vicinity of the wound and was gradually absorbed, instead of injecting ammonia into a vein it was thrown into the tissues contiguous to the part where the venom was injected, with the following result:

Nov. 4, 1887—12:53 P. M.—Injected a strong, healthy pigeon in the right side of the breast with 3 minims of glycerine venom, followed at once with 25 minims of ammonia solution.

12:55 P. M.—Bird died, having had tetanic spasms almost immediately after the last injection. The post mortem examination showed the heart to be empty, and much fluidity of the extravasated blood in vicinity of wound was noticed.

Inasmuch as it had been shown by previous experiments that a lethal dose of 3 minims of glycerine venom requires a much longer time to produce death in pigeons, the supposition naturally arose that perhaps the ammonia itself was the cause of death, and the following experiment was tried a few days after:

Nov. 8—12:11 P. M.—Injected 25 minims of ammonia solution in breast of healthy pigeon.

12:13½ P. M.—The pigeon fell over backward from its perch, gave a convulsive struggle, and died in half a minute.

Five minims of glycerine venom were thrown into the leg of a rabbit, followed by 30 minims of ammonia solution, and the rabbit perished in five minutes.

The question may well be asked, if Halford's solution of ammonia has such a startling effect when injected into the tissues, what would be the result of throwing it directly into the veins? The evidence being so conclusive regarding the inefficacy of ammonia as an antidote, no further sacrifices of animals were made.

Among the many remedies that have been recommended in snake bite the different species of *Euphorbia* hold a prominent place, in fact in the Western States and Territories it is believed a specific not only for man but beast, as has been stated to the writer by his friend Capt. Chas. Bendire, U. S. A., and that this belief was held by our trans-Atlantic brethren is shown by the following statement of Dr. Hurant *Jour. de Chem. Med. Pharm. et Toxicol.*, Par., 1839, 2 s., v. 272:

While botanizing in the country a favorite dog was bitten by a viper; fortunately close at hand he found the *Euphorbia cyparissias*, and having expressed some of the juice he pressed it into the wound and applied the bruised leaves. The dog recovered.

Dr. B. J. D. Irwin, U. S. A., *A. J. M. S.*, Phila., 1861, n. s., p. 89, speaks of using *Euphorbia prostrata*—called Gollindrineria by Mexicans. Gave four fluid ounces of a watery solution of *E. p.*, and applied bruised plant to wound—repeated dose in one hour. Animals recovered. Other *Euphorbias* said to be useful: *Capitata*, *correliata*, *palustris*, and *villosa*.

In view of these statements it was determined to try the antidotal effect of *Euphorbia*, but unfortunately only one species could be obtained at this season—*Euphorbia maculata*, of which a strong tincture was made, and to ascertain if it possessed itself poisonous qualities at 12:45 P. M., Nov. 12, 1887, a healthy male rabbit received in right hindleg a hypodermic injection of 50 minims of the tincture, and no unpleasant symptoms were manifested, the animal having been carefully watched. Nov. 14 he was perfectly well. The next experiment was as follows:

Nov. 12—12:30 P. M.—Injected 5 minims of venom solution in hindleg of rabbit, followed at once by 50 minims of alcoholic tincture *Euphorbia maculata*, and 2 fluid drams given by stomach, and wet pad of tincture applied over wound.

12:35 P. M.—When released animal was very feeble, hardly able to stand.

1:15 P. M.—Gave rabbit 1 dram of tincture *Euphorbia* and 1 dram of water per mouth; animal very weak.

1:20 P. M.—Rabbit very nearly dead; respiration fast; has lost all motion.

2:15 P. M.—Rabbit quietly died; very little swelling or discoloration of the part injected.

This single experiment is given for what it is worth, and can hardly be considered as a fair test, but efforts will be made to obtain the species of *Euphorbia* mentioned as an antidote by Dr. Irwin, and its effects will be further investigated.

Dr. Robert Fletcher in his valuable paper entitled "A Study of some recent Experiments in Serpent Venom," in the *Am. Jour. of Med. Sci.*, 1883, n. so., LXXXVI., 144, mentions a case reported by a French physician of a person bitten by a viper, in which the very grave symptoms developed had been cured by the administration of jaborandi, which produced copious salivation and perspiration, the dangerous effects of the venom gradually disappearing.

This case was looked up and was found in the *Gaz. Hebd. de Med. et Chir.*, Par., 1882, XIX. 835, the reporter being Dr. Josso. He states that the patient was bitten by a viper between the thumb and index finger, and that when called to see her all the characteristic dangerous symptoms of poisoning from snake venom were present, notwithstanding that phenic acid had been freely used as a supposed antidote. Having seen an account of the use of jaborandi by the South Americans in snake bite, he determined to give it a trial, and four grammes of the leaves were infused in a glass of water and given at 2 P. M. of the 13th inst., and on the 14th the patient was well with the exception of pains in the arms and some swelling, which lasted for three weeks after the accident. As already stated, copious salivation and perspiration were produced, but no mention is made of any action upon the kidneys. As no other cases had been reported, and the writer being aware that venom was supposed to be eliminated by the skin and kidneys, he determined to examine the subject thoroughly. The testimony, so far as could be ascertained, is as follows:

Dr. B. S. Barton in "An account of the most effective means of preventing the deleterious consequences of the bite of the *Crotalus horridus* or rattlesnake" (sm. 4to. Phila., 1792), speaks of the use of the common garden rue (*Ruta graveolens*) as used by the Indians of New Jersey to produce copious perspiration as a cure for rattler's bite, giving two tablespoonfuls of the juice every two hours until violent sweating was produced. The author thinks it may have been of service. In some cases after a bite a ligature was applied above the injured part, wound scarified, and salt and gunpowder laid in the wound, over the whole was bound a piece of white walnut bark (*Juglans alba*). Early settlers do this. The salt and gunpowder excite a discharge of blood from the scarified part, especially of serum, and the white walnut bark possesses the evacuant power of cantharides and contributes to the further discharge of the serum and with it the snake poison. He gives quite a long list of plants which have been used and recommended.

Dr. A. Coutance, in his work entitled "Venins et Poisons," 8, Paris, 1888, p. 178-179, speaking of a dog bitten to death by a *fer de lance* says: "A cubic centimeter of urine from a dog, dead from the bite of a *Trigonocephalus* was injected beneath the skin of a rat, which died the next morning. The kidneys are therefore, as believed by Lauder Brunton and Fayer, a means by which serpent venom is eliminated. Richard Balsamos killed pigeons by inoculating them with the urine of dogs which had been bitten in India by venomous sea snakes, but it is a question if normal urine might not produce the same effect by reason of the ptomaines contained therein."

As some non-professional readers may care to know what jaborandi is, and what effect is produced by it, the following short summary is given:

Jaborandi is an extract made from dry leaves of *Pilocarpus pennatifolius*, a South American plant, its properties being due to a volatile oil and two alkaloids, pilocarpine and jaborine.

Dose: Extract, gr. ii-x.

Dose: Infusion, f. oz. ss.

Dose: Pilocarpine nit., gr. ¼-ss.

Dose: Tincture of jaborandi, U. S. Ph., f. oz. ¼-1.

Dose: Ext. pilocarpi fl., M. 5-60.

"Pilocarpine stimulates the peripheral terminations of efferent nerves going to glands, and first stimulates and then paralyzes the efferent nerves going to structures composed of involuntary muscular fiber. In large doses it lessens, but does not quite destroy, the irritability of voluntary muscles and motive nerves." (Lauder Brunton.) It increases flow of saliva enormously, the secretion of sweat and excites the secretion of tears, cerumen in ears, mucus from nose and from bronchial mucous membrane, of gastric juice, intestinal juice and urine from the kidneys. Upon the circulation: Vessels become dilated at first, pulse rapid, feeling of heat over the body. Blood pressure falls a little at first with quicker pulse and rises with a slower pulse. Respiration is increased, with dyspnoea. Is used as a cardiac stimulant when digitalis fails."





Now as will be seen from these statements, this South American plant really seems to possess all those properties which might be supposed necessary to constitute a true physiological antidote to serpent venom, and so far as our limited experiments go, there appears to be good warrant for such a belief, as in all of our experiments the so-called antidote was first tried on healthy animals without producing any ill effects. The first experiment was as follows:

Nov. 28—12:20 A. M.—Injected 5 minims of solution rattlesnake venom into left leg of strong rabbit, followed immediately by 10 drops of fluid ext. jaborandi, in 10 drops of water; and 10 drops jaborandi and 4oz. water was forced into the animal's stomach with a syringe.

2:30 P. M.—Animal slightly lame in the injected leg, holds it up when walking; but eats well.

Nov. 29—11 A. M.—Animal still a little lame, slight swelling and tenderness of the injected leg—otherwise seems to be in good condition.

Nov. 30—11 A. M.—Animal in about the same condition as yesterday—but improving.

Dec. 1—11 A. M.—Animal still slightly lame; a hard tumor formed at the seat of injection.

Dec. 2—11 A. M.—Animal in same condition as yesterday; appetite normal.

Dec. 5—Swelling entirely gone, animal perfectly well.

It was noticed in this case that the animal urinated freely and very frequently, and that the mouth and nostrils were very moist. Chickens and pigeons being peculiarly susceptible to venom it was determined to try the effect of the jaborandi upon them, and on

Dec. 3—12:30 P. M.—Injected 5 minims of *Crotalus* venom into leg of chicken, followed by 10 minims of fl. ext. jaborandi, in water, by the stomach.

1 P. M.—Chicken appeared not so well, lying down. Gave 10 minims more of jaborandi in stomach.

3 P. M.—Chicken standing up, and feathers drooping. Does not seem very sick.

Dec. 5—10 A. M.—Chicken found dead, probably died during the night as it was alive yesterday (Sunday) at 1 P. M.

In this case it may have been that not enough of the jaborandi was given to overcome the double lethal dose of the venom, but the experiment shows that life was prolonged after a dose of venom which if allowed to act without hindrance would have destroyed life in about two hours. Another experiment was tried upon another fowl, a smaller dose of venom and a larger amount of jaborandi being given, but the chicken only lived two days. These two experiments would seem to show that in the case of fowls poisoned by serpent venom jaborandi has only the effect of prolonging life. To verify the former experiment upon a rabbit it was resolved to again try the antidotal effect of the drug with the following result.

Dec. 5—12:05 P. M.—Injected 10 minims of rattlesnake venom solution into right leg of rabbit, followed by 15 minims of fl. ext. jaborandi; also gave 15 drops jaborandi, in water, in stomach.

12:15 P. M.—Rabbit sluggish and indisposed to move. Respiration hurried, and animal seems very sick.

12:30 P. M.—Gave 15 minims more of jaborandi hypodermically.

Dec. 6—Rabbit appears perfectly well and is eating. Copious discharge of serum from wounds made by syringe, and a good deal of urination.

Dec. 8—Rabbit appears perfectly well, but has a healthy looking raw surface near point of injection on leg which is healing.

Dec. 10—Rabbit well, excepting ulcer, which is healing.

Dec. 12—Perfectly well.

One more experiment was tried upon another rabbit, in which a fourfold lethal dose of the venom was injected, viz., 20 minims followed by 60 minims at intervals of jaborandi, with 60 by stomach, the animal recovering perfectly. From the foregoing experiments with the fluid extract of jaborandi it will be seen that while this substance appears to have antidotal effects upon rabbits, in fowls it fails, as has already been stated, but it is intended to pursue this line of experimentation still further, especially with the active principle known as pilocarpine. It may be mentioned that a medical man of Washington city is so convinced of the efficacy of the jaborandi that he has offered himself for the purpose of an experiment with venom, and in addition to this offer the writer has received a communication from a person in Ohio also proposing to submit to the test. Until we have experi-

mented further, however, the scientific devotion of these gentlemen will not be tried.

## SNAKE BITE AND ITS ANTIDOTE.—IV.

Experiments With *Crotalus* Venom and Reputed Antidotes, with Notes on the Saliva of *Heloderma* ("Gila Monster").

BY H. C. YARROW, M.D.

Curator Department Reptiles, U. S. National Museum.

A GREAT number of different plans of treatment have been suggested to the writer, and many substances have been sent to the National Museum to be experimented with, but in view of the fact that most of the latter were substances of which the proposer would not reveal the identity, no attention was paid to such except in one instance, that of a "mad stone," or "snake stone," so-called, the composition of which is reported upon by Geo. P. Merrill, Curator of Lithology and Physical Geology, U. S. Nat. Museum. This was sent by Donald MacRae, from Wilmington, N. C., and is "an indurated and impure kaolin apparently. Its virtue as a mad stone doubtless is due wholly to its high absorptive power, which would cause it to adhere to the wound for a time or until saturated." This is presumably the substance which in the United States has so great a reputation among the common people when used in cases of snake bite or mad dog bite; but it is quite a different thing from what is known as the snake stone in India, which is generally found to be, on examination, nothing but a piece of calcined deer horn.

A very interesting account of it is given by Dr. Alfred Eteson, Surgeon-Major, Sappers and Miners, Roorkee, in the *Indian Medical Gazette*, Calcutta, 1876, X., 309. He speaks of having received such a stone from a Catholic priest in British Burmah, which was simply a flat piece of calcined horn, three-quarters of an inch square and one and a half lines thick, and resembled a flint, except that all the edges were square and it was very smooth, with an even grade of close cancellations clearly visible. This stone was one of a number made by another priest for the use of the mission fathers. Dr. Eteson had occasion to use this stone a short time after in a case of snake bite, and states as follows: " \* \* \* I pressed down the stone over the punctures, it adhered at once, I removed my fingers, then sloped his hand and turned it round; lastly, I drew on the stone with moderate force until it lifted the skin, as a sucker would do. In about a quarter of an hour the patient himself first mentioned that the stone was loosed. I touched it with one finger and it became displaced." The man recovered.

Dr. Eteson states with regard to his case: "It is not worth much, for the identity of the snake and the precise conditions of the bite were not established, but at all events the stone did what it was professed it would do, and there was no suspicion of the man having been otherwise than genuinely bitten. When this particular stone was shown to the Indian snake charmers they appeared greatly surprised at its form, their own being small, rounded and pebble-shaped, but they recognized it as genuine." Dr. Eteson being determined to investigate the matter still further, corresponded with the priest at Bassein who manufactured the snake stones and received the following directions for making them: "Cut or saw in the shape of a gun flint the hard part of a good deer's horn. Polish these pieces by rubbing them on a stone. Soak them for eight hours in good vinegar. Take a small earthen pot (chatty) and place the bits of horn in the center surrounded by rice hulls in such a way that the stones shall not touch each other. Fill the pot with rice hulls and seal its cover hermetically with earth. Put the pot in the center of a little fire made with rice hulls and let it remain for twelve hours. After the cooking, place the stones again in the vinegar for seven hours. Take out the stones and test them on the lips, if they stick like a cupping glass they are good. To preserve them they should be wrapped in cotton and kept from the air. After one has been used it should be soaked in milk, which will remove the venom." The priest stated that out of sixty stones thus prepared only six were found to be of service.

Sir Joseph Tennant, in his work on Ceylon, 5th ed., 1860, I., p. 197, speaks of the Pamboo Kaloo, a snake stone, which he saw applied by Indian snake charmers in two cases with apparent good effect. Those he saw were of the size of a small almond, intensely black and





highly polished, though of an extremely light substance. Dr. Davy, on the authority of Sir Alexander Johnson, says the manufacture of these stones is a lucrative business, and is carried on by the monks of Manilla, who supply the Indian merchants with them, and his analysis confirms that of Mr. Faraday, who declared the stone to be calcined horn.

In Mexico a similar stone was used which was prepared as follows: Take a piece of hartshorn of any convenient size and shape; cover it well round with grass or hay and inclosing both in a thin piece of sheet copper well wrapped round them place the whole parcel in a charcoal fire till the bone is sufficiently charred. When cold remove the calcined horn from its envelope, when it will be ready for immediate use. In this state it will resemble a solid black fibrous substance of the same shape and size as before it was subjected to this treatment. 1. "Use—The wound being slightly punctured, apply the bone to the opening, to which it will adhere firmly, for the space of ten minutes, and when it falls it should be received into a basin of water. It should then be dried in a cloth and again applied to the wound. But it will not adhere longer than about one minute. In like manner it may be applied a third time, but it will fall almost immediately, and nothing will cause it to adhere any more." It will be noticed that the Mexican method of preparing the stones does not differ materially from the East Indian plan. A number of reliable observers have tested these stones and found them to be of no value, among them may be mentioned Fontana, Viand-Grand-Marais, Sir Joseph Fayrer, Vincent Richards and others; it has also been carefully tested by Dr. John Shortt of Madras, who states that he had some difficulty in getting the stone to adhere; dogs and chickens were bitten but all died. He sums up: "There is no truth in the virtues attributed to the snake stone, for it has neither the power to absorb or otherwise neutralize the snake poison from the wound." (*Lancet*, London, 1867, 1, 5, 76.)

In view of these unfavorable reports the results of the

writer's experiments with the kaolin snake stone will probably be read with some interest, although they were so few in number as to prove little besides the fact that the stone actually did adhere and became charged with blood.

The first experiment was tried

Jan. 4, 1888—11:55 A. M.—Injected 10 minims of glycerine venom mixed with ten minims of water into right leg of chicken, a ligature having been previously applied above point of puncture. A number of superficial incisions were then made in the vicinity of the wound, and the so-called mad stone applied with firm pressure. It held on for a number of minutes and then fell off, and there was a copious flow of blood following its detachment. The stone appeared saturated with blood and was placed in water and cleansed. The ligature was removed from the limb and the fowl liberated.

Jan. 5—12 M.—The chicken is apparently very sick, with quickened respiration, is sluggish, crouches down and is averse to movement. In the vicinity of the injection there is much engorgement of the tissues. There is a copious flow of bloody serum from the wound. From this time up to Jan. 9 the chicken gradually improved, and at this date appears entirely well. It walks around, eats well, and the wound is cicatrized. It must be confessed that the result of this experiment was entirely unexpected, as it was supposed that the dose of venom given (10 minims) would produce death in about thirty minutes.

To verify the former test a second was tried.

Jan. 13—12:15 P. M.—Injected 10 minims of venom and 10 minims of water into left leg of chicken, no ligature being applied. Multiple superficial incisions were made in the vicinity of the puncture and a new piece of the stone was at once applied. It held on firmly for nearly fifteen minutes and absorbed considerable blood, falling off finally by its own weight. The chicken seemed to suffer little or no inconvenience from the operation, and walked about picking up corn.

Jan. 16.—Is still doing well and the wound healing rapidly.

Jan. 20.—Chicken in perfect health, wound cicatrized entirely.

It should be mentioned that both these experiments were tried upon the same fowl, and it may be that the former inoculation with venom protected it from the second. Another experiment tried upon a fowl failed, the bird dying in about four hours.

In this connection attention is invited to a very interesting paper by Prof. Henry Sewell, of the University of Michigan, published in the *Journal of Physiology*, Cambridge, 1887, VIII., 203, entitled "Experiments on the Preventive Inoculation of Rattlesnake Venom."

Prof. Sewell assumes in this article that an analogy exists between the venom of serpents and the ptomaines produced under the influence of bacterial organisms, he therefore thought that if "immunity from the fatal effects of snake bite could be secured in an animal by means of repeated inoculations with doses of the poison too small to produce ill effects, we may suspect that the same sort of resistance against germ disease might follow the inoculation of the appropriate ptomaines, provided that it is through the products of their metabolism that bacteria produce their fatal effects." To settle this point his experiments were tried with the following results: First, that rattlesnake venom, kept for some time in glycerine, underwent a gradual deterioration of power, this view being in opposition to the experience of other observers. Second, that "repeated inoculation of pigeons with sublethal doses of rattlesnake venom produces a continually increasing resistance toward the injurious effects of the poison without apparent influence on the general health of the animals." These results are abundantly proved by the tables which accompany the report.

It may be of interest at this point to give a brief account of the different remedies and plans of treatment that have been suggested from time to time for snake bite. Some years since the attention of scientific men was called to a reputed remedy known as Bibron's antidote, of which Dr. W. A. Hammond, U. S. A., in the *Am. Jour. Med. Sci.*, Philadelphia, 1858, n. s., XXXV., 94, 82, states that according to Prince Paul of Wurtemberg, Prof. Bibron allowed a rattlesnake to bite him on the lips, cheeks, etc., and by taking the antidote suffered no inconvenience whatever. Dr. Hammond reports one case in which a man was bitten by large rattler, four minutes after the bite was given a dose of the Bibron antidote and unpleasant symptoms disappeared but returned; in forty minutes another dose was given. In five minutes all pain had vanished and he recovered perfectly. He had animals bitten, a wolf three months old, thirty minutes after the bite when symptoms had become marked, six drops of antidote were given, wolf became well almost immediately and ate a piece of meat. Same wolf bitten next day in three places, but there was some delay in giving the antidote, wolf died comatose in twenty-seven minutes. Snake made to bite a dog, which died because antidote could not be given. Forty-five minutes after, same snake was made to bite another dog, in three minutes after the injury the antidote was given before symptoms developed, in fifteen minutes another dose, and in two hours he appeared perfectly well. Dr. Coolidge in same paper reported case of girl fifteen years old bitten at Fort Riley; ten minutes after, the doctor placed a ligature above the bite, made free incision and gave the antidote, repeated twenty minutes after, injecting into the finger Brainard's preparation of iodine. Girl got well with extensive suppuration of back of hand.

The formulæ for the preparation of this antidote is as follows:

#### BIBRON'S ANTIDOTE.

R Potass. iod. .... gr. iv.  
Hydrarg. chl. corros. .... gr. ii.  
Bromine ..... f. dr. v.

M. Sig. Ten drops in tablespoonful of wine or brandy, to be repeated if necessary. Put in glass-stoppered bottle.

After Dr. Hammond's experiments so much faith was placed in this preparation that it was furnished to all the military posts in the West and South, and the writer remembers to have seen a bottle of it occupying a prominent position in the serpent room of the Academy of Natural Sciences, Philadelphia, then in charge of Prof. E. D. Cope.

Mr. Xantus de Vesey performed a number of experiments with the Bibron antidote, and states that none of his animals perished of snake bite when the remedy was

used. Dr. S. Weir Mitchell experimented upon sixteen dogs, with that singular care for which he is noted, with the following results, which are simply negative. Of eight dogs bitten and treated with the antidote two died, while of eight bitten and not so treated three died. It is intended to try the effect of the Bibron antidote again if a sufficient supply of venom can be obtained.

In 1853 Dr. David Brainerd, of Chicago, in conjunction





with Dr. Green, proposed a plan of treatment for snake bite, known popularly as the iodine treatment, which attracted some attention at the time, the process being as follows: "10grs. iodine and 30grs. iodide of potassium are dissolved in 1oz. of water. The bitten part is cupped or a ligature is placed on the limb until the tissues are so swollen with serum as to allow of the injection passing readily through the distended areolar space. A small trocar and canula is then pushed laterally into the bitten part, so as to reach the site of the wound, and the injection effected by screwing to the trocar a small syringe charged with iodine, and so filling the part by pressing down the piston of the syringe, while the cupping glass remains over the wound and exhaustion is kept up with its aid."

Dr. Mitchell, commenting upon the procedure, very justly says: "Apart from the antidotal value of this ingenious means, it is clear that the necessary apparatus is rarely at hand, and that cups of various curves to fit the equally various surfaces of the body as advised by Dr. Brainerd, are not likely to come into general use in localities where the rattlesnake is found." In Brainerd's experiments one-half of the pigeons treated by Green and himself died, and in Mitchell's experiments out of seven pigeons six died, so that he states that he was unable to confirm Brainerd's conclusions, although he admits that the preparation has a retarding action upon the venom. In cases in which the venom and iodine was mixed together before being thrown under the skin all the pigeons died. It is a fact, however, that iodine does prevent the usual local manifestations to a certain degree. Tannic acid was found to act similarly, and Dr. M. thinks it is due to the action of these agents upon the tissues and not upon the venom.

Different preparations of arsenic have been recommended from time to time by various authors, the famous Tanjore pill having attained quite a celebrity in the East Indies. It is composed of arsenious acid, three East India roots, of which two are purgative, and one an active acro-narcotic, mixed with pepper and the juice of the wild cotton plant. In each pill is three-quarters of a grain of arsenic, and two of the pills are given at a dose, a single one an hour after. We might suppose from the large dose of the mineral that in some cases if the venom did not kill the pill certainly would. This preparation has been experimented upon by several persons, who report against its use. Per contra. Dr. J. P. Ireland in *Med. Chir. Tr.*, Lond., 1817, II., 396, treated soldiers bitten at Santa Lucia by the *fer de lance* with arsenic in large doses, as follows:

R Liq. potass. arsenat.....f. dr. ii.  
Tinct. opii .....gtt. x.  
Aqua menth. pip.....oz. iss.

to which was added half an ounce of lime juice; this was repeated every half hour for four successive hours—this would be 1gr. of arsenic to each dose. In addition a cathartic clyster was given, and the scarified parts rubbed with a liniment containing oil terebinthina, liquor ammonia and oil olivæ. He reports four cases cured, and one at Martinique.

Another modification of the arsenic treatment is recommended by Dr. L. Lanszweert in the *Pacif. M. & S. J.*, San Fran. 1871-2, V., 108. Arseniate of strychnia, 30grs. of pure strychnia in 4oz. of distilled water containing 75grs. of arsenic acid, and evaporating until crystallization takes place, drying the crystals and reserving the liquid, with the addition of 8oz. of alcohol, for external application. For internal use, 1gr. of this arseniate of strychnia is mixed with 10grs. of sugar and 25grs. of turmeric and divided into twelve powders. One powder to be given at the time of the bite and every 15 or 20 minutes after until better. Upon recurrence of symptoms give every hour. Reports cure but no details of cases.

Alcohol in various forms is probably to-day the agent in which the great portion of the people of the world have the utmost confidence as an antidote, a faith unfortunately not well founded if we may believe the many experiments which have been tried. According to Mitchell it is merely a counter-active agent, a stimulus simply, which may buoy the patient over the prostration produced by the venom, but as a direct antidote it fails, and this is proved by the fact that a mixture of alcohol and venom is no less deadly than the venom itself. It has been claimed that persons in an intoxicated condition or those habitually indulging in alcoholic liquor cannot be poisoned by venomous snakes, but abundant proof to the contrary exists, notably in the case of Adam Lake reported by Dr. Horner in the *North Amer. Med. & Surg.*

*Jour.* 1831, XI., 227. This man had been in the habit of taking from half a pint to a pint of alcoholic liquor daily, and was intoxicated when bitten by a rattlesnake. Notwithstanding the services of excellent physicians, a number of reputed antidotes being used, he died in less than twenty-four hours. The proper use of alcohol in snake bite and conditions under which it should be employed will be considered under the treatment of snake bite further on.

Dr. R. Harlan, in *Tr. Am. Phil. Soc.*, Philadelphia, 1838, n. s., III., 300, gives an interesting account of various antidotes used in rattlesnake bites. The *Prenanthis serpentaria* of Pursh, called lion's foot, is said to have cured moccasin bites seen by Pursh himself; but these may have been harmless water moccasins. The Assembly of South Carolina purchased from a negro a secret remedy, the man allowing himself to be bitten by a number of snakes, jumping naked into a tub of snakes. He cured himself by swallowing tablespoonful doses of the *Alisma plantago* expressed juice, repeating it until the effects of the poison were counteracted. A number of experiments were tried with a decoction of *Hieraceum venosum*, a secret remedy purchased from itinerant showmen, one of whom allowed snakes to bite him several times. He swallowed a few ounces of a decoction of the root and held the raw neck of the snake over the bite, the head having been cut off. The *Hieraceum venosum* is vulgarly known as hawk's weed, adder's tongue, poor robin's plantain, rattlesnake weed, etc. Man entirely recovered, but venom from same snake killed a pup. Local symptoms existed in man's case. He winds up by

stating: "Had I occasion to treat a wound inflicted by a poisonous reptile my faith in the *Hieraceum venosum* as a cure is not such as to induce me to resort to its employment to the exclusion of the less equivocal means of suction, pressure or ligature." He supposed the animals had been so long in captivity as not to have much venom.

With regard to the *Alisma plantago*, it was used in Dr. Horner's case and failed to have the slightest antidotal effect.

In 1873 appeared a curious little book by S. B. Higgins, S. A., honorary member of the Homeopathic Institute of the United States of Colombia, entitled "Ophidians; zöological arrangement of the different genera, including varieties known in North and South America, the East Indies, South Africa and Australia. Their poisons and all that is known of their nature. Their galls as antidotes to the snake venom. Pathological, toxicological and microscopical facts, together with much interesting matter hitherto not published." The entire *raison d'être* for the work seems to be a desire to prove the correctness of the following corollary of the author: "Every animal poison has its perfect and specific antidote in the gall of the animal or reptile in which that poison is secreted." After mentioning a number of different methods of cure in vogue in South America, he states the following, which may be taken as evidence of the charlatanry of the so-called curers: "For the bite of the sierre (python) [a harmless snake] open a hen alive and put half of it upon the wounded part, binding it fast with a bandage. Diet—the first day of the cure give the patient fowl; when better beef and salt fish may be permitted. Absolutely prohibited—fish, eggs, bananas, aquacates (alligator pear), cheese, anything acid or flatulent. Great care must be taken not to go barefooted, and on no account to step in fowls' excrement (this is mortal), total abstinence from any carnal act; and he must not allow any woman, pregnant or menstruating, to come near him while being cured."

Of his own method of cure he states as follows: "It must always be borne in mind that the gall of a snake has its virtues most fully developed shortly after the skin has been cast and when its poison is most venomous, provided, however, that the reptile has not eaten any food in the meantime, in which case the gall-bladder will be found nearly or quite empty. Many experiments with this substance combined with alcohol in widely different proportions of each ingredient have led me to adopt the following as the method of preparation which has proven itself most efficacious in a great number of cases. Proportion, one drop of pure gall to ten drops of as pure alcohol, or high wines, or spirits of wine, as can be procured. The mixture must be thoroughly shaken and allowed to stand for a couple of days, when a lead-colored sediment will have deposited itself, the supernatant liquid can be poured off carefully into a perfectly clean





new vial, using a bit of sponge in the neck of a small funnel to filter it, when it is ready for use. Never mix galls of different species."

Method of Administration.—"For all ordinary cases of bite, 5 or 10 drops of prepared gall (selecting if possible that of the kind causing the bite) in half a tumbler of water well mixed, to administer a tablespoonful of the mixture every five, ten, fifteen or twenty minutes, according to the nature of the symptoms, and varying the dose from three to ten drops of gall, according to the age, sex, condition and susceptibility of the patient, will afford entire relief. In fifty cases treated, I have given ten-drop doses of gall in four ounces of water in two cases only, all the others have been cured by five-drop doses, continuing the remedy at more prolonged intervals, as the symptoms of the action of the poison disappear, and in the ten cases cited, where a five-drop dose was given in tablespoonfuls every five minutes without producing relief, the dose was immediately repeated and entire relief ultimately ensued.

"I invariably make a deep cruciform incision in the wound with a lancet and bathe the limb in water as hot as can be borne, into which I pour a few drops of prepared gall. When the blood flows a bright red (and not before) a small pellet of cotton or sponge, saturated with the gall (prepared) applied to the wound and secured with a bandage will stop the flow of blood, unless a large vein or artery is punctured by the fang; in this case cauterization is necessary."

As a comment upon the method of cure proposed by Higgins the reader is referred to Rep. No. 27 in Rep. Sanit. Meas. in India, fol., London, 1875, VII., 274, entitled, "Experiments at St. Bartholomew's Hospital to test the effect of Mr. Higgins's antidote to snake poison." Present, Dr. Forbes Watson, Dr. Fayer, Dr. Brunton and Mr. S. B. Higgins. Several experiments were tried, the antidote being administered by Mr. Higgins himself, but in each case it failed to have any antidotal effect. The committee state that the cobra poison used in these experiments was supplied by Dr. Fayer and that the antidote was prepared by Mr. Higgins himself from the gall of the *Lomo di machete* snake, ten drops of gall being diluted with 100 drops of alcohol of 95 per cent., and ten drops of this solution being diluted with four fluid ounces of water.

It is intended to conduct a series of experiments with snake gall to verify or disprove those of the persons named.

A few years since, in some parts of the South, great reliance was placed in a certain weed or plant called Jestis weed or Justise weed, so named from a person celebrated as a curer of snake bites. This person, called Isham Justise, resided in 1800 in Sumter District, South Carolina, and was so convinced himself of the efficacy of his remedy that he frequently made the offer to allow snakes to bite him for the sum of one dollar. The plant he used is known to botanists as *Eupatorium linearifolium* of Linnæus and Elliott, although the *Eupatorium hyssopifolium* is also known as Justise's weed and possesses similar medical properties. The common name of the plant is boneset or wild hoarhound. Upon what was considered undoubted evidence from respectable citizens, Justise was granted a sum of money by the State Legislature upon his making known the secret of his remedy. A number of cases are reported of the cure of snake bite, using this plant as an antidote, and Mr. Haynesworth in the *Phila. Med. and Phys. Journ.*, 1808, III., pt. I., 57, gives a detailed account of nine cases of recovery from rattlesnake bite, in which the weed was employed. It is prepared by boiling a handful of the plant in a quart of new milk down to a pint, and of this a tablespoonful is given every few minutes until the dangerous symptoms

are over. It should be mentioned that the South American plants *Aya-pana* and *Vejuco du Guaco*, reputed as antidotal to snake venom, also belong to the genus *Eupatoria*. Some little attention has been given to this reputed antidote, as the writer believes that if it really is of benefit in snake poison, it must be so owing to the analogy of its therapeutic effect with that of jaborandi, both being tonic, diaphoretic, diuretic and laxative.

In 1873 Drs. Fayer, Brunton and Richards instituted a series of experiments with a view to determining whether continued artificial respiration in cases of snake bite would prolong life, and thereby give the system a chance to eliminate the poison. They were successful in prolonging life, but eventually all the animals died from the venom. It may be worth while to further mention a few popular remedies

that have been recommended and used from time to time.

Cazentre, in *Journ. des Conn. Med. Chir.*, Par., 1850, 182, recommends cedron, the seeds, if in powder, three or four grains bruised and put in a teaspoonful of brandy or alcohol and swallowed, powder put on wound also. Natives chew it up and swallow. Viand-Grand-Marais in the *Rev. Med. Franç. et Etrang.* Par., 1874, I., 362, recommends the same substance, giving statements of cases cured. He also strongly commends the guaco.

The liquor potassa cure has met with some degree of favor, but the evidence is conflicting, as the following notes will show:

Dr. J. Shortt, in *Med. Times and Gaz.*, London, 1873, II., 215, reports a case in which he gave to a man bitten by a venomous snake, *Bungarus arcuatus*, in the first forty-eight hours 72oz. of brandy and 4½oz. of liquor potassa by the mouth; 14oz. of brandy, 3½oz. of liquor potassa by enemata, 4oz. in a bath. Gave 20 minims in 1oz. of brandy every twenty minutes, wound scarified and alkaline bath given. Bitten May 16, got well May 27. Dr. Shortt claims that this is the third case of snake bite saved by the potash treatment. H. Esmond White reports a case, p. 413 same journal, in which potassa treatment with brandy failed, death occurring in one hour and twenty-five minutes.

Dr. E. B. Shapleigh reports a case in the *Am. Jour. Med. Sci.*, Philadelphia, April, 1869, n. s., 392, in which incisions were made in vicinity of injury. Brandy was administered freely and caustic potassa applied locally, but the patient died in forty minutes.

A host of other substances have been recommended, such as carbolic acid, olive oil, viper's fat, to say nothing of scores of plants and roots, but space will not admit of a discussion of these at this time.

#### EXPERIMENTS WITH EXTRACTINE PANCREATINE.

De Lacerda announced his opinion that the injection of pancreatine into the tissues would produce the same effect as venom, and the experiments of others seeming to confirm this theory, notably those of Béchamp and Baltus in *Compt. Rend. Acad. Sci.*, Par., February and March, 1880, which were as follows: "Injected into femoral of dog 3 grams of pancreatine at 9 A. M., died at 5 P. M. Another case: Bloody fæces, vomiting, emission of urine; lived ten days. Some got well." The conclusions of Béchamp and Baltus are that the intra-vascular injection of pure pancreatine produces functional symptoms of great gravity, and produces death if the injected material is about 0. gr., 15 par kilogrammes of the weight of the animal. Digestion seems to diminish the toxic effects of the pancreatine. Injected pancreatine is only partly eliminated by the kidneys, and when found is unaltered in character.

In view of these facts it was determined to try the effect of pancreatine on fowls. Through the courtesy of Messrs. Fairchild Bros. and Foster, of New York city, the writer was furnished with a remarkably pure sample of the *Extractum pancreatis*. This was used in solution with distilled water in the following proportion: One half dram of *Extractum pancreatis* to one-half fluid ounce of distilled water.

Nov. 4, 1887—12:40 P. M.—Injected black pigeon with 25 minims of pancreatis solution in right thigh. Bird commenced to droop at once, feathers ruffled, whether from fright or injury by hypodermic needle uncertain.

2:30 P. M.—Bird seems better.

Nov. 5.—Pigeon in normal condition, eating heartily.

Nov. 6 and 7.—Bird entirely well.

12:29 P. M.—Injected hen No. 2 with 75 minims of solution of extract pancreatis (½ dram to 1oz. of water) in right thigh.

12:35 P. M.—Respiration much quickened, mouth gaping.

1:30 P. M.—Fowl eating corn, but seemed inclined to lie down. Respiration still rather fast and mouth gaping, though not as much as at first.

3 P. M.—Fowl in about the same condition as at 1:30.

Nov. 9.—Hen seems to be as healthy as ever, and has a good appetite.

The next experiment, as will be seen from the notes, was really a very severe test and would seem to indicate that pancreatine, if poisonous, must be very much feeblener in action than snake venom.

Nov. 10—1 P. M.—Injected in both legs and breast of fowl 25 minims of sol. ext. pancreatis (½ dram to ½oz. distilled water) in each part.

1:05 P. M.—Fowl uneasy, and breathing labored, in-





- clined to lie down.  
 2:30 P. M.—Fowl seems to have lost use of legs; breathing fast with mouth open.  
 Nov. 11—11 A. M.—Fowl not able to stand, but sits down with wings outstretched. Respiration labored. Defecates freely.  
 2:30 P. M.—Fowl in about the same condition as this morning. Has eaten a small quantity of corn.  
 Nov. 12—11 A. M.—Fowl unable to stand; eats lying down; defecates freely.  
 2:30 P. M.—Fowl in same condition.  
 Nov. 13—Fowl in same condition. Paralysis of hindpart of body, unable to stand without leaning against something. Loss of power in muscles of the rectum.  
 Nov. 14—Same condition.  
 Nov. 15—Same condition.  
 Nov. 16—Fowl a little stronger in her legs. Was taken from the cage and tied with a cord so as to allow of more liberty.  
 Nov. 17—Fowl a good deal stronger than yesterday.  
 Nov. 18—Chicken can stand on her legs, but puts one before the other to keep from losing its balance while eating.

- Nov. 21—Chicken very nearly recovered, can use its legs almost normally. Eats well.  
 Nov. 25—Entirely well.

Several other experiments were tried with *Extractum pancreatis*, but without definite result.

Those who have read de Lacerda's work on serpent venom will notice the similarity of symptoms in his cases treated with pancreatine and our own, except that in no case did we lose a single subject, while several of his perished.

#### EXPERIMENTS WITH CROTALUS VENOM IN SNAKES AND LIZARDS.

Fontana, in his celebrated work on poisons, states as a law that the venom of a serpent is not a poison for itself or for other species, whether harmless or otherwise, and a few interesting experiments have been tried with a view to determine the question, particularly as a mass of conflicting evidence exists. Weir Mitchell in his early work was convinced that the poison of *Crotalus*, when injected hypodermically into the same species, could kill, but in his last volume he states this is not the case. Fayer does not believe that the poison of cobra is poisonous to itself, while Vincent Richards holds an opposite view. Dr. J. Dormet publishes in *Nature*, London, 1883-4, XXIX., p. 504, an account of a black snake of Australia, which, being held forcibly and provoked, turned and bit itself just behind the head, death taking place in one minute. Our experiments show that *Crotalus* venom is not poisonous to rattlesnakes, eutæniæ (garter snakes) or lizards. The first experiment was upon *Eutænia sirtalis*, the common garter snake.

- Oct. 28—12:15 P. M.—Injected 2 drops of glycerine venom and 3 drops of water into muscular tissue of belly of *Eutænia*.  
 3 P. M.—Snake in as good condition as before injection.  
 Oct. 29—Snake all right.  
 12:20 P. M.—Injected 3 drops of glycerine venom and 3 drops of water into muscular tissue of belly of *Crotalus*.  
 3 P. M.—Snake as lively as ever, and shows no effect whatever of the venom.  
 Oct. 30—Snake all right.  
 12:30 P. M.—Injected 5 minims of venom solution and 5 minims of water into same *Eutænia* used before. No result. Injected 10 minims into small *Crotalus*, no result having been obtained by 5 minims.  
 Oct. 31—No result.  
 Allowed large vigorous *Crotalus* to strike *Eutænia* (the same one used before) twice in muscles of the back.  
 Nov. 1—No result.  
 Nov. 4—No result.  
 Nov. 8—12 M.—The *Eutænia* which had been struck before was again struck by an active rattler, who held on well.  
 1:30 P. M.—No result.  
 3 P. M.—No result.  
 Nov. 9—No result.  
 Dec. 12—12:05 P. M.—Injected 5 minims of rattlesnake venom solution in 10 drops of water, into muscular tissue of back of *Heloderma* (Gila monster), which had been in confinement for some time, and was not very strong.

Dec. 15—All right. Injected 10 drops more of venom into the right side of the belly of the same *Heloderma*.

Dec. 17—No result. Injected 15 drops more of venom into muscles of belly of same *Heloderma*.

Dec. 20—All right.

Dec. 22—Injected 25 drops of *Crotalus* venom solution into back of another *Heloderma*, followed by 25 drops more into flesh of belly. Absolutely no result.

Dec. 23—Injected 25 drops of *Crotalus* venom solution into the back of a small hog nose snake (*Heterodon platyrhinos*) with no result, notwithstanding the reptile was weak and sickly and had been in confinement without food for over four months.

These experiments, so far as they have gone, seem to prove conclusively that Fontana's statement made as early as 1776 is correct.

#### BITE OF THE GILA MONSTER.

BY DR. H. C. YARROW.

[This is Part VI. of Dr. Yarrow's series of papers on "Snake Bite and Its Antidote."]

ON Feb. 7, 1883, Drs. S. Weir Mitchell and Edward T. Reichert read a paper before the College of Physicians of Philadelphia, entitled "A Partial Study of the Poison of *Heloderma suspectum* Cope, the Gila Monster," in which the statement was made that after several experiments with the saliva of this reptile, they had come to the conclusion that it possessed strongly venomous properties. This had been suspected by some naturalists, from the fact that this lizard possessed anterior deciduous grooved teeth, which communicated by ducts with large glands near the angle of the lower jaw. All sorts of conflicting reports have been published from time to time regarding this reptile, some observers claiming that it is deadly venomous, others believing it perfectly harmless; in fact, in some parts of the Southwest it was kept as a household pet. Bocourt and Dumeril mention the bad name it has in Mexico, and Sumichrast states that the natives hold it in the utmost terror, and consider it as more fatal than any serpent. A fowl bitten by it died in twelve hours, with bloody fluid exuding from its mouth, the wound being of a purple tint. A cat bitten was very ill, but recovered, remaining thin and weak. Sir John Lubbock reports that a *Heloderma* sent him killed a frog in a few minutes, a guinea pig in three minutes. Dr. R. W. Shufeldt, of the United States Army, reports serious symptoms after having received a bite on the right thumb, but no permanent disability followed.

The writer has for several years endeavored to trace out an authentic account of death resulting from the bite of a Gila monster, and the following is all the evidence in his possession. The first account was secured through Dr. S. P. Guiberson, of Ventura county, Cal., and is as follows:

"G. J. Hayes, a miner in from the Frazer mine, says that in 1878, or '80, in Tip-Top Mining Camp, Arizona, he saw a Gila monster bite a man by the name of Johnny Bostick, who at the time was under the influence of liquor. That he took hold of the *Heloderma* and shoved his finger at it, and the reptile seized his finger, and its jaws had to be pried open before he could disengage his finger. The *Heloderma* was 22in. long and lay on the card table. It was also seen by a man named Lou Smith, and a lot of Italian miners. Immediately Mr. John Bostick drank large quantities of liquor, and from the effects of the bite one side was paralyzed, and he died in about three months, April 19, 1878. I hereby certify that the above statement is correct. (Signed) G. J. HAYES."

Subscribed and sworn to before me, a notary public, this 19th day of April, 1886.—S. P. GUIBERSON, Notary Public for Ventura county, Cal.

The second affidavit, which follows, differs somewhat from the first, but relates to the same individual. The query is, was the *Heloderma* bite the cause of death or was it the whisky so lavishly administered.

STATE OF CALIFORNIA, County of Ventura.—R. C. Carleton who first being duly sworn, deposes and says that he was present at the time, and knows of his own knowledge, that Johnny Bostick, of Tip-Top, Arizona, was bitten by a Gila monster, from the effects of which he afterward died. That the Gila monster seized one of the fingers or thumb of the said Johnny Bostick, and that in order to disengage the reptile the boys cut its head off, that deponent thinks it occurred in 1883. Subscribed and sworn to before me this first day of December, 1886.—R. C. CARLETON.

S. P. GUIBERSON, Notary Public. (A true copy.)

In conversing with Dr. F. V. Ainsworth, U. S. A., who has had a large experience in Arizona, upon the subject





of the bite of the Gila monster, he informed the writer that he had heard of a case of death from the bite of this reptile, but that his brother Frank K. Ainsworth was conversant with the details, and he obligingly offered to write and procure full particulars. From the letter which follows, it will be seen that the case is reported by Dr. G. E. Goodfellow of Tombstone, Arizona, to Dr. Ainsworth:

TOMBSTONE, July 23, 1887.—*My dear Ainsworth:* I at last am ready to reply to your letter concerning "snakes." The Fairbanks case was as follows: Yeager, about 55 years of age, was in May, 1885, in Fairbanks, Arizona Territory, bitten by a Gila monster. He, to prove the innocuousness of the beast, put his left thumb and forefinger into its mouth, and he was bitten. He was immediately loaded to the guards with whisky—it happened in a saloon—and he seemed all right, save for a slight numbness and swelling in the hand and arm. He sat down in a chair in the saloon, talked with those around for an hour. The crowd thinning out, he seemed to drop asleep. In about an hour more, the saloon keeper spoke to him, but not making a reply, he was taken hold of and found to be dead. I was sent for, but before I could leave received a second message announcing his death. He was a man addicted to the use of liquor, and so far as I can ascertain had been on a prolonged spree for months. Whether he died of the reptilian poison or a combination of whisky, disease and Gila monster I cannot say.

About four years ago on the lower San Pedro I was informed that a man had been bitten in the foot while in the field and died within three hours. I could neither prove nor disprove the case.

That the Gila monster is a poisonous lizard cannot now be denied. That its bite is fatal uniformly is open to discussion. I have always considered that they were a trifle more poisonous than the scorpion, tarantula and centipede, not even approaching the rattlesnake, and I have been accustomed to regard the bite of the three first mentioned as little worse than the sting of a bee or wasp. I have known of bee stings killing, but though I have seen many bitten, and have had a personal experience as well, never have I known of a death to occur from the bite of a scorpion, tarantula or centipede. That they can kill under certain conditions I am convinced. \* \* \* Very respectfully, G. E. GOODFELLOW.

These accounts are the only authentic ones the writer has been able to gather, after ten years of constant labor and research.

On the other side it may be stated that Mr. Horan, the superintendent of the National Museum, has been bitten several times by this lizard without serious results following.

The first experiment of Mitchell and Reichert was as follows: "About 4 minims (of saliva) was diluted with one-half cubic centimetre of water, and thrown into the breast muscles of a large strong pigeon at 4:25 P. M. In three minutes the pigeon was rocking on its feet and walking unsteadily. At the same time the respiration became rapid and short, and at the fifth minute feeble, at the sixth minute the bird fell in convulsions with dilated pupils, and was dead before the end of the seventh minute. The first contrast to the effect of venom was shown when the wound made by the hypodermic needle was examined. There was not the least trace of local action, such as is so characteristic of the bite of serpents, and especially of the *Crotalidae*. The muscles and nerves responded perfectly to weak induced currents, and to mechanical stimuli. The heart was arrested in the fullest diastole, and was full of firm black clots. The intestines looked congested. The spine was not examined." A number of other experiments made by these experienced investigators left no doubt in their minds as to the terrible venomous character of the *Heloderma* saliva.

Before giving notes of the experiments made at the National Museum, it may be well to describe the process by which Drs. Mitchell and Reichert obtained the saliva and our own. The first consisted in "provoking the reptile to bite on a saucer edge, which it was not disposed to do. When once it had seized the saucer it was hard to pull it away, so powerful was the grip of the lizard's jaws. After a moment a thin fluid-like saliva dripped in small quantities from the lower jaw. It was slightly tinted with blood, due to the violence of the bite, and it had a faint and not unpleasant aromatic odor. The secretion thus collected from the mouth was distinctly alkaline in contrast to serpent venoms, which are all alike acid."

Our own method consisted in forcing the lizard to bite upon a piece of artist's gum, which being elastic and yielding, did no injury to the teeth and afforded a fair hold. So soon as the saliva appeared to be flowing it was carefully swabbed up with pledgets of absorbent cotton, which were washed out with glycerine, and in this way we had no difficulty in securing all of the fluid needed. It was preserved in glycerine the same as our serpent venom.

The first experiment, Nov. 8, 1887, was as follows:  
Nov. 8, 1887—12:17 P. M.—Held left hindleg of rabbit to

*Heloderma*, who grasped it with his teeth, and held on for three-fourths of a minute, biting fiercely.

1:30 P. M.—Rabbit a little lame, but enjoyed eating as much as before.

3 P. M.—No result so far.

Nov. 9.—Rabbit appears to be perfectly well with the exception of a very slight lameness of the left hindleg, due to the lacerated wound made by the lizard's teeth.

12:30 P. M.—Held leg of another rabbit near the mouth of a different *Heloderma* from the one used in the former experiment, and irritated the reptile until he took hold. In this case the rabbit's leg was seized several times and bitten to the bone, the reptile being unwilling to let go. There was a copious flow of saliva, which ran over the teeth wounds and was rubbed in by the experimenters, care having been taken to remove the hair from the rabbit's leg. In fact this was done in every case, as it was feared the thick fur might prevent the saliva from reaching the wounds.

3 P. M.—No result.

Nov. 10.—No result.

Nov. 11.—No result except slight lameness.

Nov. 17—12:45 P. M.—Injected three minims of solution of *Heloderma* saliva in leg of hen (brown). Respiration somewhat increased, but no other symptoms noticed.

2:30 P. M.—Fowl in about the same condition; respiration slightly increased and breathes with beak partly open.

Nov. 18.—Fowl appears to be entirely recovered.

Nov. 20.—Chicken completely recovered.

In this case the increased respiration was probably due to the fact that the chicken being a very noisy one it became necessary to compress its throat to avoid annoying other workers in the Museum.

Nov. 22—12:19 P. M.—Injected 10 minims of solution of *Heloderma* saliva and 10 minims of water into left breast of another hen. This chicken was very thin

but perfectly healthy, and had been used for two rattlesnake venom experiments with ligature and recovered.

12:25 P. M.—Increase of respiration, wants to lie down, defecates, feathers ruffled.

12:30 P. M.—Panting heavily; peculiar outward and inward movement of rectum; eyes closed and very drowsy.

Nov. 28.—Chicken entirely recovered, and has been so for several days.

12:35 P. M.—Injected 25 minims of solution of *Heloderma* saliva into left leg of another hen.

12:40 P. M.—Hen lying down, respiration quickened, and breathes with mouth open.

2:30 P. M.—Chicken still lying down and breathing fast.

Nov. 29—11 A. M.—Chicken in same condition as yesterday; will not eat.

Nov. 30—11 A. M.—Chicken improving; eats a little.

Dec. 1—11 A. M.—Chicken appears to be all right; eats well.

Dec. 2—11 A. M.—Chicken entirely recovered.

Dec. 5—12:15 P. M.—Injected 25 minims of solution *Heloderma* saliva into breast of chicken, same quantity into right leg, same quantity into left leg, making in all 75 minims. In a short time fowl had copious watery discharge *per anum*, with a curious oscillatory movement of that opening.

12:25.—Chicken lying down with its feathers much ruffled.

Dec. 6.—Chicken found dead. This fowl had been used for previous experiments, and was very thin and weak, and it is by no means certain whether the copious diarrhoea probably produced by the glycerine did not cause its death.

Dec. 5.—Forced largest *Heloderma* to bite a chicken on the leg (from which feathers had been removed) several times. There was a copious flow of saliva and many lacerated wounds.

Dec. 6.—Chicken seems perfectly well, no swelling or local manifestations whatever.

Dec. 7.—Chicken perfectly well.

Fearing that possibly the glycerine solution of venom (2drs. of saliva to 6drs. of glycerine) was too weak or had lost its strength through keeping, on Dec. 8 the following conclusive experiment was performed:





12:15 P. M.—Forced open the jaws of the largest and most savage *Heloderma* and collected upon a piece of absorbent cotton from ten to fifteen drops of fresh saliva. An incision was made in the breast of a chicken and the cotton placed in it and allowed to remain.

Dec. 10.—The chicken appears perfectly well; no sign of indisposition or local manifestations whatever. Wound appears to be healing kindly.

Jan. 20, 1888.—Wound in breast has been healed for some time, the cotton remains where it was placed and can be felt encysted under the skin and has produced no injury.

April 4.—The chicken alive and healthy with the cotton still *in situ*.

This experiment would seem to show that a large amount of the *Heloderma* saliva can be inserted into the tissues without producing any harm, and it is still a mystery to the writer how Drs. Mitchell and Reichert and himself obtained entirely different results. Were it not for the well-known accuracy and carefulness of Dr. Mitchell it might be supposed possibly that the hypodermic syringe used in his experiment contained a certain amount of *Crotalus* or cobra venom, but under the circumstances such a hypothesis is entirely untenable. Moreover no local symptoms were manifested as would have been the case had venom been inserted. Both the Gila monsters were good-sized active specimens, full of vigor, secreting a considerable amount of saliva, and we can hardly suppose that the short captivity they had suffered could have so modified their saliva as to render it innocuous.

## TREATMENT OF SNAKE BITE.

BY DR. H. C. YARROW.

[Seventh and concluding paper of the Series, "Snake Bite and its Antidote."]

CAN we now in view of the results of our experiments propose any plan of treatment for snake bite which will afford reasonable ground for a belief that danger may be averted and human lives spared? It is thought the question may be answered in the affirmative, especially as regards those persons bitten by North American species of poisonous reptiles, and the following suggestions are offered with the earnest desire that they may realize fully the hopes of the writer.

What shall a person do who is bitten by a venomous snake? The first advice to give is that he or she should not lose presence of mind, and become so nervous as to be incapable of cool and deliberate thoughts. If the bite is upon one of the lower limbs or upon the arms, a broad bandage of unyielding texture, if possible, should be placed tightly around the affected member, and between the bite and the heart, and be securely fastened. This bandage or ligature can be made by tearing up a shirt and using two or three thicknesses of the material, an inelastic suspender will answer, pieces of a handkerchief may be used, or if in the woods a strip of bark from a sapling can be hastily slit off and applied. A leather strap or thong is better than anything else, but even long grass rolled together so as to form a cord may be used in an emergency. In applying the band or ligature of whatever nature, it should be started about six inches above the bite and the turns made to run downward toward the puncture, and should be wrapped so tightly as to cause the injured limb to become turgid with venous blood. Having fastened it securely, a number of cross cuts should be made through the points of the puncture from the snake's fangs, deep enough to pass down into the muscular tissue, taking care to avoid veins which will be seen standing prominently forth, and bleeding from the cuts can be encouraged by rubbing the limb gently up and down below the ligature. A wide-mouthed bottle or similar utensil, from which the air has been driven forth, by burning some whisky or a piece of paper in it, should be applied to the wound and it will act as a cupping glass; or still better, let the bite be sucked by the patient himself, if he can get at it, or have some courageous friend with a healthy mouth perform this act for him. The pulse should be felt, and if it weakens, showing that possibly a portion of venom is reaching the general system notwithstanding the constricting band, whisky should be given in moderate quantities. From time to time the band should be slightly loosened and then replaced so as to admit of partial circulation, but as the heart flags, the stimulant must again be administered. It is no use to make the patient drunk, for alcoholic liquors are not antidotes, in any sense they simply act as a tonic to the failing circulation.

The writer has been informed by a gentleman, long resident in Texas, that the plan proposed has been constantly employed in that State; and that few deaths result there from the bite of venomous snakes. Of course it will be understood that these suggestions are intended to meet sudden emergencies and not to take the place of treatment by intelligent bystanders or physicians. Under all circumstances, the ligating band should be first applied and the incision made, and then if circumstances will admit the following procedure, it is thought, will be the best. Cupping glasses should be applied over the wound, after which a 20 per cent. solution of permanganate of potassa should be injected with a hypodermic syringe directly into the wounded tissue and retained there by means of the finger or compress. The flesh should also be kneaded so as to distribute the solution through the tissues in the immediate vicinity of the bite. In addition the patient should be made to swallow 20 minims fluid extract of jaborandi, or its alkaloid, pilocarpine, may be used hypodermically. If the venom appears to be gaining ground another injection of the permanganate may be given, followed by more of the jaborandi, or pilocarpine, but the latter drug should be suspended when it is found the patient is perspiring freely and when excessive salivation is produced. Carried too far this remedy would weaken instead of strengthening the heart. Whisky or brandy may also be used in limited quantities from time to time. In the absence of any of the means suggested in the way of remedies the primary fact to keep in mind is the importance of the





ligature, incision or scarifying the affected part, and the promotion of a free flow of blood. If nothing can be found to use as a cupping glass or no one is courageous enough to use the mouth, the old-fashioned country remedy of splitting open a live chicken and applying it over the wound may be tried, or as has been tried in India with success, the anus of a chicken may be applied over the wound, using a number of different fowls for the purpose. The writer recommends these methods only because there is undoubted evidence of their efficacy. A piece of porous clay might be applied as it would doubtless act in the same manner as did the snake stone in our experiments. It is very important to remember that the ligature or constricting band cannot be allowed to remain very long as gangrene would inevitably result,

it should be loosened from time to time so as to admit of a slight circulation through the affected part, and to permit a small amount of the venom only to enter the system, and the effect of this should be met by the administration of the remedies already indicated. In the case of a rapidly weakening heart, tincture digitalis in 15 drop doses might be given every two hours, or, if at hand, a few drops of nitrate of amyl might be inhaled. Everything failing it might be worth while to attempt artificial respiration, in the hope that if life could be prolonged, the system might throw off the poison, as it has been shown by the Indian Snake Commission that the action of venom actually is delayed by this method. In one case mentioned by Vincent Richards  $\frac{1}{4}$  of a grain of cobra venom was injected into a dog. "It took four hours and ten minutes before the animal appeared to be dying, until artificial respiration was resorted to. In four minutes more in the absence of this system this animal's heart would have ceased to beat and somatic death been completed. But by its steady application life was extended to forty-one hours and fifty-two minutes. In a desperate case there should be no hesitation in trying the effect of artificial respiration.

Before leaving the subject of snake bites it seems proper to allude to a matter which has of late received some little attention, viz., the preventive inoculation of serpent venom to prevent danger from bites, and while the writer does not commit himself to the theory he believes it may be worth of serious consideration. As has already been stated in this paper the Ann Arbor experiments showed conclusively that after a time with repeated inoculation of venom the animals experimented upon seemed to be much less susceptible to its effect, and quite recently an individual has been visiting the principal cities claiming an immunity from snake bite, on account of an inoculation performed on him by some South American Indians, and offering to have the matter tested upon a large dog, which had also been inoculated. It has been stated that in Philadelphia these experiments were successful. Tschudi informs us that some of the South American Indians are said to acquire an immunity from snake bite, having been previously inoculated, but the process has to be repeated from time to time. In this connection the following extract is given from "The Veterinarian," Lond., 1887, LX., 565, as it seems to bear the impress of truthfulness. "Three of the oxen were bitten by snakes. One of the bushmen undertook to cure them, and taking a knife made one or two slight incisions round the place where the bite was, which was easily seen by swelling, and rubbed in a powder which he said was made from the dried poison sacs of another snake. In a few hours the poison had entirely subsided and the cattle were as well as their half starved state would allow them to be. I expressed some doubt whether this cure would be efficacious in the case of the more deadly kind of snake, but the bushman assured me that it would, and that he was not afraid of being bitten by any snake in this country so long as he had the poison sac of another snake to use as an antidote.

"The very next day I had an opportunity of putting him to the test. While walking ahead of the wagon I saw a full-grown capell or spunghe slange lying under a bank, and calling the bushman said, 'Catch that snake alive. You are afraid of it, are you?' 'No, boss,' he replied, 'I am not afraid, and will catch it for a roll of tobacco.' Not wishing to be accessory to his death, I refused to bribe him, and went to get the driving whip to kill the snake with. I had scarcely returned when he gave it a kick with his naked foot, and the horrible reptile bit him. Coolly taking out some dried poison sacs he reduced them to powder, pricked his feet near the puncture with his knife, and rubbed the virus powder in just as he had done with the cattle. In the meantime I

had put a stop to the snake biting any more by a blow from the whip stock, and the bushman extracted the fangs, drank a drop of poison from the virus sac, and soon fell into a stupor, which lasted some hours. At first the swelling increased rapidly, but after a time it began to subside, and next morning he inoculated himself again. That night the swelling disappeared, and in four days he was as well as ever."

In conclusion it may be mentioned that this record of experimental inquiry is not intended as an exhaustive treatise, for as opportunely occurs other experiments will be tried with such supposed remedies for snake bite as may be offered, and the results will be duly published. In conducting the experiments the writer has been influenced by the motives only of adding to the sum of human knowledge and alleviating human misery, and if he has succeeded in this he will be amply repaid for the labor and dangers incident to the research. His thanks are offered to several persons who have aided him, more especially to his industrious and energetic assistant Mr. E. B. Rheem and to Capt. Bendire, U. S. A. It is proper to add that the greater part of the expenses of the investigation have been borne by the National Museum.

Mounted, Sept. 8<sup>th</sup> 1888.

