

remembered that Oliver and Schäfer\* have shown that the active principle (or principles) is non-volatile and that its activity is not destroyed by mineral acids or gastric digestion, while alkalis gradually diminish it. According to Marino-Zuco,† the toxic action is due to the presence of neurin glycerophosphate. There are also some grounds for believing a brencatechin-like body to be present,‡ which may exert some physiological action. Lastly, in extracts of the testis a peculiar nitrogenous body has been detected, free from oxygen, known as spermin and which is claimed by Poehl§ to have a marked influence upon metabolism and to act as a true physiological stimulus. Further discussion of these points at the present time, however, would have little value.

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#### A CASE OF PRIMITIVE SURGERY.

DURING the first period of my residence among Zuni Indians, in the autumn of 1890, I was called in to assist two medicine men or priests in the performance of a peculiarly interesting surgical operation.

A man belonging to the clan into which I had been adopted had for several months been suffering from the effects of either a

contusion or a strain of the right foot, caused by a throw from his horse. This had at first given little trouble, then had appeared as an ordinary stone-bruise on the right side of the foot just below the instep. The inflammation had, however, extended until the whole foot and the lower part of the leg had become excessively swollen, so much so as to cause the skin to glisten from stretching, save at a point over and around the original injury, at which point a malignant and putrid sore had developed, the odor of which was extremely offensive, and both the foot and the leg were now of livid, purplish-red hue in places, suggestive of actual decay. As a layman in medicine I should have said that the case was now one of advanced mortification, and from the general condition of the patient I should have inferred that blood poisoning was likely soon to ensue.

I gathered from the conversation of the two old surgeons who had been called in, and who had in return requested my attendance in order that I might give 'ease medicine' and 'add with (my) breath strength and endurance to (my) clan-brother,' that it was these appearances, this apparently 'decaying condition' of the man's extremity, that had determined them to perform the operation.

When I entered the room the patient was lying on the floor and, although in extreme agony, turned his face toward me expectantly and with a smile, uttering the customary words of welcome. His head was pillowed in the lap of his little old white-haired mother, who was gently stroking his forehead and talking to him in the endearing phrases of mothers to little children. At his side was a small bowl containing a clear but bright red liquid (made, I afterwards learned, from an infusion of willow-root bark) in which half floated, half stood, a cane sucking-tube about six inches long. The old surgeons were removing certain

naire sur l'action des extraits de capsules surrénales. C. R. Soc. de Biol., 1896, p. 14.

\* The physiological effects of extracts of the suprarenal capsules. *Journal of Physiol.*, Vol. 18, p. 370. See also B. Moore: On the Chemical Nature of the physiologically active substance occurring in the suprarenal gland. *Ibid.*, Vol. 17. *Proc. Physiol. Soc.*, March, 1895.

† *Archiv. d. Biol. Ital.*, Tome 10, p. 325.

‡ Brunner: *Chem. Centralblatt*, 1892, I., p. 758. Mühlmann: *Deutsche Med. Wochenschr.*, 1896, No. 26.

§ *Compt. rendu.* Tome 115, p. 129. *Zeitschr. f. Klin. Med.* Band 26, p. 133. *Centralbl. f. d. Med. Wissensch.*, 1892, p. 950. See also Bübis: *Sperminum Poehl in chemischer, physiologischer und therapeutischer Beziehung. Ibid.*, 1894, p. 703.

bandages from the foot and washing off a yellow powder made from pollen and a certain bitter root, with which the sore had been dressed. They bade me sit at the right side of the man, so as to lay my hands on his left breast and to occasionally breathe into his face and administer to him my 'white medicine' (which contained an opiate).

Then they produced, from a buckskin pouch and a roll of rags, a much shattered bottom of a dark-colored glass bottle and two or three broken nodules of obsidian, also several neat splints of cedar and masses of freshly gathered, clean yellow piñon gum, as well as a carefully tied bundle of willow-root bark and some of the yellow roots and pollen I have before mentioned. With a blunt-pointed knife, used vertically, one of them detached, by tapping, a number of small, thin, sharp flakes or chips from the bottle-glass and obsidian. Six or eight of these diminutive flakes were now selected and mounted, each in the cleft end of one of the cedar splints; some so as to form straight lancets, but others at right angles to the splint handles. The blades of one or two of these latter were wrapped round and round with sinew near the point of insertion in the splint, so that only a limited portion of the edge or tip of each protruded. These and the other improvised surgical instruments were laid out in due order on the floor. A quantity of shredded cedar-bark, buckskin scrapings, and old, soft rags were provided; also a large bowl of fresh water, and another filled with the red liquid and containing a small gourd dipper.

Everything being in readiness, the two priests closed their hands over their mouths and breathed into them, as does a man on a cold day, uttering, meanwhile, short invocations, for strength of wind or breath for the patient, and for power of wind or breath of guidance for themselves; literally the supplication was: "Their [The Being's] wind

of life, by its power may his will be strengthened and he quieted be, and likewise by it may our methods and good fortune straight be made!" Bidding the man 'Stay himself with endurance,' since 'Things must be as they must, poor child,' and telling me also to 'Stay him,' with my 'Breath of relationship and sympathy,' they set to work without further delay.

First, they bathed his foot to clear it of the astringent yellow powder, and to cleanse the sore in order that they might be the better able to inspect it. Then, very deliberately, they diagnosed the case, frequently comparing notes. It was from this diagnosis that I learned their reasons for attempting the operation. They believed that the flesh of certain muscles in the foot had died or were dying from the violence done them, and were therefore 'wi-wi-yo-a' (worm-becoming, worm-turning) in the depths of the foot. According to this theory, their plan was to make a double, or inverted T-shape, incision so that the integument could be lifted up from the affected parts in two flaps, the 'dead flesh' removed, the 'decayed' or 'black blood' fully extracted, the worms and the 'seed of their kind' found and utterly uprooted. They thereupon mapped out with their fingers the lines of the incisions they proposed to make. One of them gently bade their patient anew to 'Stay himself,' while the other seized his foot with both hands and turned it up, stretching the skin by pressure; then the first grasped one of the obsidian lancets (mounted sidewise and wrapped with sinew so that the point protruded just sufficiently to sever the skin) and deliberately, but with deft and even stroke, slashed down from the ankle about two and a-half inches, along a line corresponding in direction with that of the tendon of the little toe. He then quickly made another slash from the instep straight down to the middle of the first cut. Catching up one of the

other kind of lancets, he deepened both incisions, avoiding with the utmost skill the crooked vein that descended over this portion of the foot, and also the tendon lying over the tarsal and metatarsal bones. The wound was then squeezed strongly by the assistant, while, with water poured over it and with wads of the cedar bark used as sponges, he washed away the pus and serum that gushed forth, and then with the scraped buckskin stanching the flow of blood.

Having at the outset tenderly admonished their patient, these men seemed thereafter to be oblivious of his agony, to hold in view only his ultimate betterment. And the patient himself seemed almost as oblivious of them, although from suffering his face was drawn and ashen in color, and great drops of perspiration stood on his forehead while his breath came in short quick gasps. Yet he no more changed his grimly set but acquiescent expression than would one of the totem-animals of his ancestry, whose stoicism—as under all circumstances his kind ever do—he sought to emulate. The old surgeons took up one after another of the straight lancets, and with them dissected away the proud flesh and other diseased tissue, removing it cleanly, without severing vein or artery or tendon, until they had fairly exposed the bone itself. Here they found a swollen and diseased bit of nerve or tendon. They ruthlessly cut it out and examined it critically; stuffing some cedar-bark into the wound, they laid their lancets down and discussed thoroughly, and in an interested, leisurely manner, the question as to whether it was already a worm or only a ‘becoming’ worm. After deciding that whether worm or ‘becoming-worm’ it was not the chief or sole source of the disease, they laid it carefully aside on some ashes in a hollow potsherd. Then removing the bark and calling upon me to squeeze water into the wound they proceeded until the bone was plainly

exposed. They found the periosteum inflamed and discolored, and, therefore, with evident satisfaction, they proceeded to scrape it until every particle of the discoloration was removed. It was claimed that in the substance of the material thus scraped away the deepest source of the disease and ‘seat worms’ was found. This was also placed on the ashes with the fragment of nerve or tendon. Then one of them took a small fetish, or medicine-stone, from his wallet. It was an ovoid object of banded aragonite, much resembling a ringed worm or maggot. He laid it in the wound. He presently took it out, lifted it aloft with an air of triumph, and carefully placed it on the ashes with the ligament and bone-scrapings. The incision was now held open and thoroughly washed out, and then the chief operator, dipping up gourdfuls of the red liquid, filled his mouth therewith, and repeatedly sprayed the wound by vigorously blowing the fluid into it. All dissected surfaces were then washed, dried with the scraped buckskin, washed and dried again, until it not only became, but actually looked, clean, and was sprayed yet again with the red fluid. Finally, the openings were filled up, or rather stuffed, with the piñon-gum softened by warmth of the breath and in the hands, that were the while kept constantly wet with the red fluid. More of this gum was spread on narrow strips of cloth, and with these the wound was neatly closed as with adhesive plaster. The entire foot was sprinkled or thickly dusted over with the yellow pollen and root-powder, and then bandaged with long strips of the old rags as neatly as it would have been bandaged by a surgeon among ourselves.

The procedure of these primitive surgeons, if we consider the antiseptic treatment involved in their copious sprayings with the willow-bark infusion, in the filling of the wound with purifying piñon

gum and the remarkably effective closure of the incisions thereby, and in the surface-coating with the astringent yellow powder, would certainly seem to have been, almost from beginning to end, as strictly rational also as would have been those of one of our own surgeons. But in reality they were nothing of the sort. If we except the exceeding ingenuity and courage and the anatomic knowledge and skill displayed by these surgeons in their operations, the theories upon which they based their procedure were, from our point of view, irrational in the highest degree. They were a combination of empiric and thaumaturgic modes, chiefly the latter.

These men believed, according to the general philosophy of their people, founded on the superficial appearance of things, that blood—good, fresh, red blood—was the source of ‘new flesh.’ They believed that when the blood became thinned and black it was weakened and spoiled and must therefore be removed and replaced with fresh blood; that as blood is the source of new flesh, so is water the first source of new blood, of life itself, since nothing can live without water, howsoever abundant sustenance of other sort may be. Therefore, since the willow never lives apart from springs or other continuous sources of water, it must contain within its roots, its sources, the very essence, the very source of life. An infusion of its roots and bark becomes brightly red. It is imagined, therefore, to be the source of new life-blood, of flesh-forming blood itself, and to be effective for the renewal of decaying or ‘worm-turning’ flesh. The employment of the ‘fire-feeding’ and, therefore, ‘purifying and maturing’ piñon gum, and of the cooling and hardening yellow (or ‘winter’ root) powder and sustaining pollen, also quite, accorded to like ways of reasoning, was as strictly sustained by practical results, and

therefore seemed, in turn, to prove the propriety of such reasoning.

They also believed that the violence of the man’s injury had so weakened the part injured that it was infested with worms or else was killed and turning to worms. This belief was also based on appearances. Dead flesh putrifies, is filled with pus, or with thin, fluid, black or dead blood, stinks, and is always likely to be, with these people infested with worms (maggots). A festering sore arising from violence, real or imaginary, done to the part in which it occurs exhibits all these characteristics, and, if unchecked, leads to death. Such a sore, if malignant and deep, causes pain as of the bones. Its seed, then, must be deep-seated or in the bones themselves; this seed must be removed, else it will grow and cause death. Any pain like that arising from such a sore, though no sore be apparent, must be caused also by unseen worms or some worm born of violent injury, as by a magical or ghostly arrow.

There remain to be explained two or three of the manifestly irrational operations involved in the procedure. One was the treatment of the pain-causing worm-filament—or diseased nerve—and the ultimate ‘source of worm-turning’ in the bone they scraped; the other was the use of the maggot-fetish or medicine-stone. The supposedly incipient maggot and the infectious seed-substance of his kind in the bone were placed on the ashes, because fire-ashes are considered, in themselves, to be dissolving and destructive, and (among other quaint reasons) tend toward ‘clogging’ or ‘hindering escape;’ for no worm or insect can progress through, or escape from, fine ashes. With the scraping of the bone everything had been done that was humanly possible to remove the infection; but something more must be done, some potency applied, to absorb any remaining infection.

Therefore the fetish-stone, as a sort of spiritual sponge, was introduced.

And I would here enter a plea for the primitive medicine man. He is not usually the arrant knave or juggler so frequently pictured by travellers. His so-called 'tricks' are not attempts at deception. They are solemn operations by which he is himself as much deceived as are any of his witnesses. We are told that these earliest practitioners suck, knead or cut their patients, and end by pretending to find and extract, and by triumphantly holding aloft, some grub, insect or other small object—frequently a minute fetish-stone like the one I have described, that 'they claim' to have actually extracted from the diseased part. We aliens are the only ones of their witnesses who are deceived by them in the way we accuse them of deceiving, for what they really attempt to do is either to expose, or otherwise make as uncomfortable as possible, the animate seat of the disease, and then to furnish it with a decoy, as it were, a vehicle or body of escape, as a killed and squeezed-out body of one of its own kind, or else in the form of its kind as seen in some ancient and more potent and nearly natural object resembling it. Sometimes, again, living insects or worms, or fetishes that are supposed to be living, ravenous and inimical to the worms of disease, are introduced, that they may prey upon and destroy these worms and the seed-substance of their kind. This is especially apt to be the case when thick pus is abundant and parasites are forming; for the squeezed-out pus itself resembles worms more or less, portions of it even in mass, being streaked, seeming to contain their forms in embryo. It, also, is therefore held to be the seed-plasm or substance of worms, and the proof of this is alleged to lie in the fact that, if exposed, like dead flesh, it speedily turns to worms.

The subsequent treatment received by

the man whose case I have described, at the hands of his primitive doctors, was quite as much in keeping with this sort of philosophy as had been their operation. His wound was, of course, dressed, cleaned, copiously sprayed, and, I may add, 'Spiritually disinfected,' every day. But, in addition to this, he was put on diet—the freshest or 'newest' possible corn food—and was, for the first four days, deprived of salt (this, too, being abundant in pus-like excreta) and all flesh-food, and was thereafter until perfectly cured—for he recovered with amazing rapidity—denied all meat containing fat and other non-muscular tissue, since these, as well as old and so-to-say 'decrepit' seeds, are supposed to be, of themselves, peculiarly liable to 'worm-turning.'

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*THE INFLUENCE OF ENVIRONMENT UPON  
THE BIOLOGICAL PROCESSES OF THE  
VARIOUS MEMBERS OF THE COLON  
GROUP OF BACILLI: AN EXPERI-  
MENTAL STUDY.*

THE results found in the following pages have been made possible by a grant from the Bache fund of the Smithsonian Institution. The disposal of the grant mentioned is left to the discretion of Dr. John S. Billings and Dr. S. Weir Mitchell. The topic of this research was submitted to these gentlemen at the beginning of the year, and from time to time they have been kept informed of the progress of the work. It is with their approval that this paper is presented for publication. The research of the past year has been a continuation of the studies begun in the fall of 1895, upon the variability of bacteria.

The colon group of bacteria have been chosen for this study, and particular attention has been paid to those forms which appear to be modifications of the typical colon