Etna, Stromboli, and Vesuvius. In this diagram he had condensed to the best of his conjectural power his supposition as to what the state of the earth really is; and if any one chose to find fault with it he would not quarrel with him. He only gave it as a sort of inference from a number of things he had said.

VESUVIUS AND THE SURROUNDING COUNTRY.

(Visited March 10th-19th, 1876.)

By PROF. C. E. CROSBY, Kansas City, Mo.

ONE hundred and twenty-five miles southeast of Rome stretches Campagna, bounded on the north by the Pontine marshes, on the south by the mountains of Calabria, on the east by the foot-hills of the Apennines, and on the west by a translucent sea. Upon this level plain are two objects of interest which will claim our attention: one, Vesuvius, a low, solitary mountain by the sea, bounding from a handsome shore to the height of 4,257 feet; the other, a tract of country nearly five miles square and ten miles distant from the volcano. It will be convenient to first consider the general history and character of the latter.

Setting out afoot from Naples (pop. 415,000), a city of the greatest wealth, poverty and population in Southern Italy, one fails not to notice the peculiar soil, the strange color and the stranger texture of the rocks along his way. No sooner is this brown tufa rock seen—a specimen of which is upon the table before you—than his mind, seeking its origin, wanders far back into the unwritten past, when the Mediterranean not only covered the place of his observation but spread away eastward until it washed the feet of the snow-capped Apennines. In that distant age the back-bone of Italy was unbroken from the Alps to Sicily, but this country, so full of scientific as well as historic interest, was then only a back-bone. While surveying the evidences in silence, he images Vesuvius convulsively rising from the temperate Cænozoic sea, tens of thousands of years before the mysterious Sibylline books were carried from Cumæ, whose ruins are almost indistinguishable before him. He knows this tufa to be only the sediment of the red-hot cinder-shower that poured from that early Vesuvius. During the same epoch the site of the imperial city lay under the tepid sea, whose waters were blackened with the volcanic shower from the neighboring Alban and Cimman hills. In subsequent centuries the Roman Campagna, with its rich beds of puzziolane earth—which alone gave durability to the famous Roman cement—and the Campagna about Naples were raised into the sunlight. This account of the formation of tufa becomes more probable, knowing that Signor Guiscardi has collected from the tufa hills of Pausillipo more than a hundred species of shells, but a few of which differ from those now inhabiting the waters that lave the adjacent shores.

That you might better understand the form of Vesuvius and the character of the surrounding country, I have prepared, at a considerable expense of time, a plaster of Paris model of them for a radius of nearly twelve miles. [Prepared from a map by Prof. Phillips, of Oxford, in connection with my own observations.] For the present you will observe this tract, called by the early poets the Phlægrean Fields, lying just west of Naples, and literally covered with craters, varying from fifty to five hundred feet in height. Under the varied influences of bright sunshine, fierce internal heat, drenching rain, a balmy air, and a destructive vegetation, they have descended to us in all stages of perfection, from those whose outlines are barely traceable to those of perfect crater form, and all are extinct but one. I wonder that so interesting a country is not better known.

Here is Monte Nuovo, 456 feet high, an eruption of 1538 and the last upon record in this part of the Campagna. Its sides are covered with scoræa and blocks of trachyte, and its oval interior is but nineteen feet above the sea. This is Monte Barbaro, celebrated by Juvenal for its excellent wines. Its crater is a mile in diameter and its sides are covered with a vegetation of myrtle, arbutus and wild evergreen, but the activities that raised it are so remote as to span the whole reach of human history. To the north of these are the striking forms of Monte Grillo, Fossa Lupara, and others, but their paroxysms are buried in the deep past. I can only mention Astroni, whose crater is three and a half miles in circumference, around which are discovered only volcanic ashes and mud; its splendid form and interior vertical cliffs unmistakably indicate that where now "the wild boar and wary deer roam amid forests of oak and ilex, slaking their thirst in small lakes half covered with water lilies," was formerly the place of great volcanic disturbance, which, although unseen, is none the less certain. Furthest to the north is the Piano di Quarto, the longer axis of whose crater is but a little less than four miles.

A little back of Naples is the Pianura, which, although smaller than the last, yet dwarfs that of the present Vesuvius almost to insignificance. I have said that, with a single exception, these craters are extinct, still in many places throughout the Phlægrean Fields the stranger fails not to discover heat that is not "latent" and volcanic products that are not ancient. From hundreds of crevices long thin streams of steam, perceptibly hot, constantly pour from the ominous depths from which are deposited beautiful incrustations of sulphur and the deeply contrasted red arsenic sulphide.

I must call your attention to this crater, the Lago di Agnano, for not only did it attract the notice of the ancients, but throughout the long night of the Middle Ages it was an object of curious superstition. It is not a lake, as its name would indicate, as twenty-five years ago it was drained by an Italian engineer, and now, within its tree-clad cliffs, it presents but little else than a beautiful meadow where graze many flocks of sheep. Within the crater, on the eastern side, the infamous Tiberius built his royal palace by a mineral spring, whose temperature to-day is 180° and nauseous with hydrogen sulphide, while near these ruins, in the crannies of the rocks a few yards away, pure sulphur is being deposited.

But the point of greatest interest is the *Grotto del Cane* (Grotto of the dog), noticed 1800 years ago by Pliny in his scientific writings, and not less full of meaning for us. Before leaving Naples I provided myself with waxen strings, not knowing that the grotto was in charge of an Italian, who asks all he can get for allowing a person to examine it. I can do no better than transcribe my journal. The cavern, located in the side of the crater, is four feet wide and ten feet high, the floor rapidly inclining from the entrance. The rocks are quite warm, but endurable, and one's feet are soon damp with perspiration. When the door was opened, I noticed a white smoke a foot deep pouring out into the plain (crater)—probably the vapor of water. Advancing a couple of steps into the grotto and lowering the taper to my knees, it was instantly extinguished. With a flambeau of

hemp I advanced still further in the grotto, then, upon lowering it until immersed into the stream of suffocating gas, it was extinguished as quickly as if plunged into a stream of water. Relighting and going still further into the cave, upon lowering it it was again put out at the height of my shoulder—thus proving that I was standing shoulder deep in the carbonic acid stream which for twenty centuries has been pouring its floods of death out upon the floor of the great crater. Knowing its ultimate effect upon life, I wished to ascertain how a smaller quantity would affect a person. Telling the keeper that I wished to breathe it, he followed me into the grotto. Burying my head in the invisible gas without breathing it, I felt no peculiar sensation, and upon taking a small draught of it into my lungs, I noticed only that the air was a little "close." I then tried two deep inspirations, which produced a roaring in my ears and a dull, boozy feeling in my head, neither of which were painful. Although my vision was perfect, my eyes felt dull and the eyelids heavy. Expelling the gas from my lungs, it was difficult for a minute or two to feel any satisfaction from breathing the fresh open air. I was not satisfied, still I did not think it prudent to experiment further. The Italian's jolly wife said that a dog would become insensible in a minute and a half—consideration one franc. While holding the watch, the dog was lowered into the stream. In thirty-five seconds its eyes rolled wildly and I ordered it out. Recovering quickly in the fresh air, it was again lowered into the gas, and in fifty-five seconds the animal reeled, but he would not take it out as I ordered, leaving it until it fell, one minute and ten seconds after its immersion. When taken out and laid upon the grass, its body was limber and its eyes were closed. In one minute snuffing and choking commenced, followed by awkward efforts to regain its feet. Soon it moped slowly away and was again capering with its companions on the lawn. The fact is these dogs have been killed so many times for the benefit of travelers that they seem to enjoy it.

There is but one explanation of this phenomenon; deep down in the earth's bosom the internal fires warm and decompose the limestones driving off this river of carbonic acid. Eleven twenty-fifths of weight of common limestone is this invisible and irrespirable gas, or forty-four pounds in every one hundred pounds of rock. The amount of gas thus expelled from the deep subterranean rocks, consequently, the amount of rock chemically and physically changed since the superficial observations of Pliny were made must be enormous. Thus we have an explanation of the Guevo Upas in Java, or Valley of Poison, a half mile in circumference. It is an extinct crater, strewn with the "carcasses of tigers, deer, birds, and bones of men," caused by the constant flow of carbonic gas into it. It is no wonder that the crater, Lago Agnano, when filled with water, and, as during the Middle Ages, probably covered with carbonic acid gas, should have been the source of much superstition. With still greater force was this true when neither the existence nor the properties of the gas were known, when philosophy was empty theory, and a rigid investigation of facts, which alone determines their principles, a thought that had not taken hold of the minds of men; and to-day not a few delude themselves in vain efforts to grapple with some of the great scientific questions, absolutely if not professedly ignorant of the simplest details and elementary principles upon which they are claimed to rest.

The craters of the Phlægrean district have consumed much of our time, but I would not omit the most interesting—the Solfatara. It is especially interesting from the fact that from it has flowed the only stream of lava known to the west of Naples. This crater is an elliptical basin of several hundred acres, bounded by walls one hundred and twenty-five feet high. A path leads across the center to the opposite side, many rods of which echo to the walk as if great subterranean chambers were beneath. The guide picked up a thirty pound boulder and threw it down at my feet, causing the ground to tremble and producing a rumbling not a little startling. Not only under the brier thicket and in the shade of the arbutus was the surface perceptibly warm, but I found several places whose heat could not be endured. Throughout the crater the rocky walls are streaked with yellow, brown, red and white, while the soft floor, mingled with gray and white, abounds with the sulphates of alumina, lime and magnesia. Warned at his entrance, yet he is almost unprepared to witness the strange sight which now meets his eye at the further end of the crater. Not only does steam, scalding hot, issue from a low, narrow cavern, but the roar of its expulsion is so great that near it conversation even in a high tone is impossible. For a minute great volumes pour from the small cavern in torrents, succeeded by short intervals of comparative rest, during which I heard familiar sounds like those of steam escaping from a semi-fluid substance as heard in boiling corn-mush. The rocks within reach are too hot to be handled, and they are uniformly incrustated with bright yellow sulphur and beautiful realgar—the latter by no means plentiful. Stooping low and vigorously using the fifteen foot pole to obtain some specimens, one is apt to venture too far and is liable to get the blast of steam and irrespirable vapors full in his face. Upon the cooled specimens I could distinctly taste alum, and salt upon many of them. Who can work out the complicated reactions taking place in the laboratory below? Leaving, it is impossible not to turn and look at it again, and it is probable that we now view it with the same mingled feelings of admiration and wonder as were experienced by Strabo (30 B. C.) and his contemporaries. Upon the eastern side hollow sounds are heard beneath the feet, and hundreds of small steam vents attest the existence of great energies not far below. Searching for specimens one frequently burns his fingers, and in not a few places is it too hot for shoes. The story is authentic and the geologic evidences are unmistakable; eight hundred and eighty years ago the Solfatara was an active volcano; flame and cinders poured upward in torrents, while the air for miles around was laden with impalpable dust through which hurtled the lightning's glare, and a stream of lava flowed a mile toward the sea. The small artificial opening ten feet deep near the center of the crater is of no little interest. From the soft plaster-like mud escapes the hot steam with a heavy thud, not unlike that heard when a wagon wheel is drawn from the gutter. This escape is periodical, causing a great splash and producing an insufferable odor, much like that of sulphureted hydrogen. One has abundant opportunity to look down into it, and at the proper time he fails not to use an opportunity to get out of its reach. It is strange that this crater, within a stone's throw of the old Appian and public highway, has not been thoroughly examined; were it in the United States the people would have it all excavated in two weeks, and upon the third would have a nice current of red hot lava flowing into the bay; but these filthy, lazy, intensely religious and ragged Italians take no interest in the matter whatever. Upon analysis of these vapors by Dr. Danberry,

of Oxford, he found chlorhydric acid, ammonium chloride, hydrogen sulphide and aqueous vapor, but there seems to be no agreement as to the exact kind of chemical relations which produce them. The citations of ancient authors, tabulated by Prof. Phillips, render it probable that twenty and more centuries ago the Phlægrean Fields were in the same mingled state of activity and repose; and, considering the little interest in the various subjects of natural history, it is no wonder that their philosophy should contemplate in this tract "ominous lakes, hot springs and sulphurous vapors," significant only of conflicts between the giants and gods. I will only mention that this model reminds us of that volcanic tract on the upper "horn" of the half moon whose craters are numerous and whose dimensions are surprising.

Here is Monte Nuovo, at whose base lies Cumæ, the most ancient of the Greek cities of Italy, and the Lucrine and Avernian lakes. This eruption of the sixteenth century effected many changes in the geography of the district, as villas were overwhelmed, the area of Lucrine lake diminished by one-half, the town of Tripergola blown into the air, and every vestige of the wharves of Agrippa were destroyed. Preceding its elevation twenty-seven earthquakes shook the Campagna, an additional two hundred feet of the shore were raised into the warm sunlight, but the miserable and starving poor continued to gather the stranded and struggling life. Soon the volcanic fires broke forth; the heavens were darkened with ashes and cinders; lightnings rent the all but universal gloom and shook the air, and the inhabitants of Puzzuoli, affrighted and petitioning their saints, commenced their wild flight toward Naples, whose palaces, five miles from the eruption, were befouled with the descending mud. At its western base Lake Avernus, nearly circular and surrounded by high steep ridges covered with evergreens and oak trees, seems a deep hollow scooped out of the hills, and were it not for two hundred feet of water its crater form and origin could not have been mistaken. Lucretius' story that in his time the lake was dark and gloomy and that birds attempting to skim its surface would fall dead by the noxious gases, is not at all improbable when we remember the neighboring Grotto del Cane. It would be difficult to select a more pleasing sight than Avernus, above whose dark unruffled waters sea birds gayly skim the surface beneath an azure dome. At about this point, midway between the two lakes on the right, was the cavernous entrance to the Infernal Regions, where answers were returned by the dead, to which Ulysses came, while in the immediate neighborhood was the abode of the Cimmerians. Of this place did the early poet write—

"Dark was the cavern, wide its jaws of rock
By the black lake, and woods of mighty shade."

Not all this is poetic fancy, for the cavern is still there, extending several thousand feet beneath the hills, believed by some unpoetic people to have been only a public road to Cumæ. In a bluff by the sea, a mile beyond the Lucrine lake, are the baths of Nero. Many yards can one penetrate this dark cavern until the steam, scalding with heat, not only stops his progress but again reminds him that the great stores of heat are beneath. Further to the south are the shores of Baiæ, along which stretched some of the splendid temples and palaces of the ancient world. Strange does it seem within the roofless temple of Venus, whose walls, once of the rarest marble, yet tower to a height of seventy feet, and whose pavement was costly mosaic, to see old broken down wagons and hear the ring of the blacksmith's anvil! Further are the ruins of Bauli, where Nero planned the death of his mother, the rocky Cape Misenum and the Elysian Fields.

On the north shore of the Bay of Baiæ is the ancient town of Pozzuoli. It was here (Puteoli) that St. Paul tarried for seven days, and the more than matricide emperor practiced upon the stage. I cannot now describe the ancient amphitheater and the other many things of scientific and historical interest, except to notice the old bath house of the Romans—called in more dignified language the Temple of Jupiter Serapis, from a statue found among its ruins. You must imagine an open area—one hundred and fifteen by one hundred and thirty-four feet—on a level with and near by the seashore, strewn with slabs of porphyry, portions of granite and marble pillars with their ruined capitals, the whole surrounded by forty-two compartments, only a few of which are well preserved. Not far from the center of this area are three erect pillars of marble, whose plinth is under water and whose entablature has long been wanting. Its surface is thickly studded with the perforations of lithodermous shells—some of which will admit the little finger—to a height of twenty-three feet. Since its exhumation in the eighteenth century this structure has engaged such scientific minds as Professors Forbes and Babbage, the poet Goethe and Sir Charles Lyell, whose combined researches result in the following conclusions: First, the adjoining Bay of Baiæ during the last eighteen centuries has been undergoing a double movement of depression and elevation. Second, this vertical movement has been so gradual as to escape observation. Third, the pillars were bored by mollusks when they were beneath the sea. Many observations along the coast confirm the view that, during the centuries of the past, the country has been rising and falling like the movements of human respiration. It is claimed by a high authority that there is abundant evidence of its having descended two feet within the past hundred and twenty-five years, at which continuous rate the Phlægrean Fields and Campagna may again be submerged hundreds of feet beneath the victorious sea. Evidently there was a time when these waters did not cover so much country, for beneath the bay is an old Roman road connecting Pozzuoli and Baiæ. I must only mention the volcanic islands of Procida and Ischia, lying just outside of Cape Misenum, which were settled by the Greeks at a time antedating our own era by many centuries, but finally abandoned by them on account of the great eruptions. Again they were colonized by Hiero, King of Syracuse (B. C. 380), but a fortress having been constructed the volcanic fires were again rekindled, when the Greeks abandoned them forever. The last eruption known was in (1302) the fourteenth century, and to-day these rich islands, supporting a population of fifty thousand souls, abound with thermal springs, sulphurous fumes, steaming vents and extinct craters.

Let us study the country to the east of Naples. For thirty centuries have Chalcidians, Oscans, Samnites, Romans, Normans, and Italians successfully hovered about the rich Vesuvian slopes, made the Campagna a fruitful garden, filled it with prosperous villages, adorned it with splendid palaces and temples and paved it with excellent roads. To-day, immediately around its thirty mile base, are eighty thousand people, cultivating the soil, clipping the vine, gathering the oil and singing their erotic music in the very clouds of Vesuvian vapor. A description of the physical structure of this volcano is not a little difficult, but this

model will give you at a glance an idea of its form and surroundings. Allow me to condense its history. Far back in the past, beyond the furthest reach of written history, Vesuvius was a solitary cone rising out of the Campagna by the seaside. In the war of the Romans against the Samnites (fourth century B. C.), when the former sailed up the Sarno, which skirts the eastern base of the mountain, they beheld upon its slopes a luxuriant vegetation, and afar toward the crater the vineyards bore their loads of fruit, above which low green shrubs and tangled briars nearly concealed the true character of the underlying soil. An epigram by Martial reads—

"Here verdant vines o'erspread Vesuvius' sides;
The generous grape here poured her purple tides."

To this place came the Thracian gladiator (B. C. 73) with his brave comrades, having escaped from their bondage at Capua to the northwest. Ascending the mountains by means of bushes twisted together, they lowered themselves into the well-grassed crater. Neither historian nor poet has left a suspicion of smoldering activities beneath the mountain, and not until A. D. 63 did the dense population become aware of the mighty energies beneath them. Then the earthquakes made great openings in the Campagna, destroyed hundreds of sheep, split many statues, killed many people, drove many insane, leveled not a few palaces and laid the historic city of Pompeii in ruins. The sixteen following years passed away with occasional warnings, until the 24th of August, A. D. 79, when a little after mid-day a tree-like column of black smoke poured from the crater for the first time in the annals of history—the world knows the rest. Before the sun had half reached the horizon, midnight darkness prevailed. For eight days lightnings flashed through the universal gloom and torrents of rain fell from the condensing clouds; suffocating fumes poured from a thousand crevices; cinders, ashes, lapilli and mud showered upon the Campagna, burying five cities beneath the liquid mass. Not until recently have the topographical changes effected by that eruption been carefully determined. More than three thousand feet of the upper part of the cone were blown into the air, and of the remainder that half toward the sea was torn from its foundation to within sixteen hundred and fifty feet of its base, burying beneath the debris the towns of Oplontia, Teglum, Stabiae and the considerable cities of Herculaneum and Pompeii. Contrary to what has generally been supposed, neither the surface configuration nor the few accounts of it sustain the view that lava flowed at that time, and for upward of a thousand years (A. D. 1036) the flow of melted rock was unknown to the inhabitants of Campagna.

What is the present condition of Vesuvius? On sixty-five different occasions has lava flowed from the volcano during the last eighteen hundred years, and more than half of these within the past two hundred and forty years. Among the more important changes is the superposition of a new cone upon the shattered old one, but not sufficiently large to completely take the place occupied by the old one; the result is an open space called the atrium, one-half to three-fourths of a mile wide and three miles long, between the new cone and that part of the old one—called Monte Somma—not destroyed in the first century. So, too, on the side toward the sea the external surface of the new cone is not even with the old base, thus leaving a circular horizontal plane—the Pedimentina—many rods wide and sixteen hundred feet above the sea.

Ascending Vesuvius from the south side one takes great delight in selecting points of interest and admiring the magnificent prospect spread out below him. Eight miles due west of the crater is Naples with its ragged half a million, and from it to Torre del Annunziata, a distance of ten miles along the coast, is a continuous village street, over which the great black cone towers threateningly. Southwest of the volcano, at its base by the seashore, is Herculaneum, buried from seventy to one hundred and twelve feet beneath the present village of Resina by six different streams of lava, and in the same straight line are the thriving towns of Portici, Torre del Greco and Annunziata. Just five miles away to the southeast is the walled city of Pompeii, whose hundred and sixty-one acres, silent beneath its twenty-four feet of ashes and cinders, are but one third exhumed. Within the limits of history no lava stream has ever reached this celebrated city, although it rests upon an old leucitic current. Near it is the river Sarno, taking its rise in the mountains of Calabria, and a mile to the southeast is the buried city of Stabiae, where the naturalist Pliny lost his life. From the rocky Cape Misenum, where he had charge of the Roman fleet, he crossed the Bay of Naples to this place, where he was suffocated with the sulphurous fumes—his route being indicated upon the plan. Beneath its load of volcanic cinders excavations have furnished numerous papyri, statues and architectural designs, and the present town of Castellamare, above its ruins, is still famous for its carbonated and chalybeate waters. On the western slopes of Vesuvius and nearly half way to the summit is the observatory founded by Melloni in 1844. It is a fine two-story structure, built of lava and located upon a projection from the Pedimentina, at an altitude of two thousand feet. At present it is under the directorship of Prof. Palmieri, and is well equipped with self-registering instruments, the principal object being to record the phenomena that "precede, co-exist with and follow the eruption."

By various instrumental means the direction, intensity, and continuance of the earth movements are recorded with the utmost accuracy and certainty. Long does one gaze from the Pedimentina down upon the Bay of Naples, which, more like an inland sea, washes the feet of the fiery monarch with a liquid azure indescribably soft and beautiful. To the right is Naples, beyond which, upon the hills of Paesillo, repose the bones of Virgil, the great master of hexameter, whose song beginning—

"Tityre, tu patulæ recubans sub tegmine fagi,"

the world will not soon forget. Still further are the Phlægrean Fields, and forty-six villages of the Campagna, covered with areas of light and shadow that move as noiselessly as the dream of a poet. Southward is Capri with the sinking palaces of Tiberius (erected A. D. 37) covered with and surrounded by the rocky walls of nature's own imperial masonry. Spreading level away with an uninterrupted sweep, and bounded on the southwest by volcanic Ischia and its companion isle Procida, the splendid waters disappear in the open sea. Westward rise rugged mountains, and their beautiful coast is none other than that of Meta and Sorrento extending arrow-like under a dome of lapis lazuli.

Upon this relief I have attempted to represent the streams of the seventeenth, eighteenth, and nineteenth centuries, four eruptions belonging to the seventeenth, twenty-three to the eighteenth, and twenty-five, thus far, to the nineteenth. So startling is the impression experienced when

viewing for the first time these varied and desolate streams, that he who has read the theory and has afterward become practically acquainted with the details of any department of science well knows the crushing weight of an argument derived from the latter source compared with that of the former. The mental state effected by the study of an object is separated by a wide gulf from that condition of mind produced by studying what some one says about it. There is no mistake; literature, history, and mathematics for their acquirement require the exercise of fewer intellectual faculties than those of the natural sciences. Worthless is the opinion of that individual, in these latter departments, the development of whose powers of sense—perception—has not kept full pace with that of the judgment and reason. Speaking generally, the streams of the seventeenth century have flowed from the south side of Vesuvius, entering the sea in twelve distinct channels. One of the most memorable eruptions occurred in 1631, after rumblings and earthquakes of six months' duration, when the lava broke forth and poured down the southwestern slopes in seven grand cascades of fire and mud, destroying a part of Torre del Greco, burning Resina to the ground, boiling multitudes of fish along the shore, and destroying many thousand people. So frequent have been these hot mud streams that they are often more dreaded than the currents of lava. You will notice that the flows of the eighteenth century have burst not only from the southern side but from the eastern and western as well, here and there overlapping those of the previous century, but reaching the bay in only a single mouth. Among the more prominent of these is the eruption of 1794, at which time the glowing rock poured down the slopes with a solid front twelve to fifteen hundred feet wide, through the streets and alleys of Torre del Greco, destroying four hundred lives and forcing its way more than three hundred feet into the sea. During the present century eruptions have been more numerous than at any other. Not only do they cover the Pedimentina, but from the crater they have flowed in every direction, but reaching the sea in two distinct channels a half mile apart. But the most remarkable stream for length is that which poured out of the atrium toward Naples, in a condition not greatly unlike fluid iron, reaching a point six miles from its source—the longest stream known in its history since the eruption of A. D. 79.

It is ten minutes past twelve while I sit upon one of the loftiest points of Monte Somma. The deep and desolate atrium is far below, while tremendous volumes of steam roll upward from a crater (seven hundred and fifty yards) nearly a half mile in diameter. No language can describe this sight; it is almost terrifying. At first I stepped behind some rocks, involuntarily breathing full and irregularly with an oppressive feeling I have never elsewhere experienced. The tiresome ascent of Somma having been completed, I expected to look across a narrow gulf upon a smokestack, but through the driving clouds I saw a naked cone higher than the point upon which I stood, black as the darkness of midnight, and while exhibiting no signs of life it was all life. Expecting to witness but a mass of steam as from a caldron of boiling sap, I was filled with silent astonishment before the mountainous billows of fleecy vapors rolling slowly, majestically toward the skies, then swept sharply away by the driving winds. Somma, ascended for security, seemed but a toy above an energy capable of dashing it to atoms upon the surrounding plain. The precipice abounds with ragged projecting rocks of lava, fiery and variously colored, while its shelves are filled with scoræ and volcanic sand. For eighteen hundred years has Somma stood unchanged between the hot rain shot from the reddened throat of Vesuvius, while floods of liquid rock poured down through the atrium. Many dikes are visible while making the descent, their dimensions being from a few inches to twelve feet wide and from a few feet to five hundred in height, reminding one how inconceivable must be the forces that can thus split a mountain and fill the openings with melted rock.

Having made the dangerous descent into the great gulf which separates Somma from the cone, I thought of the Lachine Rapids of the St. Lawrence, just above Montreal. Were they instantly frozen, preserving their billowy surface, they would but poorly represent this dark, desolate, and forbidding place. These now cold but once fiery floods remind one of shapeless masses of mud, with this difference, that the former are sharp, hard, and extremely rough, while the latter, an inch to ten feet in height, are so intolerably ragged that one is in constant danger of spraining his ankles or cutting his hands by little falls. Were a thick dough of cornmeal rapidly stirred, then quickly dried so hard that it would ring under the hammer, in some respects it would simulate a lava current. A striking feature of the current is that, while flowing upon a level surface, instead of spreading out like water, it erects its own boundary walls by the rapid cooling of its sides. It is said by observers of the living current that the slowest river of a plain moves faster than a lava current upon a considerable slope. Issuing from the volcano its temperature is about 2,000°, but at a distance the cake-like and curled masses indicate the molasses-like character of the fluid. The scoræaceous and jagged surface abundantly testifies to the static pressure of the fluid and the exhalation of its contained gases. One fails not to notice the few boulders of various dimensions, several inches to three feet in diameter, from brown to bright yellow, covered with a slaggy matrix, but broken open, presenting a pleasing and attractive relief upon the somber, lifeless waste about them. Are these volcanic bombs, once torn from the strata beneath the mountain, shot from the great crater and shattered by the fall? Along the course of a current it would seem that its motion was frequently arrested for a moment, where it would heap, forming a bag or pocket ten feet in height, subsequently parting upon one or both sides, through which break the lava would pursue its destructive course. Continually is one stopping to examine these bag-like masses, botryoidal surfaces, tabular areas, curvilinear forms, and strange prominences which occasionally assume some of the most fantastic outlines, and which would afford secure retreats for animals as large as the cat and dog. With great interest does one trace a single stream from the atrium down the gentle slopes, through cultivated gardens, fruitful vineyards, orchards of olives and the golden fruit. Before you are many specimens of lava collected both from Vesuvius and the giant Etna. At the close of the evening you will have no difficulty in knowing those which were knocked from the surface of the current, as they are rough and deeply cracked, while those specimens which came from the body of the current, not in contact with the air when in a melted state, are dense in structure, while their rounded cavities will indicate the position of the cells which imprisoned the gases. This light, cylindrical specimen was evidently a bomb which came from the upper cone. Little or no pumice is found about Vesuvius, this piece and the most of our commercial article being obtained from Stromboli, whose

fires have never for a moment been quenched since the earliest recorded history.

An analysis of lava shows its general composition to be a silicate of alumina, combined with iron protoxide, potash, soda, and lime. But the lavas of different centuries, if they do not differ in chemical composition, certainly vary in their physical properties. It is not a little striking, while walking over these lava fields, to see a stream, cold, naked, and forbidding as when it flowed a century ago, while another beside it, that flowed half a century later, is covered with a crumbled powdered surface, where atmospheric vapor and the rock moss have thoroughly prepared the way for the growing vine. In many specimens you will discover crystals of leucite, olivine, and sodalite, but these perfect crystals of pyroxene I collected from Monte Rossi, an eruptive cone upon the southern flanks of Etna. This single specimen of dolomite is found in considerable quantities about Monte Somma, but is wanting in the lavas of Vesuvius. If, as mineralogists tell us, obsidian is formed by a rapid cooling of lava, it is difficult to understand why none is found here, for the conditions of its formation would not seem to be wanting. This handsome specimen inclosed in its gray matrix is owned in this city by Mr. Wilhite, who found it in Oregon of our own country. Many persons would call it a lump of dark glass. No single locality of the earth's surface has furnished so many simple minerals as the lavas of Vesuvius, and it can no longer be doubted that their manufacture in the great laboratory of nature is far from an extinct process. Here Hatty, the founder of our system of crystallography, picked up no less than eighty simple minerals, but among these no native metals have ever been found.

From the uneven crater of this volcano destruction and death have poured for centuries. Different was the scene twenty-one and a half centuries ago, when the Roman fleet under Regulus made its way to Carthage. Then the checkered vineyards extended far toward the summit, and the wild boar hid among the thickets of the crater. Now it is full of cloud-like steam of fleecy whiteness, which rolls to a great height when it is swept by a stiff breeze over the suffocated dead of its old victim, Pompeii. At no time is it possible to see across the great crater, so dense and continuous is the steam. Occasionally I saw its vertical walls, tinged with red, yellow, and brown, and the shelves of the rocks are heaped with black volcanic cinders. At Naples, eight miles away, the vapor seemed to rise but slowly, but here beside it it rises majestically upward in great torrents, impelled by energies that do not sleep. Walking from the windward side around to the south margin, whose width varies from twenty to seventy-five feet, I found the steam sulphurous and irrespirable, exciting violent coughing. The summit of the crater abounds with banks of nearly pure sulphur, rocks of variegated color, and volcanic cinders. Many portions of the surface are smoking, and not a few square rods are too hot for the soles of the boots. One delights to throw rocks into the crater from whence they came, and stepping away from the precipice to dig into the noisy cinders, where evidences of great heat soon become manifest. A guide conducting an English party placed some eggs in jets of escaping steam, which soon rendered them palatable. Thrusting a paper under a rock, it immediately took fire. Fifteen feet from the precipice, beneath a layer of cinders, I found the rocks incrustated with sulphur, sal-ammoniac, and cubic crystals of sodium chloride, several times burning my fingers while throwing them into the air. Placing my green stick used for a cane in a crevice, it cracked as in a stove, and in three minutes by the watch I withdrew it all aflame.

One never tires seeing and toying with the great energies whose source is far beneath him, but whose origin lies in nebulous aggregation. One is impelled to think beyond his naked observations, and he fails not to ask, Whence this salt, which one tastes, upon the rocks? Immediately he descends far into the bosom of the earth, where he witnesses the scalding conflict between the rocks, half reddened by internal heat, and the salt water that has poured through the creviced earth from the great Mediterranean above. A simple calculation, from the quantity of steam continually poured from the crater, gives a result not easy to anticipate. A cloud, half a mile in diameter and two miles in length, condensed to saturation at 40°, represents about 20,000 cubic yards of water. Now, allowing that this vapor rises and floats away at the rate of four miles an hour, in a single day more than enough water would pass into the atmosphere to cover 104 acres to the depth of five and a half feet. Thus, in order to form a conception of one of the probable causes of volcanic action, the imagination must enable us to realize this quantity of water making its way down through the crevices beneath the adjacent sea. Understanding this fact, the difficulty of perceiving the cause of the destruction of Herculaneum is greatly removed when we think of the descending shower and the torrents of mud that must have succeeded it. If further evidence of the sinking of the Mediterranean waters were needed, it will be necessary only to state that fish have been found in the mud volcanoes of the Caspian. Admitting this, the formation of hydroxides and hydrosilicates is no longer an enigma. This theory possesses a high degree of probability, when we remember that the active volcanoes of the world are located near bodies of water. Thus are arranged the 28 active volcanoes of Java, the 109 between Australia and China, the 30 in Guatemala and S. A. Republics, the 20 active volcanoes that separate the Atlantic from the North Polar Sea, the giants of the Sandwich group, Mounts Erebus and Terror of the Antarctic continent, and in Southern Europe, Santovin, Vesuvius, Volcano, Etna, and, lastly, Stromboli, ever white with steam by day, and at night bright with his red glare. Equally striking is the correlative fact that inland from these active volcanoes are extinct ones—instance those in Eastern France, Northern Italy, in the Apennines east and southeast of Rome, and Mount Vultur, 80 miles east of Vesuvius. Throughout the 22,000 mile circle of fire which incloses the Pacific, all of its 225 active volcanoes, as well as the remaining 75 in other parts of the world (Mayer), are not distant from the sea. Whether, as Lyell maintained, volcanoes rest upon a line of fracture, is a disputed question, but the synchronous, alternate, and irregular phenomena of various volcanoes are hardly decisive.

While standing beside the Vesuvian current of flowing lava in 1819, Sir Humphrey Davy, of the Royal Institution of Great Britain, propounded a theory which, although subsequently rejected by him, exercised no small influence over the men of his time, it being advocated by Dr. Danberry, of Oxford, in his great work on volcanoes. It was very simple, supposing only the existence of free alkaline metals in the earth, to which air and water have ready access, resulting in heat and the ready flow of lava. Expressed in a concise manner, his explanation of volcanic action was the assumption of deep-seated chemical action. As an illustra-

ion of his main thought, that of chemical action, I wish to perform an experiment or two. The possibility of chemical action being sufficient to produce volcanic phenomena must be admitted by every experimenter in physics, but the great improbability of free alkaline metals or their earths (?) existing in sufficient quantities at so great a depth, or at all, is striking to the most superficial person. Perhaps the most plausible theory is that which is ascribed to volcanic action, to the existence of a fluid interior whose energies slowly radiate into space, and whose shrinking nucleus is the source of earthquakes, explosions of liquid rock, and the elevation of mountain chains. While considering physical theories of any character, we must not forget that without acute, persistent, general, and systematic observation, they are to that extent speculative and worthless. Not after observations have been established upon the trembling sides of the volcanoes themselves, and the areas of disturbance throughout the world have been provided with seismological instruments that will automatically record the time, direction, and intensity of the subterranean forces, may we hope to lay a foundation substantial for future progress. Too many persons undertake the grandest and far-reaching generalizations, their contemporaries freely accepting or rejecting them, without a competent knowledge of the elementary facts and principles upon which they must be based. Not only in the acquirements of science but in the advancement of its state a personal knowledge of facts must precede that of its principles, and the latter that of its laws, otherwise we may not approach nearer the truth than the ancient Romans, who ascribed these phenomena to the struggling of giants overthrown by lightning from heaven, which outstretched them beneath the volcanoes, whose eruptions attest the success and sincerity of their efforts for release. We may not, like the natives of Java, annually pour rice into the crater of the Sumbing to appease the God of Destruction, nor, as did the Neapolitans for centuries, march in solemn religious procession behind the elevated bust of St. Januarius toward the invisible devil, quite successfully threatening in the crater of Vesuvius, but unless scientific questions are attacked with method, and a confidence in the uniformity instead of the confusion of law, we shall make no greater progress than they.

Laying aside the deep-seated causes, there is no concord of opinion regarding the formation of the visible part of the volcano. Conceal the upper portion of Vesuvius, we then see a truncated cone whose base sweeps the sea and beautiful Campagna in a circuit of thirty miles. No one questions that the cone above the frustum was formed by showers of volcanic sand, cinders, and lapilli, mingled with melted rock that rose from the crater—in other words, is an accumulation of matter from some point far beneath the earth's surface. A competent authority regards it highly probable that in the smoke, ashes, and cinders of Vesuvius have been carried away over the sea ten times as much matter as covered the neighboring cities and deluged her flanks. No one doubts the truth of Dryden's conception—

"By turns a pitchy cloud she rolls on high,
By turns hot embers from her entrails fly
And flakes of mountain flames that lick the sky.
Off from her bowels massy rocks are thrown,
And, shivered by the force, come piecemeal down."

But is it true, as Humboldt and Von Buch asserted, that volcanoes are formed by an upheaval of strata which are subsequently covered with lava, or shall we believe with Saussure and Lyell that the frustum is formed as the upper cone is formed—by an accumulation of material? This question, like most others in life, must be decided, not by an appeal to honored and reliable "authorities," but by a conscientious appeal to facts. The few observations made on this subject are decisive for the theory of accumulation. It is well known that the diameter of the crater and its height above the sea are continually changing, and it is probable that after it has many times blown the crater high into the air it will finally fill the atrium to the very walls of Somma. We forget that the height of the volcano is very variable. The first barometric measurement of Vesuvius was made in 1794 by Abbe Nollet, who ascertained it to be three thousand three hundred and twenty-six feet in height. Twenty-four years later it was measured by Prof. Forbes, who found that it had gained five hundred and sixty-eight feet, but in 1805, when Gay-Lussac measured it, Vesuvius had lost thirty-eight feet from its last measurement. In 1822 it was measured again by that great scientific traveler, Humboldt, whose result was four thousand and twenty-two feet, and subsequently by Schiavoni in 1863, who determined that it had gained one hundred and forty-five feet since the time of his predecessor. The last measurement was made by Prof. Palmieri, of the University of Naples, the altitude being four thousand two hundred and fifty-seven feet. But these changes in altitude have likewise been accompanied by changes in the diameter of the crater, which has oscillated to measurements greater and less than half a mile for a hundred years. Near the close of the last century its diameter was eleven hundred yards; in 1822, one thousand three hundred and twenty yards; in 1855, six hundred yards; and in 1861, seven hundred and fifty yards. These changes are constant, sometimes lowering its altitude, at other times rendering it more commanding, but enlargement is the tendency, and some time in the distant future it will have expanded so as to cover the Pedimentina, fill the great atrium, and at length assume the form and height of Vesuvius as it was in the days of heroic Sparta and the epic times of Homer. To this future will succeed another in the Psychozoic, when to her beautiful shores there shall have been added other lands now beneath the adjacent sea; then will it be witnessed far inland, solitary as now, its stony and forbidding flanks decomposed to a rich soil, its smokeless cone washed with every storm, but its changeful physique, like its predecessor, Mt. Vultur, a long testimony to the energies that once filled it, a silent monument to the dense but forgotten populations that slept beneath the lavas or hovered about her base.—*Western Review.*

GEOLOGY OF THE POLAR REGIONS.

At a recent meeting of the Geological Society, London, a paper was communicated by Captain H. W. Feilden, R.A., F.G.S., and Mr. De Ranée, Her Majesty's Geological Survey, on the geological results of the Polar Expedition under Admiral Sir G. Nares, F.R.S. The authors describe the Laurentian gneiss that occupies so large a tract in Canada as extending into the Polar area, and alike underlying the older Palæozoic rocks of the Parry Archipelago, the cretaceous and Tertiary plant-bearing beds of Disco Island, and the oolites and lias of East Greenland and Spitzbergen. Newer than the Laurentian, but older than the fossiliferous rocks of Upper Silurian age, are the Cape Rawson beds, forming the coast line between Scoresby Bay and Cape Cresswell, in lat. 82° 40'; these strata are unfossiliferous slates, and grit

dipping at very high angles. From the fact that Sir John Richardson found these ancient rocks in the Hudson Bay territory to be directly overlaid by limestones, containing corals of the Upper Silurian Niagara and Onondaga group, Sir Roderick Murchison inferred that the Polar area was dry land during the whole of the interval of time occupied by the deposition of strata elsewhere between the Laurentian and the Upper Silurian; and the examinations by Mr. Slater, Dr. Houghton, and others, of the specimens brought from the Parry Islands, have hitherto been considered to support this view.

The specimens of rocks and fossils, more than 2,000 in number, brought by the late expedition from Grinnel and Hall Lands, have made known to us, with an absolute degree of certainty, the occurrence of Lower Silurian species in rocks underlying the Upper Silurian, and as several of these Lower Silurian forms have been noted from the Arctic Archipelago, there can be little doubt that the Lower Silurians are there present also. The extensive areas of dolomite of a creamy color, discovered by McClintock around the magnetic pole, on the western side of Boothia, in King William's Island, and in Prince of Wales Land, abounding in fossils, described by Dr. Houghton, probably represent the whole of the Silurian era and possibly a portion of the Devonian.

The bases of the Silurians are seen in North Somerset, and consist of finely-stratified red sandstone and slate, resting directly on the Laurentian gneiss, resembling that found at Cape Bunney and the cliffs between Whale and Wolstenholme Sounds. Above these sandstones occur ferruginous limestones with quartz grains, and still higher in the series the cream-colored limestones come in. The Silurians occupy Prince Albert Land, the central and western portion of North Devon, and the whole of Cornwallis Island. The carboniferous limestone was discovered rising to a height of 2,000 ft., on the extreme north coast of Grinnel Land, in Fiorden and Parry Peninsulas, and contains many species of fossils in common with the rocks of the same age in Spitzbergen and the Parry Archipelago, being probably continuously connected with the limestone of that area, by way of the United States range of mountains. The coal-bearing beds that underlie the carboniferous limestones of Melville Island are absent in Grinnel Land, but they are represented by true marine Devonians, established in the Polar area for the first time, through the determination of the fossils by Mr. Etheridge.

In America a vast area is covered by cretaceous rocks. The lowest division, the Dakota group, contains lignite seams and numerous plant remains indicating a temperate flora; overlying the cretaceous series are various Tertiary beds, each characterized by a special flora, the oldest containing sub-tropical and tropical forms, as various palms of Eocene type. In the overlying Miocene beds the character of the plants indicates a more temperate climate, and many of the species occur in the Miocene beds of Disco Island, in West Greenland, and a few of them in beds associated with the 30 ft. coal seam discovered at Lady Franklin Sound by the late expedition. The warmer Eocene flora is entirely absent in the Arctic area, but the Dakota beds are represented by the "Atane strata" of West Greenland, in which the leaves of dicotyledonous plants first appear. Beneath it, in Greenland, is an older series of cretaceous plant-bearing beds, indicating a somewhat warmer climate, resembling that experienced in Egypt and the Canary Islands at the present time. In the later Miocene beds of Greenland, Spitzbergen, and the newly discovered beds of Lady Franklin Sound, the plants belong to climatal conditions 30° warmer than at present, the most northern localities marking the coldest conditions. The common fir (*Pinus abies*) was discovered in the Grinnel Land Miocene, as well as the birch, poplar, and other trees, which doubtless extended across the Polar area to Spitzbergen, where they also occur.

At the present time the coasts of Grinnel Land and Greenland are steadily rising from the sea, beds of glacio-marine, with shells of the same species as are now living in Kennedy Channel, extending up the hillsides and valleys slopes to a height of 1,000 ft., and reaching a thickness of 200 ft. to 300 ft. These deposits, which have much in common with the "boulder clays" of English geologists, are formed by the deposition of mud and sand carried down by summer torrents, and discharged into fords and arms of the sea, covered with stone and gravel-laden floes, which, melted by the heated and turbid waters, precipitate their freight on the mud below. As the land steadily rises these mud beds are elevated above the sea. The coast is fringed with the ice-foot, forming a flat terrace 50 to 100 yards in breadth, stretching from the base of the cliffs to the sea margin. This wall of ice is not made up of frozen sea water, but of the accumulated autumn snowfall, which, drifting to the beach, is converted into ice where it meets the sea water, which splashes over it.

DYSPEPSIA.

By Dr. C. F. KUNZE.*

[Translated from the German, for *The Hospital Gazette*, by PAUL H. KRETZSCHMAR, M. D., of Brooklyn, N. Y.]

DYSPEPSIA means "difficult stomach digestion," and is as such one of the most common symptoms of anatomical changes which have taken place in the stomach, but it is also a symptom of conditions in which the normal structure of the stomach is not altered or in which, with our present state of knowledge, we are unable to detect any structural changes. In the following pages this second form of dyspepsia only will be considered, and it may be stated here that just in proportion as our medical knowledge advances, the number of cases belonging to this class will diminish.

Symptoms.—The patients complain, especially after taking food, and sometimes only after they have eaten certain articles, of a sensation of heaviness and fullness in the region of the stomach. Real pain is not generally experienced. Often there is a nausea, occasionally vomiting, the stomach is bloated, in most cases the appetite is diminished, and, sometimes, patients have an entire lack of appetite for any kind of food. Some patients have a remarkable desire for highly spiced articles. The stomach digestion is much slower than normal. Percussion shows the presence of undigested food a long time after nourishment has been taken. The patient feels weary, he has no desire for mental or bodily work, and often complains of a very severe "compressing" pain in the forehead, and in the occipital region. If vomiting occurs,

* The work from which this translation has been made is entitled "Lehrbuch der Praktischen Medizin, mit besonderer Berücksichtigung der Pathologischen Anatomie und Histologie," Leipzig, 1878. It is a work which is considered by competent judges to be in many respects superior to Niemeyer. It was first published in Germany in 1870, and has since been translated into French, Italian, Dutch, and Spanish, and has reached its third edition in Germany. Several chapters of the translation are now ready for the press, and we shall present them to our readers as opportunity offers.

the food is thrown up, sometimes hours after it has been taken, in an undigested state. Not unfrequently it is saturated with foul gases, as the product of decomposition which has taken place within the stomach. If the quantity of gas present is at all considerable the stomach presents a bloated condition, known as *flatulence*, and it attempts to empty its gaseous contents by frequent eructations (ructus). Sometimes the matter vomited is of an acid reaction, depending on the presence of butyric and acetic acids. The abnormal formation of acid also gives rise to an unpleasant burning sensation in the œsophagus and pharynx (Pyrosis). The tongue is no certain criterion; in some cases it is thickly coated, in others it is entirely clean. In cases of dyspepsia of short duration, caused by an overloaded condition of the stomach, or depending on the presence of indigestible food, great relief and often permanent cure is obtained by free emesis. Not unfrequently, however, vomiting does not occur, the ingesta are not thrown up, but enter the small intestines and produce pain, cramps, rolling, flatulence, and either diarrhea or—as is often found among children—obstinate constipation. Among children such a condition is often followed by fever and restlessness at night, by increased frequency of respiration and pulse, and even by general convulsions which may prove fatal.

In chronic cases of dyspepsia, mental despondency and hypochondria are frequently developed: the state of the patient's nutrition becomes impaired, emaciation takes place.

The unpleasant sensations of fullness and pressure in the region of the stomach become permanent, and the patient complains about them even while the stomach is empty. At that time the symptoms frequently depend on a condition of chronic gastric catarrh, which often develops during the course of dyspepsia.

Etiology.—Dyspepsia—derangement of the digestive function of the stomach without any known structural changes—depends either on *ingesta*, or on a *disturbed condition of the general system*, or on *altered innervation*.

I. *Dyspepsia ab ingestis* is caused: (a.) by overloading the stomach with food, which by itself is not injurious, but interferes with proper digestion only by its quantity. To digest food properly it is only necessary that the quantity of food introduced stands in proportion to the digestive power of the stomach. If a larger quantity of food be introduced at once, the gastric juice is unable to digest all of it, the muscular action of the stomach becomes exhausted, the organ itself becomes debilitated, expanded, and the food remains longer in the stomach than normally.

(b.) By the introduction of articles which are *indigestible*. All articles which cannot be acted upon by healthy gastric juice are to be considered as belonging to this class, viz.: cartilage, tendons, tough meat generally, hard boiled albumen, etc.

(c.) By the introduction of articles which either tend to *float away* or *dilute* the gastric juice. Dyspepsia depending on this cause is often produced by drinking large quantities of cold or warm water in the morning—as has been recommended by Bock and others. To drink much cold water with the meals is not only injurious for its diluting effect on the gastric juice, but also because it diminishes the temperature of the stomach to such a degree as is incompatible with healthy digestion (Beaumont).

(d.) By the introduction of articles which influence the *chemical composition* of the gastric juice *unfavorably*. To this class belong the articles which prevent to a larger or smaller degree *fermentation*, viz.: strong coffee, tea, alcoholic drinks, etc.; all articles which are easily transformed into *acetic, butyric or carbonic acids* (carbo-hydrates) or those which are previous to their introduction into the stomach in a condition of *partial decomposition*, viz.: sour milk, sour lager beer, mouldy wine, etc.; or finally those articles which are *almost entirely decomposed*, viz.: old cheese, bad meat, etc. If the food, after its arrival in the stomach, cannot be digested properly, and especially if acetic and butyric acids are formed freely, the gastric juice itself becomes converted into acetic and butyric acid and a deranged condition of the digestive apparatus is developed, which is known under the name of "*dyspepsia acida*." The secretion of these acids by the peptic glands themselves, as has been supposed in individual cases where their presence has been frequently observed, has not been proved physiologically. Conditions of the stomach peculiar to the individual have, however, a marked influence as to the predisposition to the formation of acetic and butyric acids from the food which has been introduced. This form of dyspepsia, due to the formation of acetic or butyric acids, has nothing to do with an excessive formation of hydrochloric acid, which latter is a necessary constituent of the gastric juice and is *essential* for the digestion of food. It is a wide-spread mistake that the sour eructations of patients are due to the *excessive* formation of that kind of acid which enters into the formation of the gastric juice. The recent examinations of Leube and others show that stomach digestion depends on the presence of a certain quantity of hydrochloric acid, and that dyspepsia is much oftener caused by a deficiency of hydrochloric acid than by an excess of it. Even in vomited matter of peculiarly acid smell hydrochloric acid is mostly wanting, the acid reaction being due to the presence of acetic or butyric and not of hydrochloric acid. The question whether an increased quantity of hydrochloric acid in the gastric juice is injurious has not been determined as yet; it seems to me the only action it could have would be to cause a too rapid stomach digestion.

Not unfrequently the gastric juice is observed to act in the contrary manner. It is sometimes of *alkaline reaction*, especially if large quantities of saliva are swallowed, as is found to be the case with smokers, or in cases of catarrh of the mouth and pharynx; gastric juice of alkaline reaction cannot perform its functions and dyspepsia must follow.

II. *Dyspepsia depending on a deranged condition of the general system* is found to be present in all diseases which are accompanied by well defined febrile movements. Beaumont observed in such a condition the direct decrease and even the suppression of the gastric juice. It seems as if, in such cases, the more rapid retrograde metamorphosis depending upon the high temperature of the body interferes with the production of gastric juice. Dyspepsia is frequently observed, and forms a very troublesome complication in cases of rickets, scrofulosis, arthritis and diabetes, as a more or less constant symptom of the deranged condition of general nutrition. The relation which dyspepsia bears to the diseases mentioned is not altogether understood as yet.

III. *Dyspepsia depending on an altered condition of innervation* is observed in cases of hypochondria, hysteria, home-sickness, neuralgia, etc. The secretion of the gastric juice depends just as much on the nervous influence as the secretion of saliva and many other functions of the different organs. Cases of dyspepsia, following the continued use of opium or other narcotics, belong to this class, though there is in such cases a mechanical influence acting which should