his apparatus may be constructed. In Fig. 2, piles are driven down into the mud, etc., until their lower ends meet hard pan, and above them the masonry of the tunnel is built, as shown, concrete being placed over all. The other plan, in Fig. 3, involves digging down directly to bed rock, and building masonry therefrom upward, filling in the lower part with concrete, up to the desired level of the tunnel floor.

The invention is covered by four separate patents, granted to Mr. John E. Walsh, of 333 West street, New York city, to whom inquiries for further particulars may be addressed.

Scientific American.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

NO. 37 PARK ROW, NEW YORK.

O. D. MUNN. A. E. BEACH.

TERMS.

One copy, one year, postage included.....$3 20
One copy, six months, postage included..... 1 60

Club Rates:

Ten copies, one year, each $2 70, postage included.....$27 00
Over ten copies, same rate each, postage included..... 2 70

☞ By the new law, postage is payable in advance by the publishers, and the subscriber then receives the paper free of charge.

NOTE.—Persons subscribing will please to give their full names, and Post Office and State address, plainly written, and also state at which time they wish their subscriptions to commence, otherwise the paper will be sent from the receipt of the order. When requested, the numbers can be supplied from January 1st, when the volume commenced. In case of changing residence, state former address, as well as give the new one. No changes can be made unless the former address is given.

VOLUME XXXII., No 19. [NEW SERIES.] *Thirtieth Year.*

NEW YORK, SATURDAY, MAY 8, 1875.

Contents.

(Illustrated articles are marked with an asterisk.)

AN INLAND PENIKESE.

The success of the School of Natural History at Penikese is an encouraging indication of the growing demand for truly scientific teaching. Another indication is the favor accorded to Professor Shaler's project for an inland school of observation, to be located in the coming summer near Cumberland Gap, Ky.

Several conditions unite to make the site chosen a favorable one for an out-of-door school. The region has never been scientifically explored: the Gap is admirably fitted by Nature for the study of a great section of the fossil-bearing rocks of this country, from the Lower Silurian to the Upper Carboniferous, and for the investigation of the Appalachian system of mountains; and subsistence is incredibly cheap, milk ten cents a gallon, eggs five cents a dozen, etc. Last, but not least, the cöoperation and assistance of the thoroughly organized staff of the State Geological Survey, of which Professor Shaler is chief, will be given to the enterprise.

The special object of the school is to teach students to observe; consequently only a limited number (25) of picked men will be admitted—graduates of colleges, teachers and others, capable of appreciating and profiting by the instruction given. Among the instructors will be Dr. Asa Gray, Professor J. D. Whitney, Rafael Pumpelly, and others, besides the members of the State Surveying Corps. The various departments of geology will be chiefly studied, but only with a view to the elucidation of the problems presented by the area under exploration. Some attention will also be given to the zöology and botany of the district.

As might have been expected, the applications have been far in excess of the number that can be accepted. If successful—and it can hardly fail to be—this camp school is likely to become a permanent institution, with a new camp ground every year.

THE CHAIN OF CRIMINAL ENTAILMENT.

Having studied crime and criminals for thirty years, the New York State Prison Association concludes (in its annual report, just presented to the Legislature) that to reduce the criminal classes and break up the entailment of the evils of pauperism and crime, "which defy remedies and curative discipline in adult lives," two things are specially required, namely to sever the links in the chain of such entailed evils, and to instruct, train, and save all the children.

To use a homely saying, it is saving at the spigot and wasting at the bung to attempt the repression of crime solely through action upon adult criminals. So long as the chain of criminal entailment is unbroken, the most searching and rigorous police system possible is powerless to purge the community of evil acts and evil tendencies.

The judgments of the association are sound, so far as they go: but they do not go far enough. It is easy to point out the necessity of severing the chain of criminal entailment; the question remains: How is it to be done?

No one remedy will suffice for so complicated a disease of the social system. The structure of the chain is triple, and each element demands special treatment. The first element is heredity. The parent's crime is the child's inheritance, not absolutely, but as a rule; and the chances against the proper moral development of the progeny of the vicious are so overwhelming that it were better for the world were such children never born.

The second element is miseducation. By conscious teaching or unconscious example, the criminal classes are continually corrupting the honest and contaminating the pure The child of virtue may thus become a monster of vice and the head of a line of evil doers.

The third element is what we may call moral atavism. Constitutional virtue is the product of long culture, the fruit of moral habits covering many generations. Yet, as in herds of blooded stock there will be an occasional reversion to the primitive type, so in good families there will now and then arise children in whose moral composition the barbarism of remote ancestry strangely dominates. Instead of being heirs of all the ages, such unfortunates inherit only savagery.

What the causes and conditions of such reversions are, no one knows, though the fact is painfully patent in the "black sheep" which afflict so many domestic flocks, boys and girls who turn out badly in spite of virtuous parentage and the most careful education. Time alone can cut off or dry up this source of crime.

The means for preventing the production of criminals by education or example are twofold: The careful training of all children in habits of industry and virtue, and the rigid seclusion of all offenders against the public weal. As the community now compels the absolute retirement from public intercourse of all persons afflicted with malignant infectious diseases, so in time, we believe, the morally diseased will be isolated, not for punishment, but as a necessary precaution against the corrupting of others: a measure that will be made possible by the relative rareness of crime when the most fruitful source of criminality- -hereditary transmission —shall have been dried up.

Herein lies the great problem of prison management, to isolate the evil-disposed so as to prevent depredations against the life and property of the law-abiding and the moral purity of youth, while making the criminal classes self-supporting and, at the same time, furthering so far as possible their reclamation to paths of virtue. On these points the views of the association show an encouraging progress toward what we have heretofore styled the scientific treatment of criminals.

Touching hereditary crime, the suggestions of the association are palliative merely. Given children born with a criminal bias, the best thing undoubtedly is to counteract, so far as may be, their evil tendencies by proper training in childhood and moral surroundings in later years. So far, good: but the time has come when preventive measures also should be considered. Is it possible to lessen the number of the inheritors of crime-compelling organizations by making their generation less frequent? In plainer words, can the community prevent known criminals from completing the chain of criminal entailment?

X, a male, and Y, a female, are convicted criminals, come of criminal parentage. In all human probability their children will be criminals. Has the community any right to allow the future to be afflicted with their pernicious progeny? We say: No, no more than they should be allowed to erect a house or build a dam in such a way as to imperil life and property ten years hence. That the resultant evils can be prevented in the one case as surely as in the other (not absolutely, but very largely), we are confident. The question is: Which of the several possible ways of doing it is most consistent with our modern views of what is just and profitable?

The summary execution of criminals of every grade would soon put an end to hereditary crime: so too would the Spartan custom of killing all suspicious or undesirable infants. But these remedies are so horrible, so obnoxious to our moral sentiments and sense of justice, that they are not to be thought of. Two other methods remain: To set apart all criminals permanently, in communities or colonies, with the sexes separated, as lepers are treated in the Sandwich Islands or to eliminate their power of propagation, as suggested in our article on the generation of the wicked.

So long as the criminal classes are so numerous, their isolation is beset with many difficulties. The crime committed, not the character or moral needs of the criminal, determine the period of his seclusion. To sever the chain of heredity, the convict's imprisonment would have to be for life, regardless of the severity of his crime or the thoroughness of his subsequent reformation. This would require the capacity of the penal colonies to be immense and very burdensome to the innocent, since it would be only under peculiarly favorable circumstances that the isolated communities could be made self-supporting. Nevertheless prisons and penal colonies will always be needed, if not for punishment, at least for the separation of the criminally infected from the morally healthy, for the safety of youth.

Use would be found for them also as alternatives to the last named plan for breaking up the entailment of crime. The criminal might have the choice of the two preventives of heredity, loss of freedom with sexual isolation, or the enjoyment of civil liberty with sexual impotence. In either case the terrible stream of criminal entailment would largely cut off at its source.

The surprising favor with which the suggestions made in "The Generation of the Wicked" have been received throughout the country shows that thoughtful men are everywhere dissatisfied with the costly insufficiency of our present methods of dealing with crime, and convinced that they need to be not merely reformed but radically changed. The Prison Association might find it profitable to push their investigations into this field of inquiry also.

PICTURES BETTER THAN STORIES.

We are constantly endeavoring to impress upon our readers the advantage which a picture possesses, either as a direct substitute for verbal description or as explanatory of the same. A rough sketch will, in nine cases out of ten, convey one person's idea to another more clearly than pages of labored, written details; and this is why we ask people who send us questions about machines, or mathematical or mechanical problems, to use their pencils as much as possible; while we counsel others who cannot sketch to acquire some knowledge of that very useful accomplishment. Time is a very valuable commodity; and the mechanic or professional man, whose leisure time is seldom great, has little liking for poring over a long description when half a dozen lines, in the form of a sketch, will enable him to seize the gist of the idea in perhaps as many seconds. This is one of the reasons why we advise the inventor, who has a new idea to show to the world, to exhibit it by a picture whenever possible, and to distribute that picture widely among the people whom his production is likely to interest.

The value of pictures, or rather their superiority over words, as story tellers, is excellently illustrated by a couple of incidents which we find related in a foreign contemporary. In a village in India, recently, it became necessary in the course of some engineering operations to transport an enormous mass of metal, weighing several hundred tuns, from one point of the town to another. Ordinary means were out of the question; and as the engineers found themselves unable to devise any process, they did the next best thing, and wrote to other engineers in England who were constantly supervising such work. The latter, instead of writing out nice large pages of foolscap, beautifully embellished with Greek letter formulæ and red ink, quietly waited until the next big piece of metal which they had to transport offered a favorable opportunity. Then they prepared a camera, and photographed every step of the operation, together with all the tools and appurtenances and forwarded the prints from the negatives to India. These the engineers in the far-off country followed, and with little difficulty accomplished their task.

Another instance is that of a bridge, also to be constructed in India but not yet completed. This work involves the placing of very heavy weights and certain difficulties incident to the rapid changes of level of the water to be crossed. At the present time just such another bridge is in process of erection in London, and the assistance of photography is again called in. As the London bridge advances toward completion, photographs are constantly made; and so when the Indian engineers begin their work, they will be in possession of a set of guides of invaluable assistance to them.

SOME CURIOUS RESULTS OF EXPERIMENTAL SURGERY.

The power of the lower forms of animal life to withstand mutilation is well known. Cut an angle worm in two, and the tail end will reproduce the head and the head a tail. Other worms may be cut into many pieces and each fragment will straightway develop a complete worm. A polyp will endure decapitation a score of times, a new head growing on every time. In like manner, the stomach of one of these creatures is capable of developing all the other parts. Still lower in the scale, the normal method of multiplication is by division, and elementary cells of more highly differentiated organisms seem to retain more or less of the primitive character. By virtue of this inheritance, spiders reproduce their lost limbs and crabs their claws. In the higher forms of life, the power diminishes so far as complex organs are involved; still it is retained to a much greater degree than is commonly supposed.

Pull out a hair or a finger nail, and it will grow again. Remove a portion of the skin and it will be renewed, unless the wound is too broad or the life of the surrounding parts too feeble. Even then it is possible to transplant to the denuded surface minute particles of skin from other parts, and in a short time these epidermic islands will extend their borders until the wound is covered and the sore heals with scarcely

a scar. In like manner a severed finger may be made to grow together again, and an amputated nose built up in form with live flesh from the cheek.

In such cases muscular fibers as well as skin are restored or reunited by internal growth. This may be observed also wherever a deep cut is healed. It has been found, too, that the muscular tissues which perform involuntary motions in the interior of the body possess the same power of self-restoration. It is this recuperative faculty which enables the cattle of Abyssinia to supply their barbarous owners with steaks without losing their lives. The hungry savage throws his ox upon the ground, makes a cross cut in the skin of the flank, lifts the skin and cuts out a chunk of beef for his dinner, replaces the skin, and drives on rejoicing, trusting to internal growth to restore the mutilated part to health and soundness.

In every wound of the skin or muscle, nerves are severed. The restoration of the functions of feeling and motion, with the progressive healing of the wound, shows that the nerves are likewise capable of reparation. The renewal of nerve connection has been watched in cases, where, as is sometimes necessary, a section of a large nerve has been cut out. In a couple of months after the nerve is cut, a gray lump appears on one extremity of the severed nerve. Growth proceeds towards the opposite nerve end until a new connection is made, at first more slender than the original; but by degrees the nerve elements increase in size and whiteness, until, in from four to six months, the nervous cord is fully restored. This process, it is said, goes on even when two inches of nerve has been excised.

About a dozen years ago it was demonstrated that cartilage, formerly supposed to be incapable of renovation, was also subject to the same laws. The cartilaginous tissue of dogs and rabbits was divided, and at the end of two months was found to be completely restored. Similarly the tendons by which muscles are attached to bones are able to reunite when severed or torn out: a fortunate circumstance for a prominent clergyman of this city, whose *tendo Achillis* was suddenly snapped while walking along the street one day last winter, thus making his foot temporarily useless. Thanks however, to the gradual reunion of the tendon, the crippled limb will in time be restored to usefulness.

Still more remarkable is the restoration of bones, and even the development of bones in abnormal positions by the transplanting of the periosteum, the membrane surrounding bony structures and the principal agent in elaborating them. Formerly, in case of a badly shattered or diseased bone, the amputation of the limb was the only resource. Now the skillful surgeon excavates the damaged parts; and in a few months the limb, which has never lost its form, repairs its losses, and regains its strength. Attempts have also been made to graft healthy bones in place of diseased ones, but they have fallen short of perfect success. The transplanting of teeth has been more successful, and partial success has attended the reproduction of teeth by a sort of budding process. In its natural development, a tooth springs from a little bay or follicle, containing an organ or germ for the production of the ivory of the tooth and one for the enamel. The entire follicle taken from a puppy and grafted into the jaw of an adult dog continues its development, and a perfect tooth is the result. Doubtless the same would occur in human jaws, and possibly the dentist of the future will be prepared to set the germ of a new tooth in the place of each one he extracts, giving the patient a choice of the whole range of mammaliar dentition!

Among the curiosities of this sort of surgery, we may mention the trumpet-nosed rats with which a waggish student puzzled the naturalists of Paris. By grafting the tip of one rat's tail into the snout of another rat, he produced a nondescript creature with a trumpet-shaped proboscis, for which it had no use; yet the connection of the nerves and blood vessels was complete, and the sensibility of the part so keen as to preclude the idea of mechanical attachment. Similarly cock's combs have been furnished with teeth and spurs by transplanting.

THE RECENT REMARKABLE PROGRESS IN THE STEEL INDUSTRY.

We are inclined to believe that very few of our readers have any idea of the immense progress which has been made in the steel industry in this section of the country during the past few months. When we state that American pig has been obtained as low as $32 per tun, from which the rails produced included but one per cent of second quality, as against imported pig at $65 per tun, which yielded from ten to twelve per cent of second quality rails, eighteen months ago, we need hardly point out that competition, under these conditions, is out of the question, and that the foreign metal in our markets bids fair to lose whatever footing it may still possess. Add to the above that, with the exception of such as has been necessary to complete old contracts, no English rails have been imported into this country for some nine months, and that the importation has without doubt ceased for ever, that the Grand Trunk Railway of Canada, whose president and many of whose directors are heavy stockholders in the great Barrow plant, have found it to their interest to order 6,500 tuns of rails from the works in Troy, N. Y., rather than send to England, and that 120,000 tuns of ore, from which steel can be at once produced, with anthracite coal and without admixture of other ores, can be annually mined at the Crown Point mine in this State; and perhaps we have adduced sufficient instances to bear us out in the view that the steel production of this country is rapidly advancing toward a point of close competition with that of Great Britain.

It is well to bear in mind that the extraordinary strides which we have indicated have mainly taken place since the exploitation of the Crown Point mine, near Lake Champlain, in New York State, and have been aided by the consolidation of the two great iron-making establishments of Troy, formerly under the control of Messrs. Erastus Corning and John A. Griswold, into one great corporation, now known as the Albany and Rensselaer Iron and Steel Company. The ore of the mine above mentioned is of singular purity, and so well adapted for steel making that it finds a market in the heart of the Pennsylvania iron district, no less than 40,000 tuns being sent thither during the present year. The Port Henry product yields seventy per cent in the furnace, and the deposit is seemingly inexhaustable. The ore, however, is not capable of being smelted into steel. There is a single wall, 225 feet high by 300 feet face, of ore, while the roof is supported by pillars of ore, each containing from sixty to seventy-five thousand tuns. Upwards of $2,000,000, we are informed, have been spent in developing these resources.

The consolidated works above mentioned use up about 100,000 tuns of pig metal yearly, and can produce about 24,000 tuns of the same from their own furnaces. Their coal expenditure is in the neighborhood of 150,000 tuns.

The melting of pig for conversiou is about 300 tuns per day, and the product of steel rails 1,100 tuns, or two and a half miles, per week, two five tun converters literally turning out as many ingots in weight as is accomplished in Barrow with seven converters of like size. The metal is cast in ingots weighing a tun each, and from the time it leaves the cupola it never stops until it results in a finished bloom. Hammers are abolished and rolls substituted, and herein lies one of the important causes of the reduced cost and improved quality of the product. The latter is, by the drawing in lieu of the pounding process, rendered far more homogeneous and far more uniform throughout; while the celerity of the operation, due to the novel machinery which has been introduced, is certainly most remarkable. Each ingot makes three rails, and the bar, which on entering the rolls is thirteen inches square, is reduced to six inches in a single heat. The time occupied by the steel in changing from the bloom to a finished rail is one minute and thirty seconds. It is impossible, within the limits of this article, to describe the tables on which the metal is lifted, or the automatic fingers which turn it to present it to the rolls, or, indeed, any of the ingenious mechanism which reduces the labor of eighteen men to that of one man and a boy, and handles the great masses as if they were feathers. This we reserve for a future time, when the pencil of the artist can aid our explanation, and when we shall be enabled to tell how ingots weighing two tuns instead of one are as deftly manipulated. The cost of making the pig is about $32 per tun, and from this steel, worth $75, a sum which allows the manufacturer a fair profit, comes in competition with the English production, for which $95 is demanded on this side of the water.

The facts which we have mentioned will appear to many incomprehensible when the unsettled condition of labor in Troy for some time past is recalled. This state of affairs certainly renders the circumstances all the more remarkable, for that which has been done has been accomplished in the face of strikes, and during the prevalence of trade union intimidation, when reliable workmen were few and far between. In all the great works above mentioned, not a union man is employed. Abnegation of trade societies is a rigid condition upon those hired. As a result, skilled labor has had to be manufactured.

Brains and the green hands did what we have told; skilled labor found itself for once unable to overcome its employers as it did in Pittsburgh, and skilled labor, in the persons of the trades unions, went to the wall. Meanwhile the day laborers, the carpenters, the bakers, and who not, collected in the great plant, have, under the direction of enterprising capital, brought forth from its furnaces a production twenty per cent greater than ever before. Still better and greater, they have been the means of demonstrating to the nation that the days when the ships that float our commerce, when the mechanism which represents the highest of our inventive skill, and when the arms which protect us against our enemies, are but sources of profit to foreign hands are soon to be numbered with those for ever past.

The enterprise which has so successfully developed these resources, and the executive skill which has organized and governed the labor of this great undertaking, exhibit a power not only to emancipate the country from a foreign product, but also to free labor from the despotism of the trades unions.

CIMEX LECTULARIUS.

A correspondent, who states that he has perused with much gratification our recent article on the "Mission of the Fly," based upon Mr. Emerson's ingenious researches, sends us a pathetic epistle, in which in a few poetic, almost Miltonic, phrases he depicts dire nocturnal anguish; and then, lapsing into gross utilitarianism, he demands if we know anyuse for the bedbug. There is a vein of subtle sarcasm, we fear, underlying the request of our correspondent, or else he would not have made it; for the utility of that odoriferous insect as a stimulator to the invention of new expletives and of patent vermin eradicators is certainly unquestioned.

Still, and seriously, the writer seems to have unwittingly wandered into that same error in which nine out of ten of those whose motto is *cui bono* find themselves involved. It is an entire mistake to suppose the human race of such overweening importance in the scheme of creation that everything else is made for its benefit only. All things animate and inanimate are undoubtedly created for some wise purpose, but that such is always to enure to the advantage of man by no means follows. There have been periods in the earth's history when nothing on the globe was of the slightest human utility: man could not even exist. Again, still later, the earth, though inhabited by living beings, was unfit for humanity, for the creatures which then flourished would speedily have exterminated it. Because, then, the human race now dwells and multiplies upon the globe, there is no reason to suppose that its enemies have utterly disappeared, any more than there is to warrant a like supposition regarding things hostile to any other living creature. That the number of enemies of man is constantly decreasing is true, and that some time they may altogether disappear is not without the bounds of imagination; but it nevertheless is just as plausible to believe that the great cave bears and other gigantic brutes which peopled the earth at man's advent did not attack him a whit less fiercely than *cimex* does now. In fact, we have no doubt that some troglodyte in the recesses of his cavern, or lake dweller perched on his pile-supported lacustrine habitation, has wondered of what earthly use cave bears, and wolves, and hyenas, and gigantic saurians were, with as much fervor as any modern individual has vexed his brain with the same thought after a night's combat with the minute pests.

Clearly, then, the attempted destruction of ourselves by the bugs is only one link in the chain which pervades all animated nature, and therefore it is with equal plausibility that it may be asked: of what use are we to the bedbug? as of what use the bedbug is to us. Our correspondent who describes the effect of the ravages of *cimex* so graphically certainly will require no answer to the former question.

We know nothing good of the bedbug; he has never found, so far as we can learn, but two defenders: one, an insane Englishman who made a pet of him, and left, on dying, to his disgusted heirs, a room swarming at every point; the other, a Banian hospital at Surat, India, in which a ward was devoted entirely to vermin, as other wards were to various kinds of animals. Forbes, in his "Oriental Memoirs," says: "The overseers of the hospital frequently hired beggars from the streets, for a stipulated sum, to pass a night with the fleas, lice, and bugs, on the express condition of suffering them to enjoy their feast without molestation."

It is said that bedbugs did not appear in England until after the great fire in London in 1666, and then they arrived in the wood imported from America for rebuilding the city. It is hardly necessary for us to suggest that the bedbug, being indigenous to our soil, offers a grand opportunity for the display of another great national resource at the Centennial. Specimens of *cimicidæ*, as reared in different States, and perhaps a working model of a boarding-house bedstead, in which might be displayed the entire mode of raising the insects, would be of deep and lasting interest to foreign visitors. The fact of Pliny mentioning the bug several hundred years earlier than the time of the English writer, however, rather throws a doubt upon the assertions of the latter as to the origin of *cimex*. A variety of them certainly does infest pine woods—*ergo*, beware of pine furniture—and has been frequently found in the great forests of Sweden, and hence it is probable that in the pine lumber carried across the Atlantic whole colonies of the pest existed, which merely added to the stock already accumulated in Britain.

It is a curious fact that, in an old edition of the Scriptures known as Matthew's Bible, published in the middle of the last century, the passage translated in our modern version "thou shalt not be afraid of the terror by night" is rendered "thou shalt not nede be afraid of any bugs by night": a plausible translation in times when houses were so infested that two noblemen, after an attempt at rest in an inn, "were grievously frightened the next morning and sent for a leech, lest they were stricken with the plague."

Cimex, among other peculiar traits, hates horses and wages desperate war on fleas. He will not attack fowls, but will swallows and bats. Goeze has kept him six years without food, and he has withstood a temperature of 5° below zero, Fah., without injury. The female deposits 250 eggs at a time, which require three weeks to hatch. Against these there is practically no remedy save mercury: heat, cold, moisture, and dryness being alike destitute of effect. The insect is possessed of keen sight and of an exquisite sense of smell, by the latter of which, and not (as popularly supposed) by the sensation of heat, it is guided to its prey.

The arch enemy of the bedbug is the *reduvius personatus*, a bug which rolls itself into a ball, covers itself with dirt, and then lies motionless in wait, pouncing on the unsuspecting *cimex* the moment the latter comes within reach, and sucking its carcass dry. The objection to training and rearing the *reduvius*, as a hunter of bedbugs, is that it bites the human race with much more spite than it does its natural prey.

Finally, the use of *cimex lectularius*—if he have any, beneficial to man—is simply to preach cleanliness; for where that is maintained, he finds no resting place.

Robert Hardwicke, F.L.S.

Mr. Robert Hardwicke, founder and publisher of *Science Gossip*, a very excellent English periodical, devoted mainly to entomology, zöology, and botany, recently died of paralysis. Mr. Hardwicke is well known on both sides of the Atlantic as a zealous promoter of the cause of Science, which he has materially aided by the publication of its literature in cheap and popular form. He was an earnest advocate of the study of Nature as the greatest of all text books; and the main object of the journal, to which he devoted his best endeavors, was to inculcate like ideas among all students of Nature's works.