to set the gas check and warm the gun. These charges gave pressures from previous records of about 11 tons to the square inch. When all was ready, ten rounds, with full charges and projectiles, were fired rapidly, the ten shots being delivered in 19 minutes and 8 seconds.

The gun stood the ordeal without rupture, being the first American high-powered cast steel gun that has endured a full charge firing test of ten rounds. Whether the piece has been injuriously enlarged or strained in the trial, extended experiment alone can show.

TERRACED IRRIGATION PROCESS OF SEWAGE DISPOSAL.

T. O'CONOR SLOANE, PH.D.

The problem of sewage disposal cannot as yet be said to be adequately solved. In England, sanitarians propose new methods of treatment continually. Disinfection by chemical treatment, precipitation of the solid matter by mechanical deposition, or its removal by filtration have all been tried in every conceivable modification. Even electricity has been called in, and the electrolytic treatment is now exciting considerable attention. It is possible that a wrong conception underlies these attempts. A perfect method seems hardly realizable. Different circumstances make each case individual, and exact individual treatment.

For small systems, the subsoil irrigation method has, up to the present, met with perhaps the greatest success. Under proper conditions, it is quite inoffensive, and can dispose of large quantities of fluid. Its general principle involves the sudden and periodical delivery of the more liquid portions of sewage over a large area of ground about eighteen inches beneath the surface. The liquid matter is disposed of in three ways. A part is absorbed by the roots of the vegetation covering the soil. This portion naturally varies in amount, and in summer is far greater than in winter. A second part evaporates, after penetrating the overlying soil. A third part sinks into the subsoil.

To make the system work well, a piece of ground not too depressed must be chosen, in order that this drainage of the third portion, as specified above, may be effectual. If the soil is saturated with natural moisture, it will not answer as a filter bed. In such a case, subsoil drainage pipes must be put in below the irrigation system. The water collected by the subsoil lines will be more or less purified by the downward filtration. It will be diluted by natural water so as to be less offensive, and in many cases it can be delivered to the natural overground water courses without perceptibly polluting them. If the stream or river ultimately receiving the outflow should be in some degree polluted, it will, sooner or later, become pure again from the effects of aeration. Simple contact of running water with the air tends to purify it from offensive matter. The more broken the course of the water, and the thinner the sheet in which it is exposed to the air, the more effectual will be its purification for a given distance or time.

All these principles and methods are utilized in the arrangement here illustrated. The Waring or subsoil irrigation disposal is the basis of the work. The system is represented as applied to providing a sewage works for a small village or community.

For the sewage farm and disposal works, a piece of ground should be chosen that is lower than any of the area included in the sewer or drainage system. The field or farm must vary in level; one portion must be at least five feet lower than the other, a greater difference being desirable. This is easily secured by having a reasonably large piece of ground devoted to the work. Some kind of surface drainage—a stream or river is best—should be obtainable near at hand.

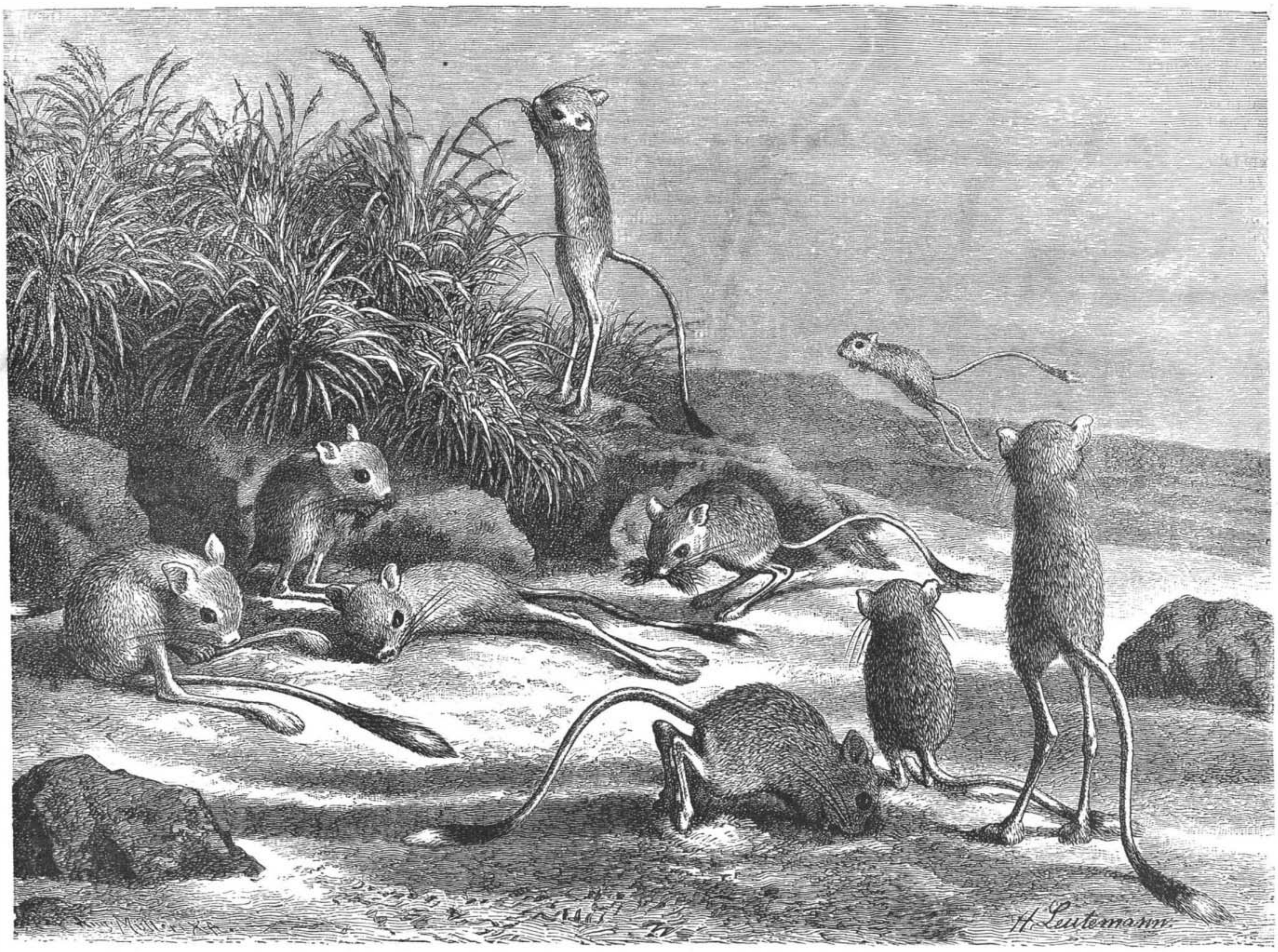
The sewage is received in a settling tank. In this receptacle it may be treated with chemicals, or it may receive them before entering. If in an isolated locality, the natural precipitation may suffice, the chamber containing the tank being properly ventilated. The principal object of chemicals would be to deodorize it. From the settling tank it overflows into the siphoning tank. From this it is periodically discharged by a siphon of any of the well known types. The liquid matter runs into the sub-surface perforated irrigation pipes, and is distributed through the soil.

Where a systematic sewage disposal is the whole function of the area, plants can be selected for cultivation upon the sewage bed that have the greatest power of assimilating water. Red clover is a good instance, as its roots penetrate very deeply. Perennial or hardy crops might exercise a good effect, even in winter. No attempt should be made to obtain a paying result. The disposal works should be treated as a subject of expense, not of profit.

Three to five or more feet under the sub-surface pipes, a set of regular subsoil drainage pipes are placed. These are represented in the illustration as crossing the others at right angles, though the relative disposition is really immaterial. At one or more places the higher ends of these pipes are connected to a high chimney. This maintains a continual aeration of the pipes and water flowing through them. If necessary, a fire may be maintained in the base of the chimney to increase the draught. The lower ends of the drain pipes deliver their flow to a conduit. These ends must be unobstructed and open, and in laying the lines care should be taken to preserve an even pitch of considerable degree, so as to prevent the possibility of the formation of traps. The air which the chimney will draw through the pipes will play an important part in purifying the drainage water.

The diluted and filtered and partly aerated sewage water collected in the conduit is conducted to a low level siphoning tank, which delivers it to a second irrigation bed. There it is subjected to a repetition of the treatment just described, including the three purifying elements of filtration, aeration, and dilution. The water finally delivered to the low level conduit will be comparatively innocuous. It will have been twice filtered, aerated, diluted, and acted on by vegetation and humus. Its purification will have progressed in something like a geometrical proportion.

It will be observed that the above description refers to the disposal of the liquid matter. The removal of solid matter is the simplest part of the problem, and can be effected in any of the well known ways. When the aqueous portions of sewage are disposed of, nine tenths of the problem is solved.



THE JERBOA—[DIPUS ÆGYPTIUS LICHTST.]

THE JERBOA.

In the diluvial strata of clay at Thiede, near Wolfenbuttel and Westeregeln in the peat district of Magdeburg, Nehring found many fossil remains of the jerboa among other rodents of the plain, and also, as comparison with modern skeletons proves, of a kind of jumping rabbit which is identical with the *Alactaga jaculus Brdt.*, still found in the steppes of southwest Siberia and Central Asia. This proves that in the so-called post-glacial period the North German plain, as far back as the mountains of Central Germany, presented the same general character as the steppes, and had a Continental climate; that is, a hotter summer and a colder winter than at the present time. But it is not probable that the coast of the European continent then had its present form, to which the North German plain owes its moist and mild climate. Europe, especially the western part, must then have been connected with the northern part of Africa, forming a compact continent. Later changes in the divisions of land and water were caused by upheavals and sinkings of the surface of the earth, the sea making a deep impression in the European-African continent. The result of this was a change of climate and, consequently, of vegetation, particularly in southern and western Europe. The steppes were changed into woods and swamps, and Germany assumed the characteristic features described to us by Cæsar and Tacitus. Under these circumstances the little rodents of the steppes could not exist, so they fled from the encroaching swamp back into the steppes of Eastern Europe and Asia, where they are still found.

The accompanying illustrations will give our readers an excellent idea of the habits of the jerboa, the roguish gnome of the desert; the manner in which they steal out of their holes at twilight, when the shadows are lengthening; their ways of cleaning themselves, of eating, resting, carrying building materials, of standing upright on their toes so as to nibble the tender tops of the grass, of supporting themselves by their long tails when sitting upright, of digging, etc. These excellent drawings were made by the well known animal painter L. Leutemann.

The coat of the jerboa is a grayish-yellow, a real sand color, on the back; the belly is white, and the two rows of hair on the end of the tail are first dark brown and then white.

The species shown in our cuts is the North African, desert jerboa (*Dipus aegyptius Lichtst.*), which is scattered over the northern part of Arabia, Egypt, and Tripoli, living gregariously in this dry, barren ground, which is covered with sharp reed grass. There they make their burrows, which are provided with many branches, and are used in common. They have their entrances, their burrows, and an escape, which extends nearly to the surface, so that they can break through in case their pursuers follow them into their holes, as the naja, also a native of this region, often does. Sometimes the lynx, or fox of the desert, surprises a jerboa far from its home, or the owl in its noiseless flight seizes one; but, as usual, man is its worst enemy. The Arabs hunt them for their flesh, catching them dead or alive in a simple manner: they break up their burrows with long poles. Many jerboas are kept in captivity, to which they soon accustom themselves. It is easy to make a nest for them. A common wooden box, the larger the better, of course, lined with sheet metal, filled a foot high with closely packed earth, and covered with wire netting, will answer perfectly. They are such neat little animals that they can be kept in a warm room without causing any annoyance. They will thrive if fed on grain, with some bread and carrots, and their funny, merry little ways at evening, the noiseless running back and forth, will richly reward the owner for the little trouble they cause.

We have taken the accompanying illustrations from "Die Natur," with the consent of the publisher.—*Illustrirte Zeitung.*

Proposed Ship Canal between Bristol and English Channels.

A scheme for connecting the Bristol and English Channels will be brought prominently before the public in the course of a few months. The route fixed upon by the engineers who have recently surveyed the district is from Stolford, in Bridgewater Bay, passing through the towns of Bridgewater, Langport, Ilminster, and Chard, to Seaton, on the English Channel. The total length of the canal will be about 45 miles, and, with the exception of the Chard range of hills, the work of excavating, etc., for the whole distance will be comparatively easy, no engineering difficulties presenting themselves. The Chard district is formed of lias, so that in excavating through the high ground an ample supply of lime will be obtained, which will be useful for the other portions of the work. The canal is intended to be in every way capable of admitting the largest mercantile steamers afloat, as well as the ships of war. From a national point of view, therefore, this new canal will be of immense importance, as our ironclads would be able to steam across from channel to channel in a couple of hours, instead of having, as at present, to go round the Land's End. The greatest benefit would also accrue to the trade of South Wales, for, when shipping to London and the Continent, by using this canal a distance of 300 miles would be saved, to say nothing of avoiding the great risks to which vessels are liable while sailing around this part of our coast.—*London Times.*

Trade Mark Infringement.

In the case of Keller *vs.* Goodrich Company, recently decided by the Supreme Court of Indiana, it appeared that the appellee had long been engaged in the manufacture of an article used in dentistry, and had printed on each box containing the same the trade mark "The Akron Dental Rubber." The appellant sold a similar article put up in boxes of a different shape and material from those used by the appellee. Upon these boxes it had printed the words "Non-Secret Dental Vulcanite, made according to our analysis of the Akron Dental Rubber." The words preceding "Akron Dental Rubber" were printed in black ink, but the words "Akron Dental Rubber" were printed in red ink, the type being large, so as to readily and quickly catch the eye. The court held that this constituted an infringement of the appellee's trade mark.

Weakness of Short Columns.

Cast iron pillars with flat ends uniformly bear about three times as much as those of the same dimensions with rounded ends, and this was found by experiment to apply to all pillars from 121 times the diameter down to 30 times. In flat-ended cast iron pillars shorter than this, there was observed to be a falling off in the strength, and the same was found to be the case in pillars of other materials, on which many experiments were made, to ascertain whether the results, as obtained from the cast iron pillars, were general. The cause of the shorter pillars falling off in strength was rendered very probable by the experiments upon wrought iron, for in that metal a pressure of from 10 to 12 tons per square inch produced a change in and reduced the length of short cylinders subjected to it; and about the same pressure per square inch of section, when required to break by flexure a wrought iron pillar with flat ends, produced a similar falling off in strength to that which was experienced when a weight per square inch not widely different from this was required to break a cast iron pillar with flat ends. The fact of cast iron pillars sustaining a marked diminution of their breaking strength by a weight nearly the same as that which produced incipient crushing in wrought iron, and a falling off in strength of wrought iron pillars, rendered it extremely probable that the same cause (incipient crushing or derangement of the parts) produced the same change on both these species of iron. The pressure which produced the change mentioned above in the breaking of cast iron pillars was about one-fourth of that which crushed the materials. I shall therefore assume here that one-fourth of the crushing weight is as great a pressure as these cast iron pillars could be loaded with, without their ultimate strength being decreased by incipient crushing, and that the length of such a pillar, if solid and with flat ends, would be about thirty times its diameter.—*E. Hodgkinson, in the Architect, London.*

18,000 or 20,000 H. P.

The great experiment of the past year has been the Inman and International Company's steamer City of New York. She was intended to make the run to New York in six days. The Etruria has crossed the Atlantic in six days and one hour, but this was an exceptional run, and the average performance of the Etruria is more like six and a half days. Consequently the City of New York must be somewhat faster than the Cunard boats. Up to the present she has failed to attain the expected speed, but she is an extremely fast ship, and it is worth notice that in stormy weather she has twice beaten the Etruria by some hours as a consequence of her great size. The City of New York has been taken off the line for the purpose of undergoing some modifications, which, it is expected, will bring up her speed to the required point.

Calculation shows that certainly not less than 18,000 indicated horse power will be needed to drive the ship at 20 knots an hour. It is possible that more will be needed, because of the way in which the hull has been put together with vertical butt straps outside. Taking, however, as a basis 18,000 horse power, we find that nine boilers have been provided to supply it. These boilers are double-ended, with six furnaces in each; the boilers are about 19 ft. long, and the grates 6 ft. 6 in.; the boilers stand fore and aft, in groups of three; there are in all 54 furnaces. The Etruria, to indicate 14,000 horse power, has 72 furnaces; but she has only compound engines, while the City of New York has triple expansion engines. The area of her grates is approximately 1,250 square feet to produce 18,000 horse power. Then each square foot of grate must represent nearly 15 horse power.

It is a very easy matter to talk of 18,000 or 20,000 horse power; but few people, we think, realize what it means. The following figures may help them to form a conception of what the much despised practical engineer has to do and does. It is more than probable that the White Star boats being built by Messrs. Harland & Woolf will develop 20,000 horse power. At least, so rumor says; for rightly or wrongly, it is asserted that they will have each 12 boilers and 72 furnaces, worked with forced draught on Howden's system. Assuming that the engines will require 18 pounds of steam per horse per hour, then 160 tons of feed water must be pumped into the boilers every hour, and 160 tons of steam will pass through the engines in the same time. In twenty-four hours the feed water will amount to 3,840 tons, occupying 138,240 cubic feet. A tank measuring 52 ft. on the side would hold one day's consumption, or it would fill a length of 493 ft. of a canal 40 ft. wide and 7 ft. deep. Taking the condensing water at thirty times the feed water, it will amount to 4,800 tons per hour—115,200 tons in twenty-four hours; or, for a six days' run across the Atlantic, to not less than 691,200 tons, or 24,883,000 cubic feet. This would fill a cubical tank 295 ft. on the side—a tank into which the biggest church in London, steeple and all, could be put and covered up. The coal consumed will be 400 tons per day, which would fill forty wagons. This will require for its combustion 8,600 tons of air, occupying a space of 222,336,000 cubic feet. It is impossible for the mind to take in the significance of these latter figures. It may help if we say that if this air was supplied to the ship through a pipe 20 ft. in diameter, the air would traverse that pipe at the rate of about 5·6 miles per hour. It will be seen that the circulating pumps and fan engines of such a ship have no sinecure.—*The Engineer.*

The Planning of Foliage.*

There are certain natural principles and forms running through both leaves and flowers; they follow a regular geometrical distribution of parts, and the form of leaf or flower follows naturally from the principle—or, if I may so say, from the anatomy—upon which it is set out. Thus flowers radiate in threes, as the lily; leaves grow in threes from the same point in the stem, and are in perfect harmony with the flower, as the anemone; leaves divide in threes, as in the water avens, clover, and wood sorrel; doubly triple, as in the columbine; and further carried on to the greatest intricacy, as we see in the parsley. Flowers again are cruciform, as in the wallflower; leaves also grow with the same arrangement, as we see in the lilac and the maple. It should be noticed, too, that that arrangement of the leaves in pairs (called "opposite leaved") extends through the whole anatomy of the plant or tree—the leaf buds being formed at the base of the leaves, they also are in pairs; the leaf buds become branches, all of which are arranged to grow in an opposite manner, the same as the leaves.

But there are many accidental circumstances (such as the leaf bud being destroyed by insects) which, in the case of branches, prevent the opposite principle from being too strictly carried out, which, if it were, would give the tree too stiff and formal an appearance. So also in alternate-leaved plants or trees it follows through the whole system, and all the branches are alternate. But to pass on from what I have called the cruciform arrangement. We next come to flowers which are divided into five petals, or set out on the pentagonal principle, and this division is again seen in the leaves. They are first divided into five lobes, with a semi-radiation, simply cut out as in the ivy, divided with deep eyes as in the vine, which we again see in the flower of the hollyhock. The lobes again subdivided, as in the maple and bryony, or separated into distinct leaflets, as in the Virginian creeper, and running again into intricacy in the field geranium and other plants. Then we have the seven lobes in the hollyhock, seven leaflets in the horse chestnut, eight petals in the coreopsis, ten divisions as in the campanula and stellaria, until we arrive at multiplicity in radiation, as we see in the daisy and sunflower and in the leaf of the lupin. Further, we see leaves and flowers take leave of radiation altogether.

Flowers run into a vast variety of forms (far too numerous for me to attempt to go into), such as the pea and bean tribe, and many others. Leaves branch in pairs from a central leaf stalk, as in the elder and rose leaf, which is carried further in the acacia and ash, and is again subdivided and carried into the greatest intricacy in the ferns. In the leaflets of the acacia we see also the heart-shape form which we observed in the petals of the strawberry and the primrose; also again in the violet leaf, but formed the contrary way.

All these facts show that there are certain natural laws, by studying which the artist can produce what form of leaf or flower may best suit his purpose, upon perfectly natural principles, but without following any one leaf or flower in particular, thus giving him such a vast field to work in that there need be no limit to genius or invention.

A Plague of Tigers in Java.

According to the administration report of Java recently laid before the Dutch Chambers, portions of that island are being depopulated through tigers. In 1882, the population of a village in the southwest of the Bantam province was removed and transferred to an island off the coast in consequence of the trouble caused to the people by tigers. These animals have now become an intolerable pest in parts of the same province. The total population is about 600,000, and in 1887, 61 were killed by tigers, and in consequence of the dread existing among the people, it has been proposed to deport the inhabitants of the villages most threatened to other parts of the country where tigers are not so common, and where they can pursue their agricultural occupations with a greater degree of safety. At present they fear to go anywhere near the borders of the forest. The people at present seem disinclined, or they lack the means and courage, to attack and destroy their enemy, although considerable rewards are offered by government for the destruction of beasts of prey. In 1888 the reward for killing a royal tiger was raised to 200 florins. It appears also that the immunity of the tiger is in part due to superstition, for it is considered wrong to kill one unless he attacks first or otherwise does injury. Moreover, guns were always very rare in this particular district, and, since a rising a few years ago, have been taken away by the authorities altogether.

* J. K. Colling, in the *Architect*, London.