own observations show, the shock loses much of its individuality as it travels further from the source. It becomes more and more preceded by a vanguard of small waves, and, for this reason, seismoscopes of different degrees of sensibility will differ in the time at which they chronicle the arrival of the group. Mr. Milne's results, as summarised by him at the end of the paper, are too numerous to be taken up in detail. The assiduity with which he has pursued these experiments deserves the greatest praise, especially as the experiments themselves are of a very high order of difficulty. It is perhaps to be regretted that Mr. Milne has not given his attention more to perfecting a single series than to multiplying results which, as he himself remarks, are often "most discordant." Seismographs will not tell the truth unless they are very well made and very carefully tended. Some of the jagged outlines of the curves are much more likely to be due to friction and shakiness and want of rigidity in the instruments than to any characteristic in the motion of the ground; and unless the lithographer has done Mr. Milne a serious injustice, there are cases where the ground suffers a considerable displacement in a good deal less than no time. He has himself observed this in one instance, and ascribes it to what must (if his explanation be correct) be called a faulty mode of setting the seismographs. It is not impossible to get results free from these defects; and a single really good set of diagrams would do much to remove the uncertainty which now attaches to many of Mr. Milne's results.

Besides the experiments with artificial earthquakes, the paper describes a laboratory investigation of the stability of cylindrical columns standing on a platform which vibrates horizontally, and of the velocity of projection of detached bodies. The projected bodies were balls, held in L-shaped notches at the top of a vertical wooden post; the post, bent slightly to begin with, was allowed to spring; the velocity of projection of the ball was determined from its trajectory, while the greatest velocity of the post-head was measured by means of a revolving plate of smoked glass. The two agreed fairly well, and with a nearly frictionless ball supported in this manner no other result was to be expected. The late Mr. Mallet used to calculate the velocity of the ground's motion from observation of the horizontal distance traversed by projected bodies, but the velocity with which a body is projected depends too largely on the mode of support, and on the amount of adhesion between the body and the support, to allow the result to be, in general, of the slightest value. With regard to the overthrow of columns, it would seem that the author falls into the error of supposing that when the resultant force got by compounding the weight of the column with its resistance to acceleration passes outside the base, the column will fall. But since the disturbing force is of short duration, all that necessarily happens in such a case is that the column will rock; whether it will fall or not is a question of much greater difficulty.

The second paper is a note by Mr. S. Sekiya, "On Prof. Ewing's Duplex Pendulum Seismometer, with Earthquake Records obtained by it." The paper is a brief but very clearly written account of a form of the duplex pendulum seismograph designed by the present writer in 1883, and now in constant use under Mr. Sekiya's care. An earlier form of the instrument has already been described in NATURE (vol. xxx. p. 152): the latest modification of it was exhibited to the British Association at Aberdeen, and will shortly be illustrated in this journal. Its function is to draw on a fixed plate a magnified diagram of the ground's horizontal motion; the figures, which are generally of great complexity, are given by Mr. Sekiya for a number of recent Japanese earthquakes.

A short paper follows by Mr. E. Knipping, "On the Meteorology of Japan," gathered from observations made at twenty-three stations during the year 1883. It mentions that the annual variation of temperature for that year in Japan was more than double that of Britain, and that changes of 14° C. or 15° C. at one station in twenty-four hours are not unfrequent in the spring and autumn.

A paper by Father Faura, S.J., of Manila, describes the Cecchi seismograph—an instrument belonging so decidedly to the old school of seismology that, by allowing its description to appear without criticism, the Society at least shows its catholicity of spirit.

Dr. Dubois contributes some notes on the earthquakes of Ischia, and refers to the effects—or rather absence of effects—of the earthquakes in excavations there, in support of the fact that seismic shocks which do much damage on the surface may pass unperceived at a certain distance beneath.

The volume concludes with a catalogue of earthquakes registered in the meteorological observatory of Tokio by Palmieri's recording seismoscopes. The list for 1884 shows the respectable total of seventy distinct disturbances, and twenty-eight were registered in the first four months of 1885.

J. A. EWING

RECENT ADVANCES IN SANITARY SCIENCE

"HYGIENE," in the words of the late Professor Parkes, "is the art of preserving health; that is, of obtaining the most perfect action of body and mind during as long a period as is consistent with the laws of life. In other words, it aims at rendering growth more perfect, decay less rapid, life more vigorous, death more remote." The art of preserving health is correlative with the science of prevention of disease, since perfect health means the absence of disease and of tendencies to disease. Hygiene is thus the art of preserving health and the science of preventing disease; and in taking into account recent advances in sanitary science we must consider recent acquisitions in our knowledge of the origin, causes, and spread of disease, more especially of those diseases known as "preventable," as well as the methods of improving the natural conditions or social relations surrounding us, which are instrumental in preserving health and counteracting disease.

The etiological relations of all diseases are a subject of interest to the sanitarian, but those which have received the most attention of recent years, and in which the most striking advances of knowledge have either already been made, or are imminent in the near future, are perhaps Asiatic cholera, typhoid or enteric fever, diphtheria, and phthisis or tubercular disease of the lungs. The mode of origin and spread of Asiatic cholera has attracted great popular attention, both on account of its possible introduction into this country from infected districts of the Continent, and from the alleged discovery by Koch of a *Spirillum* or *comma-Bacillus* asserted to be the specific cause of this terrible disease. The Report of the Government Commission consisting of Drs. Klein and Heneage Gibbes, who visited India in 1884 with the object of undertaking researches into the etiology of Asiatic cholera, has lately appeared, and in this Report the conclusions arrived at by Koch from his own researches are very directly traversed. This Report, too, has received a very cordial support from a Committee consisting of many eminent physicians and physiologists, which was convened by the Secretary of State for India for the purpose of taking it into consideration. It must be apparent, however, to any one who makes an impartial study of the literature of the subject, that, if Koch's organism has not yet been proved to be the actual cause of the disease, it has been proved to differ from all other organisms asserted to be identical with it, from the fact that its growth in various nutrient media is characteristic, and serves to distinguish it from all other organisms. As far as our knowledge at present extends, difference in manner of

growth in nutrient media affords as just a basis for distinction between micro-organisms as difference in microscopical appearance or other morphological characteristics. Koch's comma-Bacillus is therefore diagnostic of the disease, and this fact has now placed in the hands of medical men the power of at once recognising a true case of Asiatic cholera, the isolation of the organism from others in the choleraic discharges and its cultivation in suitable media being alone needed. The results of Koch's researches, whether fully accepted or not, have not affected, nor are they likely to affect, the measures on which reliance alone can be placed for the prevention of outbreaks and spread of the disease. In the words of the Committee before alluded to, "Sanitary measures in their true sense, and sanitary measures alone, are the only trustworthy means to prevent outbreaks of the disease, and to restrain its spread and mitigate its severity when it is prevalent. Experience in Europe and in the East has shown that sanitary cordons and quarantine restrictions (under whatsoever form) are not only useless as means for arresting the progress of cholera, but positively injurious."

The view that typhoid fever cannot arise *de novo*, but is always propagated by a specific contagion from a previous case of the disease, is steadily gaining ground, as the number of epidemics where the disease has been definitely traced to specifically polluted air or water increases. In many other cases, although the specific pollution has not been definitely proved, the probabilities in favour of such a view have been very great. No micro-organism has yet been found which can lay claim to be regarded as the specific contagion of the disease, but we are in possession of so many facts concerning the mode of origin and spread of this disease, that any discovery of that nature would probably not greatly affect the measures now taken for its prevention.

The etiology of diphtheria has lately received very careful study, but so far without the attainment of any results capable of exact formulation. It is not a disease invariably dependent on insanitary conditions, such as typhoid fever is, but that such conditions favour its spread and severity is more than probable. The far greater comparative frequency of diphtheria in rural districts than in large towns in this country is well known, and has been attributed to the presence in the air of the latter of the products of coal combustion. This view appears the more probable seeing that Continental cities, where wood and not coal is chiefly used as fuel, enjoy no such comparative immunity from the disease. Excessive moisture in the air of a house, whether arising from defective construction of the walls or roof, or from a water-logged soil, are conditions very often associated with diphtheria. The fact also that the disease is most prevalent in the damper seasons of the year, when vegetable matter is undergoing decay and fungus life is most active, favours the theory that the specific contagium of this disease is a mould or fungus, which flourishes most strongly in a damp and smokeless air. It is a remarkable fact that diphtheria is sometimes associated with scarlet fever in one epidemic, the two diseases appearing to be interchangeable; but this is a subject that requires further elucidation. The contagion of diphtheria is extremely persistent and long-lived, clinging with great pertinacity to infected articles, so that every article which is likely to have become contaminated requires very thorough disinfection, preferably by heat. There can be no doubt that school attendance is often a chief factor in the propagation of the disease amongst children.

Koch's discovery of the *Bacillus tuberculosis*, a micro-organism now proved to be the specific contagium of tubercular disease in men and animals, has placed tubercular phthisis in the category of contagious diseases. A peculiar disposition or tendency, whether hereditary or acquired, is no doubt wanted to enable the germ to take up its habitat in the human lung, but the fact that this idiosyncrasy can seldom be definitely recognised renders great caution necessary both on the part of members of a family in their association with a consumptive relation, and of hospital authorities in admitting into a general ward cases of tubercular disease, or of massing together into one institution patients in every stage of the disease. The Bacillus is constantly present in the sputum and probably in the breath of phthisical patients, and this points to the necessity of free ventilation of living and sleeping apartments, and disinfection of soiled articles of clothing and furniture. The external conditions which, of all others, cause a predisposition to consumption are, a damp subsoil, causing excess of moisture in the air, and the constant breathing of an atmosphere vitiated by human respiration. It has been asserted that tubercle can be propagated from animals to man by the consumption of diseased meat, or, in the case of the cow, from the milk of a tuberculous animal. Further proof is required before we can accept such an hypothesis, but there is nothing improbable in such a mode of conveyance of the disease, especially in the case of children with a tubercular predisposition.

Besides the diseases which we now know to have been propagated through the agency of milk—enteric fever, scarlet fever, diphtheria, &c., in which the introduction of the morbid matter is accidental, the milk serving only as a means for its conveyance and perhaps for its growth—there is a complaint fairly definite in character, which has been attributed to the consumption of the milk of cows suffering from foot-and-mouth disease. Here the morbid quality is inherent to the milk as taken from the cow, and is not due to an accidental introduction. The symptoms described in the epidemics recorded are fever, vesicular eruptions on the lips and in the throat and mouth, and enlargement of the glands of the neck. During the prevalence of foot-and-mouth disease, all milk taken by a household should be boiled before consumption. In view of the many dangers which threaten us through the agency of milk, it would perhaps be advisable, especially where children are the chief consumers, that this precaution should be always adopted; at least until the sanitary authorities in towns have the power of inspecting and controlling the farms and dairies in the country from which the chief part of the milk-supply is derived.

The possibility of the transmission of the contagion of small-pox for considerable distances, not exceeding one mile, through the air, has been warmly supported. There are many facts in favour of such a view, and its great probability will be seen from the following considerations. The contagion is almost undoubtedly a micro-organism of the class Bacteria, but as it has not yet been isolated and identified, we are unaware if it is capable of spore-formation or not. The spores of Bacteria can resist external agencies—heat, cold, drying, and antiseptics—to a much greater extent than the fully formed organisms, and it is probable that those diseases in which the contagion remains dormant for long periods are transmitted through spores capable of existing for long periods outside the body. But in small-pox it is not necessary to rely upon spore-formation to support theories of aërial transmission. The contagion as given off from the body of the patient is inclosed in minute epithelial scales and dry pus accumulations. Here, protected from the air and from external destructive agencies, it may be wafted as a minute dust through the air, to descend at considerable distances. That the radius of infection from a small-pox hospital as a centre does not exceed a mile may be due to the great dilution of the contagion as it is diffused through greater distances than a mile from its centre of origin, the hospital. The observations of Dr. Miquel, at the observatory of Montsouris near Paris, have shown the number and variety of solid particles which are carried in the air, and the immense distances which some of them, as pollen and spores, may be presumed to have travelled. An educated

public opinion will soon, if it does not already, regard small-pox hospitals as possible centres of infection, and will insist on their removal outside inhabited areas.

The compulsory notification of infectious diseases to sanitary authorities, either by the householder in whose house the case occurs, or by the medical attendant, or by both, has been adopted in numerous provincial towns during the last five years. This measure has done much to furnish the authorities with early information of the occurrence of infectious disease which would not otherwise have been obtained, and such information has doubtless enabled the sanitary officials to stamp out many an epidemic in the bud, which might otherwise have reached large dimensions. The more universal adoption of a measure of compulsory notification in our large towns is urgently needed.

In the domain of domestic sanitation the advances of recent years have been mostly limited to the practical applications of sound principles already acquired to the carrying out of works of construction, drainage, or water-supply of the dwelling. Houses built for the use of the well-to-do classes (not those of the speculative builder) in recent years will most generally be found to be planned and fitted on modern sanitary principles. Thorough ventilation of the drain and soil-pipe, disconnection of the waste-pipes of baths, sinks, and lavatories, and of the overflow-pipes of cisterns from the drainage system, are now understood to be necessaries of modern life. A break in the connection between the house-drain and the public sewer by means of a manhole chamber and water-seal or trap, though not considered necessary or desirable by all, is now very usually practised. We cannot doubt that the air of a public sewer is sometimes the means of disseminating disease, and any method which practically excludes such a source of danger from our houses is one to be encouraged. As knowledge extends, the simplest form of apparatus is found to be the best; many of the more complicated kinds of traps and contrivances for excluding sewer air are now discarded by builders and architects for those simpler forms which are equally effective.

In the matter of water-supply, the belief is steadily gaining ground that a water once polluted by sewage cannot be regarded as safe for drinking purposes. Safe it may be so long as filtration on the large scale is efficiently performed, but any failure to thoroughly filtrate and aërate the water in times of epidemic visitation might be attended with disastrous consequences, even supposing that filtration through sand and gravel is destructive of disease organisms or their spores. The introduction of a constant supply of water into towns, in the sense that cisterns and receptacles for storing water are no longer necessary, has been of great benefit—especially in the poorer parts of towns, where water stored on the premises is usually highly contaminated.

Of the scientific witnesses who were examined before the Royal Commission on Metropolitan Sewage Discharge, nearly all were in favour of the principle of separation of the rainfall from the sewage. "The rain to the river, the sewage to the soil." In view of the ultimate disposal of the sewage, the advantages of the "separate method" are very great, and would now probably lead to its adoption in any new scheme of sewerage for a town where the circumstances are favourable. From the public health point of view, it is also desirable to have impermeable pipe or brick sewers of small size, so that contamination of the soil by leakage into it of the contents of sewers may be avoided. In any such scheme of sewerage it must not be forgotten that not only are channels on the surfaces of the streets and roads required to convey away surface water, but pervious drains laid in the subsoil are absolutely necessary in the health interests of the town to keep the subsoil water at a permanently low level. For the disposal of the sewage, the value of a regular daily flow, and the elimination of the necessity in times of heavy rain of dealing with an enormous and uncontrollable volume of dilute sewage, must be obvious. The surface waters of towns are certainly not clean, but where the streets are efficiently scavenged they are free from taint of human excretal refuse, and fit for admission into the rivers which nature intended as drainage channels of the surrounding high lands.

The extreme importance of thoroughly ventilating sewers, is now very generally understood. Pipe sewers require as much ventilation as brick sewers, although the absence of deposit on the smooth internal surfaces of the pipes, and their consequent freedom from smell due to decomposition of deposited organic detritus, originally led to the belief that ventilating openings were not required in pipe systems of sewerage. It was not until Dr. Buchanan showed in the case of Croydon that the absence of proper ventilation in the pipe sewers of that town was in all probability instrumental in aiding the spread of enteric fever that the opinion of engineers on this matter underwent a change. Displacement of air in pipe sewers of small diameter is greatly more sudden than in brick sewers of larger diameter, and it is plain, says Dr. Buchanan, that "means of such ventilation are wanted more numerously in proportion as the displacements of air may be local and sudden." Openings into sewers from the street level are still regarded as the best practicable means for the admission of fresh air, and the exit of sewer air. Charcoal trays, Archimedean screws, and other contrivances for purifying the issuing air, or hastening its exit, are now generally abandoned as useless and inconvenient.

The purification and utilisation of the sewage of towns is a subject of much importance both in its public health and commercial aspects. The idea, so long entertained, that town sewage could by various methods be made to yield a manure which would give rise by its sale to an enormous profit is now exploded. The highest degree of purification, we now know, can only be attained on land naturally suitable from its porosity and other properties, and artificially prepared by extensive under-drainage. The agents which purify sewage in its passage through soil, by converting the nitrogenised organic matters into inorganic salts—nitrates and nitrites of the alkaline and earthy bases, and ammonia—have been discovered to be Bacterial micro-organisms, resident chiefly in the superficial 18 inches of soil, and far more abundant in some soils than in others. Sewage farming has been ascertained to be profitable, under suitable conditions. The sewage must flow from the town to the farm by gravitation—the cost of pumping will neutralise profits from the sale of farm produce; a part of the farm must be laid out as a filter bed, so that the sewage, when not required on the cultivated land or when so dilute from the presence of storm waters as to be inapplicable, may be purified on a small very porous area by the process of intermittent downward filtration. Very few growing crops are benefited by the application of sewage, except the various kinds of grasses, and of these such enormous quantities can be produced that, unless converted into "silage," or utilised on the farm in the production of stock and dairy produce, they may be expected to result in a loss, from the absence of any demand for such large quantities at all periods of the year.

In this country, the sewage farm at Birmingham is probably the best example of what has been done to solve a most difficult problem by the application of sewage to land. Here, the sewage is first freed from its suspended matters by a process of precipitation, a proceeding necessary not only to prevent warping of the land with offensive solid matters, but also to withdraw the metallic salts and acids incidental to the sewage of a manufacturing town, which would be injurious to vegetation. Even this magnificent example of dealing satisfactorily with the most difficult municipal problem of modern times is eclipsed

by the city of Berlin on the Continent. The sewage farms at Berlin have successfully dealt with the sewage of 887,500 people—nearly twice the population of Birmingham—whilst London is still allowing to run to waste an enormous amount of valuable material, at the same time polluting a river—the highway of its commerce—to an extent never previously dreamt of.

Processes of precipitating sewage by chemicals are now known to exert only a partially purifying influence. The best process yet discovered can do little more than free the sewage from its suspended matters, allowing all the dissolved constituents of sewage—by far the most valuable portion agriculturally and chemically—to pass away in the effluent. Lime dissolved as lime water, sulphate of alumina, and perhaps proto-sulphate of iron, taken together and added to the sewage in the proportion of not more than 10 to 15 grains to the gallon, are the best, most economical, and most effective precipitants. Other more valuable substances, added to the sewage with the view of increasing the value of the precipitated sludge or manure, are in large proportion lost in the effluent water, and as they do not assist precipitation might just as well be added to the sludge afterwards, if fortification is required. Half-a-crown and no more is the value per ton of the precipitated solids of sewage. This value will generally pay for the cost of their carriage a mile or so in agricultural districts, but no further.

A great improvement in dealing with the semi-liquid sewage sludge has been lately effected. The sludge containing over 90 per cent. of water was formerly allowed to dry in the air or in a drying chamber, and a most intolerable nuisance resulted. It is now possible by means of hydraulic filter-presses to convert the semi-liquid sludge into solid cakes containing 40 to 50 per cent. of water, and in this form it is innocuous to the senses, and can be readily conveyed away by cartage.

The knowledge already acquired demands that now, and in the future, the sewage of towns should, whenever possible, be utilised on land in the production of crops or dairy produce; failing this, the sewage should be freed from its solids by precipitation, and subsequently purified on land laid out as filter-beds, efficient purification, and not the production of crops, being alone aimed at. If application to land is impossible, then precipitating processes alone must be relied on, and where the sewage can be turned into the sea, and effectually got rid of without nuisance, there it may be allowable to waste valuable matter which cannot be utilised except at a cost destructive of all profits from its utilisation.

SALE OF THE JARDINE ORNITHOLOGICAL COLLECTION

THE dispersal of an ornithological collection so large, and of such historic interest, as that formed by the late Sir William Jardine, F.R.S., is an event deserving of notice. The collection was begun more than sixty years since, and was the occupation of half a century's diligent care. From its contents were described, and often figured, a majority of the species treated of in the late baronet's many works, ranging from the "Illustrations of Ornithology," commenced in 1825, to papers in journals of comparatively recent date, and it included a greater number of "type-specimens" than any other that has ever been brought to the hammer.

On Sir William's death in November 1874, it was understood that the collection would be speedily sold, and a strong hope was entertained by ornithologists that it should pass, *as a whole*, into one or other of the great museums of this country. However, this was not to be. The comparatively small "British" portion was, after a time, purchased by the Museum of Science and Art in Edinburgh, a very fitting destination for it; but the rest, consisting of between 8000 and 9000 specimens, remained in the hands of Sir William's heir. At last that gentleman determined to dispose of it by auction, and for that purpose selected Messrs. Puttick and Simpson, the well-known firm of Leicester Square, by whom it was accordingly sold on Thursday, June 17 last. However, the attendance at the sale was but small, and except in a very few instances, the prices obtained were below the average often reached at sales of collections in every way inferior in interest, while not one of the lots attained a price that may be called high. There was a certain competition among a few experts, but even this was not carried to any excess, and as a rule the prizes of the collection were knocked down for very small sums. It is a satisfaction to read, however, that most of the "type-specimens" were secured for the British Museum or for that of the University of Cambridge; but few, it is believed, falling into the hands of dealers, and hardly any, as was to be greatly feared, into those of the "plume-trade." The low prices realised were due, no doubt, to the fact that notice of the sale had reached few amateur collectors in time, and added to this was the fact, obvious on inspection, that the sale catalogue supplied very little of the information which collectors require. It was the general impression in the auction-room at the time, and has since been confirmed by the opinion of practical ornithologists, that had the catalogue set forth the special quality of the specimens, and the sale been made known more widely, a very different result would have followed, and something like the competition which attended the great sale of Mr. Bullock's museum in 1819 might have been attained, for collectors are as keen now as ever, and such a chance as this is not likely to occur again to the present generation. The long period, too, which has elapsed since Sir William Jardine's death (recorded in NATURE, vol. xi. p. 74) possibly helped also to divest the sale of his collection from a good deal of the interest which it would have inspired had its dispersal taken place soon after his decease, for memories are short in these days. The agent of the British Museum has to be congratulated for his promptness in recognising and securing at a nominal price for that institution one "type-specimen" (that of Bulwer's petrel), which, not being mentioned in the catalogue nor occurring in its expected place among the other specimens of its family, had escaped the notice of all the other ornithologists who had viewed the collection.

NOTES

AMONG the Colonials on whom honours have been conferred are Dr. Julius Von Haast, F.R.S., who has been made K.C.M.G., and Dr. A. R. C. Selwyn, who has been made C.M.G.; Dr. G. Watt, of the Indian Department of Revenue and Agriculture has been made a C.I.E.

PROF. PAUL WAGNER, on behalf of the Comité Salitero, sends us the following statement as to the result of the nitrate of soda competition. Carrying out the scheme of prizes offered by the Committee of the Saltpetre Producers' Association (Comité Salitero at Iquique, Chili) for the best popular essay treating of the importance of nitrate of soda as a manure, and the best mode of its application, the judges—Prof. L. Grandeau, Nancy (France); Prof. Adolf. Mayer, Wageningen (Holland); Prof. A. Petermann, Gembloux (Belgium); Prof. G. Thoms, Riga (Russia); Prof. Paul Wagner, Darmstadt (Germany); Mr. R. Warington, Rothamsted (England)—have examined the essays sent in, namely, thirteen German, thirteen English, and four French, and have made the following awards:—(1) To the essay with the motto, "Grau, theurer Freund, is alle Theorie," a partial prize of 350*l.* (7000 marks); (2) to the essay with the motto, "Pour pratiquer l'agriculture . . . . " a partial prize of 150*l.* (3000 marks). On opening the accompanying envelopes, the author of the first essay was found to be Dr. A. Stutzer.