and Hartig has found that its spores may lodge in cracks in the barked logs of timber lying on the ground—cracks such as those in Fig. 1 (see p. 182). In the particular forests of which the following story is told, the felling is accomplished in May (because the trunks can then be readily barked, and also because such work cannot be carried on there in the winter), and the logs remain exposed to the sun and rain, and vicissitudes of weather generally, for some time. Now it is easy to see that rain may easily wash spores into such cracks as those referred to, and the fungus obtains its hold of the timber in this way.

The next stage is sending the timber down to the timber-yards, and this is accomplished, in the districts referred to, by floating the logs down the river. Once in the river, the wood swells, and the cracks close up; but the fungus spores are already deeply imprisoned in the cracks, and have no doubt by this time emitted their germinal hyphæ, and commenced to form the mycelium. This may or may not be the case: the important point is simply hat the fungus is already there. Having arrived at the

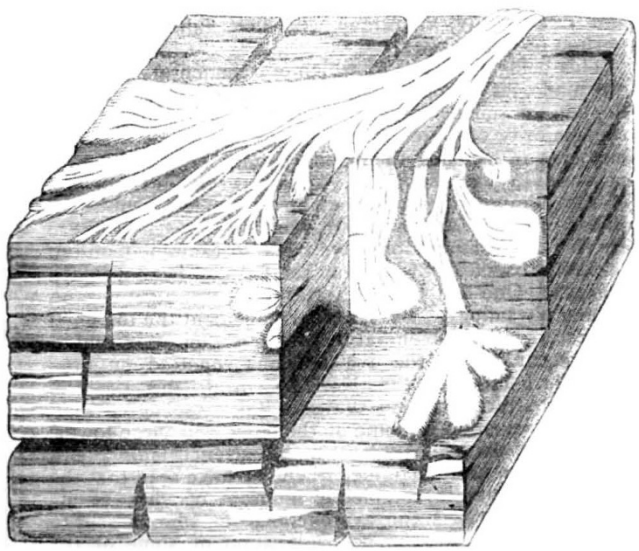

FIG. 19.—A piece of pine-wood attacked by the mycelium of *Polyporus vaporarius*. The timber has warped and cracked under the action of the fungus, becoming of a warm brown colour at the same time; in the crevices the white strands of felt-like mycelium have then increased, and on splitting the diseased timber they are found creeping and applying themselves to all the surfaces. Except that the colour is snowy white, instead of gray, this mycelium may easily be mistaken for that of *Merulius*. The fructification which it develops is, however, very different. (After R. Hartig)

timber-wharves, the logs are stacked for sawing in heaps as big as houses: after a time the sawing up begins. It usually happens that the uppermost logs when cut up show little or no signs of rot; lower down, however, red and brown streaks appear in the planks, and when the lowermost logs are reached, perhaps after some weeks or months, deep channels of powdery, rotten wood are found, running up inside the logs in such a way that their transverse sections often form triangles or V-shaped figures, with the apex of the triangle or V turned towards the periphery of the log.

The explanation is simple. The uppermost logs on the stack have dried sufficiently to arrest the progress of the mycelium, and therefore of the disease: the lower logs, however, kept damp and warm by those above, have offered every chance to the formation and spread of the mycelium deep down in the cracks of the timber. I was much impressed with this ingenious explanation, given to me personally by Prof. Hartig, and illustrated by actual specimens. It will be noticed how fully it explains the curious shape of the rotten courses, because the depths of the cracks are first diseased, and the mycelium spreads thence.

Obviously some protection would be afforded if the bark could be retained on the felled logs, or if they could be at once covered and kept covered after barking; and, again, something towards protection might be done by carting instead of floating the timber, when possible. At the same time, this is not a reliable mode of avoiding the disease by itself; and even the dry top logs in the saw-yard are not safe. Suppose the following case. The top logs of the stack are quite dry, and are cut into beams and used in building; but they have spores or young mycelium trapped in the cracks at various places. If, from contact with damp brick-work or other sources of moisture, these spores or mycelia are enabled to spread subsequently, we may have "dry-rot" in the building; but this "dry-rot" is due to *Polyporus vaporarius*, and not to the well-known *Merulius lacrymans*.

There can probably be no question of the advantage of creosoting the ends of such rafters, beams, &c.; since the creosote will act long enough to enable the timber to dry, if it is ever to dry at all. But the mycelium of *Polyporus vaporarius* makes its way into the still standing timber of pines and firs; for it is a wound-parasite, and its mycelium can obtain a hold at places which have been injured by the bites of animals, &c.: it thus happens that this form of "dry-rot" is an extremely dangerous and insidious one, and I have little doubt that it costs our English timber-merchants something, as well as Continental ones. Nor are the above the only kinds of "dry-rot" we know. Hartig has described a disease of pine-wood caused by *Polyporus mollis*, which is very similar to the last in many respects, and the suspicion may well gain ground that this important subject has by no means been exhausted yet.

H. MARSHALL WARD.

SCIENCE IN ELEMENTARY SCHOOLS.[1]

NOTHING could be more unsatisfactory than the present position of the knowledge and teaching of science in our elementary schools. Notwithstanding all the advantages that have been offered to pupil-teachers for the study of science, as a body they appear to be in a most deplorable state in this respect. Though success in the examinations of the Science and Art Department are now taken into account in placing the students of the training colleges for their teaching certificates, and average school-boys when they have been fairly taught are quite competent for these examinations, yet very few of the teachers have availed themselves of this privilege, and it does not appear that the training colleges have helped them in this respect. Very little, indeed, can be expected while the ordinary pupil-teacher is described, as he is in Mr. Oakeley's report on the working of the Training Colleges, as deficient in many elementary branches, notably mathematics. It is satisfactory, however, to notice that the quality of the candidates for admission to the Training Colleges is improving, and that these institutions are growing in teaching capacity and in popularity. The reports of the examiners for admission are not, with regard to the subject in hand, pleasant reading. One cannot expect good answering in science from candidates who are quite unable to paraphrase an ordinary piece of poetry, or to explain a common English expression. Accordingly we find that in Euclid, algebra, and mensuration, though a few papers were especially meritorious, the vast majority of the answers were very inferior. Few, if any, attempted the easy riders in Euclid, and the examiner remarks that he fears that the pupil-teachers receive but little assistance

[1] "Report of Committee of Council on Education (England and Wales), 1886-87."

from those who superintend their work. It is not easy to say whether this poor teaching or defective early training is at the root of the evil. It is worthy of remark that the metropolitan candidates, in their answers to the questions on Euclid, far surpass their provincial competitors. Many amazing blunders are quite common in the algebra papers, such as subtracting the terms of the numerator from those of the denominator, and completely ignoring the signs, and it is stated that the pupil-teachers at Chester at the end of their apprenticeship were unable to work a simple sum in algebra or to write out an easy proposition Mr. Fitch has a very able report on the Training Colleges for schoolmistresses, and from him it is plain that the same defects exist among the female as among the male pupil-teachers. At the admission examination the work in the arithmetic is satisfactory in point of accuracy, but it displays want of method, failure to appreciate the meaning of the question asked, and ignorance of principles. Thus very few of the candidates were able to give an intelligent explanation of simple arithmetical processes, such as subtraction or division. With them, as with the male pupil-teachers, book-work and memory are wholly relied on, and little attention is paid to the intelligent application of principles. "Scarcely three per cent. are able to do much more in the teaching of arithmetic than work sums more or less correctly on the black-board."

With such material to work on, it is not surprising that the results of the work at the colleges are not what they otherwise might be. Those who are below the average at admission rarely succeed very well in the array of subjects to be learnt in two years' training. With regard to the male students the reports at the close of the first year's training record that the answering of the questions set on the first book of Euclid was disappointing. The students appear to have learnt their propositions by rote, and to have displayed great want of neatness and accuracy. Though the riders were joined to the propositions on which their solution depended, and though all these riders were easy, very few of the papers were satisfactory. This inability to solve the easiest geometrical deductions is commented on again and again, and proves beyond doubt that either the students are negligently taught, or that they commit the book-work to memory without understanding it, and consequently are quite incapable of applying their knowledge to solve the simplest riders. The report for the second year is rather better; few candidates answered very well, and few answered badly, and the majority made a fair percentage of marks; but the same inability to apply their knowledge to the solution of easy deductions in Euclid is recorded. With regard to the answering in algebra and mensuration, there is nothing noticeable except that some students show a discreditable ignorance of the most fundamental questions, while the papers were generally satisfactory.

Summing up the results of the working of our male Training Colleges, Mr. Oakeley gives it as his opinion that the students are over-lectured at some of the colleges, and that the lectures are mechanically reproduced, and transferred as closely as possible to the examination papers. This, of course, is due to the defective early training of the students, and to lectures injudiciously delivered on subjects about which students know absolutely nothing. For instance, one lecturer delivered a very excellent discourse on the corrupt form of Latin used by the Roman soldiers in Britain, its causes and its effects, to a class of which few, if any, of the members knew anything whatever of Latin. Mr. Oakeley also points out one of the greatest defects in the present system of training pupil-teachers when he says that as a rule pupil-teachers see but one school at work; they have no opportunity of comparing the mode of teaching in other schools. This is, however, obviated at Homerton, and partly at Durham, by visiting neighbouring schools during school-hours.

The reports of the examiners on the progress made by the students of the female Training Colleges tell us that in arithmetic, questions on theory and principles are not well done; long problems are inaccurately done, and, as a whole, it is seen that there is yet much remains before it can be said that our present system is satisfactory as regards the knowledge given and the methods adopted. There appears to be among the students a very narrow view of their future work, a desire to regard the obtaining of their certificates as the goal and aim of their existence. The views on science of one of these maidens is worth recording:—"If I am successful in obtaining my certificate, I intend (D.V.) going in for two sciences. At the same time I propose attending a tonic sol-fa class to get my advanced certificate. Should the two sciences 'sound, light, and heat,' and 'electricity and magnetism' prove a success, I shall probably take up the science of hygiene." If the Training Colleges tend to remove the impression that the technical qualification is the end of the pupil-teacher's work, if they awaken a spirit of emulation among the students, aud enable them to teach more thoroughly and intelligently, then they will have fulfilled a large portion of their duties.

This being the stuff of which our elementary teachers are made, let us now glance at the reports of the work done in the schools under their guidance. With masters the majority of whom know little or nothing of even the elements of science the pupils cannot be expected to pass well in these subjects. Thus it is seen in the return of the number of pupils sent up on "specific subjects" (most of which are scientific), that only 16·51 of those eligible for examination have been so examined, and of these nearly one-half were from the London School Board District. One-half of the passes were in algebra and animal physiology. By a new arrangement the ten chief inspectors present biennial reports, five each year, and in the present volume the five divisions reported on are: the North-Eastern, the North Central, the Eastern, the South-Western, and Wales. All these agree that, with the exception of some of the cities and large towns, throughout the elementary schools science is untaught. This we can well imagine, when we have seen that the average teacher is completely ignorant of any of its branches, and it is the average teacher who is sent to the country schools. The explanation of some of the inspectors, that in the country for a great portion of the year the attendance of the children who are fit to be taught these subjects is very irregular, does not meet the question; for, even were the children most regular in their attendance, the subjects could not at present be taught, and until our average elementary teacher is altered they will not be taught. Following the individual reports on the subject, we find in the North-Eastern Division that arithmetic is accurately but unintelligently studied. So utterly mechanical is the teaching that in many schools mental arithmetic is regarded as a separate subject, and not as the adjunct and preliminary of all arithmetic. Having seen the complaints made by the examiners of the quality of the study of the pupil-teachers, it could only be expected that the same defects would show themselves in the scholars under their charge. Elementary science is unknown in the North-Eastern schools, except in Leeds, Sheffield, Bradford, Newcastle, and Sunderland, where algebra and animal physiology are taken up with fair results. But the inspector remarks that physiology is seldom so taught as to be of any practical benefit, and in the teaching of algebra there is a great want of thoroughness. In the North-Central Division, specific subjects are seldom taken; and about one-half the pupils sent up for examination on them passed. These subjects, taking them in the order of the number of pupils sent up on each, are algebra, magnetism and electricity, physiology, agriculture, and mechanics. In this division "arithmetic is always the most unsatisfactory

subject we have to deal with." The teaching of it is dull and mechanical, and the rules are rarely intelligently applied. In this large district there is one bright spot, which shows what can be done by ordinary industry and skill. It is the town of Nottingham, in which 2526 children were examined in specific subjects, of whom four-fifths passed. "Mechanics for boys and domestic economy for girls, are the subjects principally taken by the Nottingham Board Schools, and are taught by a specially qualified science demonstrator and assistant, who visit the various schools in turns, bringing the apparatus with them in a specially constructed hand-cart. The lectures given on these occasions are afterwards gone through again by the teachers of the schools, from notes taken at the time. These lectures are simple and interesting, and are given with great care and skill; the results are remarkably good, both as regards the actual knowledge acquired by the scholars and the stimulus given to the general intelligence. Besides the above-named subjects, physiology and algebra are often taken with very good results, and in one school the principles of agriculture are taught with marked success." This extract from Mr. Blandford's report shows that the neglect of elementary science is due, not to the dullness or irregularity of the pupils, as some of the inspectors would seem to imply, but frequently to the ignorance and incapacity of the teachers. In the Eastern Division specific subjects are rarely taken, but in the Norwich district mechanics, chemistry, and botany have been taught satisfactorily in one or more schools, and "are distinctly a gain to the boys." On the whole, however, this division is rather at a standstill. The quality of the education given has not risen as one would expect, and with regard to scientific and technical education, in the words of Mr. Synge, "there is plenty of room and need for progress in the immediate future, but at the present moment too little sign of its beginning." In the South-Western Division "elementary science has hardly any existence." In fact, except in some of the large towns, it is practically non-existent, and in the whole division, there were only about 600 children presented on specific subjects. In Wales, except in a few higher-grade schools, the teaching of science is unknown.

Some of the causes of this almost total absence of any scientific teaching in our elementary schools have been pointed out. Where science has been well taught it has borne good fruit, and where teachers and managers have set themselves steadfastly to overcome the difficulties in their way a high and encouraging measure of success has been obtained. Thus we have the remarkable testimony of the success of the experiment in Nottingham, and surely there are many other districts in England quite as competent to carry on this work as Nottingham. Why it could not be done in any town in England, it is difficult to see. In many cases where these subjects have been taught, the inspectors have wisely set their faces against them, finding but a wretched smattering amongst the pupils. Nothing else can be expected in remote rural districts, where the teacher, whose whole time is scarcely sufficient for the few rudimentary subjects, is so ambitious as to attempt to cram some of his pupils with the elementary knowledge of a science of which he is himself confessedly ignorant. But in our towns and cities competent teachers are always to be had. If the Board masters do not find themselves fit for the extra labour and extra knowledge required, there should be no difficulty in obtaining a specialist, as has been done at Nottingham. And in no place could the foundations of technical education be more surely laid than amongst the elder children of our elementary schools. In the Minutes and Instructions issued to Her Majesty's Inspectors, managers are requested to aid in every way they can the teaching of one or more specific subjects appropriate to the industrial or other needs of the locality, and the rudiments of two higher subjects to supply a foundation for future work. With this object it is suggested that where the teacher is not competent to do so—and this, according to the reports, is the rule, and not the exception—a specialist might be employed by a number of schools in a district, whose instruction would be supplemented by that of the ordinary teachers. There is only one instance, that of Nottingham, given in the reports of such suggestions having been followed.

Geography.—Where there is "a great absence of culture and general intelligence upon the part of a considerable number of the candidates," it is not surprising to find that, though the answers to the geography papers for admission to the male training colleges were fairly accurate, they were not intelligent. Here, again, the metropolitan candidates are superior to the provincial candidates, particularly in the map-drawing, though, in this particular, there has been a falling away of late. Amongst the female candidates, the geography was not very satisfactory, exhibiting inaccuracies in map-drawing, indefiniteness in the answers, and, generally, marks of defective early training. In the examinations for the first year's certificates the male candidates answered fully and accurately; but usually there was a slavish following of the words of the text-books and the lecturers' notes. At the end of the second year, there is the same report, book-knowledge without intelligence, and abundance of information imperfectly digested. With the females, the result is the same: verbatim reproduction of the books or notes they had read; fairly creditable answering; but "the style of the papers reveals the painful poverty of the general reading of the students, and the utter absence of any individuality, or attempt at description in their own words." In many papers there was a constant iteration of the same words and phrases, suggesting that the candidates had learned off by rote the answers to probable questions. With regard to the elementary schools, all the reports agree in saying that there has been a marked improvement in the teaching of geography. Where it is intelligently taught it is the favourite subject; but too frequently the children are not well grounded. While all divisions report progress in this subject, it is worthy of remark that all the maritime districts, and particularly those of the South-Western Division, including the counties of Hampshire, Dorset, Devon, Cornwall, and Somerset, surpass the inland schools in the knowledge of our country, its colonies, and its trade. And this is only natural. The teacher who would not, in Devonshire, interest a class of boys in the voyages of Drake, or who, in Somerset, would not rivet the attention of his pupils on the victories of Blake, would not be worthy of his post. Though the teachers may be congratulated, speaking generally, on the progress made in geography, there are many faults to be found. In portions of Wales and of the centre of England, geography is only fairly satisfactory. The pupils are weak in questions of latitude and longitude; they do not learn intelligently; because, most probably, they are taught mechanically and unintelligently. It should be within the power of every teacher by the use of an ordinary globe to make this portion of the subject intelligible to any ordinary boy; but few lads could understand a lesson on meridians and parallels, given by a teacher who does not use a globe at all. And yet this is quite common! Hence it is that the map-drawing is very poor, even where there is a good knowledge of geographical facts. Many of the inspectors complain of lack of globes, maps, &c.; and even where there is abundance of general maps, there are no local maps, a want which is very widely felt. In this respect our Board of Education might take a lesson from the Commissioners of National Education in Ireland, who have published local maps, and require each pupil in the higher grades to know, in addition to general geography, the map of his neighbourhood.