

COAL MINING, AND THE HEALTH OF COLLIERS.

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ABRIDGED.

THE subject I have to bring before you is an important and at the same time a very wide one. A knowledge of the working of a coal mine is by no means easily attained by a layman, and I cannot pretend to have acquired anything like the acquaintance with this very intricate matter that one trained in mining would possess. For many years, however, the miner and his work has been to me a subject of the greatest interest, and my knowledge has been gained by personal contact with these underground workers who have passed under my professional observation in large numbers—getting into thousands—and by occasional visits to the mine itself. For the purposes of this lecture, moreover, I have fortified myself by calling to my aid the kind offices of valued colliery friends and medical men who by living among, and attending professionally to, miners have been able to give me most valuable assistance.

As late as the close of the seventeenth century coal was mostly employed, or almost entirely, for household heating purposes. The uses to which steam was put and the manufacture of iron and steel, led to its immensely greater production, until to-day it stands forth as perhaps the most important industry in the country. We need recollect only the long continued strike of last year to witness the extent of its immediate and indirect effects upon the trade of the country. As years pass along also the numbers engaged in coal mines increase. In 1890 there were over a half-million employed underground, the additional number since 1869 being no less than 200,000, the exact figures being, 1869, 300,000; 1879, 385,179; in 1890, 506,812; and in 1893, 549,738.

The relation of the miners' occupation to health has received attention among others at the hands of Drs. Farr and Greenhow, who were pioneers on this subject, by Dr. Ogle whose work is deservedly so often referred to, by Dr. Arlidge in his invaluable work on the Diseases of Occupations, and by Dr. Nasmyth.

We shall mention at the outset the conditions of labour in the mine and then discuss whether these same conditions act prejudicially on health, and if so, consider the diseases to which they give rise.

The number of the workers about mines may be roughly estimated as about 680,000.* Of these 133,000 will be employed on the pit top, whilst the remaining 550,000 will pursue their avocation underground and be classed as miners. The conditions at once apparent about the miners' work are these: (1) that it is labour pursued underground; (2) consequently it is carried on by artificial light oftentimes not the best; (3) that the working places and the levels or roads which the men traverse are frequently low and need a stooping carriage; (4) that the work of coal getting is pursued in a constrained position; (5) that the atmosphere is more or less vitiated and impregnated with deleterious gases and is a dust laden one. A mine is generally worked in "shifts." Occasionally there may be three shifts but generally not more than two,† and frequently only one.

For our purpose all employed underground are regarded as miners. The work performed is, however, of various kinds. On reaching the pit bottom after descending the shaft in the cage the "onsetter" is met with, whose duty it is to see to the despatch upwards of the full and the descent of the empty tubs. Then there are men who attend to the roads, the labourers or "datallers," the "trammers" who despatch the tubs filled with coal from the working places, and the "fillers" who put the coal into them, and lastly also the "drivers" or "pony boys."

* The actual number for 1893 was 683,008; 549,738 underground, 133,270 above ground, of these latter 4,725 were females. The average for the last ten years compared with the ten years previous shows a decrease in females of 1060. No females are employed underground.

† Mr. A. H. Stokes, H.M. Inspector of Mines, tells me that in his (the Midland) district nearly all the mines have one shift of coal getters, &c., and one shift in the night of repairers. He gives me the following details of a three shift pit, the only one he thinks in his district. Pit working double shift of coal getters and one shift repairers: Banks men.—Coal drawing from 6.30 a.m. to 7 p.m. Meals, a quarter of an hour at 8 a.m., 12 noon and 4.30 p.m. Coal getters, workers, &c. (1st shift).—Miners get down by 6.15 a.m.; get out by 2.30 p.m. Coal workers (2nd shift).—Miners, fillers, draymen and boys get down by 3.30 p.m.; get out by 9.30 or 10 p.m. Repairers (3rd shift).—Draymen or repairers go down at 9 p.m.; get out at 5 a.m.

The men engaged at the coal face are the "fillers" just mentioned and the "coal-getters." These latter are the men upon whom practically all the others wait as they are the winners of the coal or "coal-getters." Their work is the most constrained, as in order to bring the mineral down in as large pieces as possible it is necessary to undercut or excavate the coal seam. To do this it is required of them that they should lie on one side, or the other, and they have to draw their bodies into the hole they have thus made under the seam and to continue the excavation to the depth of 3 to 8 feet. This process is called "holing."

A mine is lighted either by "naked lights" or by "safety lamps." Generally the "naked lights" used in England are candles, but occasionally open lamps or "torches" as they are called are used. Safety lamps are always required in fiery mines, and their employment is becoming much more general. Their construction varies considerably, but the essential points in all modern safety lamps are that the lower part is glass and the gauze at the upper part is protected by a metal casing or "bonnet," this latter being required in consequence of the more rapid currents of air which improved ventilation has brought about in mines. The light afforded by a safety lamp as used to-day is a great advance on that given by the old Davy, but still there is room for further improvement. It is of importance to bear in mind that many of the roads in a mine except main roads from the pit bottom are low, and that to traverse them it is necessary for a man, even below the average height, to stoop to pass along them. The same remark applies to the working places at the coal face, where of course the height corresponds with the thickness of the coal seam, and will vary with the seam from 3 feet to about 4 feet 6 inches, more or less.

Leaving accidents alone for the moment, let us consider the effect of the influence of pit life on the general health of the miner. Dr. Ogle's opinion after a consideration of the facts revealed by the census statistics of 1881 is well known. "The death-rates of coal miners" he says "are surprisingly low. In spite of their terrible liability to accident and their constant exposure to an atmosphere vitiated by coal dust, by foul air, and by excessively high temperature, the comparative mortality figure of these labourers is considerably below that of all males; nor is this only true of coal miners in the aggregate, but it is true with one single exception for the miners in each great coal area taken separately." The exception he refers to is furnished by South Wales and Monmouthshire and even here "the rule holds good" if accidents be excluded, as the mortality of miners from all other causes together is below that of the general male

population. Dr. Ogle goes on to show "that if we exclude accidents the mortality of the coal miners only slightly exceeds that of the most healthy class, viz., the agriculturalists, that is to say the farmer, the agricultural labourers and the gardeners."

It is said with truth that in a sense miners are picked men. Boys of poor physique would hardly be likely to undertake a labour involving such arduous work. But I do not think too much should be made of this. It would refer to many other occupations even if with less force. Another point that is sometimes mentioned is that old miners are not frequently met with, at all events, pursuing their work. I can hardly accept this as correct, because my enquiry shows that, as in any other occupation, a man will find employment as long as he is able to fulfil his duties, and in the mine a man can change from the laborious work required of the coal getter to one less irksome. That there are a great number of aged men employed about mines is shown in the evidence afforded by superannuation societies. Mr. Watson, of Barnsley, has written a paper dealing with this matter in Durham and Northumberland. The requirements for a miner to obtain an annuity of £13 a year were three: 1st, his age must be not less than 65; 2nd, he must be incapable of working; and 3rd, his membership in the Permanent Society must be not less than seven years. In 1888, 91,637 persons, old and young, were paying to this Superannuation Fund, and no fewer than 2,280 aged miners were being supported out of it. Approaching the subject from an Actuary's point of view, Mr. Neison, in a recent paper, said that statistics showed that during the working period of life, viz., the years before the attainment of 65, the occupation of mining as a whole was not of an unhealthy character, and demonstrates that the longevity of miners is not below the standard of the whole population. "Taking a group of miners of a general age-distribution nearly one-half," he affirmed, "would survive at sixty-five." Many he thought left the occupation before attaining the age mentioned for pursuits entailing less continuous hard work, but "others again literally die in harness, working up to quite an advanced age." An investigation into the experience of Friendly Societies as to the proportion of their members over sixty-five years of age suffering from protracted incapacity for labour showed that nearly one-third of the members came within this classification. Further the rate of mortality prevailing amongst this section was found to be not dissimilar to the high rate operating among the aged and infirm miners.

He gives the following table as to the age-distribution of the

mining population as compared with the general male population of England and Wales.

To every 1000 persons (males) the age-distribution of those employed in connection with coal and iron stone mines.

Ages.			Whole population England and Wales	
	1881	1891	1881	1891
15—24	353	365	301	302
25—44	454	447	409	412
45—64	172	170	222	218
65 upwards ...	21	18	68	68
Totals.....	1000	1000	1000	1000

Statistics as to the general sickness rate of miners are not so easy to obtain as rates of mortality. It appears that sick clubs recognise the fact that accidents to which miners are exposed render them a somewhat greater drain upon the funds than the ordinary members, and accordingly a small extra charge is made to them. Recently the Sheffield Equalised Druids examined this question. The Society has among its members a large number of miners. From the report it appears that according to Ratcliffe's miners' experience the average sickness is eight days and twenty hours against six days and ten hours for ordinary members each year. The Committee of the Druids Society found that their experience at the same ages was seven days and twenty-one hours for ordinary members and for miners alone nine days nine hours sick per member per year, showing that the miners have had one day twelve hours more than the ordinary experience of the Society.*

Accidents may well be credited with this increased sickness run upon Friendly Societies. To obtain information for the purpose of this lecture I issued to about twenty medical friends connected with collieries a series of questions. Those to whom they were addressed resided in all parts, from Scotland in the North, to South Wales, and different coal districts in England. From the replies with which they kindly favoured me, it is clear

* It was stated by the Vice-President of the National Association of Colliery Managers that when the Ancient Order of Foresters proposed an increase in the contributions of miners, on the score of the unhealthy nature of their occupation, the miners themselves produced figures to prove that this was not justifiable. In the joint conferences held between representative Coal-Owners and the Miners' Federation on the eight hours' question in 1891, the coal owners stated that as far as they had ascertained, only one Life Assurance Company (*i.e.*, The Scottish Temperance Insurance Company) makes an extra charge in the case of miners and railway servants, and that of one per cent. (Labour Commission, Summaries of Evidence, page 53).

that in their opinion the general sickness rate of a mining community compares not unfavourably with those of the populace generally.*

PHTHISIS.

The influence of dust, whether metallic or non-metallic, in the production of phthisis is now well known, and the subject received attention in these lectures last year. A collier passes a third of his day in an atmosphere which is laden with fine particles of coal dust. Mines differ very much in the prevalence of this dust. Thus men speak of the mines in which they work being dusty or not. A dry mine will be dusty, and a wet not so much so. That colliers will be constantly breathing these fine particles cannot be questioned, and yet Dr. Ogle says "that be the explanation what it may there can be no possibility of doubt that the mortality of coal miners from phthisis is remarkably low." This is amply borne out by the table—given by Dr. Ogle at pages xxx—xxxiii of the supplement to the 45th Annual Report of the English Registrar-General.

These figures not only show the small mortality of coal miners from phthisis as compared with the workers in other dust laden atmospheres, but their near approach to fishermen, a class of men particularly free from this disorder. The difference between the coal miner and the Cornish miner is most distinct. For every collier that succumbs to phthisis no fewer than $5\frac{1}{2}$ Cornish miners will fall victims to the same disease.

Dr. Nasmyth who has had a large experience of colliers, having been engaged for many years in a coal mining district, has gone into the subject now under consideration, and has given some valuable data.†

His general conclusion is that in the fifteen years passed under review, "It cannot be said that a high death-rate has prevailed in a population largely employed in coal mining, but quite the reverse; and these statistics go to disprove what at one time was generally accepted as a fact that coal mining was productive of phthisis."

The opinion of medical men to whom I have applied, as before mentioned, is unanimous as to the freedom of the coal

* I must here record my indebtedness for kind assistance to the following: Drs. Nasmyth (Cupar), Simons (Merthyr Tydfil), Makeig Jones (Wath), Cheesewright (Rawmarsh), Goodall (Chesterfield), Scott (Woodhouse), Hunter Walker (Workop), McCall (Conisbro), Justin McCarthy (Wellington, Salop), J. A. Smith (Wakefield), Menzies (Workop), Hale (Staveley), Gardiner (Beighton), Bankes (Aberdare), Walford (Alfreton), Halton (Barnsley).

† Annual Report (1892) of the Medical Officer of Health for the County of Fife.

miner from phthisis, and these opinions represent practically all parts of Great Britain.

The air of coal mines received very careful analysis at the hands of Dr. Angus Smith. This was as far back as 1863, and the air was undoubtedly as he found it very bad and can scarcely be compared with the condition at the present day.

Dr. Nasmyth* made a very exhaustive examination of the air in the Fifeshire mines, which may, he says, be taken as an indication of the state of the air in the mines for the rest of Scotland and, in all probability, for English mines also.

The average results of his examinations showed :

Carbonic acid in moderately deep mines ... 0·181%

Carbonic acid in deep mines over 100 fathoms 0·219%

Oxygen in deep mines 20·40%

Oxygen required to oxidise 1,000,000 volumes of air :

Moderately deep mines 30%

Deep mines 39%

The thermometric observations are very interesting. They were made between September and the following January. The highest point registered in the mine was 55°·5, and the lowest 53°; this last being recorded on twenty-one consecutive days, thus showing a remarkable uniformity of temperature. On one occasion while above ground the thermometer registered 25°, in the mine it registered 53°; but on another occasion the difference was only half a degree. Whilst therefore the temperature above ground fluctuated that in the mine remained fairly uniform; an important point, as men working under such conditions would not be exposed to chills and varying temperatures. Against this must be set the humidity of the mine, and also that men have often to work in wet places, and that in the main roads and when waiting at the pit bottom to ascend, they are often when insufficiently clad exposed to currents of air.

Dr. Nasmyth found micro-organisms varied according to the air currents; in a good current the colonies were few, where the air was more stagnant they were plentiful, and the presence of men and horses had a marked effect in increasing the numbers and kind of colonies. Taking it altogether, Dr. Nasmyth holds that whereas the air of coal mines twenty or thirty years ago was bad when ventilation was little adopted, now with properly directed currents of air it is widely different.

He thinks, moreover, that the conditions connected with a miner's occupation are as favourable to health as those in the

* British Medical Journal, Vol. II., 1888, p. 222.

occupation of any other workmen, an opinion which is borne out, he maintains, by vital statistics. He mentions the interesting and well known fact that horses and ponies underground soon improve in condition with their coats shining, which is certainly not due to grooming, as they do not get it. He has known ponies to be twenty years underground, and this at a time when ventilation was bad and when the hours of labour were longer.

It is clear from what has just been said that, though working underground, the miner pursues his avocation under not only widely improved conditions to what was formerly the case, but that with a fairly even temperature, he has to a certain extent an advantage over those whose employment necessitates exposure to all weathers and changes of temperature. Also the present methods of ventilation are such as to render the air of mines by no means so impure as might have been supposed.

The freedom of the miner from phthisis is a fact that hardly admits of dispute. Nor can this be got rid of by assuming as a reason that the miners are more or less picked men. The rarity of phthisis among miners is shown by the answers obtained by me from the medical men to whom inquiries had been addressed. Not one of these medical men admits to phthisis being anything but infrequent.

It has been asserted that the coal dust acts as a preventive to the development of phthisis. Be this as it may, and there is not evidence sufficient that I know of to prove the statement, yet it is abundantly clear that the dust of coal is very different from that that men engaged in metallic and other occupations have to breathe. The particles are not sharp, and are less penetrating, nor are they pungent and irritant like some other substances. It is a matter of daily observation that coal dust may be rubbed into accidental wounds, or lie embedded under the skin for years without the slightest irritation.

RESPIRATORY DISEASES OTHER THAN PHTHISIS.

In affections of the lungs other than phthisis, there appears little doubt that the miner fares worse than he has been shown to do under this disorder. Whereas the mean comparative mortality figure for all males is 182, Dr. Ogle gives that of coal miners at 202; and from the reports sent to me by medical friends, the opinion current among them is that the collier is liable perhaps more than others to bronchitis, especially in those getting on in life, and that pneumonia is prevalent in all ages. If however we take the tables prepared by Dr. Ogle, we see that among dust laden occupations only the carpenters, bakers, and masons have a less death-rate from respiratory

diseases than the coal miner. Dr. Ogle thinks that the actual death-rate from respiratory diseases should be higher than the figures given, and his idea is that among the deaths returned as phthisis are to be found many cases which should more properly have been classed with the disorders now under consideration. Be this as it may, it would reduce the percentage of deaths from phthisis, and in no way detract from the general statement which has been set forth as to the healthiness of the miner's occupation.

The following table gives the comparative mortality figure for each of the six great colliery districts* :—

Comparative Mortality from Respiratory Diseases.

Fishermen	...	...	...	...	...	90
Farmer	...	...	...	...	...	99
Miner, Durham	...	...	...	...	...	122
„ Lancashire	...	...	...	...	...	229
„ West Riding	...	...	...	...	...	172
„ Derbyshire	...	...	...	...	...	138
„ Staffordshire	...	...	...	...	...	260
„ S. Wales and Monmouthshire	...	...	...	...	...	293
Cornish Miner	...	...	...	...	...	458

This table again sets forth the wide difference as to mortality between the coal miner and the Cornish metalliferous miner. Respiratory diseases appear to be more frequent in dry and dusty mines. Though the particles of coal dust are not of so sharp and penetrating a character as are metallic particles, and the miner perhaps for this reason is in a great measure exempt from phthisis; yet their inhalation will no doubt be a prominent cause of the bronchial catarrh and indirectly of the emphysema from which miners suffer. The black particles settle on the mucous membrane of the bronchi even if they do not always penetrate into the lung tissue and give rise to the "black spit" so often seen in miners. Among other causes may be mentioned damp, and standing in cold currents of air when insufficiently clad.

DISEASES OF THE CIRCULATORY SYSTEM.

In Dr. Ogle's mortality tables the miner appears to advantage from these diseases. His comparative figure from these diseases is much below that for all males, which is 120; the miners' rate is 105 (Durham) and only 59 (Derbyshire). It is very little higher than the farmer and grazier at 84, and the draper at 75, and the printer at 93. The agricultural labourer stands at 97.

* Op. cit., page 58.

The table gives the various rates from the six coal districts.

Durham	...	...	...	...	105
Lancashire	...	...	...	...	96
West Riding	...	...	...	...	88
Derbyshire	...	...	...	...	59
Staffordshire	...	...	...	...	104
South Wales and Monmouthshire...	...	...	...	...	120

Even South Wales, the highest, is only up to the average rate for all males. Apart from this, however, the miner is, as is abundantly evident to those who see much of his ailments, prone to cardiac disorders. This is hardly to be wondered at considering the hard work he undertakes, pursued as it is with limbs and body cramped, and in a way rather to impede than promote a healthy circulation. To be added to this is the lifting, pushing, and dragging which forms such a notable part of the occupation of the miner. The tubs filled with coal for instance require no little effort to push them along, and especially is this the case when it is necessary to start one of these "corves." There is indeed abundant opportunity for the production of the form of heart affection which is observed in other occupations as the result of overstrain. Valvular disease is therefore met with, but not perhaps more frequently than is the case in other members of society.

Functional disorders of the heart are much more commonly observed. Miners present themselves with a rapid pulsating heart, with shortness of breath, general weakness and unfitness for work. The frequency of this functional disorder is attested to by the medical friends of whom inquiries were made. I have seen several among my patients attending for eye affections, and my colleague, Dr. Cocking, who has paid special attention to this disorder in those who have presented themselves among the medical patients at the Sheffield General Infirmary, has given me his opinion that men suffering in the manner mentioned are unfit for their employment, but that under rest from their work the heart slowly recovers a normal condition. Looking through the replies of my medical friends, it is observed that perhaps all are of opinion that organic affections of the heart are not more common among miners than is the case in the ordinary population, but that functional disorders are frequent.

DYSPEPSIA.

To this disorder, according to the information accessible to me, the miner is very subject. He takes with him into the mine a supply of food which he consumes half-way between the

time he spends underground. This he often eats quickly, returning at once to his work, and it consists not uncommonly of bacon, cheese, or pastry, washed down with a liberal supply of tea. All my friends consider this dyspepsia to be common, and to be due to over-eating and to indigestible food; I should add the cramped position which the miner will often occupy just after he has partaken of his "snap" in the mine. The consumption of injudicious food is not confined to the pit, but also occurs at their homes. The miner is a great meat eater when trade is good. Besides this, he adds a liberal use of beer indulged in chiefly at the end of the week, but by others the public house is visited either as soon as they ascend from the mine, or in the evening.

The miner notwithstanding all this comes out well when the mortality tables are considered. The comparative mortality figure for all males from liver diseases is in Dr. Ogle's table returned as thirty-nine. The miners in the six great colliery districts vary from fourteen to twenty-four; while for the affections classed in the table as "other diseases of the digestive system," miners are again below the average.

ALCOHOLISM.

Here again the average death-rate of the miner is below that of the general rate for males. This is somewhat surprising when the well-known habits of the miner are remembered, but it appears that indulgence is greatest among the younger men.

URINARY SYSTEM AND NERVOUS SYSTEM.

The miners' mortality rate for diseases of the urinary system and of the nervous system is below the average given by Dr. Ogle for males generally.

The foregoing will have shown that the contention, that the miner's occupation is by no means an unhealthy one, is well supported. On this point the opinion of the medical friends whose aid was solicited is of interest. Fourteen of sixteen answers received unreservedly express the opinion that in their judgment the occupation of the miner as far as health is concerned compares favourably with other employments. One of the exceptions put in a reservation for heart complaints.

The habits of the miner have perhaps been sufficiently referred to. On ceasing work and leaving the mine, he will wrap himself up and thus guard against exposure to the keener atmosphere he then meets. The houses they live in are often small with low rooms, and are overcrowded. Dr. Ogle has shown that they marry early and have large families.

MINERS' NYSTAGMUS.

This affection, though occasionally met with as an acquired disorder in the workers in other callings, is so much more frequently found among coal miners that it may veritably be *called a disease of miners*. It is in fact *the* disease of colliers. To this subject I have devoted a great deal of attention, and my observations were published, besides several papers previously, in a volume not long since.* The views then set forth and which will be briefly now mentioned, have received support from the researches carried on about the same time, but independently, by Nieden in Germany, Dransart in France, and others.

The disease is characterised by rapid motions of the eye-balls, the movements being brought about or aggravated by the patient looking upwards, and lessened or stayed by the gaze being cast downwards. To the patient the impression is given of objects upon which he fixes his gaze, moving generally in a circle, and this condition in many cases leads to so much giddiness and discomfort at work, that the miner has to desist and leave the mine. It is fortunately a malady that admits in the bulk of the cases of relief by either changing the kind of work performed in the mine, or for a time relinquishing employment in the pit. It is usually met with in men who have worked in the mine for some years, but it is occasionally observed in those whose time underground has been much more limited. Ninety per cent. are found in miners between the ages of twenty-five and forty-five. Though cases occur in other workers in the mine, and among these the "deputies" to be presently referred to, yet the disorder is as a rule observed in the "coal-getters," and it is this fact that gives the clue to the causation of the malady. These men, as was mentioned previously, are engaged in getting the coal down, and for this purpose, and to win it in as large pieces as possible, they excavate or "hole" the seam of coal at the bottom.† This undercutting of the coal is continued for some feet, and the miner beginning by sitting down and striking the coal with a horizontal swing of the pick at the bottom of the seam gradually draws his body underneath the coal lying on one or other of his sides, with the head flexed upon the underlying shoulder, and the eyes following the point at which the pick is striking will assume a direction upwards,

* "Miners' Nystagmus, and its relation to position at work, and the manner of Illumination." (Wright & Co., Bristol.) Illustrated by photographs taken in the mine, &c.

† There are three kinds of "holing":—At the bottom of the seam, "bottom holing;" at the top, "top holing;" and there is "middle holing."

and more or less obliquely. By upwards is meant towards the vertex, and it is this upward and oblique direction of the eyes, necessitated by the miner's work for long periods, that is the prime cause of the malady, for by it a weariness is induced in the elevator muscles of the eye-ball, and the oscillations of the globes thus result. The disorder is met with in mines in which various forms of light are in use. Thus it is observed in the workers with "safety lamps," candles, open lamps, "torches," in places lighted well with large paraffin lamps, and even in men working with gas light. This fact, together with the peculiar character of the oscillations of the eye-balls, prevents the manner of illumination in the mine being accepted as a main contributor towards the causation of the disorder. The worse the light, however, the more will the effects of strain be experienced, and hence other things as to work being equal, nystagmus will be found more frequent with the worse form of lighting. Nieden gives the proportion of men affected as five per cent., but counting the mild cases which do not interfere, or only slightly, with work, the numbers for many mines in England will exceed the estimate here given. The malady has an important bearing in that it is a cause of men becoming recipients of club relief for in some cases a considerable time.

In addition to the eye tremor just mentioned, there are other muscular conditions observed in the miner, which must be put down to the manner of his work. Associated frequently with nystagmus are observed, for instance, tremors of the head; a like condition is noticed in the muscles of the face and neck, and occasionally torticollis is met with. "Pick palsy" of the muscles of the arm is another form of occupation neurosis seen in the miner.

Miners also are subject to inflamed bursæ over the patella from kneeling, and also to a like condition over the olecranon from resting the elbow on the floor whilst striking with the pick. This latter is called "miner's elbow."

ACCIDENTS.

The workers in coal mines are peculiarly liable to accidents, and the mortality from this cause is a very high one. Dr. Ogle's table shows that whilst the proportion of 1,000 deaths of males generally between the ages of twenty-five and sixty-five from accident is 67, that of miners, taking South Wales, which is the highest of the mining districts, is 229, or more than three times the average. Fishermen, the next most liable to fatal accident, are a good deal below the miner.

It is further seen that the proportion of accidents under-

ground is greatly in excess of that among those employed among machinery and railways at or about the top of the mine.

The figures work out as follows:—

<i>Per 1,000 men.</i>						
		Underground.		Above ground.		Per 1,000,000 tons raised.
1893	...	1,709	...	900	...	6·043
1892	...	1,645	...	834	...	5·110

The total number of accidents from all causes underground in 1893 was 940, out of a total number employed of 549,738; whilst the number of fatal accidents amongst those employed at the surface was 120 out of 133,270.

A table given by Dr. Ogle (op. cit. page liii.) sets forth the deaths from accidents, with the ages of the miners involved.

This table shows that the younger hands employed are those particularly that go to swell the aggregate number of fatal accidents. This will have to be referred to again when considering skilled labour in the mine. The second point is the large proportion of the total fatal accidents that is due to falls of roof and sides. In Scotland it was stated before the Labour Commission, that no fewer than fifty per cent. of the fatal mine accidents were due to this cause. It is also found that in the returns based upon the Reports of the Mine Inspectors for 1893 out of the total number of fatal accidents 1060, there were returned 412 as caused by falls of roof and sides. In 1892 the numbers were somewhat in excess, viz., 435 out of 1016 fatal accidents.* In 1878 the ratio was 1 in 294, but in 1891 it was reduced to 1 in 388. The number of deaths in a given year from explosions is of course subject to great variation, a large colliery disaster sending the rate from this cause up, and very materially affecting also the general death-rate from accidents. Fatalities resulting from mishaps in the shaft, cage, &c., amounted in 1893 to no fewer than 103 out of the total of 1060. A consideration of the number of men who descend into and ascend from all the mines in the country in the course of one day only will create some surprise that this figure is not in reality larger. In his Report as Inspector for the Midland District for the last year, Mr. A. H. Stokes remarks on the decrease of accidents in shafts of three from the previous year, the number for the year under review being five. He proceeds to say "the small number of accidents in shafts is remarkable when we consider that upon every working day in the district

* The following comparison with other trades is interesting:—

Fatal accidents on the sea, 1 in 115 (1892); do. on railways, 1 in 543 (1893); do. in metalliferous mines, 1 in 5·0 (1893); do. coal mines, 1 in 644 (1893).—Mr. Brain, "Colliery Manager," September, 1894, page 175.

upwards of 60,000 persons are lowered and raised through shafts."

Many of the accidents resulting from falls of coal are without doubt due to carelessness on the part of the miner. It is impossible to read the reports of the inquiries which follow fatal accidents without being struck by this fact. Neglect in setting proper supports, or "spraggs" as they are called, in sufficient proximity to each other, and in failing to observe the dangerous condition of the roof, are causes of these mishaps. But besides this, the character of the coal and of the roof, whether hard or not, are factors to be remembered. In Wales the roofs are stated to be very treacherous, especially in the steam coal collieries. The evidence before the Labour Commission showed that the diminution of accidents, and the general improvement of mining was largely due to the different Coal Mines Regulation Acts. These Acts have failed, however, to prevent the employment of unskilled workmen, and this is a matter upon which the miners and their representatives feel very strongly. It was even stated before the Labour Commission that a considerable number of the accidents in South Wales, where, as has been said, the greatest proportion occurs, may be traced to the increasing number of unskilled workmen who manage to obtain employment.

Before passing from fatal accidents, a matter remains to be mentioned. It is interesting to observe, in view of the statements that are made and which are combatted in the Report of the Labour Commission, that the accidents are not influenced in any material degree by the time the men may be at work. For 1893 and 1892 the figures work out as follows:—

	1st hour.	2nd hour.	3rd hour.	4th hour.	5th hour.	6th hour.	7th hour.
1893 ...	81	77	85	71	72	92	70
1892 ...	68	73	94	90	92	91	75
		8th hour.	9th hour.	10th hour.	11th hour.	12th hour.	More than 12th hour.
1893 ...	...	54	45	35	8	—	—
1892 ...	...	66	56	25	3	2	4

Besides the fatal accidents, those less severe from which recovery takes place form a large part of the ailments of the miner. Klostermann speaking of coal mining in Germany (Bochum district), said that accidents formed a quarter of all the ailments of the coal miner, and there is no reason to suppose that the proportion is less for this country. The opportunities for accidents to body or limb in the mine are multitudinous. At the coal face, injury to limb or body by pieces of coal or stone; and in filling and tramming, trapping of fingers and jamming of legs and feet, are of frequent occurrence.

EXPLOSIONS.

The air of a coal pit is apt to be rendered impure by various circumstances. Among these may be mentioned the fact of the large number of human beings, in addition to the horses, who pass their time underground. The horses are stabled below, and are rarely taken up. Besides the effluvia from the cattle it must be remembered that the miner spends a third of the twenty-four hours in the mine and the calls of nature are there responded to. Excreta are passed at any place, and sometimes covered over and as often as not by small coal. This appears to me a matter about which improvement might take place.

The atmospheric air, moreover, in the mine becomes charged more or less with certain gases. Carbon dioxide is known to the miner as "black" or "choke damp" or "stytch." Carbon monoxide or "white damp" is more deadly and less frequently met with than carbonic acid. It results from imperfect combustion and especially spontaneous ignition. Sulphuretted hydrogen is at once detected by its smell, and arises from decomposition of iron pyrites and from the imperfect combustion of gunpowder. Light carburetted hydrogen or fire damp is commonly found in coal mines and is the cause of the explosions attended too frequently with such great loss of life. Under the name of "after-damp" is included all the products from ignition of an explosive mixture. Carbon monoxide and dioxide figure amongst its constituents, as does also light carburetted hydrogen. The miners who escape the effects of an explosion fall victims to this after-damp and in this way it is responsible for more deaths than directly result from the explosion.

To combat the conditions thus briefly mentioned and to dilute any gases as much as possible the ventilation of mines has naturally received a great amount of attention, and the success which has followed the adoption of such methods as are in use at the present day is set forth in the valuable article by Dr. Nasmyth already alluded to, which shows the greatly improved state of the air in coal mines to-day compared with even twenty years ago. The superior means adopted in the deep pits where a current varying from 100,000 to 300,000 cubic feet a minute is circulated through the workings diminishes greatly the chances of explosions, but at the same time when gas is actually ignited this same ventilation serves to supply the oxygen for the maximum intensity of flame.

The relation of coal dust to explosions is still a subject receiving a good deal of attention. The whole matter of explosions has received exhaustive treatment in the Report of

the recent Prussian Commission on Fire-damp. They give the causes of the production and the accumulation of fire-damp as follows :—

1. Continuous evolution of marsh gas without extraordinary accumulation.
2. Boring into fissures, blowers, &c.
3. Falls of roof.
4. Evolution of fire-damp from goaf or from large accumulations.
5. Accumulations resulting from the stoppage of works.
6. Accumulations behind heaps of coal, or stone, or timbering, or in the sump.
7. Accidental disturbances of the ventilation.
8. The leaving open of air doors.
9. Miscellaneous forms of neglect in the ventilation, such as omitting to inspect and maintain the arrangements for subdividing the air, &c.
10. Unknown.

Causes of ignition of the fire-damp :—

Naked lights	...	...	...	...	...	176
Matches	...	...	...	...	...	10
Opening of the safety lamp	...	...	...	...	...	58
Defects of the safety lamp	...	...	...	...	...	22
Heating of the gauze of the safety lamp	...	...	...	...	...	11
Passage of the flame of the safety lamp :						
Owing to careless handling	...	...	...	...	...	46
Too rapid an air current	...	...	...	...	...	8
Shot firing	...	...	...	...	...	94
Ventilation furnaces	...	...	...	...	...	1
Unknown...	...	...	...	...	...	11

Total number of fatal explosions 437

Statistics quoted by this Commission show no very considerable variation in the number of explosions in the different months, but in the winter, when the demand for coal is greatest, they are the most frequent. They display, moreover, a decided tendency to take place on Mondays, showing that the stoppage for the Sunday, favours the accumulation of fire-damp.

The detection of fire-damp is a matter of vital concern to all engaged in a coal mine. So much is this held to be the case, that recent researches have led to the making of safety lamps capable of detecting very small percentages of gas. It has been held that even less than one per cent. may be explosive in the presence of coal dust, and the lamps referred to estimate as little as one-half of one per cent. The ordinary method

adopted in mines is much less delicate than this, and will not detect less than 2 to 3 per cent. of fire-damp. The flame of a lamp is reduced until the luminosity almost disappears, and then the fire-damp appears as a pale flame or "cap" above it, this "cap" being due to the presence of gas in the air. The amount of gas present can be estimated by the dimensions of this cap. It will at once be understood, especially with this ordinary and less delicate test, how important it is that indications of the presence of gas should be at once recognised. The class of men in a mine who are responsible for seeing that the pit is free from dangerous quantities of gas are those called "deputies" or "firemen." It is part of their duty to visit the "workings" before the colliers go to their work, and during their "working shift," to ascertain whether or not "gas" in any amount is present. Throughout their regular day's work, moreover, they are on the look out for any accumulations of gas.

Mention has already been made of nystagmus as a disorder of the eyes to which miners are very liable, and the prominent symptom of which is that, to those afflicted, objects looked at appear to be moving, spinning round, often in a circle. Among those known to suffer from the affection are to be classed these "deputies" or firemen. Many instances have come before me. They have generally previously worked at the coal face. Now it has for long presented itself to my mind that a man afflicted in such a way that an ordinary safety lamp appeared to dance about, could hardly be regarded as a reliable tester for gas in which the proper and delicate perception of the faint cap which formed over the flame was a matter of so much importance. I not long ago discussed this subject in an article published in the *British Medical Journal*. To put my opinion to a practical test in the mine was not easy, but an opportunity presented itself, and a friend promised to observe the capacity of a "deputy" suffering from nystagmus for me in such a way that his attention would not be drawn to the fact that he was being tested. As we anticipated, he failed to recognise that gas was present until the flame had lengthened out; and tested again, and asked to speak when he saw the "cap" on my friend's lamp, he did not do so until the flame had begun to lengthen out. Other cases have shown me that this matter is one of considerable importance. On the discovery of the presence of fire-damp, the lives of perhaps the whole of the men underground are at stake. If a "deputy" has failed to detect its presence sufficiently promptly, he has paid the penalty and perished with the others. In my opinion this is a matter sufficiently momentous to bear in remembrance as being a possible explanation of the occurrence of some explosions, and

such I may add is the opinion also of some mine experts who are acquainted with my observations on this subject. It is, besides this, important that the gas tester should have keen vision.

The increased importance which has in recent years been attached to coal dust as a factor in the causation of explosions, has led to the adoption in mines of explosives designated flameless. Dynamite and its allies, amongst others, have been used, but those containing benzol require brief consideration here. Only recently I placed on record my observations on the effect of di-nitro-benzol* upon the health and eyesight of those employed in the making of explosives, of which it formed an important constituent. The Home Secretary about this time was preparing to take some action, and after enquiry by Dr. Dupré and Commander H. Smith, one of the Inspectors of Factories, the manufacture of these articles was classed as "dangerous to health," and notice was served on the manufacturers to observe "special rules."

Miners from time to time, but not many times altogether, complained to me that the use of roburite, an explosive containing the di-nitro, was injurious. But in Lancashire and the North of England the complaints were of such a character that inquiries were held. Drs. Hannah and Mounsey, with Professor Harold Dixon, F.R.S., investigated the subject in Lancashire, and made a very valuable report. They were inclined to attribute to the improper handling of the cartridges the undoubted cases of nitro-benzol poisoning which had been brought under their notice. They insisted on the necessity of complete combustion, but thought that if stringent care was exercised by the managers, shot firers, and colliers, the use of roburite would not add to the harmful conditions under which the miner worked. In Durham, Drs. Drummond and Hume, with Professor Bedson, were appointed to deal with the matter, and their report is a complete one, in particular the experimental and chemical part, which was undertaken by Professor Bedson. A careful examination of the fumes in the mine after using these explosives was made, and the report says that, "in some cases, after firing the roburite, the odour of nitro-benzol was observed, but beyond this we obtained no evidence of nitro-benzol or any similar product." He further alludes to the danger resulting from the fumes being almost entirely gaseous, because their consequent invisibility may lead the miner to return to his work sooner than he would if, for instance, gunpowder was used. They thought, moreover,

* *British Medical Journal*, March 3, 1894.

that the particles of the benzol existed in too small quantities to be hurtful. My observations showed, I think, that the di-nitro was a very subtle poison, and that among the workers with it, those apparently coming little into direct contact with the substance, either its vapour, or by handling the powder, still suffered by no means infrequently from serious constitutional symptoms. I have never had any serious effects brought to my own knowledge from the use of any explosive containing it in the mine. I should, however, recognise that under certain circumstances injurious effects may be occasioned, but should on the other hand equally hold that such effects are preventable, and would urge attention to, care in handling the cartridges, insuring perfect combustion, and by efficient ventilation affording ready escape of the fumes from the working places.

The review which I have been able to give of my subject will have shown that the miner's is a laborious and disagreeable occupation, pursued under peculiar conditions. Working underground, and thus shut off entirely from the light of day, the collier exercises his calling under like circumstances to many of the workers in metalliferous mines; but a striking difference is shown in the manner of his work, the constrained posture it requires, and above all in the atmospheric conditions, which expose him to dangers unknown to other miners. It will, however, have been observed that notwithstanding all the circumstances the miner ranks well in mortality tables, and that his occupation must be regarded as a healthy one. With the question of the limitation of the hours of labour we have here little concern. In passing, however, it may be remarked that the interference of the legislature has before now been evoked with good effect on behalf of those employed in industries which were recognised as detrimental to the health and well being of those engaged in them. It by no means follows, in the absence of these conditions, that no action should be taken, for there may be many other excellent reasons, economic and other, that render such a step desirable; and in the case of the collier no doubt such reasons are present to the minds of the advocates of a compulsory shortening of the hours of labour. It suffices for us to say, that a review of all the facts set forth in this lecture demonstrates that the miner's, compared with other occupations, is a healthy one; or to quote the words of the Labour Commission: "The weight of evidence seems to be against the idea that coal mining is an unhealthy occupation, even when allowance is made for the probability that weakly men either avoid or soon abandon it."