nated cases at the same age period there were fifty-one deaths; in other words, while less than '5 per cent. of the vaccinated children died, amongst the unvaccinated the mortality was 33 per cent., or sixty-six times as great.

THE WATER SUPPLY OF GLAMORGANSHIRE,*

BY

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THE nature of the water and the sources of supply for drinking purposes is of the greatest importance. In the southern area, in addition to river supply (usually dangerous from pollution), there are numerous springs thrown out by the shales and clays of the Lias Limestone series. The quantity is generally small, and the water contains much lime and salt (*e.g.*, the Barry and Porthcawl supplies).

The Keuper Sandstones and Marl series, especially the junction with the Dolomitic Breccia, give a constant supply to the wells of the Cardiff breweries and the Ely district. The water is usually very hard, containing sulphates and carbonates of lime and magnesia, also sodium chloride.

From the carboniferous limestones, especially along the lines of faults, we often have springs of considerable volume, thus:—

Fig. 1.

Carboniferous Limestone.

Carboniferous Limestone and Lower Limestone Shale.

A Section across the fault near Ewenny, showing the relation thereof to the Spring which supplies Bridgend.

These springs are occasionally the outflow of surface springs which had disappeared below the surface for a while. Such an instance is to be found north-east of Cefn, near Merthyr, as in Fig. 2.

* From Dr. Williams' "Sanitary Survey of Glamorganshire."

Sometimes ordinary underground streams are formed by percolation. The water from the carboniferous limestone is always hard.

Within the coal basin the watersheds of the

Fig. 2.

N.E. of Cefn, near Merthyr.

The rock is Carboniferous Limestone.

(Different shading adopted to indicate fault.)

various rivers form the principal supplies. Besides these the Pennant sandstones are full of water, and give rise to strong springs where percolation is hindered by the presence of clay bands, *e.g.*, fire-clays, thus:—

Fig. 3.

Sandstone of Pennant.

Clay bands often beneath a Coal Seam.

Diagram to show the effect of Clay bands in the Pennant Grit in forming Springs by preventing percolation. Instances numerous in every valley.

This water is soft, usually ferruginous, and occasionally slightly acid from the presence of coals. From one of these springs at least free nitrogen gas is evolved (Taff's Well). Very little of the supply of the northern area is obtained from the rocks. Water from the carboniferous limestone is hard, whereas the millstone grit above and the old red sandstone below yield softer water. The water from the surface of the hills is extremely soft, and in running over their peaty slopes it gathers much organic impurities, and when obtained from the high ground within the coal basin is still more impure, since it collects the particles of the atmosphere.

The most useful supply, therefore (balancing the commercial gain of pure water for engines against the possible injury to health by too soft water, and also the loss to breweries), is the rain supply collected on the northern area. Cardiff and Merthyr obtain their supplies from this area, and Swansea is about to be supplied from the same.

On the hills the *surface soil* consists of a considerable thickness of peat, and in the smaller tributary valleys there is much boggy ground. This condition is produced by water, after heavy rain and from springs, flowing down along their steep slopes and constantly soaking into the peat, the result being a quagmire. Naturally, the soil is derived in most cases by mere disintegration of the rocks below. Such a soil is common on the higher ground, and the rocks being pervious the soil is also pervious, or it may be due to glacial action, *e.g.*, Pwllpant old station is built on an esker. Along some of the valleys, *e.g.*, the Taff and its tributaries, also the Loughor, there are heaps and lines of clay and gravel, as well as scattered blocks, accumulated by this agent. It usually implies the shifting of the material further south than its natural outcrop, *e.g.*, on the flat north of the Cardiff Silurian outcrop we get blocks, etc., from the old red sandstone, carboniferous limestone, and coal measures, brought from the north. In the majority of cases these beds are porous, but they are very variable, and pass into impervious clays.

From the river Rhymney to the Ely there is a tract of alluvium, and such a condition is also found for some distance up along the banks of the principal rivers. West of the Ely tracts of alluvium

also occur. Wind has done much along the shore west of the Ewenny to beyond Neath by spreading sand over the surface and accumulating large sand-dunes. These beds are very porous, and well adapted for the treatment of sewage, though so far they are not used for that purpose.

In the minor folds (already noticed) water was formerly naturally collected as in a basin, and the surplus got rid of by local springs. These have been weakened or destroyed by underground workings, which discharge large volumes of water contaminated with impurities due to man and beast and the chemical products of the oxidation of the coal and associated minerals, and is no longer fit for drinking springs.

The bulk of the population withdraw from the Vale and accumulate in the valleys, the rivers have become too polluted for use, and the natural flow of the underground water is disturbed, so that the water supply of the present and the anticipated future of the coalfield is most important.

Llanbradach Colliery in the Rhymney Valley pumps about 32,000 gallons an hour from underground. This is most likely the supply from the hill country to the west—the eastern side of Mynydd Eglwysilan.

If the water level is permanently reduced in this way houses and villages situated on the ground above the valleys are in danger of losing their well water, especially during dry weather.

In the valleys shallow wells are possible occasionally in the gravels formed by rivers and ice. These deposits are irregular in thickness, and not likely to give a continual supply, and from their

porous nature are certain to take in impurities from sewage, etc. Even in the lower parts of some of the valleys care is needed with the springs from the limestone, since the water may not be pure spring water, but merely the river supply, with all its objectionable soluble contents travelling underground for a while. Such a case is recorded at Pwllloffeiriad in the Ogmore Valley.

The chief source of danger arises from disturbances of surface produced by underground workings. As far as possible mining officials seek to cause merely a gentle and even subsidence by stowing. This, however, was not done in past time. Subsidence does and must occur, and the greater the number of seams worked the greater the effect, thus:—

(a) Fault lines are disturbed, and since they frequently form the boundaries of a royalty, working

Fig 4.

Pennant Grit.

Diagram to show the effect of pumping in a deep pit on the permanent water level.

a—Level after much rain. b—Level after dry weather,
c—Level reduced by mine pumping.

Cases are numerous, *e.g.* at Llanbradach in the Rhymney Valley.

tends to exaggerate the surface effect, producing in some cases a fall of the surface to the extent of ten to twenty-five feet. This may cut off the water

Fig 5. A Diagram to show effect of a level driven into the hill from the valley, slightly rising and crossing several coal seams. The working thereof entirely upsets the water circulation. It is drained out along the level, which is made to slope for that purpose. There are numerous examples of this, e.g. at Rudry.

supply obtained from springs along the line of fault and divert it underground (Fig. 6). It may also cause contamination. Smartt proved that a fault in the chalk under Woolwich contaminated the water supply, and there is reason to believe that faults under the Thames suck in the water when the porous beds beneath are pumped out, or if the water level gets low.

(b) Workings being local, the subsidence is far from regular over a wide area. When a sudden subsidence takes place, the drainage and water supply are apt to be disturbed by the breaking of pipes, and even when gentle it destroys the gradient, and thus produces stagnancy as well as danger of breakage. The danger of leaking water pipes is well known. (See Dr. Spear's Report on Typhoid Fever Epidemic at Mountain Ash in 1888.)

Fig 6. A fault commonly forms the limit of a royalty. A fault as shown in diagram is often a line of strong Springs. Underground workings cause the water frequently to run in a different direction. The Spring (S) ceases, and the water runs down the levels left unshaded, and is pumped in an impure state from the pit. The unshaded parts are supposed to be worked out coal seams.

The water supply of the mineral districts of Glamorgan is a matter of the greatest importance. During the drought of last summer there was a

great scarcity in many localities, a condition almost bordering upon a water famine. Now, at present, a great alarm is felt that there may be an absolute water famine in the near future, if some means are not taken to provide an adequate supply. There are several water companies, but the supply provided by some of them is very defective, and inadequate to meet the needs of the inhabitants.

It has been proved that we cannot rely on obtaining a constant supply from the mineral districts, though now most of it is obtained from watersheds situated over this area. This is the experience of Swansea, where some years ago an attempt was made to construct reservoirs and collect water within the mineral basin, with the result that it proved a failure, or at any rate the supply, if obtained, was very inadequate for the purpose. In former pages I have endeavoured to show how underground working may disturb or crack the surface, thereby producing loss of water. Cardiff and Merthyr are supplied from areas north of the coalfield, but the remainder of the population obtain their water from watersheds over the mineral basin.

The population of the county in 1881 was 511,433, in 1891 it was 687,218, showing an increase of 175,785 in ten years, i.e., about 34 per cent. This increase was larger than that of any other county in the United Kingdom, except Essex, representing the Eastern population of London. These figures refer to the whole county, but excluding the two county boroughs of Cardiff and Swansea, they are 352,242 in 1881, and 467,954 in 1891, being an increase in the administrative county alone of 115,652. This increase has mainly taken place over the mineral area. In 1801 the population of the whole county was only 70,879, in 1891 it was 687,218, so that in ninety years the increase has been nearly ten times. If it increases at the same rate as during the past decade, it would reach over 11,000,000 in one hundred years hence.

The above figures show what the population may become, and how absolutely necessary it is to be in readiness to supply it with a sufficient water supply. The question naturally arises, Will the county be able to sustain such a population?

The Coal Commission appointed in 1871 reported that there was in the South Wales coalfield 32,241,472,740 tons of available coal for use, and it has been estimated that whatever the increase of population may be, there will be ample mineral wealth to sustain it. The large populations of Ystradfydwg and Pontypridd districts, some 140,000, dependent upon local companies, have at present *no* adequate supply; last summer they were actually in want.

In June, 1893, deputations from the Local Boards of the above districts waited upon the Water Committee of the Glamorgan County Council, and represented that then a serious deficiency of water existed in their districts, and that the prospects for the near future were alarming. The Committee recommended that a deputation consisting of members of the Water Committee and of the Local Authorities be sent to the Local Government Board, urging it to introduce into Parliament a measure repealing the clause prohibiting local authorities from competing in water supply with private Water Companies within their districts, and also to authorise the County Council to promote a Bill for providing a general water supply for the county. Such powers, however, were not granted, and matters must of necessity, for the present, remain in *statu quo*.

Populations spring up so rapidly within the mineral area, and they have no power of obtaining a proper water supply except by means of sanitary authorities, who cannot afford to go to Parliament for large and costly scheme or schemes that are necessary to supply the wants of their growing populations.

And now, since the supply given by the various local companies is inadequate, and in danger at any moment of being disturbed, it is absolutely necessary that the supply of the districts should be obtained by a large and general scheme created by the County Council, or a combination of local authorities, from the mountain ranges lying to the north of the coalfield. Cardiff and Merthyr already obtain their supplies from this area, and Swansea has also promoted a Bill in Parliament to obtain their water from the collecting ground of the Cray, the upper watersheds of the Usk. Until such another scheme is provided for the mineral districts of Glamorgan their present and anticipated future population cannot be said to be adequately provided with a constant and a sufficient quantity of pure and wholesome water, which is the first necessity of life.

DR. JNO. F. J. SYKES, M.O.H. of St. Pancras, has been appointed Lecturer on Public Health at Guy's Hospital Medical School. We heartily congratulate Dr. Sykes, and still more the Medical School at Guy's on the new appointment.

Public Health.

OYSTERS AND TYPHOID FEVER.

PROFESSORS HERDMAN AND RUBERT BOYCE, of Liverpool, contributed to the Ipswich meeting of the British Association the results of an incomplete experimental inquiry into the effect upon the oyster of various external conditions, including pathogenic organisms. One point established was the tolerance of sewage displayed by oysters. They could live for a prolonged period in water rendered completely opaque by the addition of fæcal matter. It hardly needed an experimental inquiry to demonstrate this point. Is it an accidental circumstance that oyster-beds, and particularly the market-ponds attached to them, are so commonly placed at the mouth of tidal rivers, in suspicious contiguity to the sewage outfalls; or have oyster-growers realised that under these conditions the oysters fatten more readily than in purer streams?

As regards the infection of the oyster by micro-organisms, the bacteriological examination of the water of the pallial cavity of the oysters and of the contents of the rectum showed that when oysters were laid down in the open water of the bay, there were but few colonies present, but when laid down near a drain-pipe, the number was enormous. Oysters were grown in water infected with the bacillus typhosus; and the latter could be identified in cultures taken from the water of the pallial cavity and rectum fourteen days after infection. The authors suggest that by methods similar to those employed in the "Bassins de dégorgement" of the French ostréiculturist, where the oysters are carefully subjected to a natural process of cleaning, oysters previously contaminated with sewage could be freed of pathogenic organisms or their products without spoiling the oyster for the market. This, no doubt, will be good news for the oyster trade (though we doubt if they will avail themselves of it in practice until the pressure of public opinion is greatly increased); but what of the long-suffering public, who will continue to be experimented on? Probably they would prefer not to eat oysters freed (?) from previous sewage contamination if they had a choice in this matter, which, it would appear, is to be settled between bacteriologists and the oyster trade, the persons most concerned being left out of the consultation!

We welcome the researches of Professors Herdman and Boyce on this important subject, and hope they will be continued. It is desirable, however, that medical officers of health should state very emphatically that they do not on this or on any other public health problem intend to allow themselves to be bound hand and foot by *ex cathedra* statements of bacteriologists. Bacteriology is as yet but a young science; it has still much to learn