travel together', he notes, and goes on to record 'in narrow lanes we were often much inconvenienced by these unceremonious travellers'.

At Tincroft mine he notes that the engine was on 'Hornblower's principle'. This is an interesting footnote to history, for Hornblower was trying to break the monopoly which patent rights had given to Boulton and Watt. The latter were eventually forced to fight a lawsuit to retain their monopoly.

Maton, however, was a physician and his observations in this field are interesting. He gives the mining population of the country as 15 000 men, women, and children. Of the miners he says:

'Most of the miners have a wretched, emaciated appearance, for they suffer from dampness, impurity of air, heat, and numerous other causes, though in Cornwall they are subjected to the fatal effects of choak damps less than in any other mining countries. *From enquiries we made amongst these miners*, the most general inconvenience experienced with regard to their bodily health is a tightness and constant uneasiness of the thorax.'

The significant fact here, apart from the symptoms described, is that he made enquiries, surely one of the earliest excursions in the field of industrial disease in this country.

In Hayle he visited the copper smelting houses, and he writes:

'Nothing can be more shocking than the appearance which the workmen in the smelting houses exhibit. So dreadfully deleterious are the fumes of arsenic constantly impregnating the air of these places and so profuse is the perspiration occasioned by the heat of the furnaces that those who have been employed at them but a few months become most emaciated figures and in the course of a few years are generally laid in their graves. Some of the poor wretches who were ladling the liquid metal from the furnaces to the moulds looked more like walking

corpses than living human beings. How melancholy a circumstance to reflect upon yet to how few does it occur, that in preparing the materials of those numerous utensils which we are taught to consider indispensable in our kitchens, several of our fellow creatures are daily deprived of the greatest blessing of life, and too seldom obtain relief but in losing life itself.'

No doubt modern industrial physicians will disagree with his diagnosis but this was 1794 and his observations must have been novel for those days. There is probably little copper worth getting in Cornwall now, but a good deal of tin. As the earth's tin reserves shrink, mining must eventually come back to the county. Only Geevor and South Crofty now work, though there is talk of opening up Levant again and prospecting elsewhere. One of the limiting factors in reopening the Cornish mining industry could be that the Cornishman, after more than 1 000 years of disembowelling his own county, may be losing his taste for mining. Foreigners are now employed in those mines which still continue to function, so if you shout down a hole in Cornwall now or in the future the answer may well come back in Italian!

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Erythrocytes of uranium miners: the red blood picture

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Vích, Z., and Křiklava, J. (1970). *Brit. J. industr. Med.*, 27, 83-85. **Erythrocytes of uranium miners: the red blood picture.** Haemoglobin concentrations, erythrocyte counts, haematocrit values, and mean corpuscular volumes, haemoglobin, and haemoglobin concentrations were determined on a group of miners in a uranium mine and in unexposed persons. There were small, statistically significant differences of mean values from those of controls, but the mean values remained well within normal limits. There was no evident damage to red blood cell formation.

White cell counts are used as indices of the effects of radiation on blood-producing organs and on the whole organism. Although a somewhat coarse one, they still constitute an easily available preventive measure.

Our aim was to see whether there were any alterations in the measurements associated with the red blood cells in uranium miners who form a special group of persons exposed to chronic radiation in their work. These were studied especially because differing opinions prevailed as to whether there were any alterations which could be used to indicate exposure to radiation.

Materials and methods

Haemoglobin and the red cell count were measured in 4 021 persons examined during one year, namely, 3 642 healthy uranium miners from the region of Příbram, working underground, who were examined periodically to monitor exposure, and 379 healthy men asking for employment in the mines. In a smaller group, 1 717 miners and 249 non-miners, haematocrit values, mean corpuscular volumes, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentrations were obtained.

Haemoglobin was determined as cyanmethaemoglobin by photocolourimetry. The erythrocytes were counted in a Bürker chamber after blood dilution with Hayem solution. The haematocrit value was determined in Wintrobe's haematocrit tubes. The calculations of red cell parameters were made according to standard formulae (Netoušek, 1962).

Results

The miners were treated as four groups according to the number of years of exposure.

TABLE 1
HAEMOGLOBIN CONCENTRATIONS, ERYTHROCYTE COUNTS AND HAEMATOCRIT VALUES IN CONTROLS AND URANIUM MINERS
Means $\pm$ SDs

Working exposure of groups	Hb (g/100 ml)	Erythrocyte counts (millions)	Haematocrit (%)
Not working in mines	15.0 $\pm$ 0.8	4.58 $\pm$ 0.25	44.8 $\pm$ 2.7
Uranium miners			
< 5 years	15.0 $\pm$ 0.8	4.64 $\pm$ 0.24 ²	45.3 $\pm$ 2.8
6-10 years	14.8 $\pm$ 0.8 ²	4.61 $\pm$ 0.26 ¹	44.9 $\pm$ 2.9
11-15 years	14.6 $\pm$ 0.9 ²	4.65 $\pm$ 0.26 ²	45.1 $\pm$ 2.9
16-20 years	14.7 $\pm$ 0.9 ²	4.56 $\pm$ 0.28	45.1 $\pm$ 3.2

Where mean is different from mean of controls:

¹P < 0.05

²P < 0.001

TABLE 2
MEAN CORPUSCULAR VOLUMES, HAEMOGLOBIN AND HAEMOGLOBIN CONCENTRATIONS
Means $\pm$ SDs

Working exposure of groups	MCV (μ^3)	MCH (pg)	MCHC (%)
Not working in mines	97.2 $\pm$ 3.2	32.3 $\pm$ 0.9	33.4 $\pm$ 1.2
Uranium miners			
< 5 years	97.2 $\pm$ 2.9	32.3 $\pm$ 0.8	33.2 $\pm$ 1.2 ¹
6-10 years	97.8 $\pm$ 2.7 ²	32.3 $\pm$ 1.0	33.0 $\pm$ 1.1 ²
11-15 years	97.5 $\pm$ 2.8	32.1 $\pm$ 0.9 ²	33.1 $\pm$ 1.3 ²
16-20 years	98.0 $\pm$ 2.8 ¹	32.4 $\pm$ 1.0	33.1 $\pm$ 1.2 ¹

Where mean is different from the mean of controls:

¹P < 0.05

²P < 0.01

³P < 0.001

Table 1 shows the haemoglobin concentrations, erythrocyte counts, and haematocrit values. Table 2 shows the mean corpuscular volumes (MCV), mean corpuscular haemoglobins (MCH), and mean corpuscular haemoglobin concentrations (MCHC). The statistical significances of the differences from control values are shown. The values for the controls had the characteristics of the normal healthy male population of Czechoslovakia (Kříklava and Vich, 1969).

Discussion

The influence of chronic radiation on uranium miners is frequently discussed. It is known that these workers have an increased incidence of cancer of the lung, but there is in them no unambiguous set of clinical symptoms representing radiation damage (Ševc, 1967). It is not even known whether there are any aberrations within the framework of a generally good state of health.

The deviations from normal in the red blood cell picture found here were not unambiguous. Similar small and variable changes have also been found by others investigating this problem (Borovanský, 1933; Petráček, 1953; Henn, 1954; Henn and Leibetseder, 1955; Pelnář, Kuřetová, Nováková, Roubal, and Šplichal, 1959; Polák and Reřicha, 1962; Dominas-Kuczkowska, Bogusławska-Jaworska, and Dobryszczyka, 1963; Bakstein, 1966; Kříklava and Vich, 1968; Vich, Kříklava, and Beran, 1968).

The differences from the controls of the mean values were always very small, but several were statistically significant. The decrease in haemoglobin content and the tendency to macrocytosis

were presumably caused by the radiation to which the miners were exposed. However, while the mean values were slightly altered, they always remained well within the normal range, so that values on individual miners could not be used as an index of exposure.

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