

Georgius Agricola: 1494 - 1555 — mining engineer and physician

His contribution to occupational medicine and the aetiology of bronchus carcinoma

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Georgius Agricola is well known in mining circles because of his textbook of mining, *De Re Metallica*, which was published posthumously in 1556. For the next 180 years, it was the only guide available to miners and metallurgists, and was widely read. It has since become a very scarce collector's item, but the 1950 reprint of the 1912 English translation by a future president of the USA and his wife is more readily available.¹

Agricola was also a physician, having trained in Italy. In 1527 he was appointed town physician at Joachimstal (now Jachymov) on the Czech side of the metalliferous Erzgebirge Mountains. In about 1533 he became town physician at Chemnitz on the German side of the mountains.

Agricola can therefore be expected to have attended the Erzgebirge miners, and his book indicates that he was familiar with the occupational diseases and hazards of mining. He described the effects of foul air, cold and wet conditions, heavy-metal poisoning and accidents. He also recorded the respiratory diseases of miners, and attributed them to dust. It is worth quoting him verbatim:

'... penetrates into the windpipe and lungs, and produces difficulty in breathing, and the disease which the Greeks call asthma.'

'... it eats away the lungs, and plants consumption in the body.'

The former description is compatible with silicosis and pneumoconiosis, the latter with tuberculosis — both traditional diseases of miners. The latter description suggests that Agricola examined the lungs *post mortem*. Neither description is compatible with bronchus carcinoma, which is usually a macroscopically localised disease that does not 'eat away the lungs'.

The Erzgebirge mines contain radioactive pitchblende, in which radium was first described by Marie Curie.^{2,3} Radium decays through, *inter alia*, radon to stable lead.⁴ Radon and its daughters, being gaseous, readily enter the lungs and are not cleared by the cilia. They therefore irradiate the bronchi, bronchioles and alveoli.

The Erzgebirge miners formed the population in whom bronchus carcinoma was first described in 1879, and in whom a 20 - 50-year exposure to mine conditions was required for the carcinoma to develop. The authors of this detailed investigation into the '*bergkrankheit*' were aware that it had previously been misdiagnosed as pulmonary

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tuberculosis. They therefore made enquiries at the distant mining communities of Modum (Sweden) and Dobschau (Hungary), and ascertained that no bronchus carcinoma occurred there.⁵ If it were assumed that the miners commenced their hazardous occupation while still in their teens, they could be expected to have developed their carcinomas by the age of 35 years or shortly thereafter.

Agricola made no distinction between the occupational diseases of the Erzgebirg miners and those of miners elsewhere. It is therefore questionable whether at that tobacco-free time the incidence of bronchus carcinoma in European miners differed from that in non-miners. It must have been a very rare disease then.

Tobacco was introduced into Europe in 1556,⁶ too late to have confounded Agricola's observations on miners' respiratory illnesses.

A recent review of the history of the radon problem in mines makes no mention of the probable contribution of tobacco smoke to the aetiology of bronchus carcinoma in radioactive mine workers.⁷

The failure of Agricola to report any respiratory disease peculiar to the Erzgebirg miners that was compatible with bronchus carcinoma suggests that radon *per se* is not carcinogenic for bronchi. It is probably the synergistic effect of tobacco smoke that is responsible for radioactive miners' bronchus carcinoma.

An alternative explanation may be that the 16th century Erzgebirg miners did not live long enough to develop bronchus carcinoma. In the northern Pennines of England, where the mines are not radioactive, the average age at death of lead miners in the years 1837 - 1841 was 47.6 years.⁸ A century later in the USA, a series of 31 uranium miners with bronchus carcinoma presented at an average age of 54 years (range 42 - 72).⁹ The lack of statistics for the 16th century, and for the Erzgebirg miners, will ensure that this possible explanation will remain unproven.

Recommendations

Tobacco smokers should not be employed in radioactive mines. Caves, especially poorly ventilated ones, are known to contain not insignificant quantities of radon.¹⁰ Smokers should therefore also not be employed as show cave guides

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