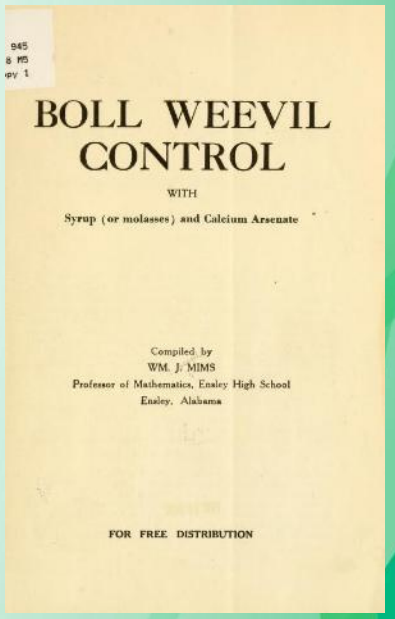


Paget’s Disease – is Arsenic the cause?

Brian Tasman-Davies

https://www.briansadventurebooks.co.uk/wp-content/uploads/2025/09/PDB-Is-Arsenic-the-cause-R3.pdf

Slide template courtesy of freepik.com

This presentation is for educational purposes and does not constitute medical advice.

Additional information is provided in separate Q & A presentation and in References list.

Introduction

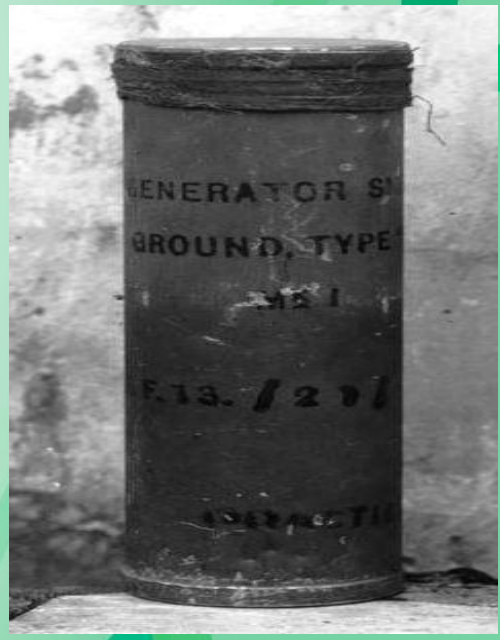
- Paget’s disease of the bone (PDB) is a chronic localized bone remodelling disorder resulting in overgrowth of poorly organized bone and leading to deformities.
- It is particularly noticeable in regions like the UK, Australia and New Zealand, and North America where populations with Anglo-Saxon heritage are concentrated.
- It is more common in people who are over the age of 55 and is often not discovered until those afflicted are over 70.
- Both genetic and environmental factors are thought to be involved. This presentation seeks to demonstrate the principal environmental factor or trigger involved in most cases, not only in the UK but worldwide.

In the wars

- In 1917 the British identified two arsenic-based substances DA (diphenylchloroarsine) and DM (diphenylaminechloroarsine) which penetrated the German gas masks then is use. It was thought that these arsenic based weapons would be a game changer, shortening the war". The substances were packed with a thermite mixture in a small metal cylinder, the weapon being called the ‘M’ device.
- The “M” devices resembled large cylindrical grenades with a fuse which were to be thrown into the German trenches causing them to be evacuated, the soldiers retreating, surrendering or being killed.
- The plan was to build up a sufficient stockpile (200,000 devices) to use on the German trenches in the spring of 1919 with a surprise offensive.

In the wars

- Secrecy was essential, all those involved being sworn to secrecy. This condition was never lifted – it remained in effect for 50 years in government archives and for the lifetimes of all those involved.
- The White Lund site on the outskirts of Morecambe and close to Lancaster was chosen to manufacture this weapon, the previous factory on the site which manufactured shells having spectacularly blown up in 1917, demolishing over 100 buildings and causing 30,000 Morecambe residents to evacuate their homes in panic.

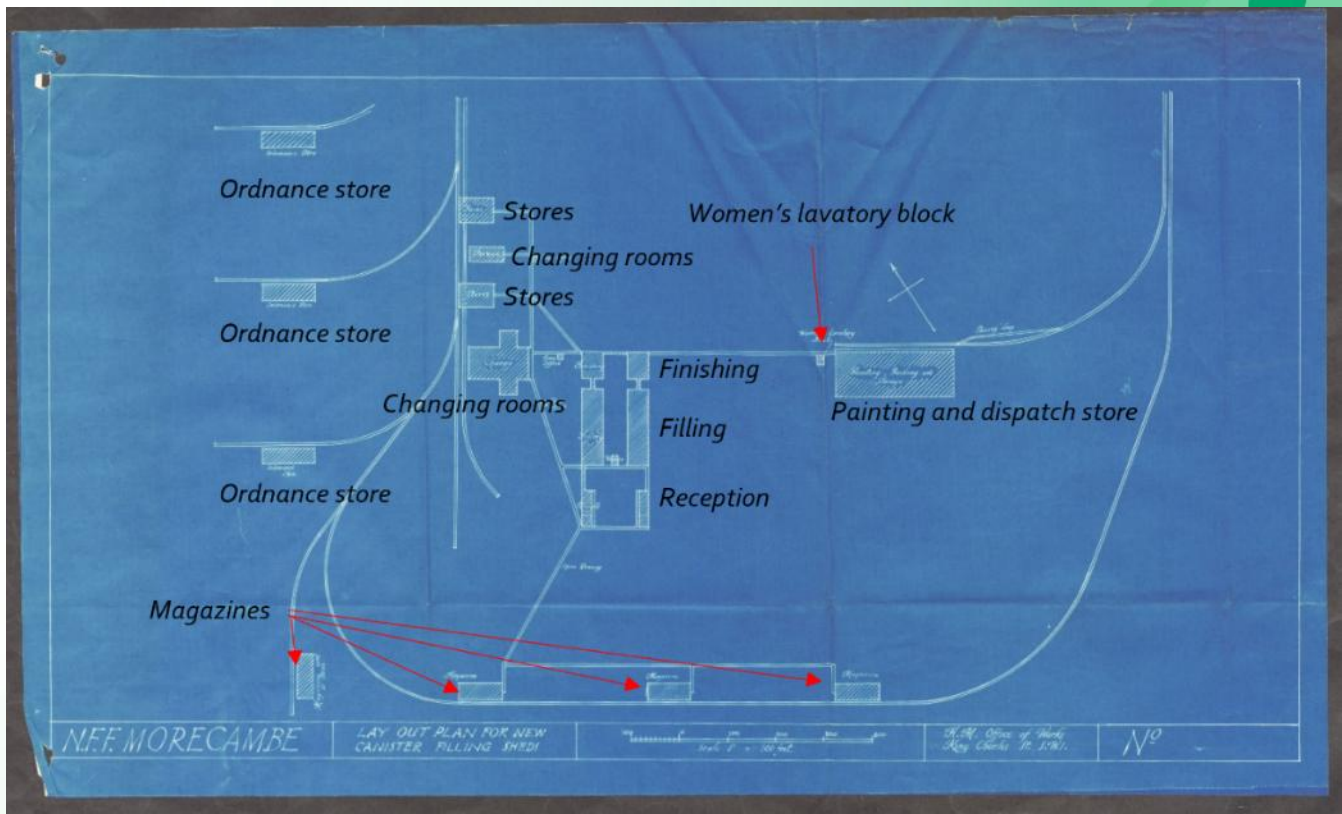


The 'M' Device Smoke Generator. © IWM Q16329

White Lund, Morecambe

- The workforce consisted of about 400 “girls” aged between about 16 and 21 and about 100 men. The girls were exposed to arsenic particulates for up to 4 days a week (2 days filling, 2 days other work).

- Work started in October 1918 and continued after the Armistice until August 1919. Despite the dangers, the girls did not leave after the war had ended and probably remained in Morecambe and Lancaster areas for the rest of their lives.



Prevalence of PDB 1970-77

- The 31 UK towns and cities studied by a team from Southampton General Hospital.
- The high figures encountered in Lancashire mill towns were noted (blue box). Only the average figure for both sexes was subsequently quoted for Lancaster (8.3%) and this figure has been used by researchers ever since.
- It should have been obvious that there was a strange anomaly, the figure for women in Lancaster being 10.0% instead of an expected figure of about 4.9%, based on a men's figure of 6.5%. Lancaster Royal Infirmary covers all inpatient cases in the towns of Morecambe and Heysham as well as Lancaster.

Prevalence of Paget's disease among hospital patients aged 55 years and ov in 31 towns

Town	No of patients	No with disease	Prevalence (%) of Paget's disease		
			Men* (n = 14 444)	Women* (n = 14 610)	Both sexes†
Lancaster	626	58	6·5	10·0	8·3
Preston	1000	82	8·6	6·3	7·5
Bolton	602	42	7·7	6·4	7·1
Wigan	600	42	8·1	5·4	6·8
Burnley	979	74	8·2	4·9	6·5
Blackburn	595	39	8·8	3·8	6·3
Bradford	1000	59	7·9	3·6	5·8
Glasgow	938	50	6·3	4·6	5·4
Leicester	1021	57	7·8	3·1	5·5
Hull	1000	53	7·6	3·1	5·3
Blackpool	949	63	6·5	4·1	5·3
Whitehaven	1002	58	7·1	3·4	5·2
Ipswich	997	50	6·5	3·8	5·1
Southampton	1000	53	6·6	3·6	5·1
Reading	989	56	7·3	2·7	5·0
Bath	998	52	5·3	4·7	5·0
Middlesbrough	734	39	5·9	3·9	4·9
Cardiff	999	41	6·6	3·3	4·9
Macclesfield	890	47	5·3	4·4	4·8
Plymouth	959	48	6·8	2·7	4·7
Portsmouth	999	55	5·4	3·9	4·6
Stoke	1000	40	4·7	4·2	4·5
Oldham	917	45	5·4	3·2	4·3
York	1000	41	5·8	2·5	4·2
Chester	970	43	5·6	2·9	4·2
Warrington	809	37	4·5	3·9	4·2
Birkenhead	994	39	4·4	3·2	3·8
Rochdale	1104	54	4·0	3·1	3·5
Newcastle	1002	32	3·9	2·6	3·2
Carlisle	1482	44	3·9	1·5	2·7
Aberdeen	899	23	2·0	2·6	2·3
All towns	29054	1516	6·2	3·9	5·0

*Age-standardised rates. †Age- and sex-standardised rates.

Lancaster PDB

- In 1975, the ages of the women who worked at White Lund would be from 71-76 years of age, perhaps a little older in some cases.

- By 1993, the rates for Lancaster were recorded as 3.7% male and 3.8% female. In comparison, Preston rates were 3.3% and 1.7% respectively in 1993. The ages of the men and women who worked at White Lund would be from 71- 94+ years at that date. Those exposed to residual dust could be younger. By 2018, the average rate for PDB in Lancaster was 0.8%.

Table 1.. Prevalence of Paget's Disease in 10 British Towns During 1993–1995

	Prevalence (with 96% CI)		
Center	*Male* (%)*	*Female* (%)*	*All** (%)*
Lancaster	3.7 (2.0, 5.4)	3.8 (2.1, 5.4)	3.7 (2.5, 4.9)
Wigan	4.2 (2.4, 6.1)	2.8 (1.4, 4.2)	3.5 (2.3, 4.6)
Warrington	4.6 (2.4, 6.7)	1.9 (0.7, 3.0)	3.1 (2.0, 4.3)
Newcastle	3.9 (1.7, 6.1)	2.3 (1.1, 3.6)	3.1 (1.9, 4.3)
Southampton	3.7 (1.8, 5.6)	1.8 (0.5, 3.1)	2.7 (1.6, 3.8)
Preston	3.3 (1.7, 4.8)	1.7 (0.5, 2.8)	2.4 (1.5, 3.4)
Bath	3.8 (1.7, 4.7)	1.3 (0.3, 2.3)	2.2 (1.3, 3.1)
Portsmouth	2.6 (1.2, 4.0)	1.7 (0.6,2.8)	2.1 (1.3, 3.0)
Cardiff	1.5 (0.3, 2.7)	1.5 (0.4, 2.7)	1.5 (0.7, 2.3)
Carlisle	1.6 (0.5, 2.7)	0.9 (0.1, 1.7)	1.2 (0.6, 1.9)
All centers	2.5 (2.1, 3.0)	1.6 (1.3, 1.9)	2.0 (1.8, 2.3)

* Age-adjusted rates; **age- and gender-adjusted rates.

What was special about Lancashire mill towns?

- Was it arsenic based insecticides in cotton bales as proposed in 2002 by JH Lever? Those workers in the mixing room in the mill would be particularly vulnerable.
- However, the theory that the arsenic would pollute the water in sufficient quantities to cause disease does not stand up to scrutiny.

What was special about Lancashire mill towns?

- Was it health and diet?
  - Many common morbid conditions found in mill workers. Also, musculoskeletal disorders, asthma and deafness.
  - Over 50% working men smoked. There was a pub culture (not many women smoked and drank beer).
  - Diet: Lancashire hotpot – lamb stew with potato. Lots of carbs, little fruit and veg.

- Was it climate?
  - The average cloud cover in Lancashire, particularly around Preston, is around 75-78%, Weather is predominantly damp, cool, wet and windy. Little UV light, especially in winter.

What was special about Lancashire mill towns?

- Was it industrial pollution?
  - Water – drinking and wastewater
  - Polluted air
    - Domestic coal
    - Industrial coal
- Was arsenic in coal the most significant factor?

[Aerofilms

A TYPICAL MANUFACTURING TOWN

An aerial view of Preston with its factories and rows of workers' houses—a st illustration of the overcrowding which has followed the Industrial Revolution. Co the modern garden city, shown on page 1489.

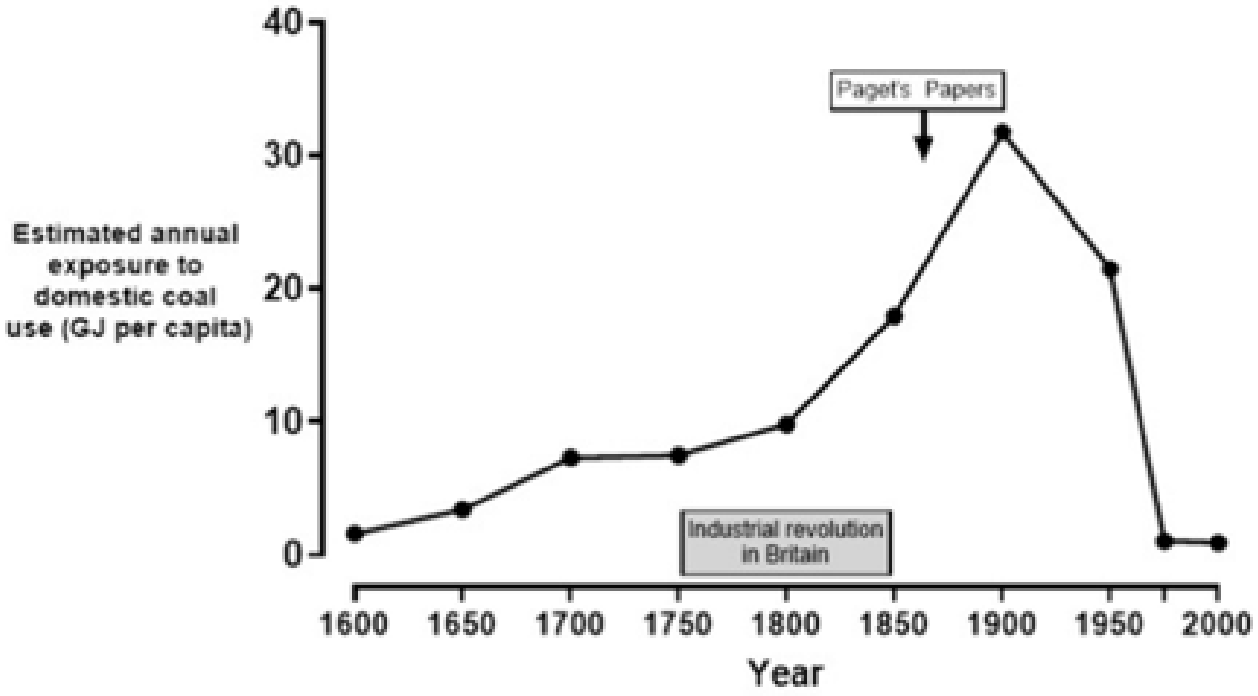
LCC Report by David Jacks Nov 2019.

Many urban areas in Lancashire suffer to some degree from poorer air quality than other parts of the county, though this is clearly much less an issue of an issue in the coastal towns of Lancaster/Morecambe, etc. presumably due in part to the direction of the prevailing winds. Preston. Blackburn and Burnley all suffer from nitrogen dioxide, benzene, sulphur dioxide and particulates. Preston and the area to the south are particularly bad. Rochdale air quality was good.

British coal

- A hypothesis by Prof. T Cundy (2024) – domestic coal.
- The concentrations (in ppmw) of these elements in pyrite in UK coal were determined, per 1 wt% pyritic S, as: Mo 2, Se 0.6, Ni 8.2, **As 21**, Pb 6.1, Sb 0.4, Cu 13.8 and Zn 8.8. Spears (1999).
- Big difference in amounts of arsenic between British coal and many sources of European coal. British coal was particularly high.

From: The Decline of Paget's Disease of Bone and Domestic Coal Use—A Hypothesis



The relationship between estimated exposure to domestic coal burning (gigajoule per capita) in England and Wales from 1600 to 2000. Note the rapid rise during the industrial revolution reaching a peak in the late nineteenth century, around the time Paget first described the disease. There was a rapid fall in the twentieth century as gas and electricity were increasingly used to heat homes and for cooking. Burning coal for domestic purposes was prohibited in Britain in 2023

UK Outliers & Anomalies

Town	Male %	Female %	Ratio M/F	Comments
Average	**6.2**	**3.9**	**1.59**	
Aberdeen	2.0	2.6	0.77	Very low figures. Female higher than men.
Carlisle	3.9	1.5	2.60	Low female figures. Surrounded by countryside.
Rochdale	4.0	3.1	1.29	Low figures for a mill town. Low pollution levels.
Plymouth	6.8	2.7	2.52	High male, low female. Dockyard. Arsenic mine.
Reading	7.3	2.7	2.70	High male, low female.
Preston	8.6	6.3	1.37	High male and female rates. Great air pollution.
Lancaster	6.5	10.0	0.65	High female figures., low pollution levels .

- These 7 towns were selected as being representative of the anomalies from the typical values expected for PDB. In each case, a detailed historical analysis was undertaken for the early 1920's.

- For the sake of brevity in this presentation, just one town, **Reading**, will be used as an example.

Reading PDB

- Perhaps surprisingly for a town in the Thames Valley in SE England, Reading had, and still has, areas suffering from deprivation and poverty as well as some more affluent areas.

- In the 1920's the major industries were:
  1. **B**rewing
  2. **B**rick and tile making
  3. **B**iscuit making
  4. **B**ulbs and seeds
  5. **B**uses and trains

- Population about 90,000 by 1920.

Coley Steps, about 1911. Reading Museum.

Reading PDB

- 7 breweries in early 20th century.
- Kilns for making bricks, tiles and flowerpots.
- Reading was a railway town - station with many platforms, workshops and goods yards.
- **Men's occupations**

Reading PDB

- 5,000 workers employed biscuit making. Factories were largely segregated into **male and female** areas.
- Over 2,000+ mainly **women** employed in bulbs and seeds harvesting and packing.

- **Prediction consistent with M 7.3%, F 2.7% for PDB. Similar exercise conducted for 6 other towns.**

Suttons Seeds order room in 1945 (Museum object no. 1946.52.41)

Photos: Reading Museum.

Medieval examples of PDB

- **Norton Priory, Runcorn, Cheshire, England**
  - Founded in 1134 as an Augustinian priory. Given abbey status in 1391.
  - Two bell-making pits were found. Bells were 65% copper, 25% tin. Size of at least one bell 1m high, 0.8m dia.

  Copper contaminated with arsenic ores probably came from Alderley Edge mine (22 miles distant).
  Local springs supplied water from the aquifer in Wilmslow Sandstone. FeAsS reductive dissolution involves anaerobic bioleaching, releasing the arsenic.

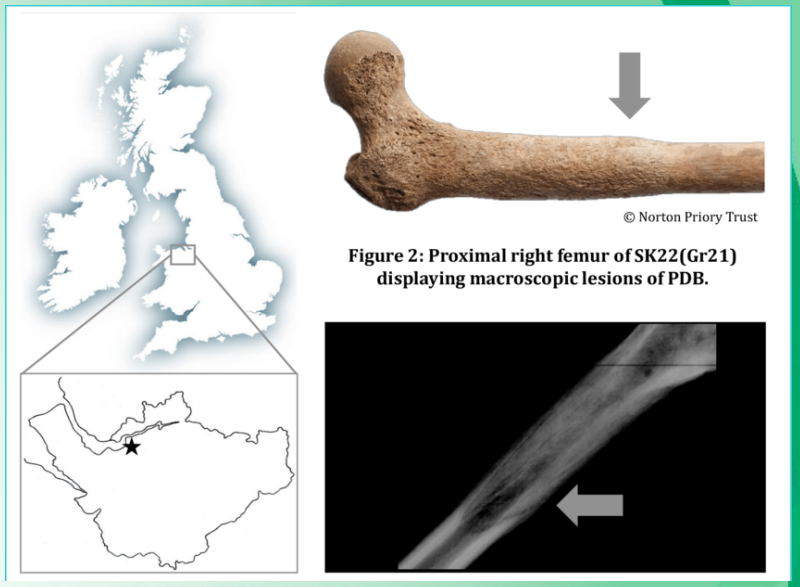


Figure 2: Proximal right femur of SK22(Gr21) displaying macroscopic lesions of PDB.

- **St Peter's , Barton-Under-Humber, Lincs**
  - 2,750 exhumations, the graves dating from AD 670. 15 cases of PDB. This locality too was used extensively for casting bells.

Where did PDB originate?

- Did the Romans have the disease? And Africans?
- Cases in the region of Iberian peninsular copper mines – Roman and Medieval

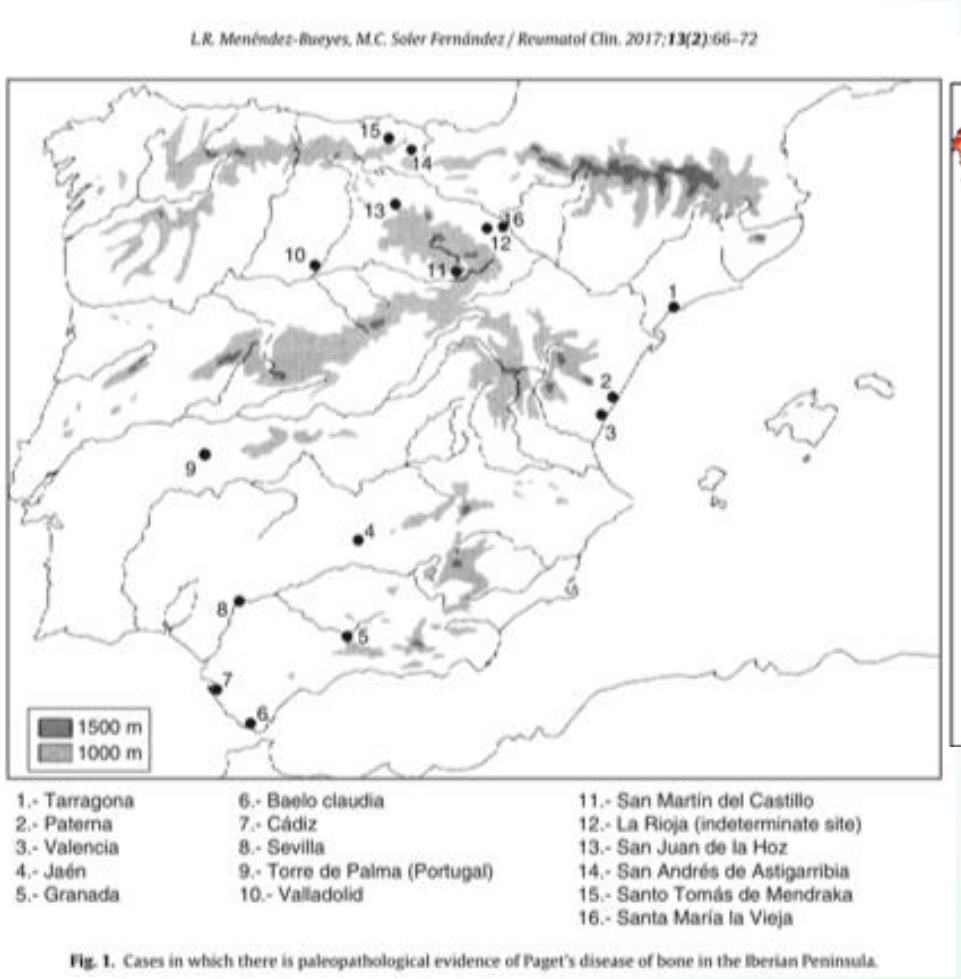
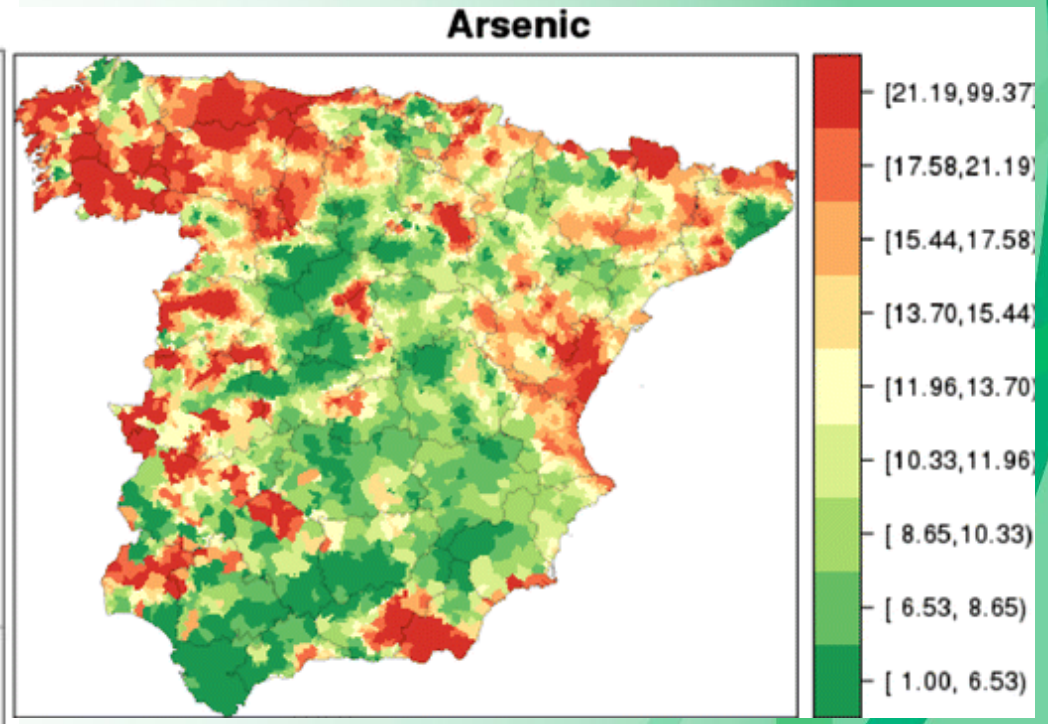


Fig. 1. Cases in which there is paleopathological evidence of Paget's disease of bone in the Iberian Peninsula.



Paget's Disease of Bone: Approach to Its *Historical Origins*

Luis R. Menéndez-Bueyesa, María del Carmen Soler Fernández. 2017

European hotspots

- **Rural areas, Campania Plain, Italy 2.4%**
- **NW Salamanca, Spain 5.7%**
- **Sierra de la Cabrera, Spain**
- **Avila, Spain**

Link to well water with high quantities of arsenic in all the above cases in rural areas.

- **Bordeaux, France 2.7%**
- **Rennes, France 2.4%**
- **Nancy, France 2.0%**

Link to arsenic sprays to control vineyard pests and grapevine trunk diseases.

Where is PDB uncommon?

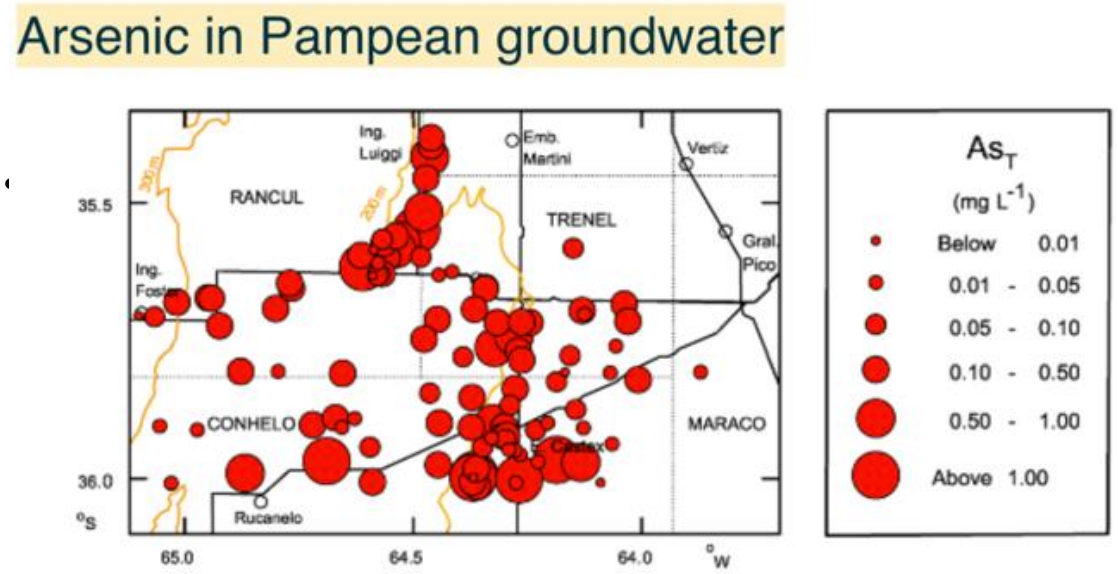
- Norway & Sweden
- Africa (but not South Africa)
- The Andean nations
- Japan

South American hotspots

- **Recife, Brazil**

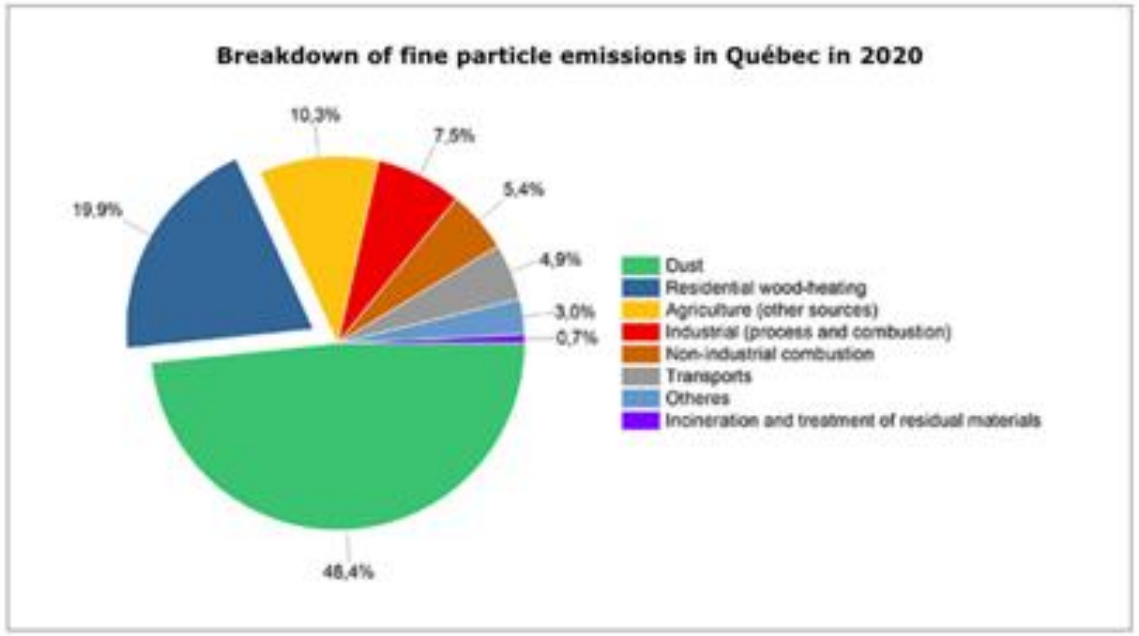
  High levels of arsenic in soils and rocks in Pernambuco State. Mines (within dotted red areas) discharge arsenic waste into rivers. Rice and water are contaminated.

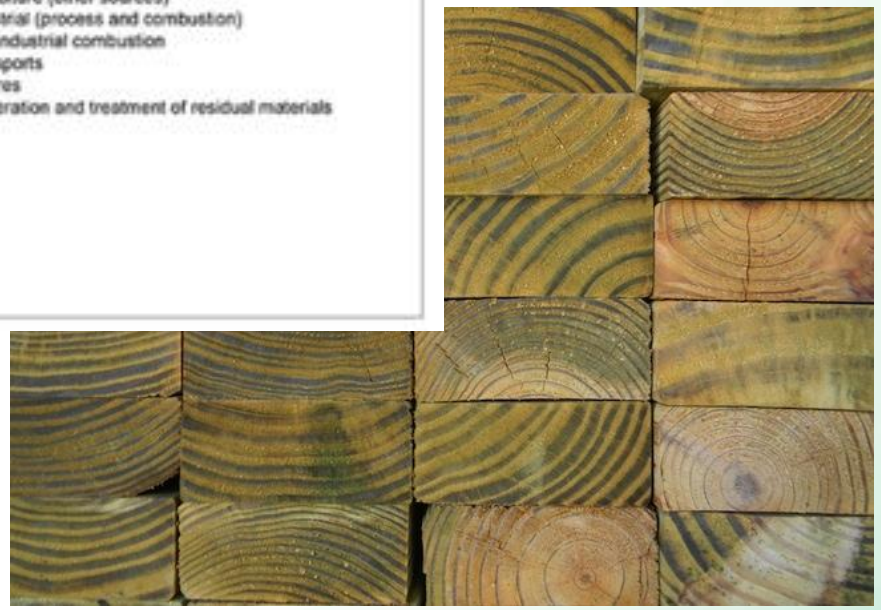
  La Pampa, Argentina

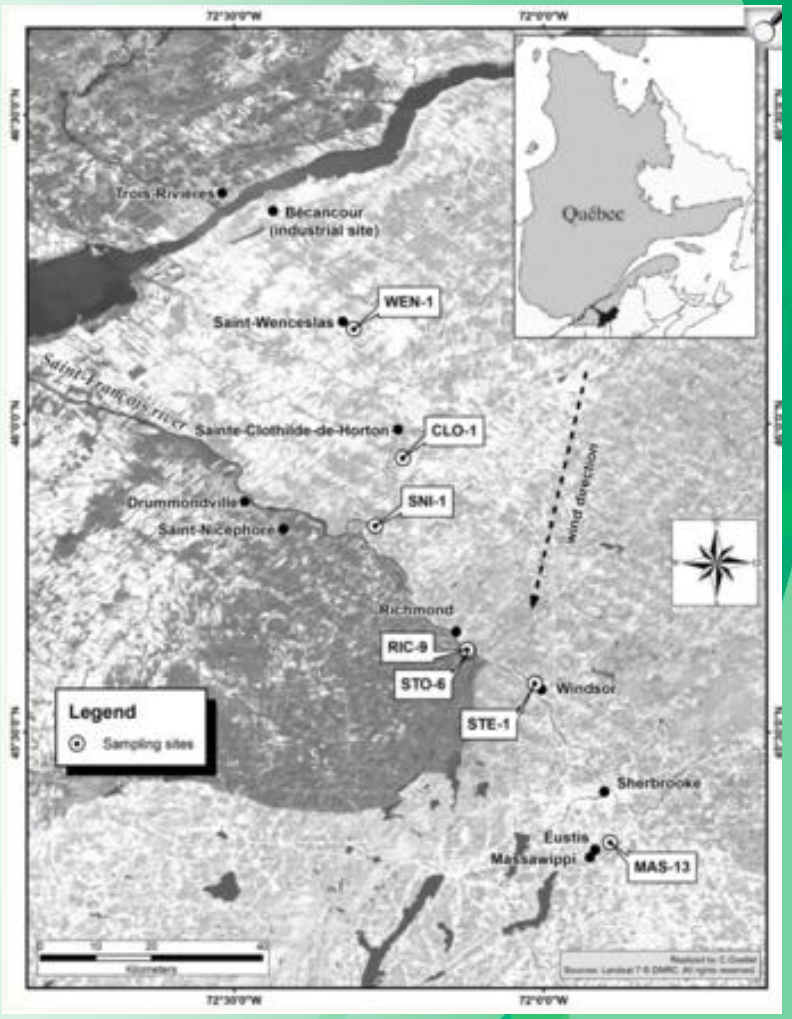


North American hotspots

- **Quebec Province south of Quebec City, Canada**
  High levels of arsenic particulates from former mines. CCA treated timber. Smoke from wood fires used for heating and cooking. French-Canadians were heavy smokers.



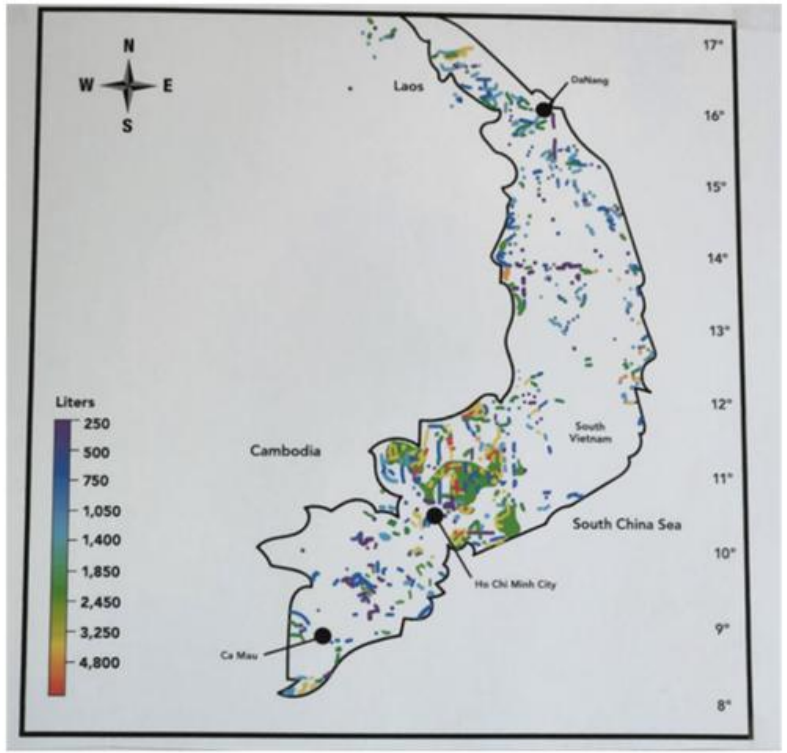




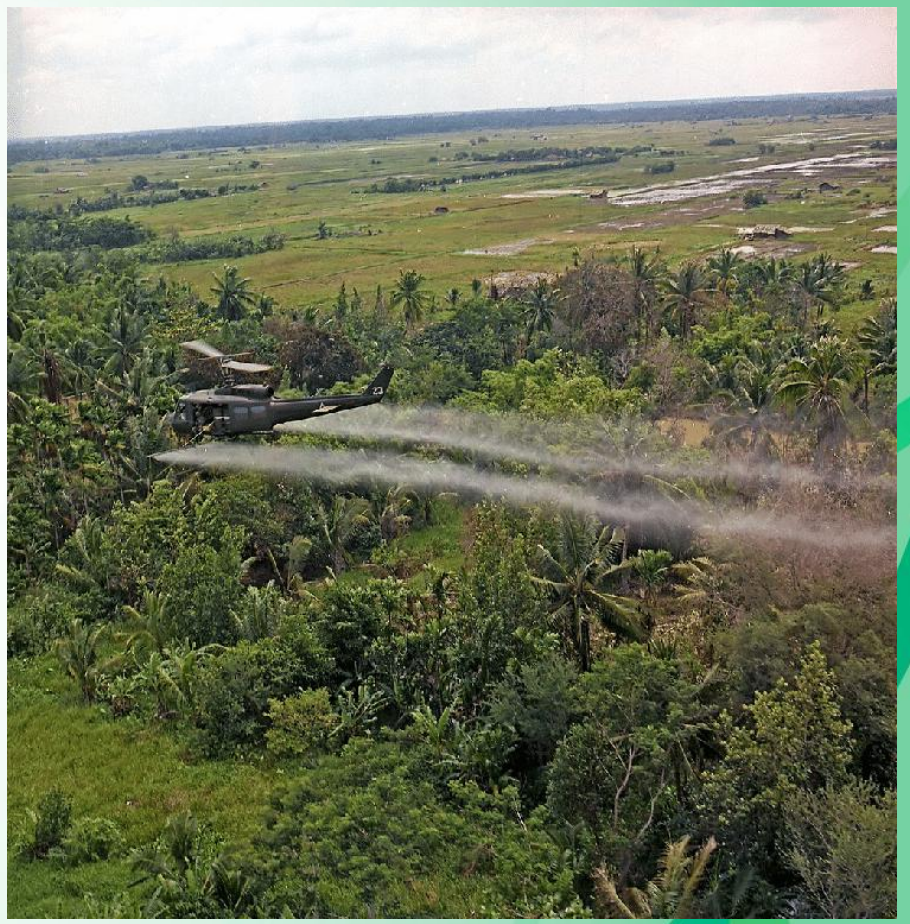
North American hotspots

- **New York and Philadelphia**
- **SE USA States veterans (African Americans) serving in Vietnam**

Operation Ranch Hand - 1.1 million gallons of Agent Blue (Cacodylic acid) a highly soluble organic arsenic compound used 1962-71



Volumes of herbicide, Agent Blue (cacodylic acid), sprayed by U.S. Air Force



New Zealand (2.6% in 2009)

Chromated copper arsenate (CCA) treated timber still in use for structural building, decking, play equipment. industrial construction, pallets & packaging, interior fittings and fixtures and, in particular, posts in vineyards.

Arsenic in Taupo Volcanic Zone (TVZ) and Waikato region

Arsenic v Paget's disease 1

- Non cancer manifestations of arsenic highly variable from one country to the next.
- PDB varies according to genetics of local population.

- Arsenic toxicity is linked to tobacco
- PDB incidence is linked to smoking

- Men less tolerant of arsenic poisoning because less efficient methylation
- PDB more prevalent in men than women

- Calcium beneficial to minimise arsenic toxicity
- Calcium may be beneficial for PDB if deficient

- Vitamin D linked to calcium absorption, hence beneficial for arsenic toxicity
- Vitamin D thought to be beneficial for PDB if deficient

- Long latency of up to 40+ years between arsenic exposure and bladder/lung cancers
- Long latency of PDB from toxic exposure to disease, typically 40+ years

- Rapid decline of particulates from coal in the atmosphere since 1960 but starting in 1926, when the 1926 Public Health (Smoke Abatement) Act was introduced
- Rapid decline in PDB since 1970's (i.e. 40 years after smoke control introduced)

Arsenic v Paget's disease 2

- Arsenic raises ALP (alkaline phosphatase) activity
- Patients with PDB often have a raised ALP level

- Arsenic decreases bone mineral density and arsenic trioxide interferes with bone remodelling (osteoblast differentiation)
- PDB is caused by abnormal activation of osteo**c**lasts. Osteo**b**lasts produce new and defective bone

- Arsenic can cause osteoarthritis
- PDB can cause osteoarthritis

- Curcumin protects against arsenic toxicity
- Curcumin beneficial for bone disorders

- Arsenic exposure interacts with SQSTM1 and zinc finger proteins
- PDB linked to SQSTM1 and ZNF687 genes (Italy)

- People of Aymara-Quechua ancestry appear to have adapted to high arsenic levels
- PDB unknown in Andean people

Is PDB a manifestation of arsenic toxicity?

Sample questions and answers follow.

Plutonium may give you grief for thousands of years, but arsenic is forever.

"A great deal of slow poisoning is going on in Great Britain."
Birmingham doctor William Hinds in 1857 regarding wallpaper using green arsenic dyes.

<u>The Poison of Kings and the King of Poisons</u>

Q & A

- Why do more men than women suffer from PDB?
- Why does the prevalence of PDB increase with deprivation?
- Why don’t Andean and Asian people get PDB? Ditto Scandinavians.
- Is arsenic the sole environmental cause of PDB?
- How does environmental legislation protect one from toxic levels of arsenic?
- What has happened to all the arsenic based chemical weapons?
- How will climate change affect number of cases in the future? Will PDB decrease or increase?
- What happened to Major TH Davies after he left Morecambe?

Why do more men than women suffer from PDB?

- Current rate about 5 per 10,000 person-years in men and 3 per 10,000 person-years in women at 75 years of age. Similar differential in the past of about 1.5 to 1.6 men to women but higher in some industrial areas.

1. Women have better arsenic methylation capacity than men.

2. In the past, men worked in more polluted areas. Mining, furnaces, steam engines, smelting plants, etc.

3. In the 1920's over 50% working men smoked, but few women smoked. Most working men also consumed large quantities of beer. Now much less difference between sexes for tobacco, 14.6% of men and 11.2% of women reporting being current smokers in 2022. Beer remains a man's drink, with only 17% of women drinking beer at least once a week (compared to 53% of men).

Why does the prevalence increase with deprivation?

- The frequency of PDB is 30% higher in the most, compared to least deprived areas.

1. Deprived areas have more heavy industry and fly-ash and other waste tips.
2. Waste incinerators are three times more likely to be in low-income areas.
3. UK studies show that people in deprived areas are disproportionately exposed to pollutants, particularly in regions like the North West, Yorkshire, Humberside, parts of Cornwall and London.
4. Of people aged 18 years and over in Wales, 22.4% living in the most deprived neighbourhoods were current smokers in 2021, compared with 6.6% living in the least deprived neighbourhoods. Similar results expected for other regions of the UK.
5. People in more deprived areas tend to experience higher rates of viral illnesses, including COVID-19 and influenza, and higher mortality rates from them, likely due to factors like poorer housing, higher population density, poor diet, higher alcohol consumption, and limited access to healthcare.

Why don’t Andean and Asian people get PDB? Ditto Scandinavians.

1. Andean people have evolved (genetic variation) to tolerate large amounts of arsenic found in the Andes (similarly, they have increased lung capacity to live at high altitudes).
2. Asians were not generally previously exposed to large amounts of arsenic. Many SE Asians now exposed to high levels of arsenic in water and pollution from coal fired power stations. Life expectancy lower than in the West. In one Bangladeshi village, no one was over 30 years old. A study indicated that Bangladeshi women show a remarkably efficient methylation of arsenic. Other diseases linked to arsenic may prove fatal prior to PDB becoming apparent
3. Scandinavians, contrary to expectations, have higher levels of vitamin D than some southern Europeans. Many regularly eat oily fish but they do not eat rice in large quantities. Little use of coal and if used this was in furnaces which were not open. They live a healthy lifestyle and smoke less than their European counterparts, using snus instead. Limited statistics.

Is arsenic the sole environmental cause of PDB?

1. It is difficult to prove if any other heavy metals or substances can or cannot cause PDB on their own, but their impact would appear to be subsidiary to arsenic, which is present in all cases.

2. Arsenic can become even more toxic when combined with other heavy metals, such as chromium, lead, mercury and cadmium, as the combined exposure can create a synergistic effect, meaning the overall toxicity is greater than the sum of each metal's toxicity alone; this is because they can interact at the cellular level and amplify harmful effects on the body.

3. As with many diseases, poor health and deficiencies in certain nutrients may contribute to the likelihood of getting a disease, in this case, PDB.

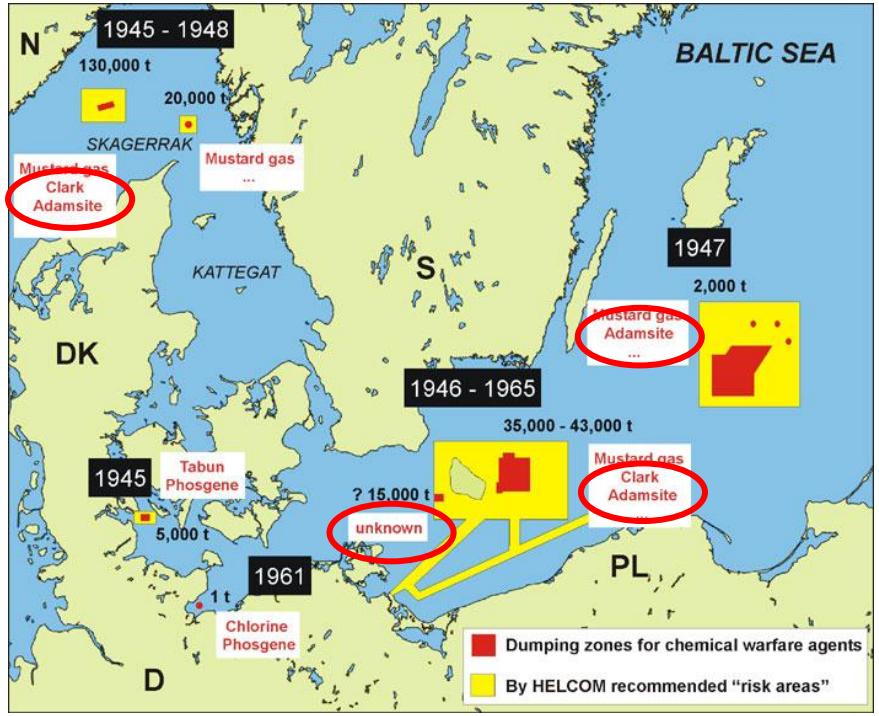
4. Viruses such as measles can make the body more susceptible to disease by damaging cells, overwhelming the immune system, and triggering autoimmune diseases.

How does environmental legislation protect one from toxic levels of arsenic?

1. It doesn’t! The WHO focuses on probability of getting lung or bladder cancer and gives limits based on “acceptable risks” for contracting these. It balances health risks with the financial burden on manufacturers, farmers and utilities to implement treatment technology. There are no safe levels of arsenic in air. There is no safe level of arsenic in drinking water for long-term consumption.
2. The USA Environmental Protection Agency (EPA) enforces an MCL (Maximum Contaminant Level) for arsenic of no more than 10 PPB, but this regulation is not purely health-based. Unlike other countries, the EU does not have a defined acceptable risk, so it is unregulated.
3. Many environmental agencies are under-funded and under-resourced. There is a paucity of air monitoring points for arsenic. These agencies tend to concentrate on testing rice products and apple juice for the under twos as this group are particularly vulnerable to arsenic poisoning.
4. It is the responsibility of food businesses to ensure food is safe and compliant with food legislation and to ensure due diligence measures are in place. Avoid eating or drinking large quantities of rice, rice milk, rice cakes and rice crispies.

What has happened to all the arsenic based chemical weapons?

Large quantities of Adamsite (DA and DM) and Lewisite in Baltic Sea. Unknown quantity in Beaufort's Dyke, North Channel, Irish Sea. Munitions corroding and releasing contents.



Disposing of German Chemical Weapons via Cairnryan Military Port

How will climate change affect number of cases in the future? Will PDB decrease or increase?

1. No coal-fired power stations are now operating in the UK, but coal fly-ash tips and lagoons can leach arsenic in heavy rain and if flooded. Tips and lagoons often lack impermeable barriers.
2. Australian coal is still mined in large quantities, much exported to China, is low in arsenic, so less chance of PDB in these places. Some Appalachian US coal is high in arsenic. Power stations filter this out electrostatically, but the contaminated fly-ash may now be processed for rare earth elements.
3. Arsenic sulphides and other rocks contaminate the ores extracted when mining for silver, gold, lead, zinc, and in particular **copper**. To meet projected global copper demand by 2050, including for the energy transition, studies suggest the need for 194 new large copper mines or an average of 6 new mines annually. This is obviously impossible, but even attempting to meet this target will create huge quantities of arsenic. So far, no satisfactory method has been devised to treat this high volume of arsenic
4. Release of arsenic from an increasing number of wildfires in past or present mining areas and former wetlands.
5. Sea level rise from climate change is expected to increase the release of arsenic into SE Asia drinking well water by reduction and by the salt effect. Sediments will be disturbed. Flooding increases dissolved arsenic by 150%.
6. Flooding and temperature affect As release, by biomethylation and biovolatilisation, from As-rich soils which can be found in many countries.

Cases may shortly start to increase in certain areas with no previous history of the disease.

What happened to Major TH Davies after he left Morecambe?

Sent to Arkhangelsk, Russia, with 50,000 devices. Put in charge of 19 chemical weapons officers. Developed first ever aerial chemical bomb whilst there. Given two of Imperial Russia's highest awards (St Vladimir). Returned to Tasmania newly married in early 1921, after suffering from PTSD. Farmed sheep, then became a minister in the Tasmanian government in 1934 until his early death in 1942 from a heart attack, probably brought on by stress and arsenic poisoning. In 1936, he advocated for chemical weapons to be outlawed.

Ministers in Premier Ogilvie's government, Tasmania. Davies on the right. (Bruce Martin).

Major Thomas Davies with modified 'M' devices. Retarder fitted on device on the right. (© Imperial War Museum Q 16330)

GAS AS A WEAPON OF WAR

Science Should be Applied to the Welfare of Humanity

MAJOR DAVIES' OUTSPOKEN COMMENT

"If there is anything that civilisation should take up, it is the prevention of chemical warfare," said the Minister for Lands and Works (Major T. H. Davies) in a special interview given at Launceston on the use of poison gas in war. He contended that science, instead of being used to kill and injure human beings, should make it possible for all persons to obtain work under better conditions, make their homes happier, and bring about shorter hours and prosperity generally.

Major Davies had wide experience with poison gases in the Great War, at the close of which he was Chief Chemical Adviser to the Allied Forces.

PREVENTION OF CHEMICAL WARFARE

MAJOR DAVIES.

"We, today, see the effects which are so far-reaching through the deadly action of gas, especially mustard gas, also phosgene and di-phosgene and other compounds which I am not prepared to discuss. If there is anything that civilisation should take up, it is the prevention of chemical warfare."

"INIQUITOUS, SCIENTIFIC POISONS"

ATTENTION TO SUFFERERS.