LEGIONELLA: HISTORY, ENVIRONMENT & MICROBIOLOGY

LD SEMINAR CAPE TOWN

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History of Legionnaire's Disease

- 1976 Bellevue Stratford Hotel Philadelphia American Legion convention – mysterious outbreak 221 cases & 34 deaths
- After 6 months of intensive investigation the organism was identified and named *Legionella pneumophila*
- Previous outbreaks of disease in the 1950s & 60s identified with an antibody test
- But it took several years before the source of the organism and ways to control it were discovered. New outbreaks were identified but there was no way of stopping them so they went on for years
- Only in 1980 that hospital water distribution systems implicated in nosocomial Legionnaires' disease. This was a breakthrough for prevention strategies.


Bellevue Stratford Hotel
Enter if you Dare

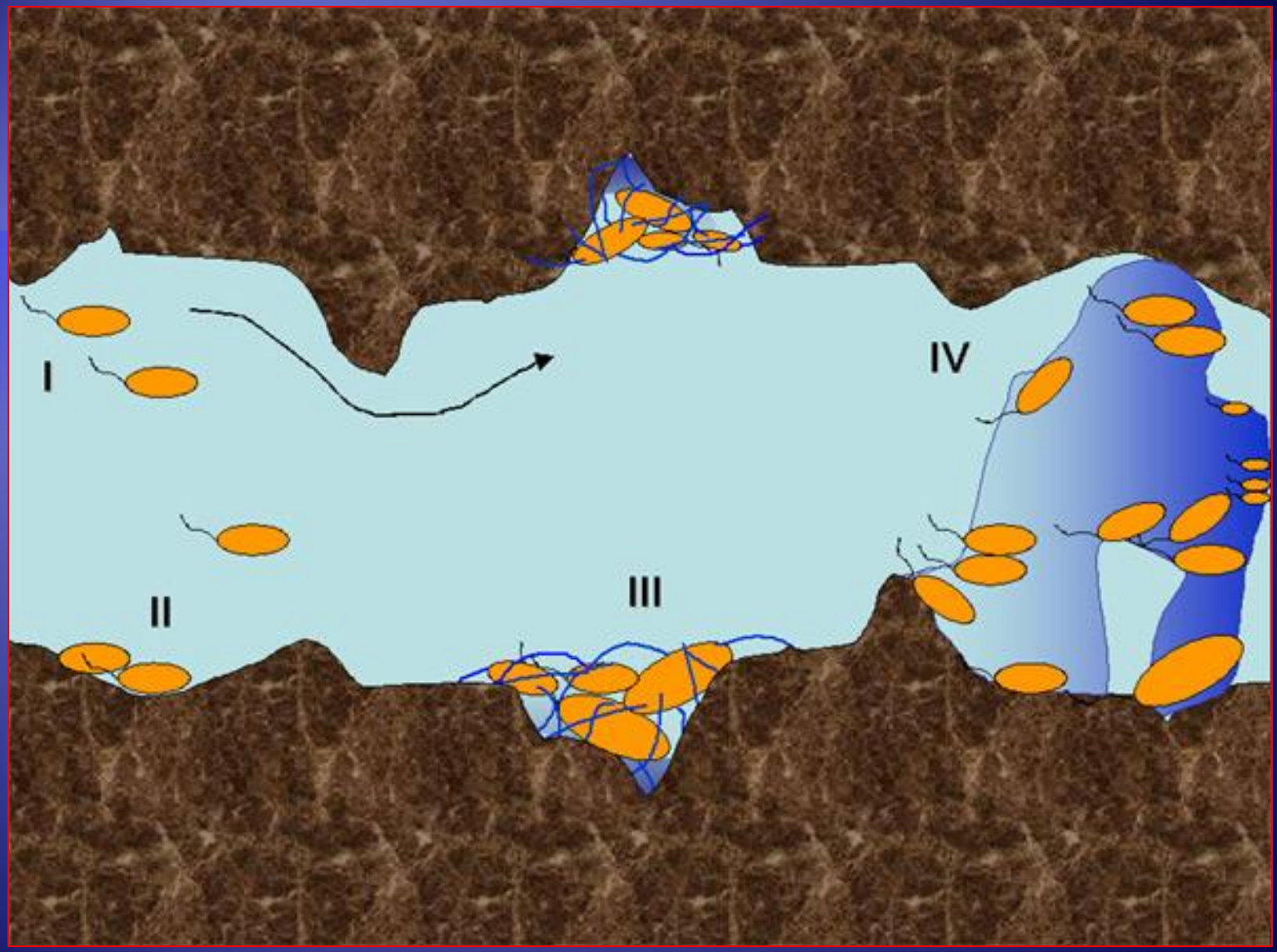
The Bellevue-Stradford Hotel

- Opened in 1904
- Originally had 1090 rooms
- After renovations reduced to 700
- Hotel served by 60 air-handling units
- Risk Factors: Large, old building, extensive renovations, complex plumbing, likelihood of stagnation / dead legs

- Hotel revamped: now 172 rooms on the top 7 floors. The rest is office space and shops.
- Now called 'Hyatt at the Bellevue'

Legionella Ecology

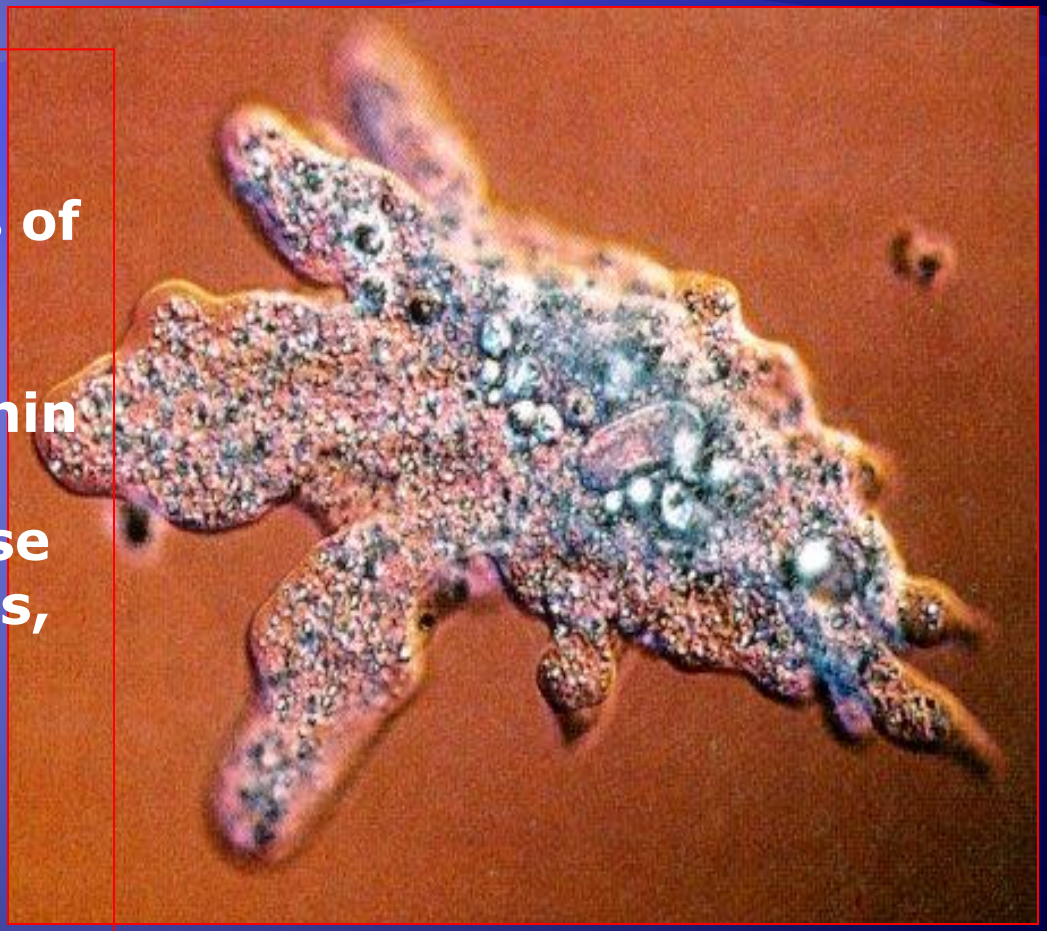
- Legionella are found in virtually all aqueous habitats – lakes, streams, damp soil, coastal oceans, hot springs etc.
- They can exist in a wide temperature range: 5 - >50° C.
- Warm water supports the highest concentration: 25 – 40° C.
- Free-living amoebae in these same waters support intracellular growth and survival during adverse conditions
- They also exist in biofilms which are made up of different bacteria and protozoa.


I
II
III
IV

Tap aerators: Biofilm & debris

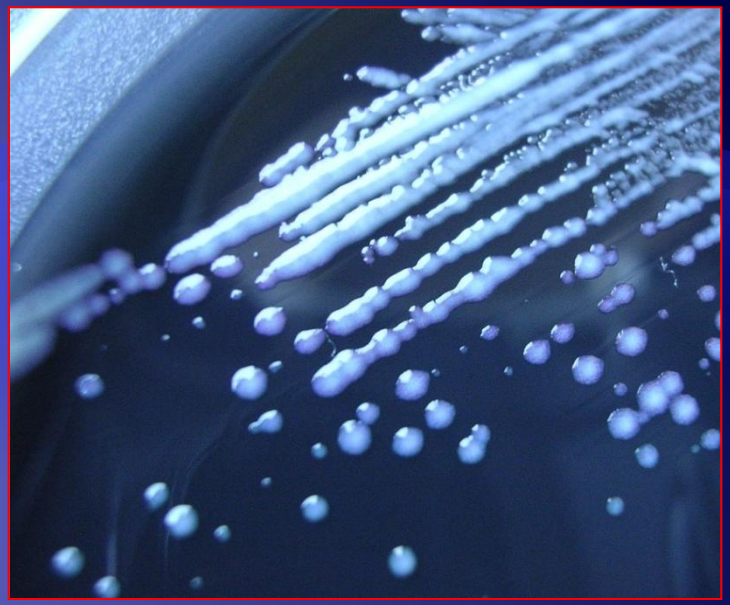
The Amoeba Connection

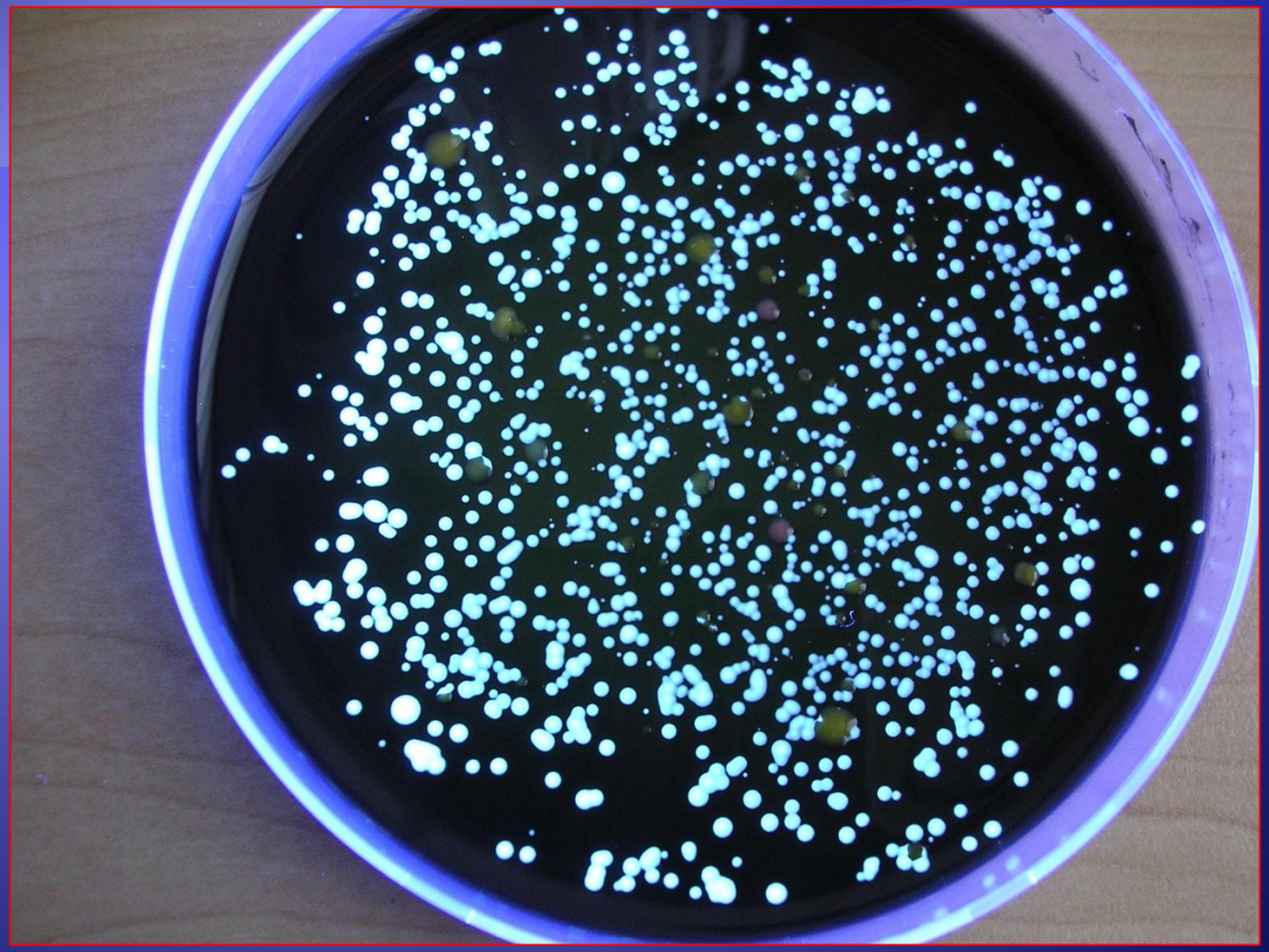
- *L. pneumophila* is a intracellular parasite of several different species of amoebae
- Legionella multiplies many thousand-fold within amoebae
- When faced with adverse environmental conditions, such as pH change, absence of nutrients or unfavourable temperatures, the amoebae encyst – thus host and parasite survives until conditions are favourable again



Legionella organisms

- Gram negative bacillus
- Does not grow on ordinary media – *specialised Lab tests are required.*
- *L. pneumophila* – 16 serogroups
- Serogroup 1: >80% of disease - UAT
- *Legionella* species - >49 species (about 20 species have been linked to sporadic cases of disease)
- 1 litre samples of water are filtered and cultured on specialised media
- It takes 10 – 14 days for final results





Environmental Sampling

- 1 Litre water samples are taken from hot taps/ showers, especially where temperature is below 50° C
- 1 Litre water samples from cold taps where temperature is >20° C
- Water samples are taken immediately after the tap is opened according to ELDSNet guidelines
- There is a difference between outbreak and surveillance sampling – outbreak sampling much more comprehensive
- Swab samples from inside shower heads & taps where there have been cases
- Saunas, jacuzzi, water features, indoor pools, misting devices
- Deliver to lab within 24 hours
- Use a SANAS accredited lab using ISO11731, NOT Malthus, MPN etc
- TPC, dip-slides, etc results do not correlate to presence /absence of Legionella
- Sampling should be linked with a Risk Assessment especially if after an outbreak

88,000 cfu *L. pneumophila* SG1 isolated from sauna tub.

Key Issues in Legionella Control

- *TEMPERATURE* : Water temperatures should be documented. When taking samples, any tap yielding water at 25 – 45° C should be tested.
- *SEDIMENT:* Systems such as roof tanks, cooling towers, boilers etc need to be serviced at least once a year to ensure that there is no build-up of sediment.
- *STAGNATION*: Buildings should be inspected to detect dead legs and pluming plans should be reviewed. Taps must be flushed if they are not regularly used.
- Temperature & Stagnation problems are often linked: CT EWGLI investigation of hotel.
- It is counter-productive to treat water systems with biocides, heat, UV etc unless these basic remedial actions have been taken.


32.4

Dead Leg

Environmental Culture Results

Cooling Towers:

- **≤ 100 cfu/l – System under control**
- **100-1000 cfu/l Review & Re-test**
- **≥ 1000 cfu/l Implement corrective action immediately**

Hot & Cold Water Systems:

- **>100 but < 1000 – Repeat tests if 1-2 samples +ve, If +ve , review control measure and do risk assessment (RA). If high proportion +ve, review measures do RA and consider disinfection.**
- **>1000 – Resample, review measures do RA and consider disinfection.**
- Reference: The Control of Legionella Bacteria in water systems. Approved Code of practice & Guidance L8 HSE

Community-Acquired LD

- Guidelines are good but we need to consider what Vladimir Drasar from the Czech Republic found:
- He delivered a paper at the 2010 EWGLI conference on 4 cases of LD acquired from domestic water in large flat dwellings
- Positive environmental cultures were related to low hot water temperatures
- These were all immunocompromised and it appears that such persons are susceptible to levels as low as 100 cfu/l.

Sources of Outbreaks

- Large buildings
- Hospitals
- Nursing homes
- Hotels
- Ships
- Whirlpool spa baths
- Misting devices
- Decorative water features

New Environmental Sources

Information from: Legionella 2009 Paris

- 25 - 30% of Hot water springs in Japan positive (also salty hot water springs)
  - April 1999 – December 2006: 1568 cases, 435 from hot springs [27%]. (Information from Shin-Ichi Yoshida)
- Garden hoses
- Roof collected rain water
- Jet washers
- Car windscreen liquid – higher risk in outbreak investigation
- Water used in road construction implicated in outbreak involving people who drove past
- Compost mix – several countries in Europe, several different species

Waste Water Treatment Ponds

Information from: EWGLI Copenhagen 2010

- **Legionella organisms may be transmitted from various kinds of wastewater treatment plants, including those linked to the wood, paper, petroleum and sewage industries.**
- **These contain extremely high numbers of bacteria which may be transmitted via the aerosol plume for up to 250 meters.**
- **Cases of Legionnaires' disease (LD) have been linked to these treatment plants.**
- **This knowledge brings a new dimension into LD outbreak investigations.**
- Two Legionnaires' disease cases associated with industrial waste water treatment plants: a case report. *BMC Infectious Diseases* 2010, 10:343 (www.biomedcentral.com/1471-2334/343)

Contamination of Cold Water systems in Hospitals

- Eurosurveillance, Vol 16. Issue 16, 21 April 2011
- **Samples from both hot & cold water taken at 4 facilities with cases of LD.**
- **Normally samples are only taken where cold water exceeds 25° C.**
- **40% of 316 cold water samples positive – temperature <20! (16% > 10,000 cfu/l). 23% of 309 warm water samples positive.**
- **Conclusions:**
  - **1) Thermal disinfection of hot water possibly took place prior to visit.**
  - **2) Cold water may have undergone warming due to poorly insulated pipes .**
  - **3) Temperatures taken at a busy time of the work-day may not be representative of the temperature during low demand.**

Exposure Factors

Contaminated aerosols are breathed in / there is micro-aspiration of contaminated water into the lungs:

- Concentration of organisms
- Degree to which water is aerosolized
- Environmental conditions: wind & humidity
- Proximity of infected aerosol to susceptible host
- The susceptibility of the host
- The virulence properties of the organism

Seasonal Factors in LD

- In 2006 the Netherlands experienced a very hot summer followed by a lot of rain.
- In that year there were 446 cases.
- In August 2010, 106 cases were reported in one month.
- [D van der Kooij, EWGLI, Copenhagen 2010]
- A study of LD cases in the Greater Philadelphia Metro examined 240 cases between 1995 – 2003.
- Increased occurrence of LD was associated with hot, wet, humid conditions 6-10 days before onset of disease.
- An inverse association was seen with increase in wind speed.
- JID 2005:192 (15 December) Fisman et al.
- Implications of these findings for SA for CT-related disease

Decontamination of Hospital Water Supplies: A Review of the Literature and the University of Iowa's Experience

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Iowa City, Iowa

Brief Overview

- Several different methods are used to control Legionella, all have been successful in some situations but have failed in others
  - Heat Rx Hospital in Sweden 65°C maintained @ 55°C but further 4 cases
  - Copper & Silver ions does not completely eradicate
  - Chlorine dioxide = 41% distal sites +ve to 4% in 18 months
- It may take many months to get counts down in complex plumbing systems


2 kg

Copper / Silver Ionization device

University of Iowa lessons

- Once *Legionella spp*. are introduced into a plumbing system
  - They are rarely eradicated
  - They are merely suppressed
- Suppression requires constant vigilance & is costly
- Removal of dead legs is critical
- Need to achieve adequate disinfectant levels
- Circulate adequate volumes of water
- Take precautions during renovation or construction (new buildings may be contaminated)

University of Iowa Summary

- You won't find:
  - Nosocomial Legionnaires' disease unless you look for it
  - Legionella in your water unless you look for it
- Dead ends and taps that aren't used can thwart decontamination efforts
- Maintaining a safe water system requires constant attention and monitoring
- Sporadic cases can still occur even when the water system is well maintained

Hospital Sampling

Take hot water samples from the following areas

- High risk areas such as: bone marrow and other transplant units, oncology & surgical unit, ICU, Renal unit, Neonatal ICU, Theatre
- The tap most distant in the building from the mains inlet (cold).
- Representative samples from each wing
- Representative samples from each floor
- Cold water holding tank (roof tank)
- Central hot water tank / representative samples from geysers
- Separate buildings

Hospital Sampling - Continued

- Hot water taps where the temperature does not reach 50°C or takes along time to come up to temperature
- Hot water taps where the flow is very slow
- Hat water taps most distant from the boiler.
- Cold water taps where the temperature is too high (lukewarm)
- Showers and taps that are seldom used may be tested in a high risk area but ideally they should be flushed on a regular basis (weekly)
- New areas not utilised yet
- Decorative water features inside the building
- Cooling towers
- Air conditioning sumps

Sampling - Continued

- PLANNING
- The first task is to map the water systems in the building with the maintenance manager or a person with a working knowledge of the plumbing and air conditioning systems.

- Representative samples should be taken so that the different systems in the building are all sampled.
- Hot and cold water systems as well as air conditioning systems should be sampled.

- FREQUENCY
- The number and frequency of sampling will be affected by the budget so it is best to start with high-risk areas first.
- It is advisable to carry out sampling once a year and more frequently in high-risk areas. Transplant sections should be tested quarterly but preferably on a monthly basis.

ELDSNet annual surveillance data

Legionnaires' disease in Europe, 2009

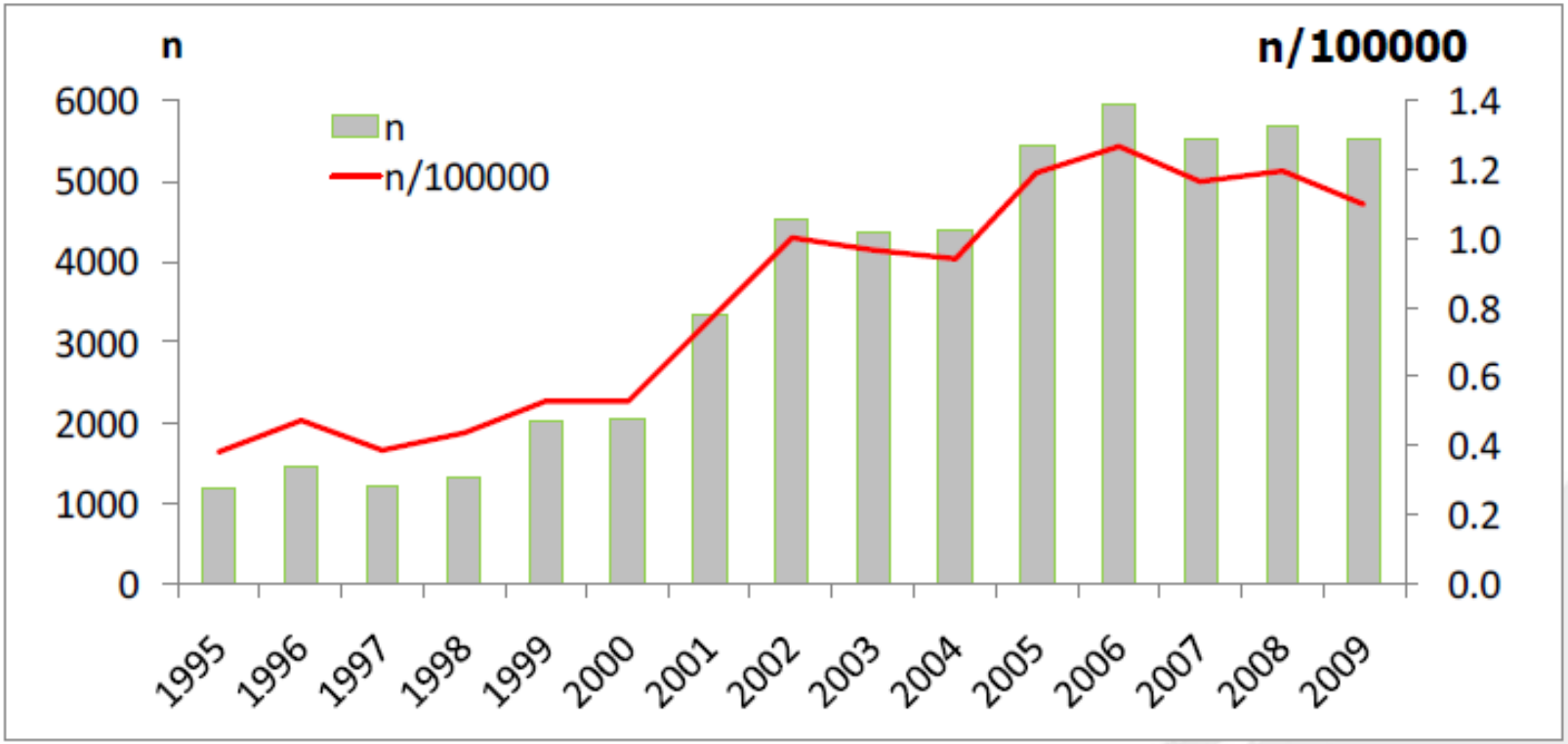
Phillip Zucs, Surveillance Unit,
European Centre for Disease Prevention and Control

Copenhagen, 15 September 2010

Cases by classification, 2009

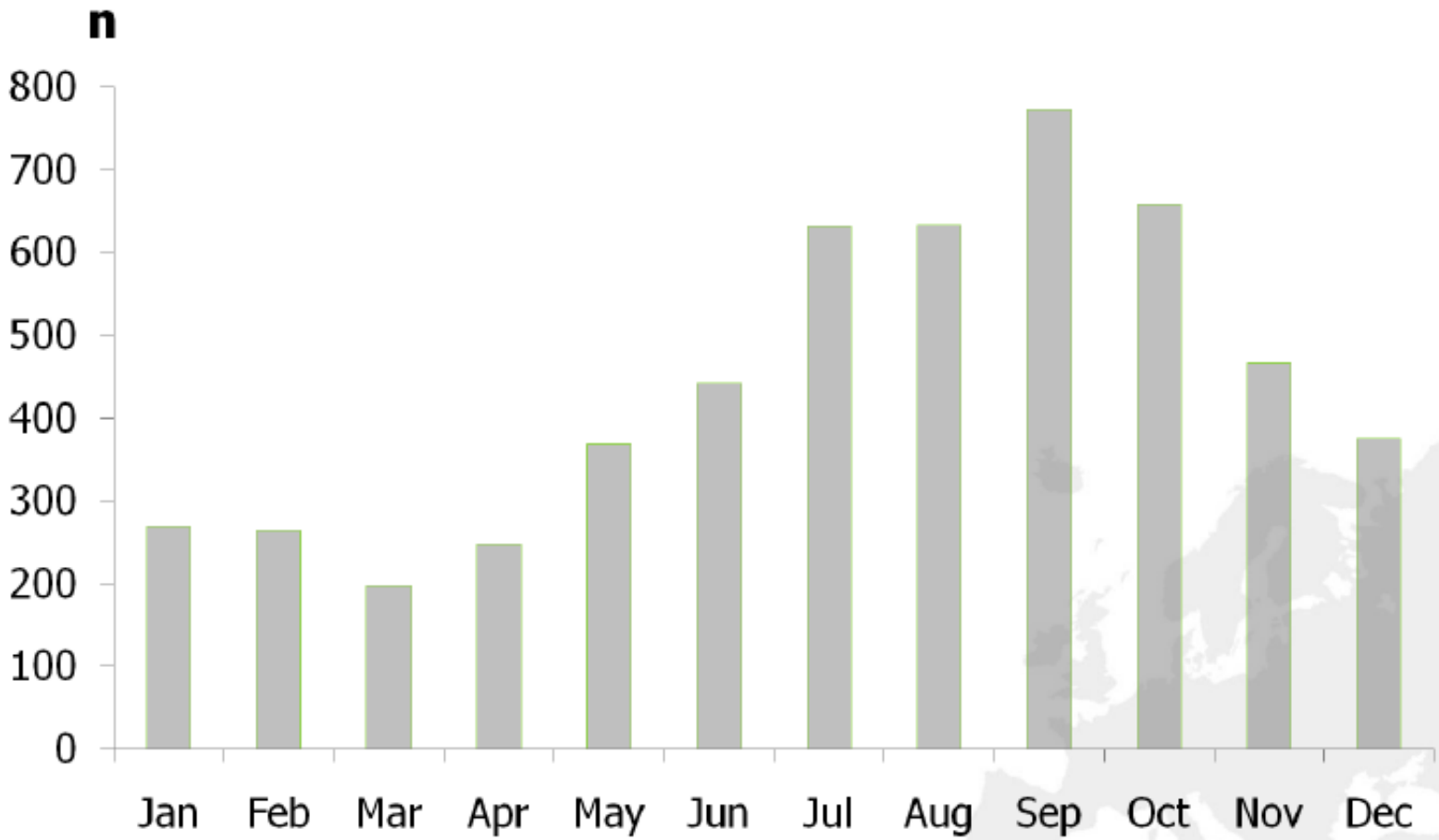
	n	%
Confirmed	5089	92.2
Probable	429	7.8
TOTAL	5518	100.0

Cases by year of onset, 1995-2009

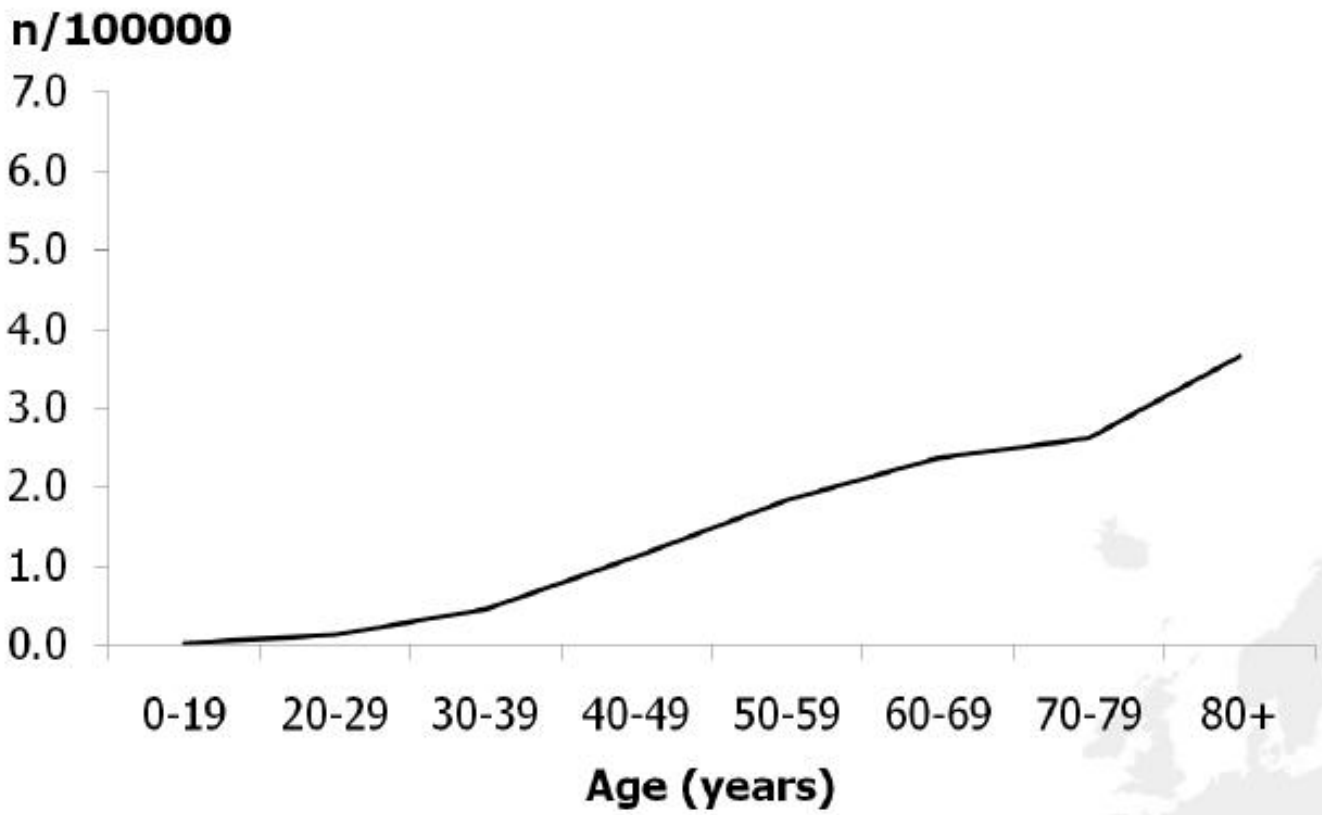


Participating countries (n)														
18	18	18	21	23	23	24	27	28	28	28	28	28	29	29

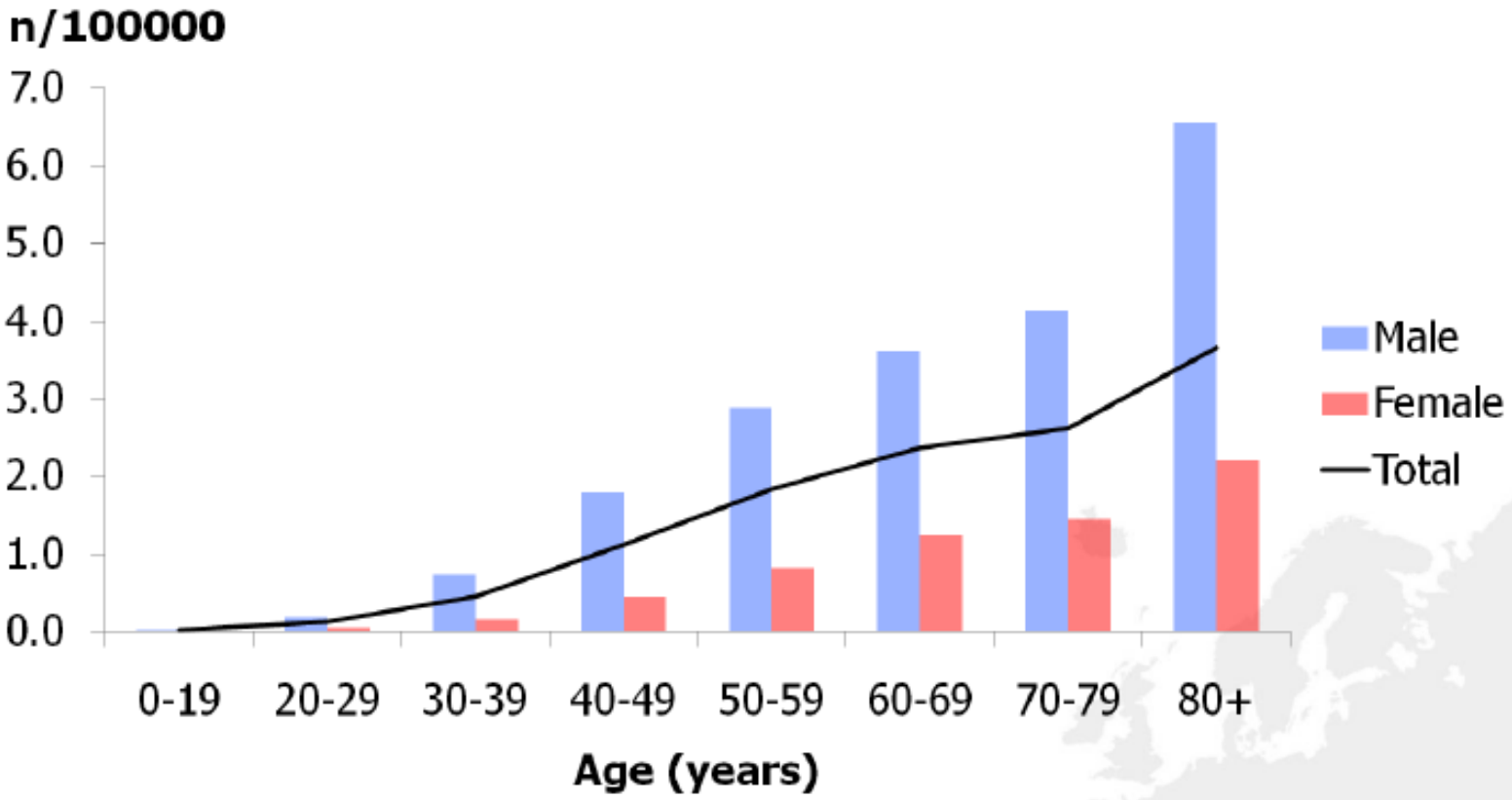
Cases by month of onset, 2009



Cases by age

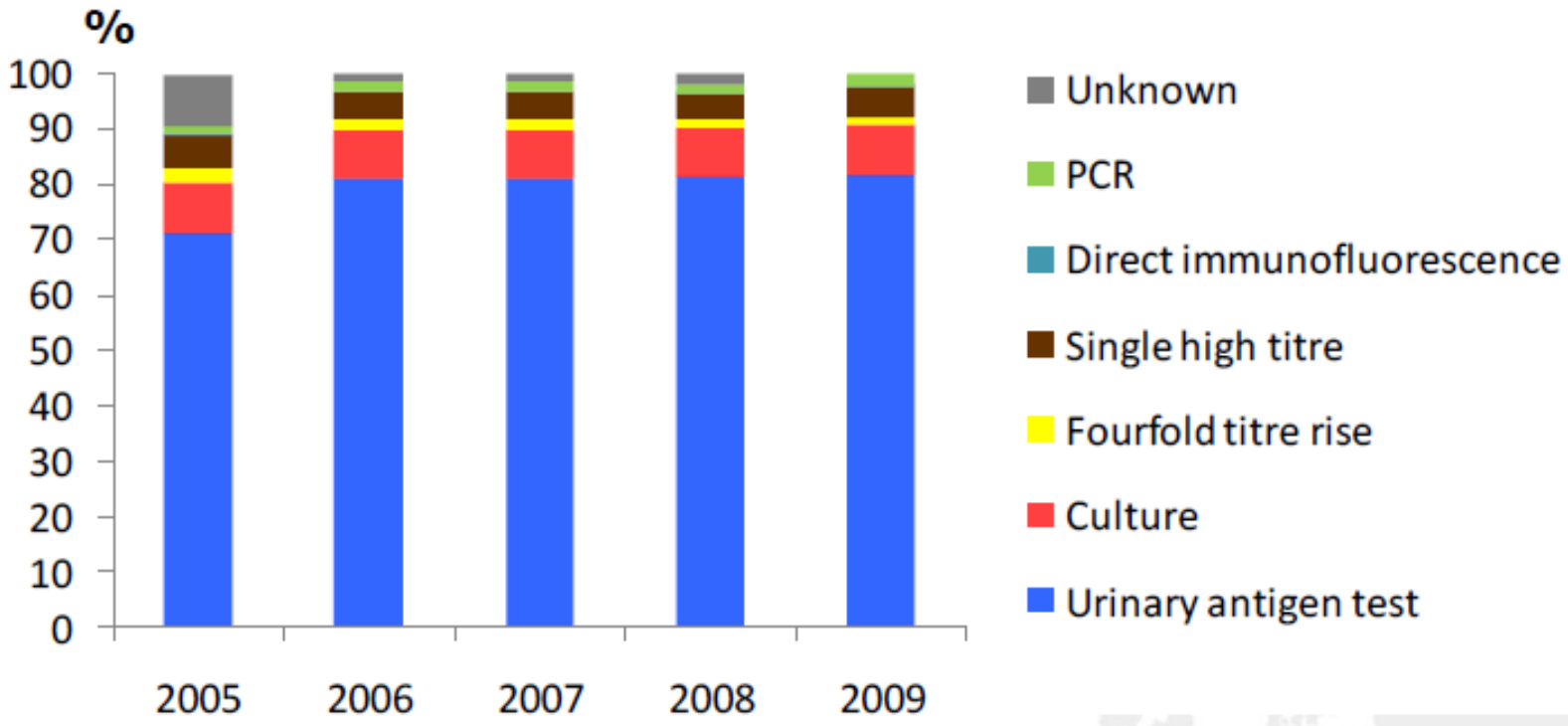

n/100000
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0-19
20-29
30-39
40-49
50-59
60-69
70-79
80+
Age (years)

Cases by age and gender



Male / female ratio by age group								Total
1.3	3.1	4.7	4.0	3.5	2.9	2.8	3.0	2.8

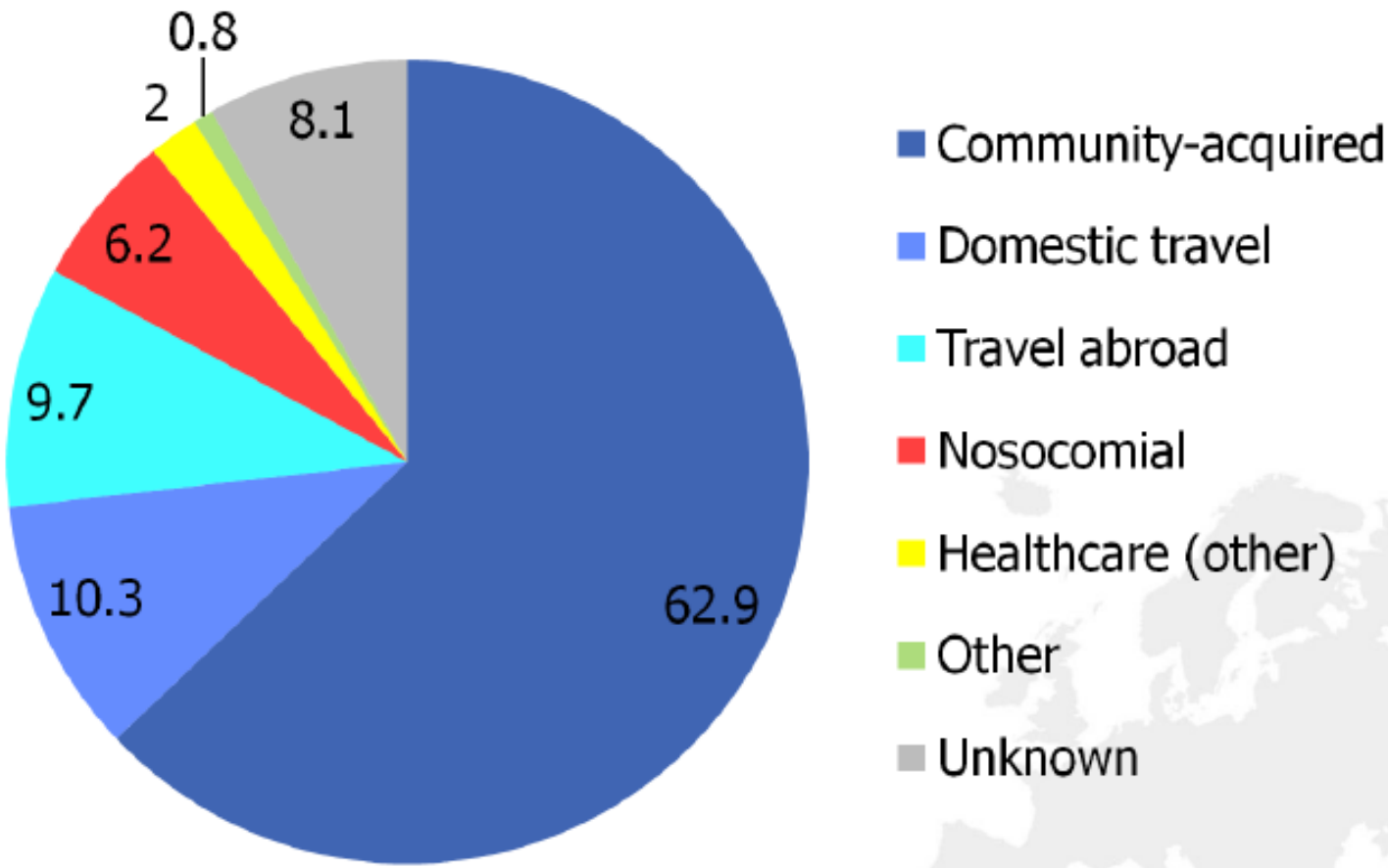
Cases by laboratory method, 2005-2009



Laboratory tests (n), by year				
5458	5967	5516	5691	5622

Cases (%) by setting, 2009

n=5378



Cases by Legionella species and serogroup, 2009

Species	n	%
L. pneumophila	5177	95.9
L. longbeachae	4	0.1
L. micdadei	2	0.0
L. bozemanii	1	0.0
L. maceachernii	1	0.0
Unknown	215	4.0
TOTAL	5400	100.0

Serogroup	n	%
1	4648	89.8
2	7	0.1
3	29	0.6
4	1	0.0
5	5	0.1
6	10	0.2
7	9	0.2
8	4	0.1
9	1	0.0
10	7	0.1
14	1	0.0
Mixed	23	0.4
Unknown	432	8.3
TOTAL	5177	100.0

Cases by outcome, 2009

	n	%
Non-fatal	3325	60.3
Fatal	404	7.3
Unknown	1785	32.4
TOTAL	5514	100.0

Conclusions

- Legionella are aquatic organisms that exploit man-made water systems
- New environmental sources of LD are continually discovered
- Control / eradication is very costly and takes considerable expertise
- High-risk buildings such as hotels, hospitals and old-age facilities should be routinely sampled
- It is essential to use a Lab that has experience and accreditation status