First Do No Harm

Protecting the Waste Handlers and the Public

Dr Nicola Rodda
Pollution Research Group – BioSciences
School of Biological and Conservation Sciences
University of KwaZulu-Natal

Classes or Categories of Pathogenic Microorganisms: The Microbial World

Viruses:

smallest; simplest; relatively resistant; do not multiply in the environment; low infective dose

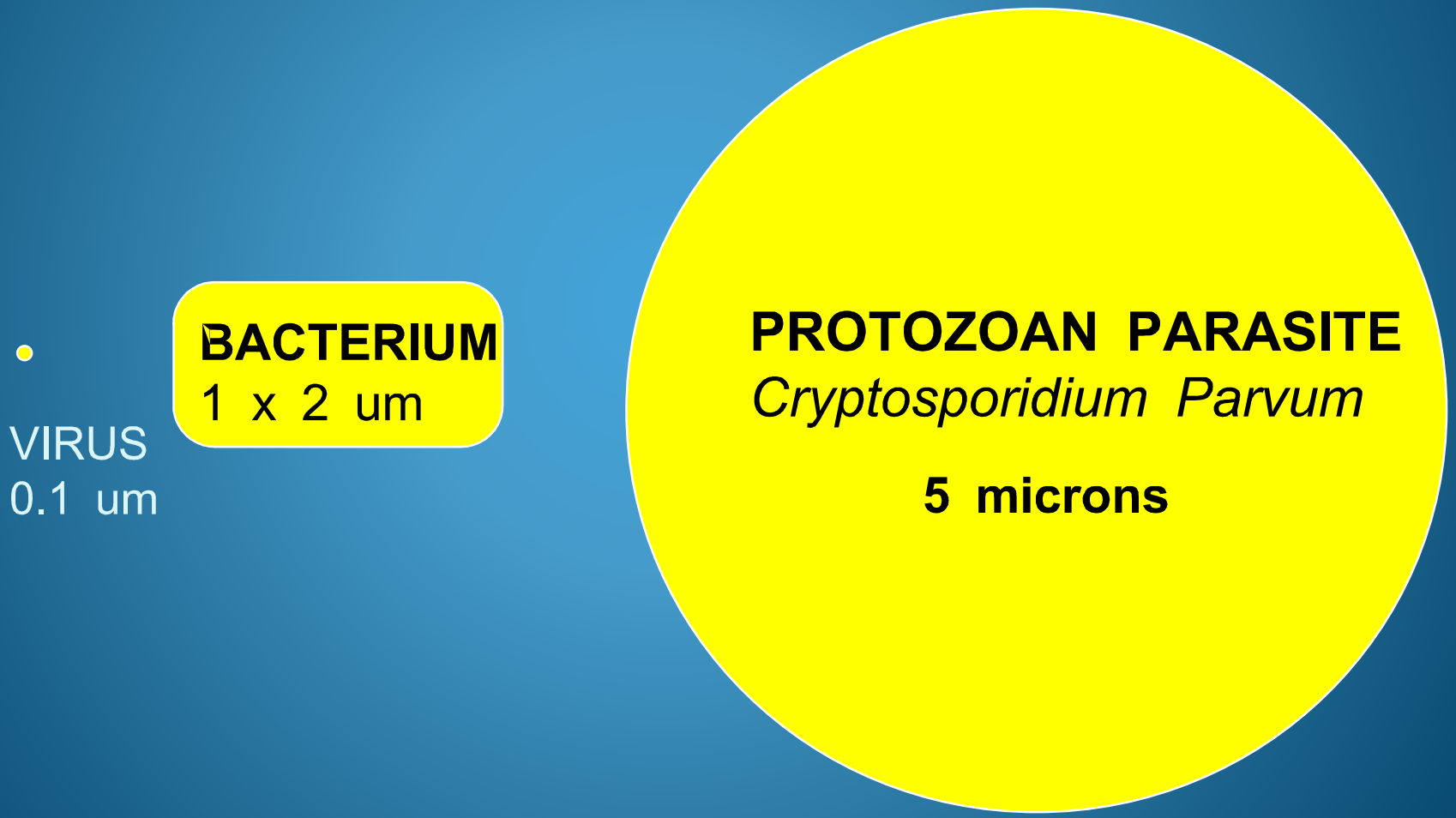
Bacteria:

0.5-2.0 µm diameter; unicellular; multiply in the environment; high infective dose

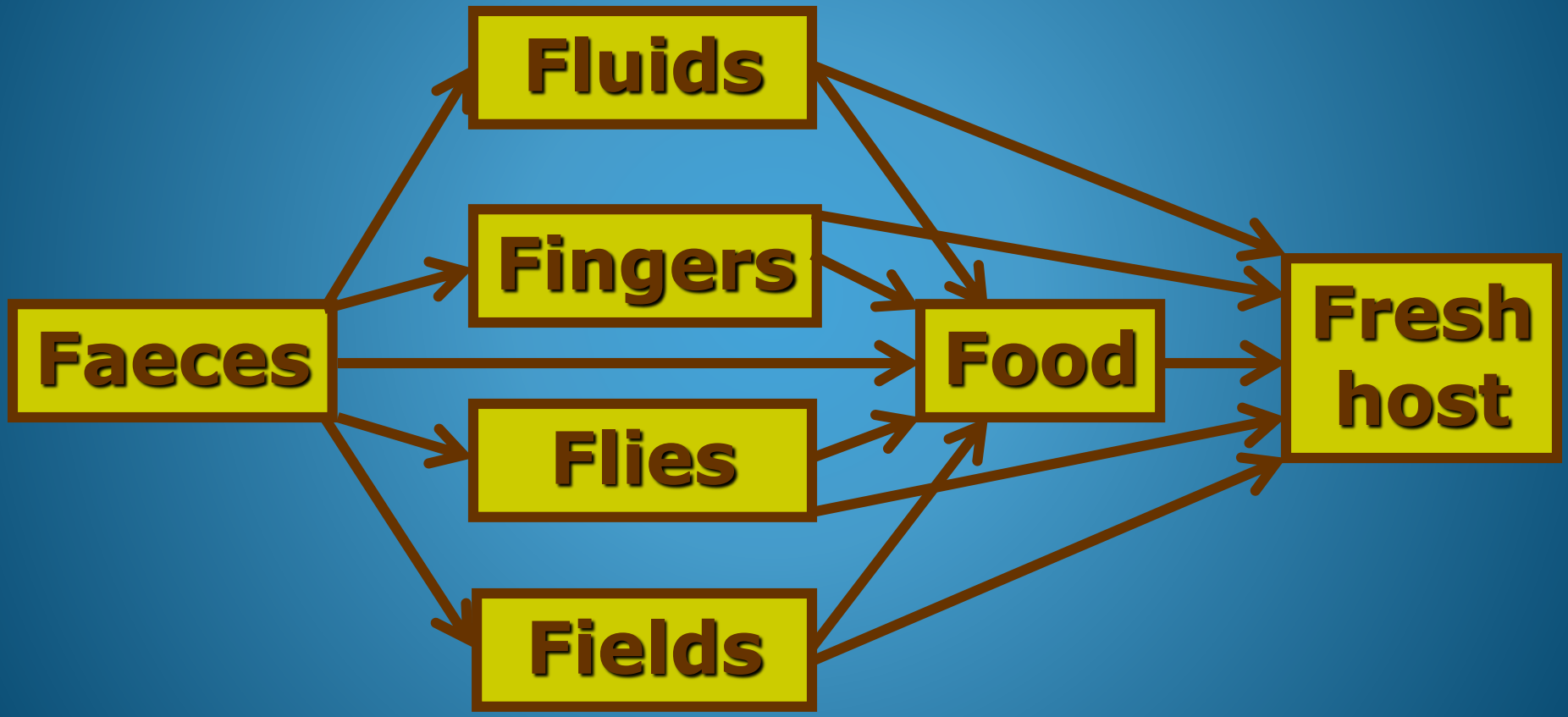
Protozoa: most >2 µm- 2 mm; unicellular; resistant (oo)cysts; do not multiply in the enviroment; low infective dose

Helminths (Worms): multicellular animals, some are parasites; highly resistant eggs/ova (25-150 µm); do not multiply in the environment; very low infective dose

Relative Sizes of Microbes



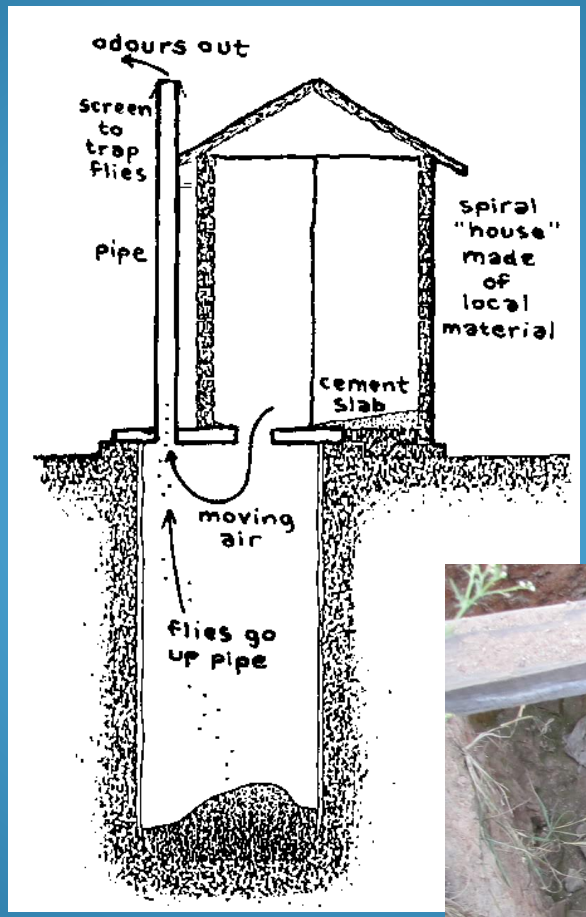
The ‘F diagram’



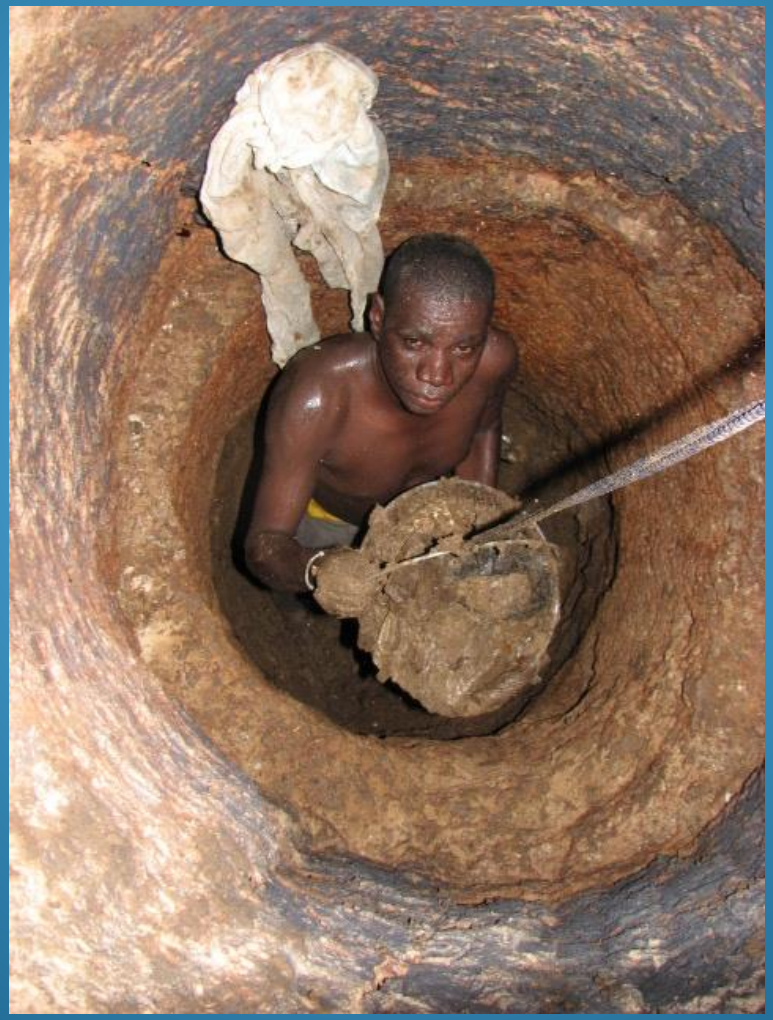
Source: Wagner & Lanoix, 1958

~1.3 million U5 diarrhoeal-disease deaths per year

That's nearly one death every 25 seconds


odours out
screen to trap flies
pipe
spiral "house" made of local material
cement slab
moving air
flies go up pipe

First do no harm.....



Urine diversion toilet emptying

Pit latrine emptying

What is an acceptable risk?

- Risk is probability of infection.
- Specifically, annual risk of 10^{-5} for microbial hazards.

  1 excess infection per 100 000 per year
- Ideally, risk reduced by treating waste.
- Clearly not possible for pit latrine waste in situ.
- Therefore introduce barriers to exposure – hazard is only a risk when there is exposure to the hazard.

Hazard

Ascaris ovum

Exposure

Observations of potential exposure after UD emptying and burial of waste

Faecal waste left exposed after UD emptying and burial of contents	72%
Burial sites highly accessible	84%
Waiting period by householders before using burial site	12%

Exposure Assumptions

- Direct oral exposure 1 g (5 g sometimes also used)
- Exposure via contaminated hands 0.1 g
- So a total of 1.1 g per worker per exposure

- For sake of example, consider exposure from a single event

  Adequate for bystander, insufficient for worker

- From UD emptying study:
- Mass of waste left on ground (per UD toilet emptied)
  - Mean 40 g
  - Max 140 g
- Mass of waste on hands (per waste handler)
  - Mean 0.4 g
  - Max 1.7 g

- From pit emptying study
- *Ascaris* ova per g wet weight of waste
  - Mean 55 ova
  - Max 2 100 ova

- Viability of ova from pits
  - Mean 30%
  - Max 50%

- From various studies
- Recovery efficiency of detection method
  - Mean 75%

That works out to.....

- Viable ova left on the ground around emptying site
  - Mean 8 500
  - Max 184 000
- Viable ova left on hands of waste handlers
  - Mean 90
  - Max 2 300

Clearly barriers for hands and mouth are needed!

So you'd think this would be just right ...

The test

Masks were tested from workers emptying pits and from workers using high pressure water spray to rinse waste through screens.

The result

High numbers of the following human parasites :

Ascaris ova

Trichuris trichiura ova

Taenia sp.

Numbers were much higher for sprayers than for emptiers.

Both these groups were at high risk of parasite infection.

How big is the risk?

- Probability of infection $P_i = 1 - e^{(-rD)}$
  - r = 1, meaning potentially a single exposure can cause infection
  - D = dose

- Remember exposure assumption: 1.1 g by direct or indirect oral exposure
- Viable *Ascaris* in 1.1 g
  - Mean 250 ova
  - Max 1 500 ova
- These are mean and max estimates of D

Risk calculations

- Mean risk of infection with no barriers (protective clothing): 1.0

- Washing with soap: reduce D by factor of 10
  - Mean risk 1.0
- Wear gloves and boots: reduce D by factor of 100
  - Mean risk 0.9
- Wear **adequate** face mask: reduce D by factor of 100
  - Mean risk 0.025 (2.5×10^{-2})
- Use deworming after exposure: reduce D by factor of 1000
  - Mean risk 0.0000025 (**2.5×10^{-6}**)

...plus
Deworming schedule

And then what?
...or where does the waste go?

Containment

- Safe disposal – minimise waste processing
  - Burial on-site where there is space
- Where space is insufficient - Landfill
  - Additional risks associated with transport

From this.....

..... To this

With thanks to...

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