

Pathogenic Free-Living Amoebae

There are several groups of amoebae that are natural aquatic or soil organisms but are also opportunistic pathogens; that is, infection is coincidental to their normal life cycle.

NAEGLERIA FOWLERI INFECTIONS

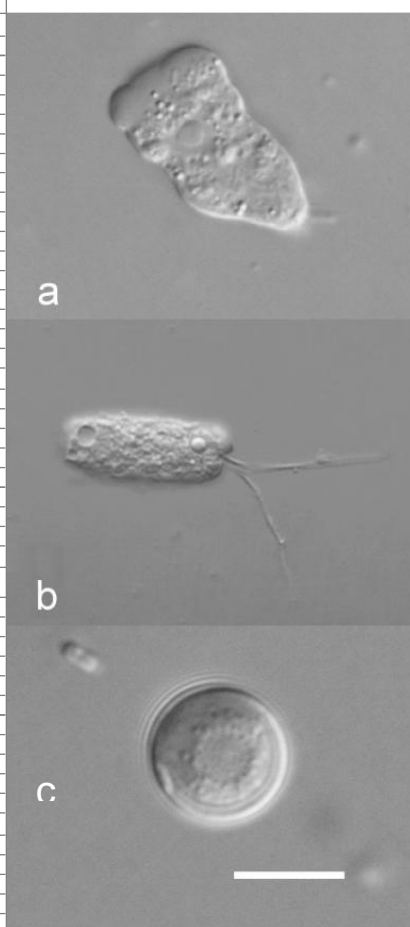


Figure 1. *Naegleria fowleri* life cycle stages.
a. trophozoite, b. flagellate, c. cyst.
Scale bar = 10 µm

The waterborne disease **primary amoebic meningoencephalitis** (PAM, sometimes called amoebic meningitis) was discovered at the Adelaide Children's Hospital in the 1960s. It has since been reported from about 15 other countries in Africa, Asia, Europe and North and South America. PAM is caused by *Naegleria fowleri*, and follows intranasal infection during swimming in warm, contaminated freshwater. Most victims have been children and the disease is almost invariably fatal. Infections have been linked with warm waters such as above-ground pipelines, tropical lakes, geothermal water, heated swimming pools or discharges of industrial cooling water. Until recent cases in the USA were identified, Australia was the only country where *Naegleria fowleri* has been associated with public water supplies.

Ecology of *Naegleria fowleri*

Temperatures suitable for *N. fowleri*, which grows fastest at 42°C, occur in water piped above ground and in other man-made environments. The life-cycle of *N. fowleri* (Figure 1) includes an amoeboid feeding stage (trophozoite), a rapidly swimming flagellate and a dormant cyst (which survives low temperature). *N. fowleri* cysts have poor resistance to desiccation, so that this species rarely occurs in soil.

Control of *Naegleria fowleri*

Chlorine kills all life-cycle stages of *Naegleria fowleri* and is the most effective way to disinfect swimming pools. However, in rural water supplies chlorine does not always reach areas that the amoebae may colonise. Chloramination, which involves successive applications of ammonia and chlorine to the water, is more effective against *N. fowleri* in practice, owing to the greater stability of monochloramine compared with free chlorine. The South Australian Water Corporation now uses this process where amoebae have been detected.

Related Organisms

There are more than 40 named species of *Naegleria*. They occupy various thermal niches, including cold polar lakes. Two species, *Naegleria australiensis* and *N. italica*, can infect laboratory mice if inoculated in large numbers, but are not known to have caused human infections. All other species appear to be benign.

AUSTRALIAN WATER QUALITY CENTRE

250 Victoria Square
Adelaide SA 5000
Telephone 1300 653 366
Facsimile 1300 883 171
GPO Box 1751
Adelaide SA 5001
awqc@sawater.com.au
www.awqc.com.au



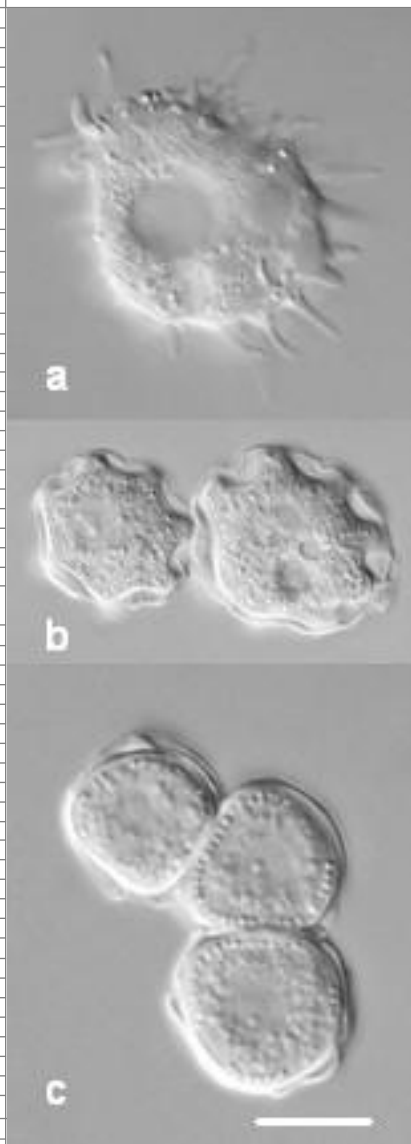


Figure 2. *Acanthamoeba* life cycle stages. a. trophozoite, b, c. cysts of two species. Scale bar = 10 µm.

ACANTHAMOEBA AND BALAMUTHIA INFECTIONS

Acanthamoeba and *Balamuthia* are groups of amoebae unrelated to *Naegleria*, but also free-living. Several species are infectious, causing two diseases.

Granulomatous amoebic encephalitis (GAE) is a brain infection somewhat different from PAM. It occurs in immune-suppressed patients, usually secondary to infection elsewhere in the body (e.g. skin ulceration) Most cases are fatal after a protracted illness. There has been one Australian case caused by *Acanthamoeba* and four cases caused by *Balamuthia*.

Amoebic Keratitis (AK) is a severe corneal (eye) infection, caused by several *Acanthamoeba* species, that appears to be growing in frequency. It occurs in two different circumstances: some patients are people who work outdoors (e.g. gardens or building sites) and who may have a damaged cornea (e.g. a scratch). Other patients are people who wear contact lenses, but who handle their lenses unhygienically. Early cases of AK resulted in loss of the eye, or necessitated a corneal graft. AK can now be treated by drugs, provided it is diagnosed quickly.

Ecology of *Acanthamoeba* and *Balamuthia*.

Acanthamoeba occur in freshwater, soil and marine environments. The dormant stage (cyst) is highly resistant to desiccation in most species, making *Acanthamoeba* the most common protozoa in soil. *Acanthamoeba* trophozoites (Fig. 2) have fine pointed acanthopodia (acanthus = spine). The cysts have characteristic angular or stellate (star-like) shapes which are used to divide them into three morphological groups containing more than 20 species. *Balamuthia* has only recently been isolated from the environment. No general source of infection has been confirmed yet, although soil rather than water is suspected.

Sources of infection by *Acanthamoeba* are hard to identify with certainty, owing to the delay between exposure to the amoeba and diagnosis. Outdoor keratitis cases probably result from exposure to soil or airborne dust, while contact lens cases may result from rinsing lenses in unsterile tap-water.

Acanthamoeba species are also suspected of playing a role in the dispersal of *Legionella pneumophila*, the bacterium responsible for Legionnaires' Disease.

Legionella can grow symbiotically inside the amoebae, which may partly explain the ability of the bacteria to thrive in soil and to spread by air.

OTHER AMOEBAE

Free-living amoebae are extremely diverse and play an important part in natural biological processes including decomposition. In soil, they are believed to contribute to control of plant diseases caused by fungi and bacteria. They can also be useful indicators of environmental change, particularly of the effects of temperature.

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