Characteristics and sources of *Echinococcus multilocularis*

**Main microbiological characteristics**

*Echinococcus multilocularis* is a small tapeworm of the Cestoda class. It is responsible for a parasitic zoonosis causing alveolar echinococcosis (AE), a potentially serious liver disease. The parasite’s life cycle mainly occurs in the wild, and the worm in its adult form is found in the intestine of a wild carnivore, the fox, which is the definitive host. In the intestines, the parasite develops between the villi and when mature produces eggs or oncospheres that are released into the environment via the faeces. Small rodents, which are the intermediate hosts, become infested by ingesting plant matter soiled by the eggs. The hexacanth embryos released from the oncosphere into the intestine of the rodents migrate to the liver where the larval form develops. The cycle is completed when these small mammals or rodents become the prey of carnivores. The parasite’s life cycle is summarised in Figure 1.

**Figure 1. Biological cycle of Echinococcus multilocularis**

- Adult of *Echinococcus multilocularis* © Franck Boué
- Data sheet on foodborne biological hazards
  September 2011

**Adult tapeworm**

- Wild or domestic carnivores are the definitive hosts. The adult tapeworm develops in the intestine and regularly releases its end proglottids containing mature eggs.

**Protoscolex**

- Small mammals are the intermediate hosts, becoming infected by ingesting plant matter soiled by the parasite's eggs. The larval stage develops in the liver in the form of alveolar vesicles in which the protoscolices will form.

**Eggs**

- Excretion of eggs or oncospheres in faeces and dissemination on plants.

- Humans become infected directly or indirectly by accidental ingestion of the parasite’s eggs. Humans are considered to be an accidental intermediate host.
Hazard sources
As definitive host, foxes are the main vector of this parasite. Pets such as dogs and cats can also be definitive hosts, but their role in maintaining the cycle is negligible compared to that of foxes. Furthermore, cats seem to be very poor carriers.

In humans, contamination is generally accidental and occurs through the ingestion of contaminated foodstuffs or through direct contact with infested animals. Humans therefore play an accidental role as intermediate hosts and form a biological and epidemiological dead end. The larval stage in small mammals is not dangerous to humans, and only carnivores ingesting infested rodents develop the adult tapeworms in their intestines.

The parasite is found throughout the Northern Hemisphere, particularly in Europe. The epidemiology of E. multilocularis is currently changing in Europe with the parasite now identified in animals outside its historical endemic area, this in countries that had either not been studied previously or that were apparently unaffected (Baltic countries, Sweden, Eastern Europe).

In France, until the end of the 1990s, the known distribution area of the parasite with foxes as a reservoir was limited to some fifteen départements in the north-east and the Auvergne region. A recent study carried out in 44 French départements, with nearly 5,000 foxes analysed, and showed that the parasite’s distribution has been extended towards the west and the south (Figure 2).

There is no institutional monitoring programme of the parasite in foxes, nor any programme for eradicating it.

Transmission routes
Humans can only become infested by the oral route, by direct ingestion of the parasite’s eggs on contaminated plant materials or, more rarely, indirectly by the ingestion of eggs carried via the hands after contact with the contaminated fur of animals carrying the parasite. However, in some exceptional extrahepatic forms, the larvae develop at the site of a bite from an infested animal.

There is no transmission between humans.

Recommendations for primary production
- As the parasite’s life cycle is sylvic (occurring mainly in wooded areas frequented by foxes), farm animals are not concerned directly. Like in humans, the larval stage of the parasite can develop in the liver in the form of alveolar vesicles. In such cases, the liver is removed and discarded during veterinary inspection at the slaughterhouse.
- For domestic carnivores, in areas where foxes are known to be highly infected, it is advisable to treat pets regularly (monthly) with a vermifuge containing praziquantel (the only compound that is active against this parasite).
- For plant crops, wherever infection is highly endemic, it is strongly recommended that animals be prevented from entering growing areas by setting up effective fencing, so as to avoid contamination by the faeces of foxes or domestic carnivores.

Human foodborne illness
Nature of the disease
The characteristics of the disease are presented in Table 1.

Human AE affects the liver in 97% of cases and acts like a very slow-developing cancer, gradually invading the hepatic tissue, the vascular and biliary systems and nearby organs. It is rare for other organs to be affected (diaphragm 35%, lungs 20%, spleen and pancreas <10%, central nervous system and bones <5%). The medical prognosis is generally less favourable when there is clinical expression.

Individual immune response to the parasite varies considerably and infection does not necessarily lead to the onset of an active parasitic illness (non-apparent forms, ranging from a simple serological form to calcified lesions).

Table 1. Disease characteristics

<table>
<thead>
<tr>
<th>Mean incubation period</th>
<th>Target population</th>
<th>Main symptoms (at diagnosis)</th>
<th>Duration of symptoms</th>
<th>Complications</th>
<th>Asymptomatic forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Several years before diagnosis (generally 5 to 15 years)</td>
<td>Anyone likely to ingest the eggs of the parasite</td>
<td>Abdominal pain: 25-30% of cases, Jaundice: 20% of cases, Hepatomegaly (enlarged liver): 15-20% of cases</td>
<td>No spontaneous resolution without treatment</td>
<td>Superinfection of the lesion or the biliary tracts, septic shock, Severe liver failure (recourse to liver transplants), Secondary biliary cirrhosis, Metastases (lung, brain and skeleton)</td>
<td>Existence of asymptomatic calcified lesions diagnosed by chance (during a check-up for some other illness)</td>
</tr>
<tr>
<td>Usual age when diagnosed: 45-70 years</td>
<td>No difference between men and women</td>
<td>More rarely, weakness and symptoms related to the extension of the lesions or metastases</td>
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<td>About one patient in three is diagnosed by chance (during a check-up for some other illness)</td>
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Figure 2. Prevalence observed in foxes in France. The white areas have not been investigated.
**Role of food**

**Main foods to consider**

It has been clearly demonstrated that human infestation results from ingestion of the parasite's eggs, although the main source of contamination has not been formally identified. All foodstuffs harvested at ground level in regions where the illness is endemic are a possible source of contamination (lettuce, dandelion, garden vegetables, mushrooms, fruits such as strawberries, blackberries and other berries). However, the risk that these foods could have been contaminated by the faeces of carnivores carrying egg-bearing parasites is minute and difficult to control. Desiccation is the main limiting factor for the survival of *Echinococcus* eggs in the environment (3 months in summer and up to 8 months in autumn and winter).

**Inactivation treatments in industrial environments**

The eggs cannot be removed from vegetable matter by simple washing. They can only be inactivated by cooking or by deep freezing at -80°C for 5 days.

Industrial freezing (-30°C) does not guarantee inactivation of the parasite's oncospheres.

<table>
<thead>
<tr>
<th>Effect of temperature</th>
<th>Duration of treatment</th>
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<tbody>
<tr>
<td>+70°C</td>
<td>5 min</td>
</tr>
<tr>
<td>+45°C / 85-95%</td>
<td>3 hours</td>
</tr>
<tr>
<td>+25°C / 27%</td>
<td>2 days</td>
</tr>
<tr>
<td>~70°C</td>
<td>96 hours</td>
</tr>
<tr>
<td>~80°C to ~83°C</td>
<td>48 hours</td>
</tr>
<tr>
<td>~196°C</td>
<td>20 hours</td>
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<tr>
<td>Ionisation</td>
<td>0.4 kGy</td>
</tr>
</tbody>
</table>

**Monitoring in food**

At only 30 µm in diameter, the parasite’s eggs are too small to be detected visually in ground-growing fruit and vegetables. Regarding production livestock, which can be intermediate hosts, infected organs are removed and discarded during veterinary inspection at the slaughterhouse.

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(1) The relationship between the dose (the amount of microbial cells ingested during a meal) and the effect on an individual.

(2) For a given effect, the relationship between the dose and the response, i.e., the probability of this effect appearing in the population.
Domestic hygiene

**Recommendations to consumers**

- In humans, individual prevention against contamination by the parasite begins with thorough hand-washing after handling animals that might be carrying the parasite’s eggs (on their fur), especially foxes (dead animals should be handled with gloves) but also pets.
- Consumers should pay particular attention to the following points:
  - domestic freezing is insufficient to inactivate the parasite’s eggs;
  - even intensive washing cannot guarantee the complete removal of the parasite’s eggs from the surface of fruit and vegetables;
  - the use of vinegar, alcohol or diluted bleach does not reduce the risk of foods being contaminated;
  - it is recommended that foods gathered at ground level be cooked before eating (5 min at 70°C) as far as possible.
- One measure for avoiding the contamination of vegetables by the faeces of carnivores carrying the parasite is to fence off domestic gardens. Equally, hand washing after any gardening activity is indispensable.
- Monthly administration to pets of a vermifuge containing praziquantel reduces the risk.

**References and links**

**General references**


**Useful links**

- National Centre of Reference (NCR) for alveolar echinococcosis (from 01 January 2012) and the FrancEchino network – Parasitology-mycology Laboratory, Besançon University Hospital Centre, Boulevard Fleming, 25030 Besançon Cedex. francechino@chu-besancon.fr - Tel.: +33 3 81 66 82 86.
- National Reference Laboratory for Echinococcoses: Nancy Laboratory for Rabies and Wildlife - ANSES, NRL Echinococcoses, Technopôle agricole et vétérinaire, BP 40009, 54220 Malzéville – Tel.: +33 3 83 29 89 50.
- WHO Collaborating Centre (WHOCC) for the prevention and treatment of echinococcoses – Besançon University Hospital Centre – ccoms@chu-besancon.fr - Tel.: +33 3 81 66 89 28.