General

Lice (singular: louse) have parasitized humans since ancient times. While most primates have only one body lice species, humans have three (pubic, body and hair lice). According to genetic analysis, the common ancestor of headlice was shared by primitive hominids and primates until 6 million years ago. Pubic lice separated about 3 million years ago. Body lice are “only” 650,000 years old (coincides with the start of hominids wearing clothing). Lice have been found on Egyptian and pre-Columbian mummies and even on bodies dug up in Pompei. The Order of lice (Phthiraptera) is divided taxonomically into sucking lice (Anoplura) and chewing lice (Mallophaga), but there are alternative taxonomic classifications. Anoplura only parasitize mammals. Only three species of Anoplura are of regular direct medical importance to humans. These wingless insects are cosmopolitan, obligate haematophages and strictly adapted to their host (there is no animal reservoir). *Polyplax spinulosa* (Anoplura) is the sucking louse of rats and acts as an occasional vector of murine typhus. Only a single species of Mallophaga (*Trichodectes canis*) is known to have medical significance. *T. canis* is the chewing louse of dogs and acts as one of the larval hosts of the dog tapeworm *Dipylidium caninum*. This insect cannot live on man.

Pubic lice

Pubic lice (*Pthirus pubis*) do not themselves transmit disease. [The name *Phthirus pubis* is also used, but in 1987 the International Commission on Zoological Nomenclature decided to keep the original spelling of *Pthirus pubis*]. They occur on areas of the body with coarse hair (pubic region, peri-anally, sometimes also on legs, eyelashes, moustache, beard and even armpits and chest). Sometimes they are present on the scalp, including neonates. Sexual contact is the main method of transmission, but is not the only one (e.g. shared clothing). Any transmission involves bodily contact. They cannot live for more than 24-48 hours away from the host. If they are present in children, the possibility of sexual abuse should be taken seriously. A significant and strong correlation between the falling incidence of pubic lice infections and increase in pubic hair removal is observed. The increased incidence of hair removal may lead to atypical patterns of pubic lice infestations or its complete eradication as the natural habitat of this parasite is destroyed.



Pthirus pubis. Pubic louse. © ITM



Pediculus humanus capitis. Head louse. © ITM

Body and head lice

Body and head lice (*Pediculus humanus corporis* and *P. h. capitis*) are two very closely related species (morphologically almost identical) but which occupy different ecological niches. The body louse *P. humanus corporis* lives in clothing and only comes onto the body to suck blood for a short time. The head louse *P. h. capitis* by contrast lives on the scalp and never on the clothing. Mutual fertilisation is possible in the laboratory, but in nature this appears not to occur and they are considered to be different species.

Fertilised females lay 6-9 eggs per day during their life. They live usually for 1 month, maximum 2. The animals are very sensitive to cold. The females attach the sticky eggs to underwear, shirts and trousers. Eggs on clothing cannot survive for more than 4 weeks

(usually only 2 weeks). The eggs hatch after 6-9 days. Once hatched, the larvae suck blood five times a day, rapidly returning to the clothing after each meal. Lice avoid light. Once adult, the animals will mate repeatedly. The reason for this is that females have no spermatheca and frequent mating is therefore crucial to build up a population. All in all this means that in optimal circumstances natural populations can increase by 10% per day. This is important in order to understand the dynamics of infections such as epidemic typhus and relapsing fever. Digestion of the blood is rapid. The red blood cells lyse. *R. prowazekii* infects the cells lining the intestine. The intracellular proliferation of *R. prowazekii* causes the insect's intestine to burst, spreading its contents into the haemolymph. The haemolymph will be stained red. The red colouration can be used in the laboratory to investigate whether a louse is infected with *R. prowazekii*. The louse dies from the infection with *R. prowazekii* and this fact was used previously to investigate which antibiotics were active against this bacterium. The antibiotic that enabled the louse to survive was then studied further. Lice are very sensitive to desiccation so that in dry environments they will not survive. Lice faeces are very dry and powder-like, with a water content of only 2%. The faeces contain a large amount of ammonium, which has an attracting effect on other lice.

P. humanus corporis can transmit *Rickettsia prowazekii* (epidemic typhus), *Bartonella quintana* (endocarditis, trench fever) and *Borrelia recurrentis* (epidemic relapsing fever). *R. prowazekii* is fatal for the insect after a few days. It is important for transmission and explains why people with louse borne typhus often have remarkably few lice. *B. recurrentis* proliferates only in the haemocoel of the insect and is transmitted by crushing an infected louse. This explains why "outbreaks" of louse borreliosis are rare unless there are massive numbers of lice. *B. quintana* can survive for up to a year in lice faeces.

The insects on clothing are destroyed by heat. For treatment, clothing is washed at 70°C, steam ironed or sterilised. In emergency situations (epidemic) insecticides are sprinkled (e.g. mixed with talc) between skin and clothing. Malathion or permethrin lotion or systemic ivermectin can be used.

P. humanus capitis. This obligate bloodsucking ectoparasite feeds three to six times per day. The female lives one month and can lay up to 300 eggs, also known as nits. The eggs are deposited very close (approximately 1 mm) to the base of the hair and are firmly

attached. Given that a hair on the scalp grows about 0.4 mm per day, it follows that virtually all nits found more than 5 mm from the base of the hair are either dead or empty (in practice a figure of 7 mm is taken). The egg shells of the nits are not removed by insecticides. Their presence after therapy sometimes causes anxiety and give rise to the mistaken belief that the insects are resistant.

Larvae and adults suck blood. The irritation from the bites can lead to chronic itching and scratching, possibly with secondary infection (e.g. impetigo) as a consequence. The insects are very dependent on their host. Even fed adult lice cannot survive for more than a few days (maximum 10) without another feed. They leave a dead person or someone with high fever fairly rapidly.

Head lice treatment

There are several options: (1) wet-comb method, (2) topical organophosphate or pyrethroid insecticides, (3) topical dimethicone, (4) systemic ivermectine, (5) topical ivermectin.

In the wet-comb method the hair is first washed with a shampoo, followed by application of a hair conditioner to make the hair as smooth as possible. A good louse-comb has teeth 0.2 to 0.3 mm apart. The teeth should have an angular cross-section. After application of the conditioner, the hair is finely combed from the neck towards the front hair-line. The teeth of the comb should be in contact with the skin. After each movement, the comb is cleaned on a piece of white paper. When finished, the hair is rinsed, and combing is started again, this time from the forehead hairline towards the neck. This is done 4 times in a period of 14 days. If living lice are still found after this period, another therapeutic option should be used. The wet-comb method is time-consuming and cumbersome. The success rate varies from 37% to 57%. The advantages are low price, lack of resistance and it can be used when one prefers to avoid topical insecticides (very young children, lactating women). In olden days, shaving the hair very short was sometimes used.

Topical pediculicides. In most cases, infestation with lice is treated with insecticides, but head lice have become more and more resistant. Treatment options are organophosphates such as 0.5% malathion [Prioderm®, Radical®] or pyrethroides such as 1% permethrin

[Nix®] or depallethrine 0.66-1% in combination with 2.6-4% piperonyl butoxide (ParaShampoo®, Pyriderm®). The contact time should be sufficiently long: at least 10′ for permethrin, 30′ for depallethrine and 12 hours for Malathion. Lotions are better than shampoos as they have a longer contact time with the hair. If after reapplication 7 days later, living lice are still found resistance is likely (reinfestation is also possible).

Dimethicone 4% (Silikom®) is applied to dry hair and is rinsed off 8 hours later. This is repeated after 7 days. The idea is to suffocate lice, cutting of the oxygen supply. The cure rate is about 70% with this method, although more study is needed.

Ivermectin is a neurotoxin acting on glutamate-gated and gamma-amino butyric acid-gated chloride channels. Oral ivermectin (Mectizan®, Stromectol®) can be used as an alternative or in case of multiresistant lice. A dose of 200 µg/kg is given twice with a 7-day interval. Studies showed a superior efficacy (95%) as compared with topical 0.5% Malathion lotion (85%) applied with the same interval. A 0.5% ivermectin topical lotion can be applied to dry hair, left for 10 minutes then rinsed with water.