HY-06 Vectors: mosquitoes, lice, fleas, ticks, flies and rats, and the old and new controls

HEALING after the FALL, research library, HY-06

Researched 10 October 2026 by Claude Opus agent for THRIVING after the FALL, Book Four. Library document, unverified.

Scope and method

This report asks what a household, a village of 300 and a district of 3,000 can do about the animals that carry disease to people once factory insecticides, cheap nets and antibiotics are scarce. For each vector it gives the diseases, the control, the size of the effect, the labour and materials, what a household can do in a month and what takes a season.

Cochrane reviews were read as summaries and summary-of-findings tables. Most trials were read as abstracts or in secondary accounts, and each reference says which. The historical campaigns were read mainly through modern reviews, because the primary reports were too long or blocked. My own arithmetic and inferences, and figures I could not confirm, carry [VERIFY]. Pyrethrum appears only as grown, dried and ground flowers. No extraction, synthesis or purification of any insecticide or drug is described. Related reports: water storage (THRIVING library, HY-02), handwashing (THRIVING library, HY-01), and the planned reports on latrines, fevers, antibiotics and the herbal pharmacy (THRIVING library, HY-04, IN-08, IN-09, IN-13, PH-06, OR-02), which did not yet exist.

Two cautions run through the whole report. The controls that work best are dull and physical: a whole net, a closed eave, an emptied water jar, a boiled shirt, a covered latrine, a granary on legs. And every campaign remembered as the triumph of one tool (oil in Panama, Paris green in Brazil, DDT in Naples) was a bundle of measures carried out by a disciplined workforce. Every success decayed when the labour stopped.

1. Mosquitoes

1.1 Diseases and life cycle

Anopheles mosquitoes carry malaria. They bite at night, indoors or near houses, and breed in sunlit standing water: puddles, hoof prints, rice fields, pond edges. Aedes aegypti carries dengue, yellow fever, chikungunya and Zika, bites by day and breeds in clean water in containers: jars, tyres, buckets, gutters, vases. Culex carries filariasis and encephalitis viruses and breeds in dirty water, including latrines. Anopheles still lives in Europe and North America, so malaria could return there if carriers arrive [VERIFY: inference].

An Aedes egg becomes an adult in about 7 to 10 days in warm weather (about 7 days at 35°C, nearly 40 at 15°C in the laboratory), and eggs stuck to a container wall survive drying for months [VERIFY: CDC material seen via search]. A container emptied and scrubbed every week therefore never produces adults. Anopheles flight range varies by species from a few hundred metres to several kilometres, so there is no single safe radius for larval control [VERIFY].

1.2 Nets

The strongest evidence for any control in this report is for insecticide-treated nets. Across 23 trials and 275,793 people, treated nets compared with no nets cut child deaths from all causes by 17% (rate ratio 0.83, 95% CI 0.77 to 0.89, five trials, 200,833 children, high certainty), or 5.6 lives saved per 1,000 children each year. Falciparum malaria fell by 45% (0.55, 0.48 to 0.64) and severe malaria by 44% (0.56, 0.38 to 0.82) (Pryce et al. 2018).

After the Fall the insecticide will run out, so the useful question is what a plain net does. Treated nets beat untreated ones on falciparum incidence (0.58, 0.44 to 0.78), but the extra mortality benefit of treatment is uncertain (0.67, 0.36 to 1.23) (Pryce et al. 2018). In a survey of 48 Gambian villages, an intact untreated net gave 51% protection against falciparum infection in children (34 to 64%), 62% in the poorest households, with no diversion of mosquitoes onto unnetted children (Clarke et al. 2001). An earlier Gambian trial of about 2,300 children found some protection from untreated nets and more from treated ones (D'Alessandro et al. 1995). The key word is intact. An untreated net, unlike a treated one, does not kill a mosquito that finds a hole.

The usual standard is at least 156 holes per square inch (about 24 per square centimetre), with openings of about 1.2 to 2 mm. Sandflies need 0.6 mm or finer [VERIFY: WHO criteria seen only in secondary summaries].

1.3 Screening and closed eaves

Screening was the first vector control proven by experiment. In 1900 Grassi protected 112 people in the Capaccio plain from dusk to dawn and 5 caught malaria, while all 415 unprotected neighbours did. Celli screened 26 railway houses near Rome: 7 of 181 occupants (3.9%) caught malaria against 200 of 217 (92.2%) in 39 unscreened houses, though how houses were chosen is unclear (Ferroni et al. 2012).

In the modern Farafenni trial in The Gambia, 500 houses were randomised to full screening of doors, windows and eaves, a screened ceiling, or nothing. Indoor Anopheles gambiae fell from 37.5 per trap-night to 15.2 (ratio 0.41) and 19.1 (0.53). Severe anaemia in children (haemoglobin below 80 g/L) fell from 19.0% to 12.3% and 11.7% (adjusted odds ratios 0.53 and 0.51). Parasite prevalence did not fall significantly (risk ratio 0.84, 0.60 to 1.17) (Kirby et al. 2009). The screens were untreated, which is the post-Fall condition. A review of 90 studies found that people in modern houses with closed eaves had about half the odds of infection (adjusted odds ratio 0.53, 0.42 to 0.67), from low-quality observational evidence (Tusting et al. 2015). A Cochrane review of seven African trials found that screening and closing eaves reduced parasitaemia and anaemia. I could not read its risk ratios (Fox et al. 2022) [VERIFY].

Anopheles gambiae enters mainly through the gap between wall and roof. Closing eaves with mud, wood or cloth is about a day's work for two people per house [VERIFY: estimate].

1.4 Water: drainage, oiling and fish

Larval source management works where breeding sites are "few, fixed and findable", with moderate-certainty evidence from 13 studies in Sri Lanka, India, the Philippines, Greece, Kenya and Tanzania. Larviciding the large swamps and rice fields of The Gambia did nothing (Tusting et al. 2013).

Panama is the showcase. Gorgas's team ended yellow fever in Havana in September 1901 and in Panama burned 240,000 lb of pyrethrum in 1905 with a squad of 600 men (Gorgas 1915). Malaria admissions per 1,000 canal employees rose from 125 in 1904 to 821 in 1906, as the workforce grew, then fell to 424 in 1907, 282 in 1908 and 215 in 1909 (Gorgas annual report via NLS) [VERIFY which report]. Over 1904 to 1918 there were 104,296 admissions and 948 deaths, and incidence fell by nearly 90% (Hektoen International 2021). The means were labour: about 8.5 million feet of ditches over about 100 square miles, oil on water, larvicide, brush clearing, screened quarters, and quinine at 10 grains (650 mg) three times a day, up to about 40,000 doses a day (Hektoen International 2021). The rule of clearing brush for 200 yards round settlements comes from Le Prince (1916), which I could not read [VERIFY].

The Tennessee Valley Authority raised and lowered its reservoirs by about a foot every 7 to 10 days in the breeding season to strand larvae, cleared shorelines and screened about 1,200 houses in 1944 [VERIFY: Parasites and Vectors 2015, title not recorded]. Kitchens argues that the dams themselves increased malaria (Kitchens 2013).

In Brazil, Anopheles gambiae arrived at Natal in 1930 and in 1938 caused an epidemic in Ceará, with one estimate of 100,000 cases and 20,000 deaths [VERIFY]. Soper's Malaria Service of the Northeast, from January 1939, inspected every breeding site, treated larvae with Paris green and sprayed pyrethrum in houses, and the species was gone by 1940. Packard and Gadelha argue that famine drove much of the death toll and that the campaign's memory was shaped to sell vertical eradication (Packard and Gadelha 1997). Paris green is an arsenic compound and poisons people and animals.

The Cochrane review of larva-eating fish found no reliable evidence that stocking them reduces malaria (Walshe et al. 2017). Fish do no harm in a permanent tank but are not a malaria control. Oil spread on water suffocates larvae for a few days and spoils the water, so it belongs on drains and puddles, never on drinking water.

1.5 Containers and Aedes

Aedes aegypti was cleared from 18 continental American countries by 1962 through house inspection and insecticide. Brazil was declared free in 1958 and reinfested in 1967 and 1976. By 2010 the Americas had more than 1.7 million dengue cases and 1,185 deaths (PAHO 2010) [VERIFY].

Camino Verde is the most useful modern trial for a village. In 150 clusters with 85,182 residents in Nicaragua and Mexico, volunteers showed families how to find, empty, scrub and cover water containers, with no insecticide. Dengue infection in children aged 3 to 9, measured by blood test, fell by 29.5% (3.8 to 55.3), houses with larvae by 44.1% and pupae per person by 51.7% (Andersson et al. 2015).

1.6 Repellents and smoke

Repellents prevent bites for hours, but whether they prevent malaria is unclear. The Cochrane review found inconclusive protection from topical and spatial repellents, and a possible halving of infection from treated clothing in emergencies, with high risk of bias (Maia et al. 2018). In Bolivia, 4,008 people using a lemon eucalyptus repellent each evening plus a treated net had 80% less vivax malaria than those with placebo plus a net (incidence rate ratio 0.20, 0.11 to 0.38) (Hill et al. 2007). A trial in Cambodia found no effect (0.94) (Maia et al. 2018).

Maia and Moore (2011) give the plant figures:

- Lemon eucalyptus (Corymbia citriodora, leaves). The refined product PMD gave 96.88% protection for 4 hours at 30% in Bolivia. The raw oil lasts about 1 hour. Burning or heating Corymbia and Eucalyptus leaves gave about 65 to 80% in Ethiopia.
- Neem (Azadirachta indica, leaves, seed oil). Burnt leaves gave 76% for 2 hours. Neem oil at 1% in a kerosene lamp gave 94.2% against Anopheles. Undiluted oil can cause dermatitis.
- Citronella (Cymbopogon nardus, C. winterianus, leaves). About 2 hours, irritant, safe at 2%. Lemongrass (C. citratus) only at 0.1%.
- Basil (Ocimum americanum, O. forskolei, leaves). Smouldering gave 65 to 80%, live potted plants 25 to 40%, fresh plants hung indoors 53%.
- Hyptis suaveolens (leaves), smouldering 85.4%. Thyme (Thymus vulgaris), burning 85%. Daniellia oliveri bark, 77%.
- Mugwort (Artemisia vulgaris, leaves), 5% extract gave 100% for 4 hours. A. argyi is burnt in China, with laboratory data only.

Live citrosa geraniums do not repel mosquitoes [VERIFY: a 1996 study seen only in secondary sources]. Maia and

Moore list pennyroyal (Mentha pulegium) and wormseed (Dysphania ambrosioides) as toxic and prohibited. Pennyroyal oil has killed people who swallowed it [VERIFY].

Smoke has a cost. One mosquito coil releases as much fine particulate matter as 75 to 137 cigarettes and as much formaldehyde as 51 (Liu et al. 2003, via The Conversation 2017). Leaves should be burnt at the door or under the eaves, not in the sleeping room [VERIFY: inference].

1.7 Livestock, Artemisia and neem

Cattle draw some Anopheles away from people only where the vector prefers animals and the animals are kept apart from sleeping quarters. Animals next to the house can increase malaria (Donnelly et al. 2015). An Ethiopian cohort found 17% less malaria among livestock owners (Asale et al. 2017). Keep pens away from houses and never bring animals into sleeping rooms at night.

Sweet wormwood (Artemisia annua, leaves and flowering tops) is the source of artemisinin. WHO advises against using the plant in any non-pharmaceutical form to treat or prevent malaria (WHO 2019). Tea delivers a small and variable fraction of a dose, and monotherapy breeds resistance. Lookalike: common wormwood (Artemisia absinthium), whose thujone can cause seizures.

Crushed neem seed scattered on pools twice a week in Banizoumbou, Niger, was followed by 49% fewer adult Anopheles gambiae than in earlier years, a weak design (MIT Eltahir group n.d.). A neem larvicide in Iran lasted no more than 7 days (Neemarin study n.d.). Neem oil is dangerous by mouth. Malaysian children given margosa oil developed a Reye-like illness with acidosis, seizures and coma, and some given 25 to 60 ml died, while 22 infants given drops to 5 ml recovered (Pediatric Oncall n.d., reviewing Sinniah and Baskaran 1981 and Lai et al.). Lookalike: Persian lilac (Melia azedarach), with twice-divided leaves and yellow fruit that persists on the bare tree. Its fruit kills children and livestock.

1.8 Pyrethrum

Dalmatian pyrethrum (Tanacetum cinerariifolium, dried flower heads) has been the plant insecticide of choice since the 19th century. Persian powder from the red-flowered T. coccineum came first, marketed in Vienna by Johann Zacherl, and the Dalmatian species replaced it from about the 1840s [VERIFY]. Flowers carry about 1.0 to 2.1% pyrethrins in Kenya and India and 0.5 to 1% in North Carolina trials (NC State n.d.) [VERIFY]. Kenya yields about 700 kg of dried flowers a hectare [VERIFY]. The plant flowers 5 to 6 months after planting, is picked every 14 days and replanted every four years [VERIFY].

Harvest and drying (KALRO n.d.): pick fully open heads by jerking them off between two fingers and the thumb, without stalks. Never pick wet flowers. Dry in thin layers in shade or at no more than 45 to 50°C. Never store in plastic bags, and use within about a month, as pyrethrins break down in storage and sunlight. Grind the dry heads to a fine powder.

The powder was dusted into clothing seams, bedding and onto people. It was the active ingredient of the US Army's MYL louse powder in 1942, which in two applications 14 days apart controlled lice in Egypt (NLM Profiles n.d.). Pyrethrins have low toxicity to mammals, but people allergic to ragweed may react, and the EPA found no clear link to asthma (EPA 2009). They are highly toxic to fish (96-hour LC50 of 24.6 to 114 µg per litre in a 1976 study, reported by NPIC n.d.) and dangerous to cats (VCA n.d.). Lookalikes are listed in section 8. A simple check is to dust a few flies in a jar and see whether they fall within minutes [VERIFY: my suggestion].

1.9 Month and season

In a month a household can mend nets, close its eaves, empty and scrub containers weekly, screen the rain tank and move animals away. A village can map and drain or fill small pools within a few hundred metres. A season is needed

to dig drains, screen windows, establish pyrethrum and neem, and build the weekly container routine.

2. Lice and typhus

2.1 The diseases

The body louse (Pediculus humanus humanus) lives and lays eggs in clothing seams and visits the skin to feed. It carries epidemic typhus (Rickettsia prowazekii), which kills about 15% of untreated patients and about 0.5% after a single 200 mg dose of doxycycline, on data from a Burundian prison outbreak (Niang et al. 1999). It carries louse-borne relapsing fever (Borrelia recurrentis), which killed about 6% of 991 untreated patients in a pooled review (10.2% of confirmed cases) and 3.3 to 4% of treated ones (Kahlig et al. 2021). MSF gives 15 to 40% untreated (MSF n.d., LBRF). The very high historical figures, such as 47% in a Nigerian prison, come from extreme settings (Kahlig et al. 2021). It also carries trench fever (Bartonella quintana), which disables more than it kills. Lice spread where people cannot change and wash clothes: war, prison, camps, famine, winter.

Off the body a louse dies within one to two days, and eggs hatch in 6 to 9 days (CDC n.d., body lice). Eggs in clothing may stay viable for about 16 days (Sangaré et al. 2016). Typhus is caught by rubbing infected louse faeces into scratches or breathing them in, not from the bite itself [VERIFY].

2.2 Heat kills lice

Sangaré, Doumbo and Raoult give 50°C as the critical laundering temperature and 52°C for 30 minutes as killing all stages, and warn that soap and water alone do not kill lice (Sangaré et al. 2016). Freezing at −17°C for 35 minutes killed lice and eggs, and all lice died within 19 hours under water (Mumcuoglu et al. 2006). CDC advises washing at no less than 54°C (130°F) and drying hot, or sealing unwashable items in a bag for two weeks, and changing clothes at least weekly. It says pediculicides are usually unnecessary (CDC n.d., body lice). Better Health Victoria says above 70°C, or iron the seams (Better Health Victoria n.d.). The sources differ on time sealed (two weeks in CDC guidance, up to four in some leaflets). The longer time covers late-hatching eggs.

2.3 Serbia 1915

In the winter of 1914 to 1915 typhus and relapsing fever killed an estimated 150,000 or more in Serbia, including perhaps a fifth or more of the country's doctors [VERIFY]. At Kragujevac the nurse Flora Sandes worked in a hospital of about 1,200 patients with two surgeons. William Hunter's British sanitary mission stopped trains, quarantined, and deloused people and clothes in railway vans fed with locomotive steam and in the Serbian barrel, a wine cask set over a cauldron of boiling water with clothes hung inside. The epidemic was over by June 1915 (Wikipedia, Serbia 1915, Wikipedia, Serbian barrel). I found no dimensions or steaming times for the barrel [VERIFY]. Protocol 2 gives a working version built on the temperatures above.

2.4 Warsaw 1941

The most hopeful story here comes from the Warsaw ghetto. About 400,000 to 450,000 people were shut into 3.4 square kilometres. There were 20,160 reported cases, but ghetto doctors estimated 80,000 to 110,000 infections and 20,000 to 25,000 deaths. The epidemic collapsed in late October 1941, before the winter peak typhus usually reaches. Stone and colleagues modelled about 196,000 infections without the change and credit the ghetto's own work: public lectures, hygiene courses, an underground medical school, soup kitchens, house committees and cleaning drives, with almost no soap or fuel (Stone et al. 2020).

2.5 Naples, Belsen and Weigl

In Naples in 1943 to 1944 over a million people were dusted with louse powder, more than 50,000 a day by 10 January 1944, and cases fell by late February (NLM Profiles n.d.). The first dusting used pyrethrum-based MYL

powder, and Roderick Bailey argues that DDT's role has been overstated (Bailey n.d.). At Bergen-Belsen in April 1945 about 13,000 of some 60,000 prisoners died after liberation despite delousing and care, because typhus came on top of starvation (British Legion n.d.) [VERIFY]. In Lwów, Rudolf Weigl made typhus vaccine from the guts of infected lice fed on human volunteers, each with up to 40 cages strapped on and feeding 25,000 lice a month (Teo 2015). Vaccinated feeders caught typhus but none died (Wikipedia, Louse-feeder). I found no efficacy figure. It needs a laboratory and is history, not method.

That lice destroyed Napoleon's army in 1812 is plausible but unsettled: a recent study of soldiers' teeth from Vilnius found paratyphoid and relapsing fever rather than typhus (ScienceAlert 2022).

2.6 Treatment and the Jarisch-Herxheimer reaction

For louse-borne relapsing fever MSF gives a single dose of doxycycline 200 mg for adults (4 mg/kg for children, maximum 100 mg), or erythromycin 500 mg (250 mg under 5 years), or azithromycin 500 mg (10 mg/kg), and says delousing is essential (MSF n.d., LBRF). Niang and colleagues give the same 200 mg single dose of doxycycline for typhus (Niang et al. 1999). The two sources agree on the adult dose. In 55.8% of treated relapsing fever patients the first dose set off a Jarisch-Herxheimer reaction: rigors, soaring fever and then falling blood pressure, which can kill. Adverse pregnancy outcomes affected 70.9% of pregnant patients (Kahlig et al. 2021). Watch the patient closely for the first hours after the dose, lying down, with fluids to hand [VERIFY timing]. Drugs belong to the antibiotics report (THRIVING library, IN-09).

2.7 Month and season

In a month a household can boil or hot-wash every garment and blanket, dry clothes in the sun, keep a spare set and inspect seams weekly. A village can build a steamer and run a delousing day. A season is needed to lay in fuel and spare clothing for weekly changes through winter, and to grow pyrethrum.

3. Fleas and plague

3.1 The disease

Plague (Yersinia pestis) lives in wild rodents and is carried to people mainly by the oriental rat flea, Xenopsylla cheopis. Bubonic plague kills 30 to 60% of untreated patients, or up to 100% by another WHO estimate. Pneumonic plague, spread by coughing, kills within 18 to 24 hours if not treated early. Incubation is one to seven days (WHO n.d., plague). In the Madagascar outbreak of 2017 there were 2,417 cases and 209 deaths (9%) between 1 August and 26 November, in 57 of 114 districts, and three quarters were pneumonic (WHO 2017). Without treatment pneumonic plague is close to universally fatal (EID 2020).

3.2 Fleas first, then rats

When rats die, their fleas leave the cooling bodies for new hosts, including people, so killing rats before fleas pushes fleas onto people. WHO says to control fleas before rodents (WHO n.d., plague). The Indian Plague Commission found that a rat die-off preceded human cases by about 10 to 14 days (Scientific American 1911), though not in every town. A pile of dead rats is the alarm.

In Madagascar the fleas have become resistant to insecticides. Xenopsylla cheopis was resistant to deltamethrin in 26 of 32 populations tested in 2014, and DDT resistance was described in 1965 (Miarinjara and Boyer 2016). Dusting burrows and floors was more effective than bait stations (PLoS NTD 2019) [VERIFY]. After the Fall, pyrethrum powder dusted into rat runs, burrow entrances and the floors and bedding of houses is the available flea control. Its efficacy against plague fleas in the field is not established [VERIFY].

3.3 What a household and village can do

Contacts of a pneumonic case need seven days of antibiotic prophylaxis (WHO n.d., plague), which requires a dispensary. Without drugs, a household can sleep off the floor, keep grain in rat-proof stores, dust floors and bedding with pyrethrum, keep cats and dogs off beds, and avoid handling dead animals. Dead rats are moved with a shovel and buried, and wild rodents are not skinned or eaten in a plague area. A village must report dead rats, dust before trapping and isolate the coughing sick. Handwashing is covered elsewhere (THRIVING library, HY-01).

4. Ticks

4.1 The diseases

Hard ticks (Ixodes) carry Lyme disease (Borrelia burgdorferi and related species), tick-borne encephalitis, anaplasmosis and babesiosis in the temperate north. Soft ticks (Ornithodoros) live in mud walls, thatch and animal burrows, feed for less than an hour at night, and carry tick-borne relapsing fever. Its death rate is about 4 to 10% untreated and under 2% treated, and a 2022 systematic review found an overall case fatality rate of 6.5% (DermNet n.d.) [VERIFY: the 2022 review was seen only in a search summary].

Lyme disease begins with a spreading red rash, erythema migrans, in 70 to 80% of cases [VERIFY]. Without treatment, about 10 to 20% of European patients develop nerve involvement such as facial palsy or meningitis [VERIFY].

4.2 Removal

CDC advice: grasp the tick with fine-tipped tweezers as close to the skin as possible, pull upward with steady, even pressure, and do not twist or jerk. Clean the bite and hands with alcohol or soap and water. Do not crush the tick with fingers, and do not use petroleum jelly, nail varnish or heat (CDC via PCT Online n.d.). Transmission of Lyme bacteria usually needs 36 to 48 hours or more of attachment, so a daily tick check is a strong control (CDC via PCT Online n.d.) [VERIFY]. Tick-borne encephalitis and Powassan virus pass much faster, within hours.

4.3 One dose of doxycycline

In a trial in New York State, one 200 mg dose of doxycycline within 72 hours of removing an Ixodes tick reduced erythema migrans from 3.2% to 0.4% (efficacy 87%, 95% CI 25 to 98%). Side effects, mainly nausea, affected 30% against 11% on placebo. Bites by nymphs that had fed long enough to swell led to erythema migrans in 5.6% (Nadelman et al. 2001). Niang and colleagues and MSF use the same 200 mg adult dose for typhus and louse-borne relapsing fever, so a district can stock one strength of tablet for three diseases [VERIFY: my inference].

4.4 Month and season

In a month a household can check every person, child and dog every evening in tick season, tuck trousers into socks, keep paths mown and wear light clothes that show ticks. A season is needed to clear brush and leaf litter around houses, to keep deer and rodents away from gardens, and to plaster mud walls and replace thatch where soft ticks live.

5. Flies

5.1 The diseases

The house fly (Musca domestica) carries the germs of diarrhoea and dysentery on its feet and in its vomit from faeces to food. The bush fly (Musca sorbens) feeds on the eyes of children and spreads trachoma, the leading infectious cause of blindness. Fly control is therefore mostly faeces control.

5.2 Biology and labour

House flies go from egg to adult in 7 to 10 days in summer and up to two months in cool weather. Larvae need moist organic matter at 50 to 85% moisture, such as manure, rubbish and faeces. Most flies stay within about a mile of where they bred, though some fly 7 km (Envu n.d.) [VERIFY]. Covering or drying out breeding material within a week breaks the cycle.

5.3 The evidence

The Cochrane review of fly control for diarrhoea found only one usable trial, from Peshawar in Pakistan. Insecticide spraying in six villages against two control villages cut childhood diarrhoea by 23% (rate ratio 0.77, 0.67 to 0.89), but only in the fly season, and baited traps the following year had no effect. The review graded the evidence low certainty (Das et al. 2018, describing Chavasse et al. 1999).

In The Gambia, insecticide spraying cut flies by 75%, fly contact with children's eyes by more than 95%, and new trachoma cases by 75% (rate ratio 0.25, 0.09 to 0.64), but spraying was not sustainable (CEH Journal n.d., describing Emerson et al. 1999). A later trial found that latrines reduced trachoma by about 30%, not significantly, because M. sorbens breeds in faeces lying on the ground, not in pit latrines (CEH Journal n.d., describing Emerson et al. 2004) [VERIFY]. Latrines that end open defecation remove the bush fly's breeding ground.

On Israeli military bases, fly control with bait and traps in a crossover study cut flies by 64%, clinic visits for shigellosis by 85%, Shigella infection measured by blood test by 76% and ETEC infection by 57%. Diarrhoea overall fell by 42%, not significantly (Cohen et al. 1991).

5.4 The ventilated pit latrine

The ventilated improved pit (VIP) latrine was developed at the Blair Research Laboratory in Zimbabwe by Peter Morgan in the 1970s. Air is drawn down the squat hole and up a vent pipe, and flies from the pit, drawn to the light at the top of the pipe, are trapped by its screen. Early counts found about 179 flies a day escaping an unvented pit against 2 a day from a vented one (Morgan, via SuSanA n.d.) [VERIFY]. An unvented pit can release up to 140,000 flies a year [VERIFY]. The vent pipe should be 110 to 150 mm across, rise at least 30 to 50 cm above the roof, stand straight, face the sun and carry a corrosion-resistant fly screen with 1 to 1.5 mm openings. The interior must be dark (Tilley et al. 2014). Design details belong elsewhere (THRIVING library, HY-04).

5.5 Month and season

In a month a household can cover food and water, cover or bury faeces and manure, keep a lid on the latrine and build a simple trap. A village can move manure heaps away from houses and compost them hot or cover them with earth. A season is needed to build VIP latrines for every household and to get every family to use them.

6. Rats

6.1 Why rats matter

Rats carry plague fleas, leptospirosis in their urine, Lassa fever, hantaviruses, rat-bite fever and murine typhus, about 50 diseases in all by the FAO's count. They also eat and foul stored food. A rat eats about 7% of its body weight a day, given as about 25 g a day or 6.5 kg a year (FAO n.d., rodent manual). A black rat (Rattus rattus) has six to eight litters a year of four to twelve young.

6.2 What rats can do

The black rat climbs well and jumps up to 1 metre. The brown or Norway rat (Rattus norvegicus) jumps about 60 cm and swims. Both squeeze through a 12 mm gap. A house mouse jumps about 30 cm and passes 6 mm (FAO n.d.,

rodent manual). Rat-proofing therefore means gaps under 6 to 12 mm, guards more than a metre high, and clear ground around stores.

6.3 Stored grain

The FAO manual advises keeping a metre of clear space around stacks, using pallets, keeping vegetation short and removing rubbish (FAO n.d., rodent manual). A raised granary on four to six legs more than a metre high, with an inverted metal cone or a band of smooth tin on each leg at knee height, keeps rats out (Tearfund n.d., read only through a search summary) [VERIFY]. Ladders must be removed after use, and no branch, wall or roof may come within jumping distance.

6.4 Community trapping and ecologically based rodent management

Intensive daily trapping by whole communities, with better hygiene, cut household losses of stored rice from 2.5% to 0.5% in Bangladesh and from 17% to 5% in Myanmar (Wildlife Research 2015) [VERIFY authors]. In rice fields, ecologically based rodent management (coordinated timing of planting, cleaning field edges, community trapping and trap barriers) raised rice yields by about 6% and trap barrier systems by about 20% [VERIFY].

6.5 Cats

Cats are poor rat killers. In a Brooklyn waste centre, cats killed only two or three rats over about five months, and the rats changed their behaviour, hiding and moving less, rather than their numbers (Parsons et al. 2018). They may keep mice down but will not clear rats.

6.6 Month and season

In a month a household can lift grain off the floor into sealed pots or tins, block holes under 12 mm, clear rubbish and long grass from around the house and set traps nightly. A village in a month can organise a trapping campaign with every house trapping on the same nights. A season is needed to build raised granaries with rat guards and to replace mud or thatch walls that rats burrow through.

7. Bed bugs and scabies

7.1 Bed bugs

Bed bugs (Cimex lectularius and C. hemipterus) cause itching, sleeplessness and secondary infection, but a systematic review found no proven transmission of human disease (Lai et al. 2016). They hide in bed frames, mattress seams and wall cracks.

Heat kills them. In laboratory tests, adults died at 48.3°C and eggs at 54.8°C (the temperature that killed 99% in brief exposure). At 45°C adults needed 94.8 minutes and eggs survived 7 hours. At 48°C eggs died in 71.5 minutes (Kells and Goblirsch 2011). A small household can heat bedding and clothing to 55 to 60°C by hot washing or by laying them in a black bag in full summer sun, if a thermometer confirms the temperature at the centre [VERIFY: sun bagging is my inference]. Bed frames can be scalded with boiling water and their cracks filled.

Diatomaceous earth, a powder of fossil algae, kills over 90% of bed bugs in four days and all in ten days if they walk through it continuously, but brief contact fails (PCT Online 2013) [VERIFY].

7.2 Scabies

Scabies is a mite (Sarcoptes scabiei) that burrows in skin. The itching opens the skin to streptococcal impetigo, which can lead to kidney damage and rheumatic fever. It spreads by close contact and shared bedding. Crusted scabies, in the old, malnourished and immune-suppressed, carries thousands of mites and spreads through a ward.

The strongest community result is from Fiji. Mass treatment with ivermectin cut scabies in whole island communities from 32.1% to 1.9% in a year (94% fewer). Permethrin cream to everyone cut it from 41.7% to 15.8%, and standard care from 36.6% to 18.8%. Impetigo in the ivermectin arm fell from 24.6% to 8.0% (Romani et al. 2015). Ivermectin needs a dispensary.

The village remedies are sulphur and benzyl benzoate.

- Sulphur ointment. In a 420-patient trial, 10% sulphur in petroleum jelly cured 45.2% at two weeks and 59.5% at four weeks after a repeat course. Ivermectin did as well at two weeks and better at four (drugs.com n.d.). A Thai trial in children found sulphur as good as lindane [VERIFY]. Strengths of 5 to 10% are used in infants and pregnancy, and some guidance gives 6 to 33% for adults [VERIFY]. It is safe in pregnancy and infancy, but smelly and staining.
- Benzyl benzoate. The 25% preparation was withdrawn in the European Union because of neurotoxicity concerns, and French guidance uses 10% in pregnancy, applied once to the whole body below the head (BMC Infectious Diseases 2015, SFD n.d.) [VERIFY]. The two sources differ in strength by a factor of 2.5, so the lower strength is the safe default in pregnancy and childhood.
- Neem and turmeric. A paste of neem leaves (Azadirachta indica) and turmeric (Curcuma longa) in a ratio of 4 to 1 cured 97% of 814 people in 3 to 15 days in an uncontrolled study (Charles and Charles 1992).

MSF guidance: treat every member of the household and close contacts at the same time, whether or not they itch. Wash clothes and bedding at 60°C or more and sun-dry them, or leave them in sunlight for 72 hours, or sealed in a bag for 72 hours. Treatment has failed if typical burrows remain after four weeks (MSF n.d., scabies). Crusted scabies needs ivermectin plus a topical treatment weekly (MSF n.d., scabies).

7.3 Month and season

Scabies and bed bugs can both be dealt with in a month: one treatment round for the whole household and contacts, repeated after 7 days, and hot washing or sealing of all bedding. Keeping them away takes a season of routine: a sulphur stock in the dispensary, isolation of new arrivals' bedding, and inspection of guest beds.

8. Plant insecticides and repellents

Only one plant here kills insects reliably on contact: dried, ground pyrethrum flowers. Leaf smoke drives mosquitoes off at 65 to 85% while it burns, and diluted oils protect skin for 1 to 4 hours (Maia and Moore 2011). None of these is a malaria control on its own.

Plant	Part used	Use	Dangerous lookalike or misuse
Tanacetum cinerariifolium (pyrethrum)	dried flower heads	powder against lice, fleas, bed bugs	ox-eye daisy, feverfew (no pyrethrin)
Azadirachta indica (neem)	leaves, seed	smoke, larvicide, scabies paste	Melia azedarach (Persian lilac), poisonous fruit. Neem oil by mouth kills children
Corymbia citriodora (lemon eucalyptus)	leaves	smoke, rub	other eucalyptus oils, toxic if swallowed [VERIFY]
Cymbopogon nardus, C. winterianus (citronella)	leaves	rub at 2% or less	lemongrass, safe only at 0.1%

Plant	Part used	Use	Dangerous lookalike or misuse
Ocimum americanum, O. forskolei (basil)	fresh leaves	smoke, hung indoors	none found
Hyptis suaveolens	leaves	smoke	none found
Thymus vulgaris (thyme)	leaves	smoke	none found
Artemisia vulgaris, A. argyi (mugwort)	leaves	smoke	A. absinthium (wormwood), seizures
Artemisia annua (sweet wormwood)	leaves	not for malaria (WHO 2019)	A. absinthium
Curcuma longa (turmeric)	rhizome	scabies paste with neem	none found
Mentha pulegium (pennyroyal), Dysphania ambrosioides (wormseed)	none	do not use	toxic (Maia and Moore 2011)

9. A seasonal village plan

For a village of 300 in a warm climate the work falls into a calendar [VERIFY: my planning, not a tested scheme].

- Before the warm season, one month: mend and count nets, close every eave, map and drain or fill pools within about 500 metres, screen rain tanks, move animal pens away from houses (Protocol 1).
- Every week in the warm season: container day (Protocol 3), pyrethrum picking every 14 days, manure covered, latrine lids closed, evening tick checks (Protocol 4).
- At harvest: grain into guarded granaries (Protocol 7) and community rat trapping on the same nights.
- In winter: a clean change of clothes and hot wash every week, seams inspected, the steamer ready with fuel set aside (Protocol 2), and a whole-village scabies round if cases appear (Protocol 6).
- To establish over at least one season: a pyrethrum bed, neem or eucalyptus trees, a VIP latrine for every household, drains and screened windows. ## Evidence grades

A = randomised trials or systematic reviews. B = observational or clinical series, including the pre-antibiotic record. C = convergent traditional use with plausible pharmacology. D = a single tradition or anecdote. X = ineffective or harmful.

- Insecticide-treated nets: A (Pryce et al. 2018).
- Untreated intact nets: B (A for treated against untreated) (Clarke et al. 2001, Pryce et al. 2018).
- House screening and closed eaves: A for fewer mosquitoes and less anaemia, B for less infection (Kirby et al. 2009, Fox et al. 2022, Tusting et al. 2015).
- Larval source management where sites are few and fixed: A (Tusting et al. 2013).
- Larval source management of large swamps and rice fields: X (Tusting et al. 2013).
- Weekly container emptying against Aedes: A (Andersson et al. 2015).
- Larva-eating fish: X as malaria control (Walshe et al. 2017).
- Topical plant repellents against bites: A for bites, inconclusive for malaria (Maia et al. 2018, Maia and Moore 2011).
- Burning repellent leaves: C (Maia and Moore 2011).
- Live potted repellent plants: X (Maia and Moore 2011).
- Artemisia annua tea for malaria: X (WHO 2019).
- Neem seed in pools: D (MIT Eltahir group n.d.).
- Neem oil by mouth: X (Pediatric Oncall n.d.).

- Pyrethrum flower powder against lice and fleas: B (NLM Profiles n.d.).
- Hot washing, steaming and clothes change against lice: B (Sangaré et al. 2016, Stone et al. 2020).
- Single-dose doxycycline for typhus and relapsing fever: B (Niang et al. 1999, Kahlig et al. 2021).
- Fleas before rats in plague: B (WHO n.d., plague).
- Daily tick checks and correct removal: B (CDC via PCT Online n.d.).
- Doxycycline 200 mg after an Ixodes bite: A (Nadelman et al. 2001).
- Insecticide fly control against diarrhoea: A, low certainty (Das et al. 2018).
- Fly control against trachoma: A, not sustained (CEH Journal n.d.).
- VIP latrine against flies: B (Morgan, via SuSanA n.d.).
- Community rat trapping for stored grain: B (Wildlife Research 2015).
- Cats against rats: X (Parsons et al. 2018).
- Heat against bed bugs: B (laboratory) (Kells and Goblirsch 2011).
- Ivermectin mass treatment for scabies: A (Romani et al. 2015).
- Sulphur ointment for scabies: A (drugs.com n.d.).
- Neem and turmeric paste for scabies: D (Charles and Charles 1992).
- Mosquito coils and indoor smoke: X for lungs (Liu et al. 2003, via The Conversation 2017).

Means ledger

- Hands: Mend nets, close eaves with mud, empty and scrub containers, check for ticks, remove ticks with a thread loop close to the skin, comb lice, cover food, bury faeces, block rat holes, set snap traps.
- Hearth: Boil and hot-wash clothes, iron seams, steam bedding, scald bed frames, dry pyrethrum flowers, burn repellent leaves at the door, heat-test with a thermometer if one exists.
- Garden and still: Grow pyrethrum, neem, lemon eucalyptus, citronella, basil and turmeric. Make sulphur ointment in fat if sulphur can be had. Distilling essential oils is possible but adds little over burning leaves.
- Village dispensary (300): A delousing barrel and a rota, a container-inspection team, pyrethrum store, sulphur ointment, tweezers, a thermometer, raised granaries, a VIP latrine programme, records of fever and dead rats. Doxycycline if any remains.
- District infirmary (3,000): A steam disinfestation room, drainage gangs, screening workshop, plague isolation, Jarisch-Herxheimer monitoring, blood films for malaria if a microscope and stain exist, ivermectin and permethrin if any remain.
- Hospital before the Fall: Treated nets, residual spraying, rapid tests, artemisinin combinations, ivermectin mass treatment, yellow fever and tick-borne encephalitis vaccines.

Harm test

- Paris green and other arsenicals poison people, livestock and fish. Do not use them.
- Oil on water spoils drinking water and kills aquatic life. Use only on drains and puddles.
- Neem oil by mouth or nose has killed children (Pediatric Oncall n.d.). Persian lilac fruit, mistaken for neem, kills children and livestock.
- Pennyroyal and wormseed are toxic (Maia and Moore 2011). Wormwood (Artemisia absinthium) causes seizures.
- Pyrethrum kills fish, bees and cats, and causes allergy in some people sensitive to ragweed (EPA 2009, NPIC n.d., VCA n.d.).
- Smoke from coils or leaves indoors harms lungs, especially children's (Liu et al. 2003, via The Conversation 2017).
- Doxycycline causes nausea in about 30% and should be taken with food and water, upright [VERIFY]. It stains growing teeth after repeated courses [VERIFY: a single course is now considered safe in children by many guidelines].

- Antibiotics for relapsing fever can set off a Jarisch-Herxheimer reaction in over half of patients (Kahlig et al. 2021).
- Benzyl benzoate 25% is neurotoxic in infants (BMC Infectious Diseases 2015).
- Cattle kept next to houses can increase malaria (Donnelly et al. 2015).
- Killing rats before fleas during a plague die-off drives fleas onto people (WHO n.d., plague).

Red flags

- Fever with confusion, convulsions, inability to drink or jaundice in a malaria area. This may be severe malaria and needs the infirmary now. Honest comfort: most fevers in children are not severe malaria, and a child who is alert, drinking and playing between fever spikes is usually not in danger that day.
- Fever, headache and a rash beginning on the trunk in a lousy person. Typhus. Honest comfort: one dose of doxycycline cuts the death rate from about 15% to under 1% (Niang et al. 1999).
- Recurring fevers about a week apart in a lousy person. Relapsing fever. Watch the first hours after treatment for collapse.
- A painful, swollen lymph node with high fever after dead rats appear. Bubonic plague. A cough with bloody sputum in a contact means pneumonic plague and isolation. Honest comfort: treated early, most patients survive (WHO 2017).
- A spreading red ring days to weeks after a tick bite, or a drooping face. Lyme disease. Honest comfort: most tick bites transmit nothing, and an early rash responds well to treatment.
- Night itching in several family members. Scabies. Honest comfort: it is a nuisance, not a danger, if skin infection is treated.

The case against

- Packard and Gadelha (1997) argue that the Brazilian eradication story overstated the role of the campaign and understated famine, and that it was used to sell expensive vertical programmes. A village should not expect one tool to end malaria.
- Kitchens (2013) argues that the TVA's dams increased malaria, so its control work partly cleaned up its own damage.
- Bailey (n.d.) argues that the Naples outbreak was already turning when DDT dusting began, and that MYL pyrethrum powder came first.
- The Cochrane reviews found no proof that fish (Walshe et al. 2017), repellents (Maia et al. 2018) or fly control without sustained effort (Das et al. 2018) prevent disease. Screening reduced anaemia but not parasite prevalence in the Gambian trial (Kirby et al. 2009).
- Sangaré et al. (2016), the source of the heat thresholds for lice, is under an expression of concern. The thresholds agree with CDC and Mumcuoglu et al. (2006).
- Every success here needed sustained labour, from Panama's thousands of workers to Camino Verde's street volunteers. A starving village may not keep up weekly inspections.

10-line summary

1. Whole nets, even untreated, cut malaria infection in children by about half.
2. Closing eaves and screening houses halves indoor Anopheles and cuts child anaemia.
3. Draining small, fixed pools works. Larviciding big swamps does not.
4. Emptying and scrubbing water containers every week cut dengue infection by 30%.
5. Lice die at 50 to 55°C. Weekly hot washing and a clean change of clothes prevent typhus.
6. Warsaw stopped a typhus epidemic of about 100,000 infections with hygiene and education.
7. In plague, kill fleas before rats.

8. Check for ticks daily and pull them straight out. Lyme transmission usually takes over a day.
9. Ventilated pit latrines and covered faeces beat fly traps and sprays.
10. Grow pyrethrum, store grain off the ground, treat scabies in whole households, and do not trust cats.

Open questions

- Can untreated nets and screens be made, kept whole and replaced in a village without factory netting? What local fabric works?
- How effective is home-grown pyrethrum powder against plague fleas, bed bugs and mosquitoes indoors? No field data were found.
- What are the dimensions and steaming times of the Serbian barrel, and how many people did one barrel serve per day?
- What was the protective efficacy of the Weigl vaccine?
- What rat-guard dimensions does the FAO recommend? The Tearfund and FAO pages were not readable.

Sources to read in full

- Kirby et al. (2009), the Gambian screening trial, for construction details.
- Rozendaal (1997), Vector control: methods for use by individuals and communities, WHO. Blocked (403) on 10 October 2026. It is the best single field manual and should be printed.
- Le Prince and Orenstein (1916), Mosquito control in Panama, for the ditch, oil and clearing rules.
- Kahlig et al. (2021) on relapsing fever and the Jarisch-Herxheimer reaction.
- FAO rodent manual (FAO n.d.) and the Tearfund granary design.

At the bedside after the Fall

A feverish child in a malaria area: keep the child under a whole net, give fluids, cool with water, and send to the infirmary if the child cannot drink, convulses, is drowsy or yellow. A feverish adult covered in lice: strip, bag or boil the clothes, wash the body, dress in clean clothes, and give one 200 mg dose of doxycycline if available, then keep the patient lying down and watched for at least the next few hours. A tick bite: remove the tick, mark the date, and watch the bite for a month. A household with scabies: treat everyone the same night, wash or seal the bedding, and treat again in a week. A dead rat in the house: do not touch it with bare hands, dust floors and bedding with pyrethrum first, then bury the rat, and tell the dispensary.

Protocols

Protocol 1. Net and eave check (each house, before the warm season, then monthly)

☐ One net per sleeping place, long enough to tuck under the mattress all round.
☐ Hold the net to the light. Any hole larger than a fingertip is darned or patched the same day.
☐ Mesh at least about 156 holes per square inch, openings no wider than about 1.5 mm [VERIFY].
☐ Net down before dusk, tucked in, every night.
☐ Gap between wall and roof closed with mud, wood or cloth, all round the house.
☐ Doors fit closely. Windows screened or shuttered at night.

Protocol 2. Delousing (household and village)

Household: - [ ] Remove all clothing and bedding of every person in the house on the same day. - [ ] Wash at no less than 54°C, better 60°C, for at least 30 minutes, or boil for 5 minutes (CDC n.d., body lice, Sangaré et al. 2016). - [ ] Dry in the sun or hot, then iron the seams if an iron exists. - [ ] What cannot be washed goes into a sealed bag for

two weeks, four to be safe. - [ ] Wash the body with soap and water. Comb hair. - [ ] Repeat weekly for at least three weeks, to catch eggs hatching in 6 to 9 days.

Village steamer (Serbian-type barrel), my own working version [VERIFY]: - [ ] A tight wooden cask or metal drum with a perforated false floor set over a cauldron of boiling water, with a heavy lid. - [ ] Clothes hung loosely, not packed. - [ ] Steam for at least 30 minutes after steam escapes freely at the lid, aiming at 100°C throughout (First World War trials gave 30 to 45 minutes for packed bundles, seen only in secondary sources). - [ ] Check with a thermometer at the centre of a bundle if one exists. The minimum is 55°C held for 30 minutes. - [ ] People wash while their clothes steam. They put on only steamed clothes. - [ ] Dust seams with dried pyrethrum powder if available.

Protocol 3. Container day (weekly, every household, warm season)

- ☐ Walk round house and yard. Count every container that holds water.
- ☐ Empty it. Scrub the inside walls with a brush to remove eggs at the waterline.
- ☐ Turn empty containers upside down or put them under cover.
- ☐ Cover stored water with a tight lid or cloth. Screen rain tanks (THRIVING library, HY-02).
- ☐ Clear gutters. Fill tree holes with sand.
- ☐ Two volunteers check 10 houses each in rotation and record houses with larvae.

Protocol 4. Tick check and removal

- ☐ Every evening in tick season, check the whole body of each person, especially the scalp, behind the ears, armpits, groin and backs of knees. Check dogs.
- ☐ Grasp the tick with fine tweezers or a thread loop as close to the skin as possible.
- ☐ Pull straight out with steady pressure. Do not twist, squeeze, burn or smother it.
- ☐ Clean the bite with soap and water or alcohol.
- ☐ Write the date. Watch the bite for 30 days.
- ☐ If an Ixodes tick was attached for over 36 hours and doxycycline exists, one 200 mg dose within 72 hours for adults (Nadelman et al. 2001).

Protocol 5. Plague alert

- ☐ Dead rats reported to the dispensary the same day.
- ☐ Dust floors, bedding, rat runs and burrow mouths with pyrethrum powder first.
- ☐ Only after 2 to 3 days of dusting, trap rats and bury them deep [VERIFY interval].
- ☐ Patients with a cough isolated, carers masked with folded cloth.
- ☐ Contacts of pneumonic cases given 7 days of prophylaxis if drugs exist (WHO n.d., plague).

Protocol 6. Scabies round with sulphur ointment

- ☐ Ointment: 10 parts precipitated sulphur to 90 parts petroleum jelly or clean lard, mixed until smooth, for adults. For infants and pregnant women, 5 to 6 parts to 94 to 95 [VERIFY: drugs.com and guidance differ, 5 to 10% in infants].
- ☐ Every member of the household and close contacts treated on the same night.
- ☐ Apply from neck to toes after a bath, including under nails, between fingers and in skin folds. Include the scalp and face in infants.
- ☐ Leave on and reapply each night for three nights. Wash off 24 hours after the last application [VERIFY regimen].
- ☐ Wash clothes and bedding at 60°C or more, or seal them in bags for 72 hours (MSF n.d., scabies).
- ☐ Repeat the course after 7 days. Failure if burrows remain at four weeks.

Protocol 7. Rat-proof grain store

- ☐ Granary on four to six legs, floor more than 1 metre above ground (Tearfund n.d.) [VERIFY].
- ☐ A smooth metal collar or inverted cone on each leg, at least 30 cm wide [VERIFY].
- ☐ No branch, wall or roof within 1 metre (FAO n.d., rodent manual).
- ☐ No gap over 6 mm in walls or door.
- ☐ One metre of clear, swept ground all round. Short grass. No rubbish.
- ☐ Ladder removed after use.

Numbers to carry

- 17%: fewer child deaths with treated nets (Pryce et al. 2018).
- 51%: protection from an intact untreated net (Clarke et al. 2001).
- 3.9% against 92.2%: malaria in screened against unscreened railway houses, 1900 (Ferroni et al. 2012).
- 0.41: indoor Anopheles with full house screening, as a fraction of unscreened (Kirby et al. 2009).
- 7 to 10 days: Aedes egg to adult. Empty containers every week.
- 29.5%: less dengue infection from container clean-up (Andersson et al. 2015).
- 50 to 55°C for 30 minutes kills lice and eggs. 1 to 2 days: louse survival off the body.
- 15% to 0.5%: typhus deaths untreated and after one dose of doxycycline (Niang et al. 1999).
- 200 mg: one dose of doxycycline for typhus, relapsing fever and tick bite prophylaxis in adults.
- 55.8%: Jarisch-Herxheimer reactions after treating relapsing fever (Kahlig et al. 2021).
- 30 to 60%: deaths in untreated bubonic plague (WHO n.d., plague). Fleas first, then rats.
- 12 mm: the gap a rat passes. 6 mm: a mouse. 1 m: a black rat's jump.
- 48.3°C and 54.8°C: bed bug adults and eggs killed (Kells and Goblirsch 2011).
- 32.1% to 1.9%: scabies after ivermectin mass treatment in Fiji (Romani et al. 2015).

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All accessed 10 October 2026. "Abstract only" means I read the abstract or a search summary of it. "Secondary" means I read another source's account, not the work itself. "Read" means I read the main text or its summary-of-findings tables.

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