Pulex irritans
human flea

By Jordan Wyrwa

Geographic Range

Pulex irritans has been found all over the world except for the Arctic. This species likely originated in Central or South America, but thrives in temperate climates. (Buckland and Sadler, 1989)

Biogeographic Regions: nearctic (introduced) ; palearctic (introduced) ; oriental (introduced) ; ethiopian (introduced) ; neotropical (native) ; australian (introduced) ; oceanic islands (introduced)

Other Geographic Terms: cosmopolitan

Habitat

Classification

Kingdom
Animalia
animals

Class
Insecta
insects

Order

Siphonaptera

Family
Pulicidae

Genus
Pulex

Species
Pulex irritans
human flea

As a nidicolous ectoparasite, an adult *P. irritans* is found on its hosts exterior when it needs to feed. Hosts for this species are generally mammals, and are primarily larger carnivores, including humans. When not feeding, *P. irritans* can be found in nests of host animals or nearly anywhere within a human house. This species has a cosmopolitan distribution, so its habitat varies extensively depending on geographic location. Eggs, larvae and pupae are usually also found in the immediate habitat of the host, if not on the host. Eggs almost always fall off the host, so pupae are also found in the host's habitat. (Buckland and Sadler, 1989; Roberts and Janovy, 2009; Theobald, 1892)

Habitat Regions: temperate ; tropical ; terrestrial

Terrestrial Biomes: tundra ; taiga ; desert or dune ; savanna or grassland ; chaparral ; forest ; rainforest ; scrub forest ; mountains

Other Habitat Features: urban ; suburban ; agricultural

Physical Description

All fleas have the same general morphology with some minor exceptions in various species. An adult *Pulex irritans* is reddish-brown in color, with females being 2.5 to 3.5 mm long and males being 2 to 2.5 mm long. The body is laterally compressed and wingless. The abdomen and thorax (nearly continuous) are much larger than the head. The head itself is very short and house a small pair of antennae which are found in small grooves posterior to the ocelli. The antennae have five segments each. *Pulex irritans* is telmophagus, thus the mouthparts are specialized for piercing and sucking. Unlike most fleas, this species does not have genal or pronotal ctenidia.

All fleas have three pairs of legs, each one with five segments (not including the five tarsal seg-

ments). The coxae are greatly enlarged and are the source of fleas' impressive jumping due to a protein called resilin. Pretarsal claws are present on *P. irritans*.

The abdomen is subdivided into ten segments. Setae are found on the tergites (dorsal sclerites). The pygidium is a small, circular depression found on the ninth abdominal tergite that functions as a sense organ. The most posterior portions of the abdomen house reproductive organs and genitalia. Females have a sperm-storing structure called the spermatheca. The male genitalia is known as the aedeagus and is arguably the most complex genitalia in the animal kingdom. Males also have two stylets to hold and position the female during copulation.

Pulex irritans eggs are oval and white in color.

All flea larvae resemble maggots with neither legs nor eyes. They are opaque-white colored, have several setae and are extremely active. The head has some sclerotization and is darker than the rest of the body. The most posterior segment has two small, brown hooks.

Pulex irritans pupae are surrounded by a silken, sticky cocoon which easily picks up debris which aids in camouflage. (Buckland and Sadler, 1989; Chandler, 1922; Roberts and Janovy, 2009; Theobald, 1892)

> **Other Physical Features:** ectothermic ; bilateral symmetry
>
> **Sexual Dimorphism:** female larger

Range length

2 to 3.5 mm

0.08 to 0.14 in

Development

Like all fleas, *P. irritans* is holometabolous (complete metamorphosis, egg-larva-pupa-adult). Eggs hatch in four to six days. The larvae molt three times and then pupate approximately eleven days post-copulation. The length of the larval stage depends on temperature and humidity and ranges from a single day to several months. (Chandler, 1922; Kellogg, 1908; Kelly, et al., 2009)

Development - Life Cycle: metamorphosis

Reproduction

Currently there are no known mating rituals, mate selection or mate defenses exhibited by *Pulex irritans*. Like most fleas, *Pulex irritans* mate opportunistically and are polygynandrous. When two fleas each other, a male will use his maxillary palps to determine if he has encountered a female. (Smit, 1958; Whiting, et al., 2008)

Mating System: polygynandrous (promiscuous)

When a male *Pulex irritans* comes into contact with a female, the male's maxillary palps touch the female, and the male's antennae become erect. The male will then move behind the female and stand on his head. While the male is grasping the female with his antennae, he lifts his abdomen and extends his aedeagus into the female's spermatheca. Insemination can be as short as a few seconds, but typically takes more time. The female will later haphazardly lay between eight and twelve eggs individually. The eggs hatch about four to six days later. The larvae pupate approximately eleven days post-copulation, and emerge from their cocoons to become adults the following day. (Chan-

dler, 1922; Kellogg, 1908; Mullen and Durden, 2009; Theobald, 1892)

> **Key Reproductive Features:** semelparous ; year-round breeding ; gonochoric/gonochoristic/dioecious (sexes separate) ; sexual ; fertilization (internal) ; oviparous

Breeding interval	Breeding season	Range gestation period
The breeding interval for *Pulex irritans* is unknown.	*Pulex irritans* may breed year round.	4 to 6 days

After females oviposit, *Pulex irritans* exhibits little parental investment. A significant contribution to a larva's diet is dropped feces from adults. (Chandler, 1922; Kelly, et al., 2009)

> **Parental Investment:** no parental involvement

Lifespan/Longevity

An adult *P. irritans* can live for a few weeks to over a year. A significant portion of the overall lifespan of a single *P. irritans* can come from the pupal stage, which can last from one day to many months. The egg and larval stage are much shorter in comparison. Therefore, from egg to adult, one *P. irritans* could live to over two years. (Chandler, 1922; Kellogg, 1908; Kelly, et al., 2009)

Range lifespan
Status: wild
>2 (high) years

Behavior

Pulex irritans has three pairs of legs used primarily for walking or running, but has extensive jumping abilities for escaping or getting onto a host. The enlarged coxae contain a highly elastic protein named resilin which is the primary reason for this ability. To jump, the flea will first lock their coxae back, compressing the resilin bands. The jump begins when the tergo-trochanteral depressor muscle relaxes, releasing the coxae. The resilin rapidly expands and causes the flea to summersault through the air at approximately 200 times gravitational acceleration. Jumping fleas can move more than 30 cm in about 0.02 seconds. The pretarsal claws on the middle or hind legs catch onto the host or substrate. Jumps can be made in rapid succession. Oriental rat fleas have been known to make up to 600 jumps per hour for 72 hours straight.

Pulex irritans are usually found in small colonies or groups. They will move onto the host to feed, but are primarily found around the host's immediate habitat. (Buckland and Sadler, 1989; Chandler, 1922; Mullen and Durden, 2009; Theobald, 1892)

> **Key Behaviors:** saltatorial ; parasite ; motile

Home Range

Specific home range size for *Pulex irritans* is currently unknown, however most fleas spend their lives on or around a suitable host.

Communication and Perception

Pulex irritans depends mainly on its ocelli and pygidial sensilla or pygidium to find a host. The ocelli can detect changes in light. The pygidium can detect carbon dioxide, air currents and certain odors. *Pulex irritans* can also sense vibrations.

When looking for a mate, a male will use his maxillary palps to determine if he has encountered a female. (Barrett and Brophy, 2008; Mullen and Durden, 2009; Whiting, et al., 2008)

> **Perception Channels:** visual ; tactile ; vibrations ; chemical

Food Habits

Adult *P. irritans* require blood meals in order to produce offspring. They will feed on most any mammal (including humans), but they most commonly parasitize domestic dogs and *domestic pigs*. Larvae feed on various organic matter found within their habitat, including feces from the adult fleas as it contains undigested blood. (Buckland and Sadler, 1989; Chandler, 1922; Mullen and Durden, 2009)

> **Primary Diet:** carnivore (sanguivore)
>
> **Animal Foods:** blood

Predation

While not directly preying on fleas, many hosts have grooming mechanisms to remove these parasites.

Mesostigmatid mites, pseudoscorpions and various ants, beetles and other arthropods found in the hosts' habitats eat *P. irritans*. Specifically, black fungus beetles are known to prey upon this species. Eggs, larvae and pupae are especially vulnerable. ("Integrated Pest Management Manual-Fleas", 2010; Mullen and Durden, 2009)

Known Predators

- black fungus beetles (*Alphitobius laevigatus*)
- mites (Mesostigmata)

- pseudoscorpions (Pseudoscorpionida)
- ants (Formicidae)
- beetles (Coleoptera)

Ecosystem Roles

Pulex irritans is a parasitic species that uses a wide array of hosts, mostly in Mammalia and some in Aves. Since they feed on blood, excessive bites from this species can lead to anemia in the host.

Pulex irritans also serves as a vector for various pathogens including plague-causing bacteria (*Yersinia pestis*), bacteria causing murine typhus (*Rickettsia typhi*), bacteria causing feline spotted-fever (*Rickettsia felis*), protozoa (*Nosema pulicis*), parasitic nematodes (*Steinernema carpocapsae*), and pteromalid wasps (*Bairamlia fuscipes*).

Yersinia pestis can actually lead to the death of the flea. An adult *P. irritans* obtains the plague agent after feeding from an infected host. The bacteria multiply rapidly in the gut just anterior to the proventriculus and block further blood meals. When the flea attemps to feed, the blood is simply regurgitated back into the host after encountering the mass of *Y. pestis* in the flea's gut. The regurgitated blood carry some bacteria back into the host, infecting a new individual. Since it cannot feed, the flea will become stressed and attempt to feed more often than usual, intensifying the spread of plague. (Azad, et al., 1997; Azad, 1990; Brouqui and Raoult, 2006; Mullen and Durden, 2009; Ruiz, 2001)

> **Ecosystem Impact:** parasite

Species Used as Host

- mammals (Mammalia)

- birds (Aves)

Commensal/Parasitic Species

- bacteria (*Yersinia pestis*)
- bacteria (*Rickettsia typhi*)
- bacteria (*Rickettsia felis*)
- protozoa (*Nosema pulicis*)
- parasitic nematodes (*Steinernema carpocapsae*)
- pteromalid wasps (*Bairamlia fuscipes*)

Economic Importance for Humans: Positive

Pulex irritans is a parasite of humans as well as a vector for disease, thus it provides no benefits. (Azad, et al., 1997; Azad, 1990; Brouqui and Raoult, 2006; Rolain, et al., 2005)

Economic Importance for Humans: Negative

Pulex irritans is a vector for the following human diseases: plague (agent: *Yersinia pestsis*), murine typhus (agent: *Rickettsia typhi*) and flea-borne spotted rickettsiosis (agent: *Rickettsia felis*). Bites from *P. irritans* are slightly raised, often grouped together and cause itching. They can have a bright red appearance due to blood escaping from the puncture wound. Infestations of *P. irritans* in human households often require drastic removal efforts that may cost significant amounts of money. (Azad, et al., 1997; Azad, 1990; Brouqui and Raoult, 2006; Ruiz, 2001; Sutton, 1916)

> **Negative Impacts:** injures humans (bites or stings , carries human disease) ; causes or carries domestic animal disease ; household pest

Conservation Status

Pulex irritans is a cosmopolitan species with a wide range of hosts. Currently, this species large population size and global distribution do not put it at risk for endangerment. (Buckland and Sadler, 1989)

IUCN Red List	US Federal List	CITES
Not Evaluated	No special status	No special status

State of Michigan List
No special status

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References

2010. "Integrated Pest Management Manual-Fleas" (On-line). National Park Service, U.S. Department of the Interior. Accessed April 02, 2010 at http://www.nature.nps.gov/biology/ipm/manual/fleas.cfm.

Azad, A. 1990. Epidemiology of Murine Typhus. *Annual Review of Entomology*, 35: 553-569.

Azad, A., S. Radulovic, J. Higgins, B. Noden, J. Troyer. 1997. Flea-borne Rickettsioses: Ecologic Considerations. *Emerging Infectious Diseases*, 3: 319-327. Accessed February 17, 2010 at ftp://ftp.cdc.gov/pub/EID/vol3no3/adobe/azad.pdf.

Barrett, J., P. Brophy. 2008. "Parasitic Arthropods I" (On-line). Aberystwyth University Parasitology Group: homepage. Accessed April 02, 2010 at http://www.aber.ac.uk/parasitology/Edu/Arthro/ArthTxt1.htm.

Brouqui, P., D. Raoult. 2006. Arthropod-Borne Diseases in Homeless. *Annals New York Academy of Sciences*, 1078: 223-235.

Buckland, P., J. Sadler. 1989. A Biogeography of the Human Flea, Pulex irritans L. (Siphonaptera: Pulicidae). *Journal of Biogeography*, 16: 115-120. Accessed February 08, 2010 at http://www.jstor.org/stable/2845085.

Chandler, A. 1922. *Animal Parasites and Human Disease*. New York: John Wiley & Sons, Inc.. Accessed April 01, 2010 at http://www.biodiversitylibrary.org/page/18142579#5.

Eads, R. 1948. Ectoparasites from a Series of Texas Coyotes. *Journal of Mammalogy*, 29: 268-271. Accessed February 09, 2010 at http://www.jstor.org/stable/1375392.

Irons, J., R. Eads, C. Johnson, O. Walker, M. Norris. 1952. Southwest Texas Q Fever Studies. *The Journal of Parasitology*, 38: 1-5. Accessed February 09, 2010 at http://www.jstor.org/stable/3274164.

Kellogg, V. 1908. *American Insects*. New York: Henry Holt and Company. Accessed March 08, 2010 at http://www.biodiversitylibrary.org/page/1013949#390.

Kelly, C., T. Fellers, M. Davidson. 2009. "Human Flea (*Pulex irritans*)" (On-line). Olympus Microscopy, Darkfield Digital Image Gallery. Ac-

cessed April 02, 2010 at http://www.olympusmicro.com/micd/galleries/dark-field/pulexirritans1.html.

Kerr, J. 1921. *Zoology for Medical Students*. London: MacMillan and Co., Limited. Accessed April 01, 2010 at http://www.biodiversitylibrary.org/page/21547223#11.

Laudisoit, A., H. Leirs, R. Makundi, S. Van Dongen, S. Davis, S. Neerinckx, J. Deckers, R. Libois. 2007. Plague and the Human Flea, Tanzania. *Emerging Infectious Diseases*, 13: 687-693.

Mullen, G., L. Durden. 2009. *Medical and Veterinary Entomology: Second Edition*. Burlington, MA: Elsevier, Inc. Accessed April 15, 2010 at http://books.google.com/books?id=6R1v9o-uaI4C&pg=PA115&dq=pulex+irritans&ei=MZXGS8TiCY_yzQTx86CRCA&cd=3#v=onepage&q=pulex%20irritans&f=false.

Perez-Martinez, L., J. Venzal, D. Gonzalez-Acuna, A. Portillo, J. Blanco, J. Oteo. 2009. Bartonella rochalimae and Other Bartonella spp. in Fleas, Chile. *Emerging Infectious Diseases*, 15: 1150-1152. Accessed February 17, 2010 at http://www.cdc.gov/EID/content/15/7/1150.htm.

Raoult, D., B. La Scola, M. Enea, P. Fournier, V. Roux, F. Fenollar, M. Galvao, X. de Lamballerie. 2001. A Flea-Associated Rickettsia Pathogenic for Huamsn. *Emerging Infectious Diseases*, 7: 73-81.

Roberts, L., J. Janovy. 2009. *Gerald D. Schmidt & Larry S. Roberts' Foundations of Parasitology*. New York, NY: McGraw-Hill.

Rolain, J., O. Bourry, B. Davoust, D. Raoult. 2005. Bartonella quintana and Rickettsia felis in Gabon. *Emerging Infectious Diseases*, 11: 1742-1744.

Ruiz, A. 2001. Plague in the Americas. *Emerging Infectious Diseases*, 7: 539-540.

Smit, F. 1958. A Preliminary Note on the Occurence of Pulex irritans L. and Pulex simulans Baker in North America. *The Journal of Parasitology*, 44: 523-526. Accessed February 08, 2010 at http://www.jstor.org/stable/3274425.

Sutton, R. 1916. *Diseases of the Skin*. St. Louis: C.V. Mosby Company. Accessed April 15, 2010 at http://books.google.com/books?id=5PBY5xtLCWIC&pg=PA790&dq=pulex+irritans&ei=MZXGS8TiCY_yzQTx86CRCA&cd=2#v=onepage&q=pulex%20irritans&f=false.

Theobald, F. 1892. *An Account of British Flies (Diptera)*. London: Elliot Stock, 62, Paternoster Row, E.C.. Accessed March 31, 2010 at http://www.biodiversitylibrary.org/page/20682702#5.

Ugbomoiko, U., L. Ariza, J. Heukelbach. 2008. Parasites of importance for human health in Nigerian dogs: high prevalence and limited knowledge of pet owners. *BMC Veterinary Research*, 4: 1-9.

Whiting, M., A. Whiting, M. Hastriter, K. Dittmar. 2008. A molecular phylogeny of flea (Insecta: Siphonaptera): origins and host associations. *Cladistics*, 24: 1-31.

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