

The little-known relationship between class insecta and rodents

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Abstract

Rodents are one of the largest order of mammals and they are ubiquitous worldwide. Research has been done over the past years globally to understand the function and ecological role of rodents. However little has been done to unravel the type of relationships which exist between rodents and insects across the taxa. In this article a description of rodents relationship with some insect species and some diseases was reviewed. The information was got from reviewing previous studies using online databases like PubMed, Hinari and google scholar. Insects in particular of the following orders: Coleoptera, Diptera and Siphonaptera have been found to associate more with rodents as a source of food, act as biological vectors for microorganisms, hosts for sucking insects and important in the obligatory ectoparasitism point for rodents. The mutual relationship which exists between rodents and fleas for instance is of great concern and attracts global attention from researchers, ecologists and medical practitioners.

Keywords biodiversity; ectoparasite; insect; rodentia.

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1 Introduction

Rodentia is the largest order of mammals encompassing at least 40% of recognized mammalian species. They are ubiquitous and occur in all continents except Antarctica. Most species are small sized and they are usually vegetarian. They cost billions of dollars in crop losses each year. Some are carriers of human diseases. However, various rodent species are economically important as food source and in biomedical research. (O'Brien et al., 2006).

When people think of ectoparasitic arthropods, the first things that appear in their minds are the ailments they cause, the irritation caused by their bites, and the agents that cause the diseases they transmit. Arthropod-mediated host immunosuppression provides a favorable environment for the generation of vector-borne

pathogens. The suppression of the body's ability to protect from innate disease and infection is known as immunosuppression (Wikel, 1999).

1.1 Coleoptera

Among the insects with ectoparasitic features, the order Coleoptera has a large place. Leiodidae family; It includes 335 known species in the Americas north of Mexico, and they have some distinctly diverse biology. The genus *Leptinus* Müller 1817, with 3 Nearctic and 6 Palearctic species, is ectoparasitic on small rodents and insect eaters (Coleoptera: Leiodidae: Platypsyllinae) (Peck, 2006).

1.2 Diptera

Another insect group that is closely related to rodents is the order Diptera. Sandflies (Diptera: Psychodidae) have an important place in public health because they act as biological vectors for microorganisms such as *Leishmania* genus protozoan parasites that cause leishmaniasis, and *Bartonella bacilliformis*, which causes various viruses from the Filavivirus family that causes sandfly fever. Sandflies also spend most of their lives in dark and damp areas such as caves, animal shelters, wall cracks and crevices, and rodent nests (Pekağırbaş, et al., 2017; Belkaid, et al., 2000).

Both males and females of flies belonging to genus *Stomoxys*, which usually show an aggressive diet, suck blood. Although these flies, also called barn flies, have a wide variety of hosts like rats, guinea pigs, rabbits, monkeys, horses, camels, goats, pelicans and cattle form their main hosts (Oğuz et al., 2016). Similarly, *Cuterebra* (Diptera: Oestridae) includes obligate dermal parasites of new world mammals and rodents. In the Neotropics, however, little is known about *Cuterebra*, particularly its main hosts or its effects on rodent population dynamics (Bermúdez et al., 2010).

1.3 Phthiraptera

Lice also have an important place in the obligatory ectoparasitism point for rodents. *Hoplopleura affinis* (Burmeister, 1839) was collected from a rodent species in central and eastern Croatia. Another species, *Polyplax serrata*, was collected on four different rodent hosts in the plains, mountains, and Mediterranean part of Croatia (Krcmar and Trilar, 2017).

Rodents are the most common hosts of sucking lice. Globally, 40% of rodent species are known to host sucking lice, and 67% of the described species of sucking lice parasitize rodents. The two most species-rich genera, *Hoplopleura* Enderlein, 1904, and *Polyplax* Enderlein, 1904, have 136 and 79 species, respectively. A new carnivore record was made for a new species of sucking lice, *Hoplopleura villosissima* Wang (Psocodea: Phthiraptera: Hoplopleuridae) and *Polyplax spinulosa* Burmeister, 1839 (Psocodea: Phthiraptera: Polyplacidae) from *Rattus villosissimus* Waite (Rodentia: Muridae), endemic to Australia (Wang et al., 2018).

1.4 Siphonaptera

Fleas appear as another living group in the ectoparasites of rodents. The preferred hosts of fleas are domestic and wild furry animals, especially squirrels, chipmunks, prairie dogs and other terrestrial rodents. Although fleas are generally classified by host specificity (or the presence or absence of head combs), all fleas can quickly adapt from animal to nearby human hosts, especially if their preferred hosts have been destroyed by diseases or pesticides. Adult fleas can feed on blood in their hosts for up to one year and can survive up to 125 days apart from their hosts (Diaz, 2006). From this point of view, these bloodsuckers are also a potential danger to humans.

According to Haddis (2004), fleas are the vehicles of infection among rodents and humans. Fleas live upon the blood of humans, birds and other mammals. Fleas have preferred animal hosts, for instance cats, dogs, rat, hens, bats, rabbits, moles etc., are host to specific fleas. In case of bubonic plague, the fleas of infected rats, in sucking the blood take in plague bacilli (*Yersinia pestis*) into their system. The bacilli multiply in the flea's gullets and block them. Plague is essentially a disease of rodents transmitted by rodent fleas, but it may under

certain conditions cause serious outbreaks among humans.

Murine typhus (endemic flea-borne typhus) is not communicable directly from man to man. It is transmitted from an infected rat to the flea through blood meals and humans get it by the faeces and crushed fleas, contaminating abraded skin and at the site of flea bites.

2 Discussion

Zuo and Guo (2011) in their study proposed the existence of potential co-evolutionary processes which contribute towards determining the distribution of ectoparasites on rodents. However Hawlena et al. (2008) noted that temporal variation in body condition and immunological variables of animals that harbor parasites may explain patterns of variation in infestation, as well as parasite impact on the host. The stochasticity of changes in the temporal pattern of infestation level of rodents by fleas suggests that they are related to changes in the host itself rather than to periodic changes in the environment of the host (Krasnov et al., 2006a). There are indications that environmental, host-, and parasite-related factors affect reciprocal responses of both rodents and fleas (Krasnov et al., 2002; Gouy De Bellocq et al., 2006).

Generally fleas cause irritation and allergy, damage the host's skin, inject toxins, induce anemia and cause immunodepression that may confer an advantage on a superimposed infection (Cox, 2001). On the other hand, non-specific immune system cells produced against fleas (e.g., monocytes, neutrophils, and basophils) may be activated against the superimposed infection as well, thus increasing the immune response to phytohaemagglutinin (PHA) injection (Cox, 2001). Potential negative effects of flea infestation on the host are not limited to blood removal alone.

In their research, Hawlena et al. (2008) noted that flea survival was affected by the age of the host, being higher in juveniles, the less resistant cohort. However, contrary to their prediction, fleas did not respond to temporal variability in body condition and immunocompetence of the rodents. The physical and chemical properties of the host's blood as well as host skin structure are important characteristics to which a host-specific flea is adapted (Lehane, 2005).

Food availability and quality in desert habitats is spatially and temporally unpredictable, and rodents often face periods of food shortage (Khokhlova et al., 2001). It has been shown that food restriction brings about reductions in fat stores, metabolic rate, heart rate, immunological variables, and overall activity (Gutman et al., 2006; Martin et al., 2007). Energy restriction often leads to suppression of immune function and may reduce the time and energy that is invested in grooming, thus increasing the risk of parasitism (Heitman et al., 2003). Parasites do not necessarily induce negative effects if hosts have an energy surplus at the time of infestation (Munger and Karasov, 1989), or are able to compensate for losses through increased food consumption (Tripet and Richner, 1997). Therefore, the effects of parasites should be most significant when the host is food-restricted and compensatory mechanisms are limited. There are other examples where parasites exacerbate the effects of food or nutritional shortage (Thompson et al., 2005), and it is likely that the main negative impact of fleas and other parasites on their hosts will appear during periods of food scarcity (Hawlena et al., 2008).

In rodents age differences between adult and juvenile hosts, may cause vital changes in the host as an environment for its fleas (Hawlena et al., 2008). In spite of the age-dependent differences in body condition and immunocompetence in rodents, Hawlena et al. (2008), found no indication that juvenile rodents suffer more from flea infestation than adults do. Rodents in better body condition may have more resources to allocate to costly defense mechanisms (Sheldon and Verhulst, 1996), and these mechanisms may reduce the fitness of their parasites (Clayton, 1991; Bize et al., 2008).

In New Zealand forests, Dugdale (1996), Alley et al. (2001), and Towns et al. (2009) noted that the European house mouse and ship rat are well known to be important predators of litter dwelling

macroinvertebrates. In a study by Wardle et al. (2009), rodents were found to influence two macrofaunal groups, i.e., beetles and spiders, though often positively. These two groups are well known to serve as prey for both mice and rats in New Zealand forests (Alley et al., 2001; Towns et al., 2009).

Wardle et al. (2009) in their results on seabird islands invaded by rats indicated that of 11 groups of invertebrates detrimentally affected, only Lepidoptera, Coleoptera and Chilopoda might suffer direct effects by virtue of their size and susceptibility to predation by rats. Extirpations driven by invasion of rats on islands appear to be far more prevalent amongst above-ground mega-invertebrates such as tenebrionid beetles in the Mediterranean (Palmer and Pons, 1996), giant stick insects in the Pacific (Pridell et al., 2003) and flightless crickets in New Zealand (McIntyre, 2001).

Clair (2010) mentioned that it is apparent that invertebrate taxa that may be extirpated (locally driven to extinction) by rodents tend to be larger-bodied than those that are merely suppressed, and that rodent-suppressed taxa have over twice the body length, on average, of those which are unaffected. It is equally important to note that rodents indirectly affect insect population growth through destruction of plants. Few studies have addressed rodent impacts on invertebrate populations via effects on plants. The cushion plant *Azorella selago* is an important habitat for invertebrates on Marion Island, and its destructive use as a nesting habitat by mice is thus likely to affect invertebrate populations (Barendse and Chown, 2001; Phiri et al., 2009). In New Zealand, regeneration of Karo (*Pittosporum crassifolium*) plants is strongly inhibited by *R. exulans*, and when this plant species recovered following eradication of rabbits and *R. exulans* from Korapuki Island, populations of the New Zealand endemic scale insect (*Coelostomidia zealandica*) also recovered (Campbell and Atkinson, 2002; Towns, 2002); direct interaction between rats and scale insects could be excluded as the mechanism of impact because before rat eradication the insects remained abundant on the few surviving host plant individuals (Towns, 2002).

The local extinction of the large weevil *Hadramphus stilborcarpae* occurred at the same time as the severe reduction of its host plant *Stilbocarpa lyelli* by *R. rattus* shortly after the invasion of Big South Cape Island in New Zealand (Kuschel and Worthy, 1996). Rat-infested islands showed much greater predator-escape responses than the same species from rat-free sites (Bremner et al., 1989), and Meads (1990) observed two New Zealand giant myriapod species and a stag beetle (*Dorcus helmsi*) which only reach their largest sizes on rodent-free islands; this may be due to selection of large prey by rodents, or (more likely) to generally increased predation pressure that shortens average and maximum lifespans and prevents recruitment to old (large) size-classes. The potential for directional selection and evolutionary change is clear, which perhaps suggests that even low rodent densities serve to suppress the recovery of invertebrate populations (Rufaut and Gibbs, 2003). Thus this relationship of rodents and the invertebrates have led to myriapod species and stag beetle evolving into much smaller insects to reduce their chances of predation.

3 Conclusion and Recommendation

Coleoptera-Leiodidae: Platypsyllinae is an ectoparasite of rodents. Dipterans there are Psychodidae which are vectors to Leishmania and Bartonella baciliforms. Genus stomoxys and Cuterebra in the order insecta are also rodents ectoparasites. Cuterebra research is lagging. Rodents are host to the order Phthiraptera as well, specifically sucking lice. Siphonapterans parasitize rodents for instance fleas known to transmit plague disease to humans. There is no doubt that rodents and insects play an intergral ecological role to the ecosystem. It is the mutual relationships between insects and rodents which have enabled most rodents to continue to exist in various continents on this globe. The insect from the following orders Coleoptera, Siphonaptera and Diptera have played an indispensable role to the functionality, coexistence and performance of rodents over years and in diverse environments. Although the parasitic relationships of insects with rodents (beaver, mouse, rat,

squirrel) are known, considering that there are more than 30 Insect Orders in the world, other hosts or intermediate host relationships need to be studied extensively. There may exist new unidentified insect species and records that are parasitic to rodents to be investigated.

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