

Review

Fleas (Insecta: Siphonaptera) of Peru: A Review of Their Diversity and the Host Specificity in the Country

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Abstract: In the Neotropical biogeographic region, there are about 290 known species and subspecies of fleas, which have as their main hosts to the rodent subfamily Sigmodontinae. In Peru, more than 22 years have passed since the last list of known flea species was published. This study presents a review and update of the fleas recorded in Peru from 1908 to 2024. This list contains information on the flea species, including their known hosts, the localities in Peru where they were reported, the main references and some comments. In addition, the specificity of flea–host interactions was assessed using an interaction network approach. In the literature review, 86 flea species were found distributed among 9 families, 34 genera and 19 subspecies. These fleas were recorded parasitizing at least 71 species of mammals and birds (14 orders, 28 families, 54 genera), 15 reported only at the genera level and seven undetermined ones. The flea–host interaction network exhibited a modular structure, indicating that these interactions tend to be specialized. A sigmodontine rodent (*Akodon mollis*) and a Rhopalopsyllidae flea (*Polygenis litargus*) were highly connected across modules and the overall network, and thus were important to maintain the structure. This review contributes to the knowledge of fleas in Peru, synthesizing the scattered information and providing information on the interaction they have with their hosts.

Keywords: fleas; interaction networks; modularity; Peru; Siphonaptera



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1. Introduction

The order Siphonaptera, which includes insects commonly known as fleas, represents a relatively small group of wingless, holometabolous, obligate hematophagous insects of higher vertebrates, especially mammals and birds, which they parasitize during their adult phase [1–3].

Fleas have a cosmopolitan distribution, including Antarctica, where *Glaciopsyllus antarcticus* Smit and Dunnet, 1962 has been reported parasitizing the silver petrel *Fulmarus glacialis* (Smith, 1840) [4]. The geographical distribution of this group is mentioned as uneven since the greatest diversity is found in the Palearctic Region with 892 species, followed by Nearctic, Afrotropical and Neotropical, respectively, with 299, 275 and 289 species and, finally, the Eastern and Austral regions with 191 and 68 species, respectively [5–7]. Worldwide, 2652 flea species have been recorded [8], of which 86 species were reported from different parts of Peru.

Regarding the flea fauna of South America, it mainly comprises species in the families Malacopsyllidae and Rhopalopsyllidae and the subfamily Craneopsyllinae [7,9,10]. For the Neotropical biogeographic region, around 290 species are known [6], and 144 species are

known for the Andean biogeographic region [11], with cricetid rodents of the subfamily Sigmodontinae as main hosts in the Neotropics [3].

The study of fleas in South America began in 1879 when Weyenbergh published the first descriptions of native species for this region. In Peru, one of the first efforts to quantify flea diversity was carried out by Macchiavello [12], who compiled the first list and zoogeographic distribution of all flea species recorded on the Southwestern Coast of America (Ecuador, Peru and Chile). In later years, the greatest contribution to the study of flea diversity at a taxonomic, systematic and zoogeographic level would be made by Johnson [13] in his monographs, where the South American flea fauna is described, in which 59 species are recognized for Peru. Finally, the works of Hopkins and Rothschild [14], Smit [15–18], Schramm and Lewis [19,20] and Hastriter et al. [21] would raise that number to 77 species.

The association of fleas and their hosts represents an important ecological issue, because some flea species are strict parasites, while others show very low or no preference [22]. Marked host specificity is characteristic of various insect groups such as Phthiraptera, which parasitize birds [23] and Nycteribiidae flies, which parasitize bats [24]. This specificity can be counterproductive for their fitness since they depend on the survival of a specific host species. In this case, which presents a certain degree of specificity, it can be said that its inability to feed and reproduce on organisms other than its strict hosts can be interpreted as a negative factor in maintaining a high reproductive potential. In contrast, this characteristic of specificity is not prevalent in fleas [22,25,26].

The specificity of parasitic interactions has been widely explored using species interaction network frameworks [27]. Through the structure of these networks, it is possible to examine community-level properties of ecological processes [28]. This approach also facilitates the identification of species' roles in maintaining the network, thus highlighting key species for the ecological processes at the community level [29]. In parasite ecology, interaction network methods have been applied to describe the temporal dynamics of parasitic associations [30], assess the effects of biological invasions [31], explore functional traits [32] and determine potential parasite transmission pathways [33], among other objectives (see [27,34,35]). Consequently, a network-based approach is often well suited for describing these antagonistic interactions and can provide valuable insights to advance our understanding of parasite ecology.

There is not an updated compilation on the richness of fleas in Peru and most of the Peruvian scientific literature on this subject is dispersed, old and difficult to access. Considering this and the biological relevance of fleas, a new synthesis for Peruvian fleas is required. Therefore, the objective of this study is to present an updated review of the flea species reported in Peru, including their geographic distribution, hosts, specificity and interaction between species.

2. Materials and Methods

2.1. Parasite–Host Checklist

The list was compiled from an extensive bibliographic review in the main databases such as PubMed, Scopus and Science Direct, as well as physical and virtual documents from national and international libraries, collections and museums. Reports in all available languages published from 1908 to May 2024 were included. This list does not include records of abstracts from scientific meetings such as symposia, congresses, or undergraduate theses. The advanced search tools of Google Scholar, SciELO, PubMed, Scopus, ScienceDirect, Dialnet, JSTOR and Refseek were used, considering the following terms and their combinations as follows: “fleas”, “Siphonaptera”, “ectoparasites”, “Peru” and the names of the Peruvian departments. The list is presented in alphabetical order and is composed of two parts. The first correspond to flea species, including their hosts, the localities they inhabit in Peru (including districts, provinces and/or departments), the type of specificity according to the number of hosts (including those recorded throughout America), and some comments, if necessary (e.g., distribution in other countries, redescrptions and taxonomic notes for

classification). The second part presents hosts and the fleas recorded on each of them and is presented as a Supplementary Table S1.

The classification of fleas is based on Whiting et al. [36] and Hastriter and Bossard [37]. The classification and validation of the mammalian host species follows Pacheco et al. [38] and for birds Plenge et al. [39]. The host specificity of the parasites was classified as follows: monoxenous when fleas were found on a single host species; oligoxenous when they were found on more than one host species, but of the same genus; pleioxenous when found on hosts of the same family; polyxenous when found on hosts of different families, but of the same order; and euryxenous when found on hosts of different orders [40,41].

2.2. Flea–Host Interaction Network

A flea–host interaction network at the national scale was constructed using only records where species were identified to the species level, to minimize bias due to taxonomic uncertainty [42]. This network was binary, as the data sources were highly heterogeneous, making it a suitable representation of the fundamental niches of species at large scales [43]. The structure of the network was evaluated by assessing its modularity and nestedness, as well as the internal nestedness of modules. Modularity (Q) was determined using the DIRT-LPA algorithm [44], while nestedness was assessed with the NODF index. In line with Felix et al. [45], nestedness was calculated for the entire network ($NODF_{total}$), as well as for pairs of species within the same module ($NODF_{sm}$) and pairs from different modules ($NODF_{dm}$). To determine the significance of modularity and total nestedness ($NODF_{total}$), null models following Vázquez et al. [46] were employed. For $NODF_{sm}$ and $NODF_{dm}$, however, the modular configuration needed to be considered, so the restricted null model of Felix et al. [47] was applied. The previously mentioned non-restricted null model [46] will be referred to as the “free” null model. For each test, 1000 random matrices were generated using the respective null models, and Z-scores and p -values (derived from Monte Carlo procedures) were calculated.

Important species for the entire network were identified using normalized degree centrality and betweenness centrality. The former measures the number of interactions a species has relative to the total number of possible interactions, while the latter reflects the frequency with which a species appears in the shortest paths between pairs of species in the network, indicating its role as a connector. Species that rank high in both centralities are well connected both directly and indirectly within the network, thereby significantly contributing to its stability. Following an approach similar to Messeder et al. [48], the top 10 species in both metrics were considered crucial for maintaining network connectivity. Additionally, due to the network’s modular structure (see results), species were further evaluated for among-module connectivity and within-module degree, as described by Guimerà and Amaral [49] and Olesen et al. [50]. The classification of species was based on thresholds established by Olesen et al. [50]: 0.62 for among-module connectivity and 2.5 for within-module degree. Species with high values in several of these metrics were identified as key to maintaining the network’s structural integrity.

All analyses, including both network-level and species-level assessments, were conducted in R v.4.2.3 using the bipartite package [51].

3. Results

A total of 596 flea–host interactions were reported in the literature, from which 91 records did not contain information on the identity of the hosts. Fleas belonged to 9 families, 34 genera, 86 species and 19 subspecies. Regarding the hosts, these were made up of 71 species among mammals and birds (14 orders, 28 families, 54 genera), 15 were reported only at the genera level and there were 7 undetermined ones.

Figure 1 shows the frequency of hosts (at suprageneric taxa level) parasitized by fleas in Peru parasitizing some species of flea. It can be observed that the group of rodents was the main host (63.9%) and, within them, the Cricetidae family occupies 44.2%.

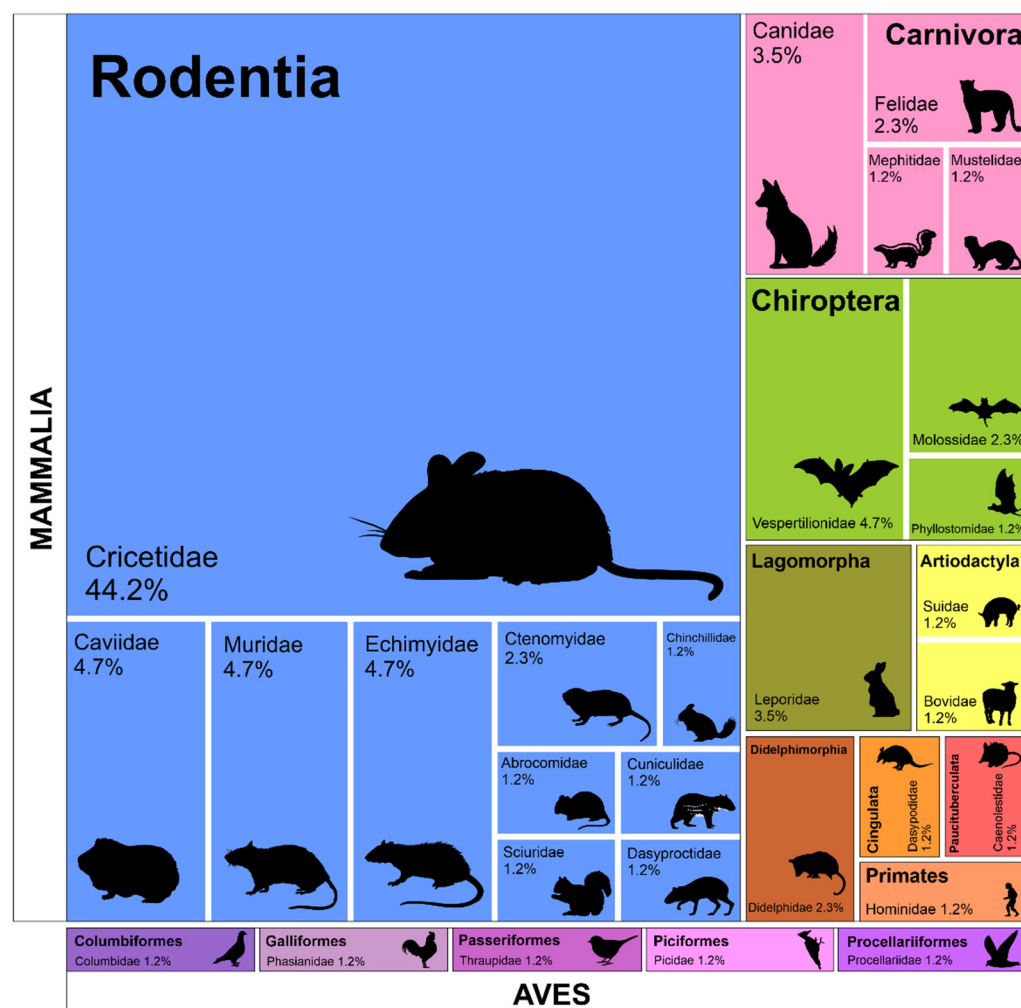


Figure 1. Hierarchy table of mammals and birds recorded as hosts cited in the flea literature in Peru.

The hosts with the highest number of reports of fleas associated with them were the species *Akodon mollis* Thomas, 1894 “Soft Grass Mouse” ($n = 17$), *Rattus rattus* (Linnaeus, 1758) “House rat” ($n = 13$), *Rattus norvegicus* (Berkenhout, 1769) “Brown Rat” ($n = 12$), *Phyllotis andium* Thomas, 1912 “Andean Leaf-eared Mouse” ($n = 10$), all belonging to the order Rodentia. The flea species with the highest host records in Peru were found to be *Polygenis (Polygenis) litargus* (Jordan & Rothschild, 1923) ($n = 23$), *Pulex irritans* Linnaeus, 1758 ($n = 16$), *Ctenocephalides canis* (Curtis, 1826) ($n = 12$) and *Echidnophaga gallinacea* (Westwood, 1875) ($n = 11$). Regarding the geographic distribution of flea species in Peru, the four species with the greatest distribution were *C. canis*, *Ctenocephalides felis* (Bouche, 1835), *Tunga penetrans* Linnaeus, 1758 and *Tiamastus cavicola* (Weyenbergh, 1881), which were recorded in 19, 11, 10 and 9 departments, respectively.

Likewise, the departments that presented the highest flea richness were Piura ($n = 30$), Ancash ($n = 26$), Puno ($n = 25$), La Libertad ($n = 17$) and those that presented the highest diversity of flea-infested hosts were Piura ($n = 34$), Puno ($n = 20$), Lima ($n = 18$) and La Libertad ($n = 17$). At least one flea–host association was reported in all departments except in Madre de Dios (Figure 2).

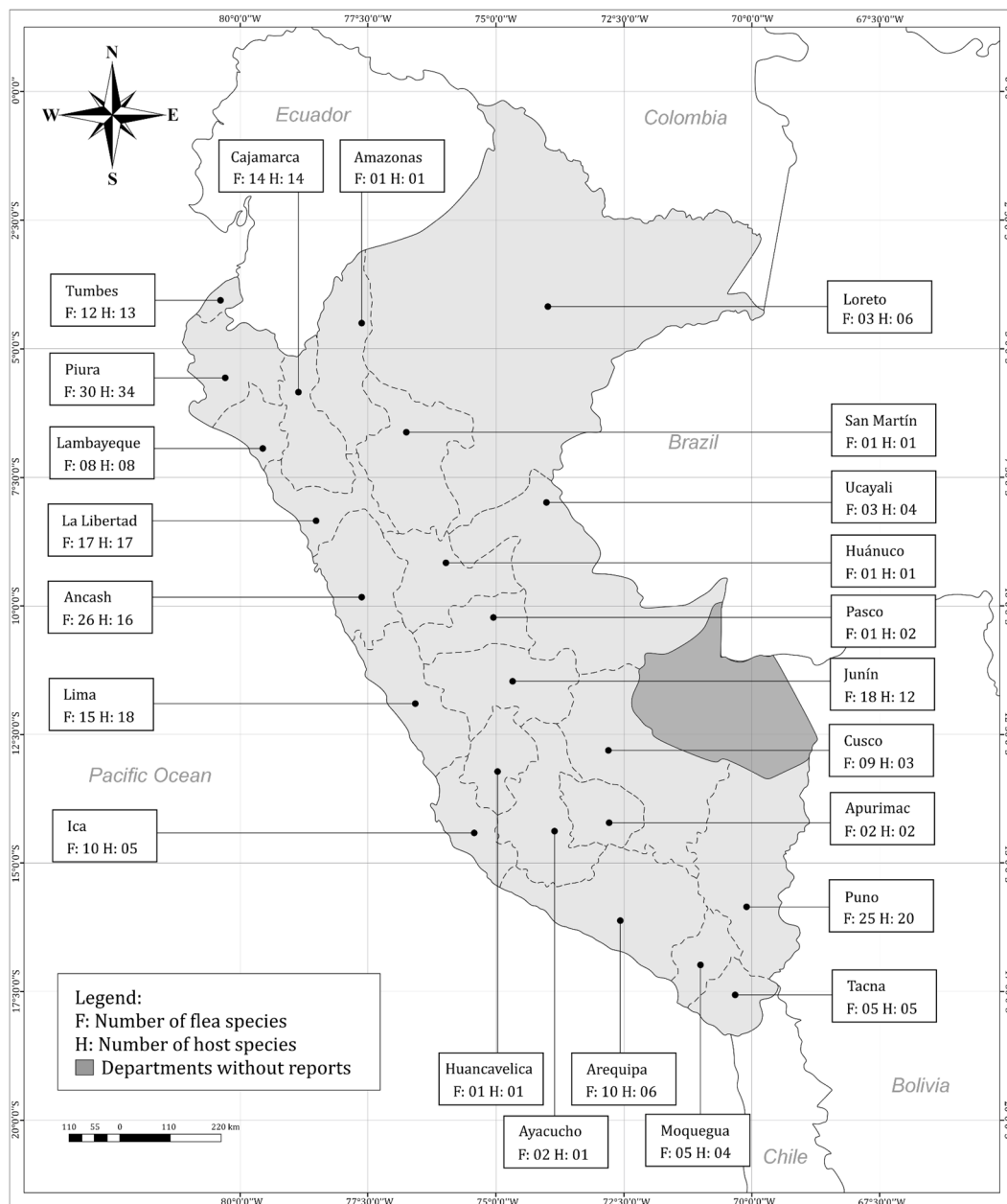


Figure 2. Summary of the number of records of flea species and their hosts cited in each of the departments of Peru.

Fleas of the family Pulicidae were most widespread across different families of hosts (15 families). Rhopalopsyllidae were the most prevalent fleas among mammal families (14 families). Only Pulicidae and Tungidae were found in both birds and mammals. Some flea families were found only in rodent species (Hystrihopsyllidae, Ceratophyllidae, Pygiopsyllidae and Leptopsyllidae) or only in bat species (Ichnopsyllidae) (Figure 3).



Figure 3. Bipartite interaction network between flea families and their host families in Peru.

Regarding host specificity, 13 monoxenous species, 2 oligoxenous species, 13 pleioxenous species, 19 polyxenous species and 36 euryxenous species were found. The specificity of the two species could not be determined because the hosts were not reported. Figures 4 and 5 show some specimens of representative flea species in Peru hosted at the entomological collection of the Natural History Museum of the Faculty of Natural Sciences and Mathematics of the Federico Villarreal National University-MUFV.

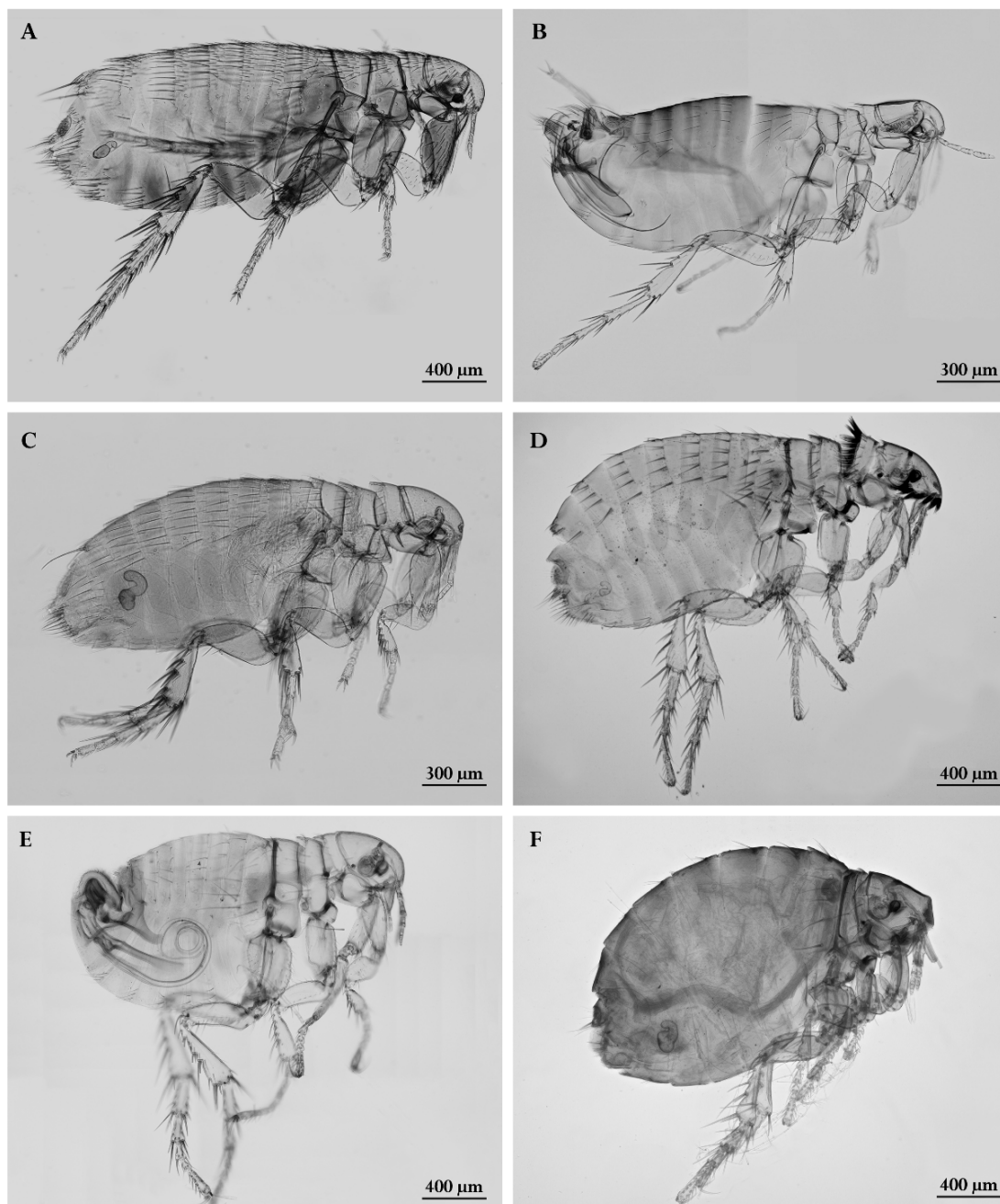


Figure 4. Specimens of some representative fleas in Peru deposited in the MUFV entomological collection. (A) Female of *Polygenis* (*Polygenis*) *litargus*; (B) male *Ectinorus* (*Ectinorus*) *disjugis* Jordan, 1942; (C) female of *Tetrapysyllus* (*Phylliver*) *elutus* Johnson, 1957; (D) female of *Ctenocephalides felis felis* (Bouche, 1835); (E) male of *Pulex irritans* Linnaeus, 1758; (F) female of *Echidnophaga gallinacea* (Westwood, 1875).

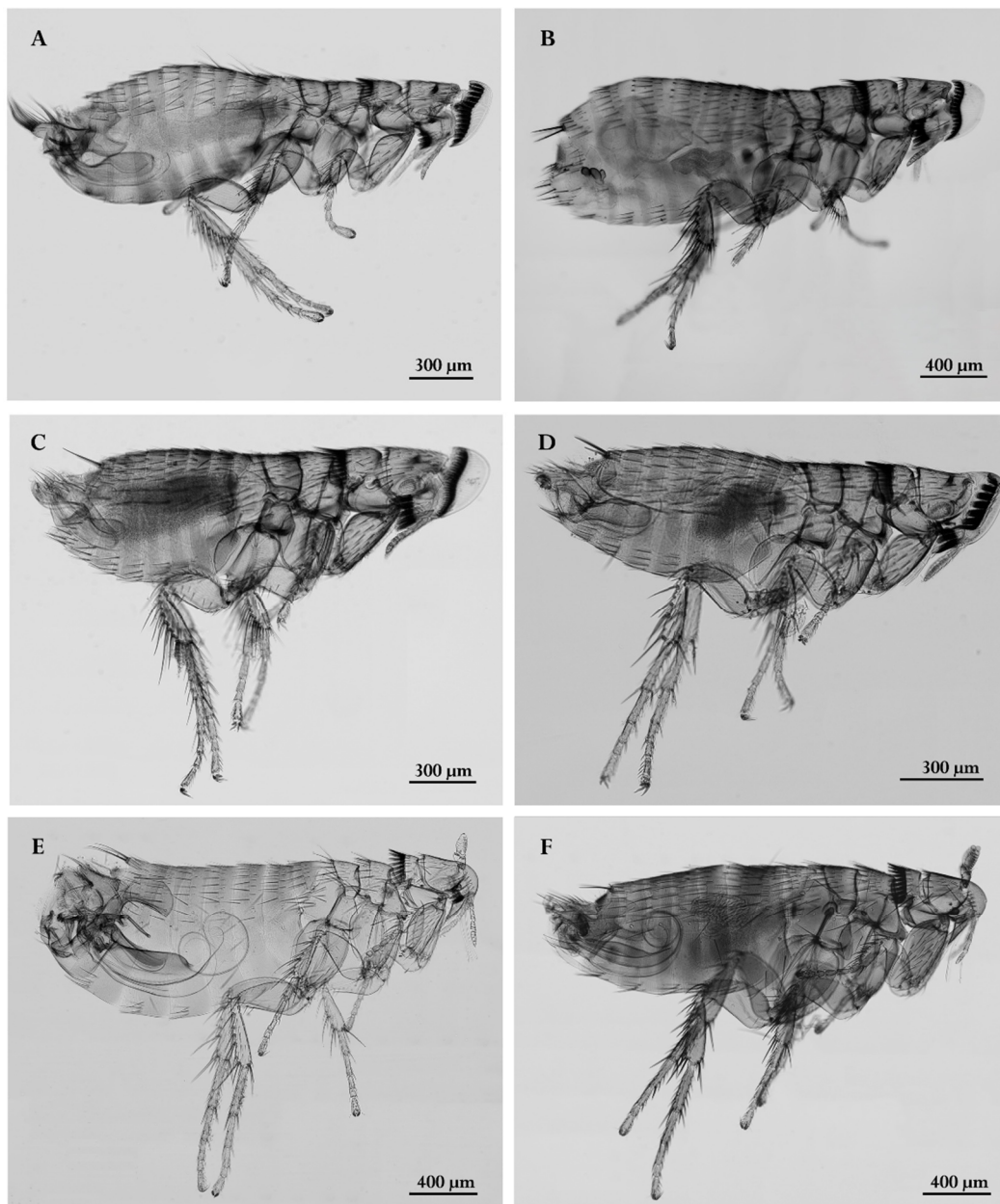


Figure 5. Specimens of some representative fleas in Peru deposited in the MUFV entomological collection. (A) Male of *Plocopsylla achilles* (Rothschild, 1911); (B) female of *Sphinctopsylla inca* (Rothschild, 1914); (C) male of *Craneopsylla minerva minerva* (Rothschild, 1903); (D) male of *Cleopsylla townsendi* Rothschild, 1914; (E) male of *Neotyphloceras crassispina hemisus* Jordan, 1936; (F) male of *Plusaetis* sp.

3.1. Parasite–Host Checklist

Class Insecta;
Order Siphonaptera;
Family Ceratophyllidae;
Subfamily Ceratophyllinae.

1. *Ceratophyllus titicacensis* Smit, 1978

Host: Unknown.

Distribution in Peru: Capachica peninsula, Lago Titicaca, **Puno**.

Specificity: Unknown.

Reference: [17,21].

This species was collected from an abandoned nest, possibly of the Big-billed Cormorant *Phalacrocorax olivaceus* (Humboldt). It is distributed in the Andean subregion, specifically, in Puno, Peru. Its classification is based on having relatively longer pronotum and shorter pronotal spines; the male has a larger spiculate area, and the female lacks a sinuosity on the posterior margin of sternum VII and a thicker spermathecal duct [17].

2. *Dasypsyllus (Neornipsyllus) lewisi* Hastriter & Schlatter, 2006

Host: *Thomasomys* sp.

Distribution in Peru: Huancabamba, Tambo, **Piura**.

Specificity: Monoxenous.

Reference: [52].

This species was described from a single male specimen collected in Piura, its distribution is restricted to this locality so far. It can be differentiated from the other male species of the subgenus by the presence of reduced and inconspicuous triangular lobes on the aedeagus, a wider ventral proctiger at the apex and a wide telomere with a thick and blunt spiniform on the dorsocaudal margin [52]. The female is unknown.

3. *Dasypsyllus (Neornipsyllus) plumosissimus* Smit, 1976

Host: *Catamenia analis griseiventris* (d'Orbigny & Lafresnaye, 1837).

Distribution in Peru: **Cusco**.

Specificity: Monoxenous.

Reference: [16,52].

This species was described from a single male specimen collected in Cusco, and its distribution is restricted to this locality so far. It can be distinguished from the other species of the subgenus by the extraordinary development of the intersegmental membrane between sternums VIII and IX [16]. The female is unknown.

4. *Dasypsyllus (Neornipsyllus) stejnegeri* (Jordan, 1937)

Host: *Colaptes rupicola* d'Orbigny, 1840.

Distribution in Peru: Recuay, **Ancash**.

Specificity: Euryxenous (Charadriiformes and Passeriformes).

Reference: [21,52].

This species is distributed in the Canadian, Caribbean, Patagonian and Western American subregions. In South America, it is reported in Argentina, Chile and central Peru. The male is distinguished from the rest of the species of the subgenus by having the telomere with a right angle on its ventrocaudal margin and is narrow and tapered from the base to the apex with two setae on the ventral margin. The female has a pointed dorsal lobe of the sternum VII and a semi-globular spermatheca.

5. *Nosopsyllus (Nosopsyllus) fasciatus* (Bosc d'Antic, 1800)

Host: Unknown.

Distribution in Peru: **Puno**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [21].

This species is native to the Palearctic region but has a cosmopolitan distribution. It has a predilection for synanthropic rodents and is a relevant species due to its association with disease transmission such as plague, rickettsiosis, bartonellosis, tularemia, Q fever, trypanosomiasis and myxomatosis [53,54].

6. *Nosopsyllus (Nosopsyllus) londiniensis londiniensis* (Rothschild, 1903)

Host: *R. rattus*, *Rattus* sp.

Distribution in Peru: **Cajamarca**.

Specificity: Polyxenous (Muridae and Cricetidae).

Reference: [12,13,21].

This species has been reported from the Eastern Mediterranean, European and the Western Mediterranean Provinces, as well as the Saharo-Arabian subregion. In the Americas, it has been reported from Argentina, Ecuador and Peru [10,12].

7. *Plusaetis dolens quitanus* (Jordan, 1931)

Host: *A. mollis*; *Ichthyomys stolzmanni* Thomas, 1893; *Mus musculus* Linnaeus, 1758; *Phyllotis amicus* (Thomas, 1900); *P. andium* Thomas, 1912.

Distribution in Peru: Huaylas, Huayllan, Pomabamba, Pariacota, Huaraz, Parque Nacional del Huascarán, Huaylas, Recuay, Recuay, **Ancash**; Cicur, Huancabamba, Siclamache, Sondorillo, **Piura**.

Specificity: Polyxenous (Muridae and Cricetidae).

Reference: [13,21,55].

Reported as *Pleochaetis dolens quitanus* in Piura, Smit [56] later relocated this species to the genus *Plusaetis* Smit, 1983 [57]. Hastriter et al. [21] extend its geographic distribution further south, to the department of Ancash.

8. *Plusaetis equatoris equatoris* (Jordan, 1933)

Host: *A. mollis*; *Cavia porcellus* (Linnaeus, 1758); *Oligoryzomys destructor* (Tschudi, 1844); *Sylvilagus* sp.

Distribution in Peru: Huancabamba, **Piura**.

Specificity: Euryxenous (Rodentia and Lagomorpha).

Reference: [12,13].

Reported as *Pleochaetis equatoris equatoris* by Macchiavello, [12]. This species was relocated to the genus *Plusaetis* [57]. Hastriter et al. [21] consider that probably the specimens of *P. equatoris equatoris* recorded by Macchiavello are actually *P. dolens quitanus*. The host in Huancabamba was reported as *Oligoryzomys longicaudatus* (Bennett, 1832), but this species is not distributed in Peru [38].

Family Ctenophthalmidae.

Subfamily Ctenophthalminae.

9. *Agastopsylla hirsutior* Traub, 1952

Host: *Abrothrix jelskii* (Thomas, 1894).

Distribution in Peru: Caccachara, **Moquegua**.

Specificity: Pleioxenous (*Abrothrix* and *Akodon*).

Reference: [13,14,58].

Distributed in Argentina and southern Peru. It was described from a single female holotype, which was lost over time. The diagnosis of this species was modified by López-Berrizbeitia et al. [59] and the male of this species is described for the first time based on specimens collected from *Akodon spegazzinii* Thomas 1897 from Tucumán, Argentina. It differs from the other species of the genus by having the lateral surface of the posterior tibia densely covered by 22–24 setae, the male telomere is notably short and the lateral margins converge towards the apex.

10. *Agastopsylla nylota nylota* Traub, 1952

Host: *Calomys lepidus* (Thomas, 1894).

Distribution in Peru: Carhuamayo, **Junín**.

Specificity: Pleioxenous (Cricetidae: *Phyllotis* and *Calomys*).

Reference: [13,14,58].

Distributed in Argentina and central Peru [59]. It was described from a single male specimen, which is differentiated from the other males of the genus by having a telomere with a strongly oblique apical margin. A subspecies *Agastopsylla nylota euneomys* Lewis, 1984 was described from cricetids in Chile and is differentiated by the presence of a genal comb of three spines, labial palpus extending to apex of forecoxa, total length of telomere more than three times the length of its wide. While *A. nylota nylota* has a genal comb of four to five spines, labial palpus extending to the apex of forecoxa, the total length of the telomere is more than three times the length of its width [59].

11. *Agastopsylla pearsoni* Traub, 1952

Host: *C. lepidus*; *Chinchillula sahamae* Thomas, 1898.

Distribution in Peru: Picotani, San Antonio de Putina, **Puno**.

Specificity: Pleioxenous (Cricetidae).

Reference: [14,58].

In the Neotropics region, this is distributed towards the south, including Argentina, Chile and southern Peru [10]. It was described for the first time in Peru. Males are differentiated from the rest of the species of the genus by the absence of patches of bristles on tergum VII, the apical part of the truncated mobile finger forming two apical angles and sterno VIII with eleven setae. Females are differentiated by a ventral anal lobe with a defined submedial angle on the ventral margin.

12. *Neotyphloceras chilensis* Jordan, 1936

Host: *R. norvegicus*.

Distribution in Peru: San Damiano hacienda, **Ancash**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [14].

It is distributed in Argentina, Chile and the central Andes in Peru. Initially, it was listed as a subspecies of *Neotyphloceras crassispina* by Jordan [60], later it was elevated to the status of species by Sanchez et al. Ref. [61] based it on the shape of the apex of the fixed process of the clasper noticeably turned upwards and the chaetotaxy of the ventral margin of the distal arm of sternum IX with five curved spine-like bristles, the first one wider and strongly pigmented, and located in the center above the others.

13. *Neotyphloceras crassispina crassispina* Rothschild, 1914

Host: *Abrocoma cinerea* Thomas, 1919; *A. jelskii*; *Auliscomys boliviensis* (Waterhouse, 1846); *Calomys sorellus* (Thomas, 1900); *C. sahamae*, *P. amicus*; *Phyllotis osilae* J.A. Allen, 1901; *Phyllotis xanthopygus* (Waterhouse, 1837), *Rattus* sp.

Distribution in Peru: **Ancash**; Hacienda Matara, **Apurímac**; Caylloma, **Arequipa**; San Ignacio, **Cajamarca**; Pachacayo, **Junín**; Matucana, **Lima**; Caccachara, Ilave, Huacullani, Pisacoma, **Puno**.

Specificity: Polyxenous (Cricetidae and Muridae).

Reference: [13,14,21,55,58,62,63].

The genus and species were described from Muridae species captured in Peru. It is currently distributed in Argentina, Bolivia, Chile and Peru. Sanchez and Lareschi [64] developed the most exhaustive key for the taxonomic identification of the species and subspecies of the genus *Neotyphloceras*. It is distinguished from *Neotyphloceras crassispina hemisus* by the absence of dorsal spinelets on the abdominal tergites.

14. *Neotyphloceras crassispina hemisus* Jordan, 1936

Host: *Aegialomys xanthaeolus* (Thomas, 1894); *A. mollis*; *P. andium*; *R. norvegicus*; *Thomomys* sp.

Distribution in Peru: Chiquian, Pariacota, Huaraz, Parque Nacional Huascarán, Huaylas, Recuay, Valle del Río Santa, Choquechaca, Hauzlas, Llampá, Caraz, **Ancash**.

Specificity: Polyxenous (Rodentia).

Reference: [14,21].

It is distributed in Argentina, Bolivia and Chile and, in Peru, it has only been reported in the department of Ancash. It was redescribed by López-Berrizbeitia et al. [65] from male and female specimens collected in Catamarca, Argentina and they provide new diagnostic morphological characters for both sexes. It is distinguished from *N. crassispina crassispina* by the presence of dorsal spinelets in the abdominal tergites.

15. *Neotyphloceras rosenbergi* (Rothschild, 1914)

Host: *A. xanthaeolus*; *A. mollis*; *Didelphis* sp.; *Rhipidomys leucodactylus* (Tschudi, 1845).

Distribution in Peru: Cascas, **Cajamarca**; Cascas, **La Libertad**; Huancabamba, La Laguna, **Piura**; **Puno**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [13,14,21,55,60].

Geographic distribution in South America, including Bolivia, Colombia, Ecuador, Venezuela and Peru. Sanchez et al. [66] redescribe this species and extend its geographic range to Bolivia, as previously it was only recorded as far north as Peru. It is easily distinguishable from the rest of the species of the genus by the first frontal row with eight or nine setae; chaetotaxy of the dorsal margin of the posterior tibia 2, 2, 2, 2, 2, 1, 2, 2; and apical seta of the mobile process of the clasper slightly pigmented.

Subfamily Doratopsyllinae

16. *Adoratopsylla (Tritopsylla) intermedia intermedia* (Wagner, 1901)

Host: *Didelphis marsupialis* Linnaeus, 1758.

Distribution in Peru: Hacienda Limon, Balsas, **Junín**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [14].

It is reported in didelphids and cricetid mice from Argentina, Brazil, Ecuador, Paraguay, Peru and Venezuela. In Peru, it was reported in *Didelphis (paraguayensis) andinus* Allen, 1902, but this species is not found in Peru [38]. The males of this species are differentiated from the rest of the genus by having a posterodorsal lobe of the immobile process of the clasper that ends well below the subconical apical lobe, a sinus that is not as narrow.

17. *Adoratopsylla (Tritopsylla) intermedia coph* (Jordan, 1926)

Host: *Didelphis marsupialis* Lund, 1840.

Distribution in Peru: La Laguna, **Piura**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [14].

Remark: It is reported in didelphids and cricetid mice from the northern part of South America, including Colombia, Costa Rica, Ecuador, French Guiana, Panama and northern Peru. In Peru, it was reported in *D. (paraguayensis) andinus*, but this species is not found in Peru [38].

Family Ischnopsyllidae.

Subfamily Ischnopsyllinae.

18. *Hormopsylla egena* Jordan, 1950

Host: Unknown.

Distribution in Peru: Trujillo, **La Libertad**.

Specificity: Unknown.

Reference: [13,55].

This species was described from seven female specimens, collected from rat burrows on the roofs of houses inhabited by bats. The male is unknown. Its distribution is restricted to this locality [55].

19. *Hormopsylla trux* Jordan, 1950

Host: "Bat".

Distribution in Peru: Cementerio chino, Trujillo, **La Libertad**.

Specificity: Monoxenous.

Reference: [13,55].

Species described from a male and female specimen. The host bat species have not been identified. Its distribution is currently restricted to this locality [55]. The species is similar to *Hormopsylla fosteri* Rothschild, 1903, but differs considerably in the sclerotization of certain parts of the skeleton and the genitalia.

20. *Myodopsylla setosa* Johnson, 1956

Host: “Bat”.

Distribution in Peru: Yucay, **Cusco**.

Specificity: Monoxenous.

Reference: [13,67].

This species was first discovered and described in Peru by Johnson [67]. The specimens were collected from unidentified bats. It is distinguished from the rest of the species of the genus by the presence of a false comb on the third abdominal tergum and, in the male, it has a pair of caudal bristles longer than the width of the mobile finger and curved apically.

21. *Myodopsylla wolffsohni wolffsohni* (Rothschild, 1903)

Host: *Myotis albescens* (É. Geoffroy, 1806).

Distribution in Peru: Unknown.

Specificity: Polyxenous (Chiroptera: Molossidae and Vespertilionidae).

Reference: [68].

In South America, it has been reported in Argentina, Brazil, Chile, Paraguay, Peru and Uruguay. The type of hosts are usually species of the genus *Myotis*. It is distinguished from the rest of the species of the genus by the presence of false combs only on tergum I–II and the presence of 5–6 setae at the apex of the eighth tergum in males.

22. *Rothschildopsylla noctilionis* (da Costa Lima, 1920)

Host: *Eptesicus brasiliensis* (Desmarest, 1819).

Distribution in Peru: Jenaro Herrera, **Loreto**.

Specificity: Polyxenous (Chiroptera: Noctilionidae and Vespertilionidae).

Reference: [69].

Remark: In South America, it has been reported in Brazil and central eastern Peru. This is the only species of the genus, the diagnosis of the genus is the same for the species and is characterized by small thin bristles on the front and combs present on abdominal terga I and II.

23. *Sternopsylla distincta speciosa* Johnson, 1957

Host: *Tadarida brasiliensis* (I. Geoffroy, 1824).

Distribution in Peru: Quince Mil, **Cusco**.

Specificity: Polyxenous (Chiroptera: Molossidae and Vespertilionidae).

Reference: [13].

In South America, it is distributed in Argentina, Colombia, Paraguay, Peru, Panama and Venezuela.

Family Leptopsyllidae.

Subfamily Leptopsyllinae.

24. *Leptopsylla segnis* (Schonherr, 1811)

Host: *Akodon* sp.; *Cavia aperea* Erxleben, 1777; *M. musculus*; *R. norvegicus*; *R. rattus*.

Distribution in Peru: Chimbote, Santa, Huayllan, Pomabamba, Valle del Río Santa, Choquechaca, **Ancash**; Chinchá, **Ica**; Huacho, **Lima**; Moche, Otusco, Trujillo, **La Libertad**; Sapollica, **Piura**; **Lambayeque**; **Tumbes**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [12,13,21,55].

Cosmopolitan species of zoonotic importance as they transmit pathogens that cause bartonellosis, murine typhus (*Rickettsia typhi*) and flea-borne spotted fever (*Rickettsia felis*). Together with *Xenopsylla cheopis*, they are considered the most important flea species that effectively cause the transmission of murine typhus [70]. It is easily distinguishable from the rest of the species by the presence of a vertical genal comb with three to six spines and two or more short, thickened spiniform bristles on the anterodorsal angle of the head.

Family Pulicidae.

25. *Cediopsylla spillmanni* Jordan, 1930

Host: *C. porcellus*; *Sylvilagus brasiliensis* (Linnaeus, 1758).

Distribution in Peru: Ayabaca, Huancabamba, Soccha, Siclamache, **Piura**.

Specificity: Euryxenous (Lagomorpha and Rodentia).

Reference: [12,71].

Distributed in Ecuador and northwestern Peru. Diagnosis is based on the presence of a short vertical or subvertical genal comb with rounded spines.

26. *Ctenocephalides canis* (Curtis, 1826)

Host: *Canis familiaris* Linnaeus, 1758; *Cavia* sp.; *D. andina*; *Didelphis* sp.; *Felis catus* Linnaeus, 1758; *Gallus gallus* (Linnaeus, 1758); *Homo sapiens* Linnaeus, 1758; *M. musculus*; *Neogale* sp.; *R. norvegicus*; *R. rattus*; *Sus scrofa* Linnaeus, 1758.

Distribution in Peru: **Ancash**; **Cajamarca**; Chinchá, **Ica**; **Junín**; Moche, **Trujillo**, **La Libertad**; Ucupe, **Lambayeque**; Barranca, Comas, Independencia, San Juan de Lurigancho, San Martín de Porras, **Lima**; **Piura**; **Tumbes**.

Specificity: Euryxenous.

Reference: [12,13,21,72,73].

Cosmopolitan species, except at the poles. Macchiavello [12] mentions this species in “*Canis*” in all the departments in the coastal and Andean regions of Peru.

27. *Ctenocephalides felis felis* (Bouche, 1835)

Host: *C. familiaris*; *C. porcellus*; *Didelphis* sp.; *F. catus*; *G. gallus*; *H. sapiens*; *R. norvegicus*; *Rattus* sp.; *R. rattus*.

Distribution in Peru: Utcubamba, **Amazonas**; Chimbote, Valle del Río Santa, Choquechaca, Hauzlas, **Ancash**; **Cajamarca**; **Ica**; Trujillo, **La Libertad**; **Lambayeque**; Barranca, Comas, Huacho, Huaral, Independencia, San Juan de Lurigancho, San Martín de Porras, **Lima**; **Piura**; **Tumbes**.

Specificity: Euryxenous.

Reference: [12,13,21,55,73–76].

Cosmopolitan species, except at the poles. Macchiavello [12] mentions this species parasitizing *Felis catus* in all the departments from the Peruvian Coast. It is probably found in domestic animals from all the departments of Peru.

28. *Echidnophaga gallinacea* (Westwood, 1875)

Host: *C. familiaris*; *C. aperea*; *C. porcellus*; *Columba livia* J.F.Gmelin, 1789; *D. andina*; *F. catus*; *G. gallus*; *Oryctolagus cuniculus* (Linnaeus, 1758); *R. norvegicus*; *R. rattus*; *Sigmodon peruanus* J. A. Allen, 1897; *Sus scrofa*.

Distribution in Peru: Vinzos, Santa, **Ancash**; **Cajamarca**; Trujillo, **La Libertad**; Barranca, Carmen de la Legua, Comas, Huacho, Independencia, San Juan de Lurigancho, San Martín de Porras, **Lima**; **Moquegua**; **Tumbes**.

Specificity: Euryxenous.

Reference: [12,13,21,55,72,73,75,77–79].

Cosmopolitan. This species is a major pest of poultry that can cause severe pathology or death if left untreated and is rarely recorded in free-living bird species. Macchiavelli [12] reports it in multiple mammalian hosts although this species is more closely related to poultry, urban and, infrequently, wild birds.

29. *Euhoplosyllus andensis* (Jordan, 1933)

Host: *Sylvilagus* sp.

Distribution in Peru: Soccha, Huancabamba; **Piura**.

Specificity: Euryxenous (Rodentia and Lagomorpha).

Reference: [12,13].

It is distributed in Ecuador and northwestern Peru. This genus was elevated from its status as a subgenus of *Hoplosyllus* Baker, 1905 to a genus by Ewing [80].

30. *Euhoplosyllus manconis* (Jordan, 1950)

Host: *Sylvilagus* sp.

Distribution in Peru: Huancabamba, Siclamanche, **Piura**.

Specificity: Monoxenous.

Reference: [13,21,55,81].

It is distributed in northwestern Peru. This species is closely related to *E. andensis* and is distinguished from it by having an anal stylet more than twice as long as it is wide.

31. *Pulex irritans* Linnaeus, 1758

Host: *Caenolestes caniventer* Anthony, 1921; *C. familiaris*; *C. porcellus*; *Conepatus* sp.; *F. catus*; *G. gallus*; *H. sapiens*; *L. viscacia*; *Lycalopex* sp.; *M. musculus*; *O. cuniculus*; *R. norvegicus*; *R. rattus*; *S. peruanus*; *S. scrofa*; *Sylvilagus* sp.

Distribution in Peru: Valle del Río Santa, Choquechaca, Hauzlas, **Ancash**; **Cajamarca**; **Ica**; **La Libertad**; **Lambayeque**; Comas, Independencia, San Juan de Lurigancho, San Martín de Porras, **Lima**; Sapollica, Ayabaca, Montero, Suyo, Paimas, Lagunas, **Piura**; **Tumbes**.

Specificity: Euryxenous.

Reference: [12,13,21,55,71,72].

Cosmopolitan species is of great relevance and importance in public health because it is one of the flea species most associated with humans, causing zoonoses by bacterial pathogens. Lareschi et al. [82] mention that this species was confused for many years with the closely related species *Pulex simulans* Baker, 1895 and discuss the classification of both species in which they establish the differences: number of setae on each side of the sinus of the sternites VII in females (4–6 in *P. irritans* vs. 7–9 in *P. simulans*); the shape of the aedeagal sclerite (das) (thin in *P. irritans* vs. strong in *P. simulans*), the length of clasper process 1 (P1) (long and completely covering processes 2 and 3 in *P. irritans* vs. short and not covering the other processes in *P. simulans*) and the presence (in *P. irritans*) or absence (in *P. simulans*) of an expansion at the clasper.

32. *Pulex (Pulex) simulans* Baker, 1895

Host: *C. aperea*; *C. familiaris*.

Distribution in Peru: Chiribaya Baja, Valle de Moquegua, **Moquegua**.

Specificity: Euryxenous (Rodentia and Carnivora).

Reference: [77,83,84].

This species was found during a paleoparasitological study of several animal mummies (guinea pigs and dogs) from Chiribaya Baja, and was recovered in good condition to obtain DNA material [84].

33. *Xenopsylla cheopis* (Rothschild, 1903)

Host: *C. porcellus*; *Didelphis* sp.; *G. gallus*; *H. sapiens*; *M. musculus*; *R. norvegicus*; *R. rattus*.

Distribution in Peru: **Ancash**; **Cajamarca**; **Ica**; **La Libertad**; El Sauce, Barco, Algarrobo, Kerguer y La Ramada, Salas, Ucupe, **Lambayeque**; Huacho, **Lima**; Sapollica, Ayabaca, Suyo, Paimas, Lagunas, **Piura**; **Tumbes**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [12,13,21,55,71,85].

Considered a cosmopolitan species, it is the main vector of the bubonic plague bacterium, *Yersinia pestis*, and also of bacteria belonging to the genera *Rickettsia* and *Bartonella* [86]. It is also mentioned as the vector of protozoa such as *Trypanosoma* sp. and of cestodes such as *Hymenolepis diminuta* [87]. It differs from the other two species of the genus *Xenopsylla* Glinkiewicz, 1907 recorded in South America by having the distal arm of the ninth sternum in the male equally sclerotized throughout its length, and the female with the base of the tail of the spermatheca not strongly ventricose.

Family Pygiopsyllidae.

34. *Ctenidiosomus spillmanni* Jordan, 1931

Host: *Cavia* sp.

Distribution in Peru: Huancabamba, Piura.

Specificity: Monoxenous.

Reference: [13,55].

This species was described from a single female collected by Professor F. Spillmann in 1930 in Pichincha, Ecuador. Jordan [55] first described males of this species from fleas collected from rural dwellings and domestic animals in Huancabamba, Piura.

Family Rhopalopsyllidae.

Subfamily Parapsyllinae.

35. *Delostichus phyllotis* Johnson, 1957

Host: *Cavia* sp.; *Phyllotis xanthopygus*.

Distribution in Peru: Yura, **Arequipa**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [13,18,88].

It is distributed in southwestern South America, including Chile and southern Peru. The type host was mentioned as *Phyllotis arenarius*, which was later synonymized with *P. xanthopygus*. It differs from the rest of the species of the genus by having the procoxa without particularly large bristles than the others, the fifth protarsal segment longer and the row formed by its plantar bristles not oblique.

36. *Delostichus xenurus* (Rothschild, 1914)

Host: *Lagidium viscacia*.

Distribution in Peru: Llampá, **Ancash**.

Specificity: Monoxenous.

Reference: [18,62].

Distributed in the central Andes of Peru at 4000 m above sea level. Initially described as *Parapsyllus xenurus* Rothschild, 1914; later modified by Jordan, [89]. The differentiation from the other species of the genus is based on the presence of short bristles at the base of the first antennal segment, not reaching the base of the club; the posterior margin of the genal process is convex.

37. *Ectinorus (Ectinorus) alejoi* Hastriter, 2002

Host: *L. viscacia*.

Distribution in Peru: Recuay, **Ancash**.

Specificity: Monoxenous.

Reference: [21,90].

Distributed only in central western Peru. Hastriter and Sage [90] mention this species as being distributed in southern Peru, but do not specify the localities, districts or departments. The type host was *L. peruanum* Meyen, 1833, later synonymized with *L. viscacia*. It can be distinguished from the rest of the species in the genus by the absence of spurs on the first abdominal tergum, it is close to *E. viscachae* (Wagner, 1937) and it can be differentiated from it by the details of the clasper, St. VIII and st. IX in the male, and, in the female, by the modified abdominal segments and the shape of the spermatheca.

38. *Ectinorus (Ectinorus) claviger* (Rothschild, 1914)

Host: *C. lepidus*; *L. viscacia*.

Distribution in Peru: Recuay, **Ancash**; Querobamba, **Ayacucho**; Carhuamayo, La Oroya, **Junín**; Querobamba, **Puno**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [13,18,21,62,91].

It is distributed throughout the Peruvian Andes. Johnson [13] mentions this species in two possible hosts, *Akodon chraeomys jelskii* or *Phyllotis p. limatus*, but this was not detailed. Hastriter et al. [21] complement the description of the females of this species. The diagnosis in both sexes is an antennal pedicel without a row of small lateral setae; tergum I without marginal spurs; and labial palpus with 5 segments. Male with posterior margin of telomere

not convex; process of basimeris ventralis not digitiform, not shorter than the telomere, with a rounded apex and covered with spiniform setae. Female with sensillum with less than 20 sensitive pits on each side; protuberance of spermatheca not subspherical and perula of copulatory bursa spherical.

39. *Ectinorus (Ectinorus) disjugis* Jordan, 1942

Host: *A. pictus*.

Distribution in Peru: Cailloma, **Arequipa**.

Specificity: Polyxenous (Ctenomyidae and Cricetidae).

Reference: [18].

Distributed in Argentina and southern Peru. Initially described as female specimens, the male was first described by López-Berrizbeitia et al. [92]. Both sexes are characterized by a six-segmented labial palp; seven dorsal notches on the posterior tibia; and a middle abdominal terga with a seta of the main row below the level of the spiracle.

40. *Ectinorus (Ectinorus) hecate* Johnson, 1957

Host: *Leopardus garleppi* (Matschie, 1912).

Distribution in Peru: Huaylarco, **Arequipa**.

Specificity: Monoxenous.

Reference: [13,18].

Distributed only in southern Peru. Described only from female specimens, the male is unknown. The type host, *L. garleppi*, is considered an accidental host [13,18]. The female is distinguished from the other species of the subgenus by presenting an antennal pedicel without a row of small lateral setae; tergum I with marginal spurs; labial palpus with 5 segments; pronotum with two rows of setae; and caudal margin of S-VII strongly straight.

41. *Ectinorus (Ectinorus) hertigi* (Johnson, 1957)

Host: *Ctenomys peruanus* Sanborn & Pearson, 1947.

Distribution in Peru: Pampa Queullicota, Ilave, Pichupichuni, **Puno**.

Specificity: Oligoxenous (*Ctenomys fulvus* from Chile).

Reference: [13,18].

Distributed in Chile and southeastern Peru. First described in Peru as *Dysmicus hertigi* by Johnson [13], later modified by Smit [18]. Morphologically similar to *E. (Ectinorus) claviger*, males differ in having a smooth posterior margin of pronotum; metepimere with two rows of setae; the arm of the dorsoapical angle of S-IX more angular; straight ventral margin; manubrium with rounded apex; and apex of basimere not bilobed. Females have sensillum with less than 20 sensory pits on each side; cribriform area at the level of the surface of the bulge; and metepimere with two rows of setae.

42. *Ectinorus (Ectinorus) hirsutus* Hastriter, 2009

Host: *N. ebriosus*.

Distribution in Peru: Yauli, **Junín**.

Specificity: Monoxenous.

Reference: [93].

Distributed only in Central Peru. The holotype host is *Neotomys* sp. captured in Junín; currently, the only species in Peru of the genus *Neotomys* is *N. ebriosus* [38]. Males are distinguished from members of the subgenus *Ectinorus* by the following characters: apical spurs present on T-I; the process basimeris ventralis is apical and not attached ventrally to the basimere margin; the crochet is spoon-shaped and S-VIII has an accessory lobe with setae extending beyond the ventral apex of the caudal margin of S-VIII [93].

43. *Ectinorus (Ectinorus) ineptus* Johnson, 1957

Host: *A. pictus*.

Distribution in Peru: Picotani, **Puno**.

Specificity: Pleioxenous (Cricetidae).

Reference: [13,18].

Distribution in Chile and southeastern Peru. Described from male specimens by Johnson [13], the female was later described by Beaucournu and Gallardo [94] and redescribed by Beaucournu et al. [95].

44. *Ectinorus (Ectinorus) pearsoni* (Johnson, 1957)

Host: *Phyllotis* sp.

Distribution in Peru: Pomata, **Puno**.

Specificity: Pleioxenous (*Akodon* and *Phyllotis*).

Reference: [13,18].

Distributed in Bolivia and southeastern Peru. The female is unknown. The male is distinguished from the rest of the subgenus by having an antennal peduncle without a row of small lateral setae; tergum I without marginal spurs, basimere with a process basimeris ventralis, labial palpus with 5 segments, which does not extend beyond the middle of the anterior trochanter, posterior margin of the pronotum smooth, metepimer with a row of setae, manubrium basally is quite narrow.

45. *Ectinorus (Ectinorus) sentus* (Rothschild, 1914)

Host: *L. viscacia*.

Distribution in Peru: La Oroya, **Junín**.

Specificity: Monoxenous.

Reference: [13,18,21,62].

Distributed only in central Peru. The female is unknown. The male is similar to *E. (Ectinorus) claviger*, but differs from the latter by having a ventral basimere process shorter than the telomere (not shorter than the telomere in *E. (Ectinorus) claviger*).

46. *Ectinorus (Ectinorus) simonsi* (Rothschild, 1904)

Host: *G. musteloides*.

Distribution in Peru: Yura, **Arequipa**.

Specificity: Polyxenous (Octodontidae, Chinchillidae and Caviidae).

Reference: [18].

Distributed in Bolivia, Chile and southwestern Peru. Species described as *Pulex simonsi*, later synonymised with *Dysmicus acheronis* (Johnson, 1957) and redescribed by Smit, [18]. Diagnosis similar to *E. (Ectinorus) claviger* and *E. (Ectinorus) sentus*, males are differentiated from other similar species by having a thin telomere, approximately five times longer than its maximum width; females are similar to *E. (Ectinorus) hertigi* and are differentiated only by the presence of a single row of setae on the metepimeron; posterior margin of sternum VI with a shallow sinus; non-quadrangular spermatheca.

47. *Ectinorus (Ectinorus) viscachae* (Wagner, 1937)

Host: *G. musteloides*; *L. viscacia*.

Distribution in Peru: Yura, **Arequipa**; Querobamba, Tayapampa, **Ayacucho**; La Oroya, **Junín**; Caccachara, Ilave, Santa Rosa, Pisacoma, **Puno**.

Specificity: Euryxenous (Rodentia and Lagomorpha).

Reference: [13,18,58].

Distributed in central and southern Peru. This species was reported with its synonyms *Dysmicus viscachae* Wagner, 1937 and *Dysmicus acheronis* (Johnson, 1957) in Puno and Arequipa, respectively. Males are differentiated from the others within the subgenus by having a basimere without a basimeris ventralis process, a club-shaped distal arm of sterno IX and a wide telomere towards the apex. Females are differentiated from the others within the subgenus by having a labial palp with 5 segments, a sensillum with more than 20 pits on each side, an almost spherical spermatheca and sterno II with a lateral patch with more than 6 setae.

48. *Parapsyllus cedei* Smit 1970

Host: *Pelecanoides garnotii* (Lesson, 1828).

Distribution in Peru: Islas de las viejas, **Ica**.

Specificity: Polyxenous (Procellariiformes: Procellariidae and Pelecanoides).

Reference: [18].

Distributed on Genovesa, Santa Cruz and Plaza Islands in the Galapagos and, in Peru, only on the Viejas Islands. The originally described species was collected from nests of shearwater and petrels [18]. This species belongs to the longicornis-gwuip subgroup and is distinguished from all other members by the presence of 5 notches on the posterior margin of the meso- and metatibiae and 3 pairs of lateral plantar setae.

49. *Tetrapsyllus (Phylliver) bleptus* (Jordan et Rothschild, 1923)

Host: *A. cinerea*; *A. jelskii*; *Akodon* sp.; *C. lepidus*; *Ctenomys opimus* Wagner, 1848; *C. sahamae*; *P. andium*; *Phyllotis* sp.; *P. xanthopygus*; *P. lemminus*.

Distribution in Peru: Pariacota, Huaraz, **Ancash**; Carhuamayo, **Junín**; Caccachara, **Puno**.

Specificity: Pleioxenous (Cricetidae).

Reference: [13,18,21,58].

This species has a distribution in the Andean and Patagonian subregions. In Argentina, it has been reported on *Akodon simulator*, *A. spegazzinii* *Phyllotis osilae* [96] and *Reithrodon caurinus* [97]. Beaucournu and Gallardo [98] mention that *T. (P.) bleptus* is a recognized species in several locations of western Argentina and southern Peru; it was also reported in Chile on *Phyllotis darwini*. The male is distinguished from the rest of the subgenus *Phylliver* by having a telomere that extends beyond the apex of the basimere and 20 or fewer setae on the lateral surface of the hind tibia. The female has a non-angulated hilla, a sinus presenting on the posterior margin of S-VII and the same characteristic of the tibia as the male [96].

50. *Tetrapsyllus (Phylliver) elutus* Johnson, 1957

Host: *A. albiventer*.

Distribution in Peru: Pampa de Capazo, Ilave, **Puno**.

Specificity: Pleioxenous (Cricetidae).

Reference: [13,18].

It is distributed in the Andean subregion of Chile and southeastern Peru. This species is very similar to *T. (P.) bleptus*, The females of both species are indistinguishable, but males are different., In male *T. (P.) elutus*, the apex of the telomere does not extend beyond the basimere.

51. *Tetrapsyllus (Phylliver) tristis* Johnson, 1957

Host: *A. jelskii*; *C. peruanus*; *C. opimus*.

Distribution in Peru: Lago Suches, **Moquegua**; Pampa de Ancomarca; Pampa Queullecota, **Puno**.

Specificity: Polyxenous (Cricetidae and Ctenomyidae).

Reference: [13,18].

Distribution only in southern Peru. The morphological characterization of *T. (P.) tristis* stands out for the observation of more than 30 setae on the lateral surface of the metatibia, unlike the other species that consist of at least 20 setae in the same position.

52. *Tetrapsyllus (Tetrapsyllus) comis* Jordan, 1931

Host: *A. mollis*; *T. cinereus*.

Distribution in Peru: El Tambo. Huancabamba, **Piura**.

Specificity: Pleioxenous (Cricetidae).

Reference: [18].

Its distribution covers the Andean subregion. Berrizbeitia et al. [96] mention a certain morphological characterization for this species through the study of its genitalia; the males of *T. (T.) comis* have a narrow telomere with few and tiny bristles on the mesal surface; as for the female, she has the spermatheca with a spherical protuberance.

Subfamily Rhopalopsyllinae

53. *Polygenis (Ayeshaepsylla) thurmani* Johnson, 1957

Host: *A. jelskii*; *O. destructor*; *P. osilae*.

Distribution in Peru: Limbani, **Puno**.

Specificity: Pleioxenous.

Reference: [13,18].

This species is found in the Andean subregion. In male individuals of *P. (A.) thurmani*, the sclerotized internal tube of the aedeagus is reflected dorsally.

54. *Polygenis (Gephyropsylla) klagesi klagesi* (Rothschild, 1904)

Host: *A. mollis*; *Neacomys* sp.; *Neacomys spinosus* (Thomas, 1882); *Proechimys breviceauda* (Gunther, 1877); *Proechimys decumanus* (Thomas, 1899); *Proechimys simonsi* Thomas, 1900; *Proechimys* sp.

Distribution in Peru: Jenaro Herrera, **Loreto**; Aguas Verdes, La Palma, Papayal, **Tumbes**.

Specificity: Polyxenous.

Reference: [18,69].

It has a distribution in the Amazon, Brazilian and Caribbean subregions. Méndez [25] reports the presence of this species in Ecuador, Colombia, Venezuela, Trinidad and Costa Rica. *P. klagesi* is distinguished from the rest of the species of the genus by having a group of two setae on the subapical dorsal notch of the metatibia, the third segment of the protarsus is wider than it is long and the fifth segment is one and a half times longer than it is wide.

55. *Polygenis (Gephyropsylla) klagesi samuelis* (Jordan & Rothschild 1923)

Host: *A. xanthaeolus*; *D. marsupialis*; *Myoprocta pratti* Pocock, 1913; *P. simonsi*.

Distribution in Peru: Isla Matapalo, **Tumbes**; Pucallpa, **Ucayali**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [18,69].

This species is distributed in the Caribbean, Andean and Amazonian subregions. Parasitizing marsupials have also been reported in Colombia [99] and Brazil [100].

56. *Polygenis (Polygenis) bohlsi bohlsi* (Wagner, 1901)

Host: *A. mollis*; *A. xanthaeolus*; *Lycalopex* sp.; *P. andium*; *Thomasomys taczanowskii* (Thomas, 1882).

Distribution in Peru: Catacaos, Huancabamba, La Laguna, Suyo, **Piura**.

Specificity: Euryxenous.

Reference: [18].

Very wide distribution, found in Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Paraguay, Peru and Venezuela. Smit [18] mentions *Phyllotis auritus* (= *Reithrodon auritus*) (Fischer, 1814) from Peru as a host of *P. (Polygenis) bohlsi bohlsi*; however, this mammal is not known in the country [38].

57. *Polygenis (Polygenis) brachinus* Jordan, 1950

Host: *A. xanthaeolus*; *A. mollis*; *Nectomys apicalis* Peters, 1861; *R. rattus*; *Sylvilagus* sp.; *Thomasomys gracilis* Thomas, 1917.

Distribution in Peru: Cascas, El Sauce, Pueblo Nuevo, **Cajamarca**; Chanchamayo, **Junín**; Cajas, Canchaque, Huancabamba, Huaylas, Pundín, Siclamache, **Piura**.

Specificity: Euryxenous.

Reference: [13,18,55].

Described based on specimens collected from wild rabbits in Huancabamba, Piura. This species has very characteristic genitalia, which differs noticeably from closely related species, making it easier to recognize. The spermatheca of females has a very short tail, smaller than that of *P. (P.) litargus*; males have a ventral division close to the row of setae on sternites VIII.

58. *Polygenis (Polygenis) impavidus* Johnson, 1957

Host: *Thomasomys* sp.

Distribution in Peru: Limapunche, **Cusco**; Sandia, Tambopata, San Juan, Limbani, **Puno**.

Specificity: Monoxenous.

Reference: [13,18].

This species has a geographical distribution in the Andean subregion. It is characterized by presenting 6 notches in the metatibia, including the apical notch, females are distinguished by having the anal stylet three and a half times longer than wide, and the males have the apical part of the coiled internal tube of the aedeagus very small and barely completes one turn.

59. *Polygenis (Polygenis) litargus* (Jordan & Rothschild 1923)

Host: *Aegialomys* sp.; *A. xanthaeolus*; *A. mollis*; *Akodon* sp.; *D. marsupialis*; *Didelphis* sp.; *Euryoryzomys nitidus* (Thomas, 1884); *N. spinosus*; *O. arenalis*, *O. destructor*; *Oxymycterus inca* Thomas, 1900; *P. amicus*; *P. andium*; *P. decumanus*; *Proechimys* sp.; *R. norvegicus*; *R. rattus*; *R. leucodactylus*; *S. peruanus*; *Simosciurus nebouxii* (I. Geoffroy St.-Hilaire, 1855); *Sylvilagus* sp.; *Thomasomys* sp.

Distribution in Peru: Valle del Rio Santa, Choquechaca, Hauzlas, Llampá, **Ancash**; Cascas, El Sauce, El Mirador, Pueblo Nuevo, **Cajamarca**; Nazca, **Ica**; Verrugas Cañon, **Junín**; Campiña La Merced, Hacienda Laredo, Trujillo, **La Libertad**; Pimental, **Lambayeque**; Sapillica, Ayabaca, Montero, Sujo, Paimas, Catacaos, La Laguna, Cazaderos, Huancabamba, Huaylas, Jabonillos, Lancones, Quebrada Pasayo, Socchabamba, **Piura**; Aguas Verdes, Isla Matapalo, La Palma, Papayal, **Tumbes**.

Specificity: Euryxenous.

Reference: [12,13,18,21,55,71,101].

Macchiavello [12] mentions that on the northern border of Peru, *Polygenis (P.) litargus* lives in open fields and is found as a unique species in various species of wild rodents, and highlights its potential as a vector of plague; it can also occasionally feed on humans.

60. *Polygenis (Polygenis) litus* (Jordan & Rothschild 1908)

Host: *S. nebouxii*; “Cricetinae”.

Distribution in Peru: Lancones, **Piura**.

Specificity: Polyxenous.

Reference: [12,13,18].

Macchiavello [12] and Johnson [13] mention this species in a mouse belonging to the subfamily Cricetinae. The host in Peru was reported as *Sciurus stramineus nebouxii*, but the only species of the genus *Simosciurus* in Peru is *S. nebouxii* [38].

61. *Polygenis (Polygenis) roberti roberti* (Rothschild, 1905)

Host: Unknown.

Distribution in Peru: Sivia, **Cusco**.

Specificity: Euryxenous.

Reference: [18].

Reported in the Amazon, Andean and Brazilian subregions. It has also been identified in Argentina [102]. In Brazil, *P. r. roberti* was found parasitizing marsupials, felines and rodents.

62. *Polygenis (Polygenis) roberti beebei* (I.Fox, 1947)

Host: *Dasypus novemcinctus* Linnaeus, 1758; *E. nitidus*; *Oligoryzomys arenalis* (Thomas, 1913).

Distribution in Peru: Sivia, **Apurímac**; Hacienda Cadena: Marcapata, **Cusco**.

Specificity: Euryxenous.

Reference: [13,18].

Johnson [13] mentions this species on *O. longicaudatus* in a locality stated as “Frontera con Ecuador”, probably referring to some site in the department of Tumbes and to another host, *O. arenalis*. It is distributed in the Amazon, Andean and Caribbean subregions, and is present in Argentina [103], Venezuela [104] and Costa Rica [105].

63. *Polygenis (Polygenis) rimatus* (Jordan, 1932)

Host: *A. xanthaeolus*; *A. mollis*.

Distribution in Peru: Llampá, **Ancash**; Huancabamba, **Piura**.

Specificity: Euryxenous.

Reference: [18].

This species has been reported in the Andean, Brazilian and Patagonian subregions. It has also been reported in northwestern Bolivia [106], and, although rodents predominate among its hosts, in Brazil it has also been identified on marsupials [107].

64. *Rhopalopsyllus australis tupinus* (Jordan & Rothschild 1923)

Host: *M. pratti*; *Speothos venaticus* (Lund, 1842).

Distribution in Peru: Río Perené, **Junín**; Huancabamba, **Piura**; Pucallpa, **Ucayali**.

Specificity: Euryxenous.

Reference: [12,13,18,69].

This species is distributed in the Brazilian subregion and has also been reported in Colombia, Panama, Mexico, Trinidad, Venezuela and Guyana in a wide range of mammals such as marsupials, carnivores, lagomorphs, anteaters, ungulates and rodents [99,108]. Jordan and Rothschild [109] report *R. a. tupinus* in Bolivia, parasitizing *Speothos venaticus* under its synonym *Icticyon venaticus* Lund 1842.

65. *Rhopalopsyllus cacticus* Jordan & Rothschild 1908

Host: *A. mollis*; *C. porcellus*; *D. novemcinctus*; *P. amicus*; *S. brasiliensis*.

Distribution in Peru: Río Perené, **Junín**; Matucana, **Lima**; Huancabamba, Soccha, **Piura**.

Specificity: Euryxenous.

Reference: [12,13,18,110].

This species is found in the Andean subregion. It was first described in Peru as *Tatusia novemcincta*, a synonym of *Dasypus novemcinctus*. It has been reported in Panama [111]; in addition, Lewis [112] notes that subspecies of *R. cacticus* are distributed from Texas to Venezuela and Peru.

66. *Rhopalopsyllus lugubris lugubris* Jordan & Rothschild 1908

Host: *Cuniculus paca* (Linnaeus, 1766); *D. marsupialis*; *F. catus*.

Distribution in Peru: Oxapampa, **Pasco**; **Piura**; Pucallpa, **Ucayali**.

Specificity: Euryxenous.

Reference: [12,13,18,21,69].

This species has a wide distribution, being found in the Amazon, Andean, Brazilian and Caribbean subregions. In addition to Peru, it has been reported in Colombia, Argentina, Brazil, Bolivia, Venezuela, Costa Rica and Panama [99,105,113–115]. Although it is commonly associated with didelphids, it has been reported in cervids (*Mazama gouazoubira*) in Brazil [116,117].

67. *Tiamastus cavicola* (Weyenbergh 1881)

Host: *A. xanthaeolus*; *C. familiaris*; *C. aperea*; *C. porcellus*; *F. catus*; *G. musteloides*; *R. norvegicus*; *R. rattus*.

Distribution in Peru: Valle del Río Santa, Choquechaca, Hauzlas, Llampá, **Ancash**; Yura, **Arequipa**; Cutervo, El Páramo, Jaén, **Cajamarca**; La Raya, **Cuzco**; Hacienda San Pablo, **Ica**; Lago Junín, **Junín**; Otuzco, Trujillo, **La Libertad**; Villa Eten, **Lambayeque**; **Moquegua**; Huacho, **Lima**; Huancabamba, Sapillica, Ayabaca, Soccha, **Piura**; **Tumbes**.

Specificity: Euryxenous.

Reference: [12,18,21,55,71,75,76,118].

This species is distributed in the Andean and Patagonian subregions. Dittmar [118] mentions that it is an indigenous species in South America, in the neotropical region, having a wide geographic range, found in Argentina, Peru, Chile and Bolivia.

Family Stephanocircidae.

Subfamily Craneopsyllinae.

68. *Cleopsylla townsendi* Rothschild, 1914

Host: *A. jelskii*; *Akodon albiventer* Thomas, 1897; *Akodon lutescens* J. A. Allen, 1901; *A. mollis*; *A. boliviensis*; *Auliscomys pictus* (Thomas, 1884); *C. sahamae*; *O. destructor*; *Phyllotis limatus* Thomas, 1912; *P. amicus*; *P. andium*; *Punomys lemminus* Osgood, 1943.

Distribution in Peru: Chiquian, Pariacota, Huaraz, Huaylas, Parque Nacional Huascarán, Río Santos, Recuay, Collao, Pampa de Ancomarca, Pampa de Capazo, **Ancash**; Carhuamayo, Jauja, Pampa de Ancomarca, **Junín**; Caccachara, Mariscal Nieto, **Moquegua**; Pachacayo Pampa de Capazo Caccachara, Ilave, Limbani, Picotani, San Antonio de Putina, **Puno**; Tarata, **Tacna**.

Specificity: Polyxenous (Rodentia: Cricetidae and Octodontidae).

Reference: [13,21,62,119].

The genus and species were described based on specimens collected from mice in Pachacayo, Puno. It is currently distributed in Argentina, Chile and south-central Peru [10,119]. It is distinguished from other species of the genus by the absence of a false comb at the level of the fourth and fifth dorsal lateral notch on the metatibia and males by the length of the distal arm of the sterno IX, which is four times longer than its widest portion.

69. *Craneopsylla minerva minerva* (Rothschild, 1903)

Host: *A. mollis*; *Akodon* sp; *Auliscomys sublimis* (Thomas, 1900); *P. amicus*; *P. andium*; *P. limatus*; *Rattus* sp; *Thomasomys* sp.

Distribution in Peru: Valle del Río Santa, Choquechaca, Hauzlas, Pariacota, Huaraz, Yungilla, Huari, Parque Nacional Huascarán, Huaylas, Recuay, **Ancash**; Arequipa; Sapollica, Ayabaca, Siclamanché, **Piura**; Limbani, **Puno**; Tarata, **Tacna**.

Specificity: Euryxenous (Rodentia and Didelphimorphia).

Reference: [12,13,21,71].

This subspecies has a wide geographic distribution in South America, including Argentina, Brazil, Chile, Ecuador, Paraguay, Peru, Uruguay and Venezuela. In Peru, they have only been reported in cricetid and murid rodents; in Argentina and Paraguay, they are also reported in didelphids. It can be distinguished from the only other subspecies, *Craneopsylla minerva wolffhuegeli* (Rothschild, 1909), by the presence of five spines on each side of the genal comb.

70. *Nonnapsylla rothschildi* Wagner, 1938

Host: *Galea musteloides* Meyen, 1833.

Distribution in Peru: Pisacoma, Pomata, **Puno**.

Specificity: Polyxenous (Rodentia).

Reference: [13].

The genus *Nonnapsylla* Wagner, 1938 includes only 1 species, *Nonnapsylla rothschildi*. Two subspecies were recognized by Johnson [13]. Moreover, Lareschi et al. [120] conclude that both subspecies must be considered synonymous. It is distributed in Argentina, Bolivia, Chile and southeastern Peru. The diagnosis of the genus is the same for the species, based on the angled anterior margin of the head, the helmet completely separated from the rest of the head, with striations, and the presence of an area of marginal and submarginal mesal setae on the procoxa.

71. *Plocopsylla achilles* (Rothschild, 1911)

Host: *A. mollis*; *Nephelomys albigularis* (Tomes, 1860); *P. andium*.

Distribution in Peru: Chiquian, Parque Nacional Huascarán, Huaylas, Recuay, **Ancash**; Chota, **Cajamarca**.

Specificity: Polyxenous (Cricetidae and Muridae)

Reference: [13,21].

It is distributed in Chile, Ecuador and central eastern and northeastern Peru. Schramm and Lewis [20] revised the genus *Plocopsylla* Jordan (1931) and restructured it into two groups and six subgroups based on the mobile process, sterno IX and the clasper with the mesal process. The diagnosis of the species is based on the presence of five spines on the

genal comb and a genal spine that is at least half as long as the longest adjacent one on the genal comb.

72. *Plocopsylla enderleini* Wagner, 1933

Host: *C. sahamae*.

Distribution in Peru: Cailloma, **Arequipa**; Limbani, Picotani, **Puno**; Tarata, **Tacna**.

Specificity: Polyxenous (Chinchillidae, Muridae and Cricetidae).

Reference: [13,20].

It is geographically distributed in Bolivia, Chile and southern Peru. The type of host is “rat” from La Paz, Bolivia, but *C. sahamae* is mentioned in other localities and in undetermined cricetids from Puno [20]. The classification of the species is based on the presence of six spines on the genal comb without basal notches, the prectenidial area of the helmet with a width 1.5 times the length of the longest spine of the adjacent comb.

73. *Plocopsylla hector* Jordan, 1931

Host: *A. mollis*; *O. destructor*; *R. rattus*; *Thomasomys* sp.

Distribution in Peru: Tambo, **La Libertad**; Huancabamba, **Piura**; Sauce, **San Martín**.

Specificity: Polyxenous (Cricetidae and Muridae).

Reference: [20].

It is distributed in Ecuador and northern Peru. Schramm and Lewis [20] mention the locality of Tambo in Piura, but according to the coordinates (7.35 S, 78.42 W), it belongs to the department of La Libertad. The diagnosis is based on the setae on the dorsal margin of the metatibia forming a false comb and the width of the prectenidial hoof approximately equal to or greater than the length of the longest spine of the hoof.

74. *Plocopsylla inti* Johnson, 1957

Host: *Phyllotis magister* Thomas, 1912; *P. limatus*.

Distribution in Peru: Tarata, **Tacna**.

Specificity: Oligoxenous (*Phyllotis*).

Reference: [13].

Distributed only in southern Peru, it is easily distinguishable from the rest of the species of the genus by the presence of seven spines on the genal comb.

75. *Plocopsylla kilya* Schramm et Lewis, 1987

Host: *A. xanthaeolus*; *Thomasomys* sp.; *Thomasomys cinereus* (Thomas, 1882).

Distribution in Peru: Tambo, **La Libertad**; Huancabamba, **Piura**.

Specificity: Pleioxenous (Cricetidae).

Reference: [20].

Distributed only in northern Peru. Schramm and Lewis [20] mention the locality of Tambo in Piura, but according to the coordinates (7.35 S, 78.42 W), it belongs to the department of La Libertad. This species has the same diagnosis as *P. hector* to separate it from the rest of the species of the genus, but differs from the latter in having the width of the prectenidial helmet much smaller than the length of the longest spine of the helmet.

76. *Plocopsylla pallas* (Rothschild, 1914)

Host: *A. mollis*; *C. lepidus*; *P. amicus*; *P. andium*.

Distribution in Peru: Río Santos, Recuay, Pariacota, **Huaraz**, Ancash; Carhuamayo, Pachacayo, **Junín**.

Specificity: Pleioxenous (Cricetidae).

Reference: [20,21,62].

Distributed only in the central Andes of Peru. Described from female specimens, and later, Hastriter et al. [21] described the male. The diagnosis is based on the presence of six spines on the genal comb without a basal notch and the width of the prectenidial helmet is twice the length of the longest spine on the helmet.

77. *Plocopsylla viracocha* Schramm et Lewis, 1987

Host: *P. limatus*; *P. osilae*; *Phyllotis* sp.; *P. lemminus*.

Distribution in Peru: Heda, **Arequipa**; Huancavelica, **Huancavelica**; Limbani, **Puno**; Caccachara, Pampa de Ancomarca, Tarata, **Tacna**.

Specificity: Pleioxenous (Cricetidae).

Reference: [20].

Distributed in Chile and southern Peru. Schramm and Lewis [20] mention the coordinates 17.20 S, 70.00 W; 17.10 S, 70.15 W; 17.02 S, 70.20 W as belonging to the department of Puno, but, they are actually part Tacna. Also, 16.10 S, 71.00 W was wrongly attributed to Puno when, it actually belongs to Arequipa. The morphology is similar to *P. pallas* and *P. enderleni*; it is differentiated from both species by having the lowest of the 3 bristles on the fourth to sixth dorsal notch from the proximal end of the hind tibia and separated from the other 2 bristles by a space equal to or greater than the basal width of the lowest bristle.

78. *Sphinctopsylla inca* (Rothschild, 1914)

Host: *A. mollis*; *A. pictus*; *P. andium*; *P. osilae*.

Distribution in Peru: Chiquian, Parque Nacional Huascarán, Huaylas, **Ancash**; Carhuamayo, Pachacayo, **Junín**; Pomata, **Puno**.

Specificity: Pleioxenous (Cricetidae).

Reference: [13,21,62].

It is distributed in Bolivia, Ecuador, the central Andes and southern Peru [121]. Initially described as *Craneopsylla inca* and later changed to the genus *Sphinctopsylla* by Jordan [122]. Currently, there are six species in this genus and *S. inca* is the only one recorded in Peru. It can be differentiated from the rest of the species of the genus by presenting only two rows of setae on the pronotum, the pronotal comb with the last dorsal spines with fine tips and a genal comb with five spines.

79. *Tiarapsylla bella* Johnson, 1956

Host: *Leopardus garleppi* (Matschie, 1912).

Distribution in Peru: Picotani, **Puno**.

Specificity: Monoxenous.

Reference: [13,67].

Distributed only in southeastern Peru. It was described from female specimens. It was discovered from wild cats in Peru. Johnson [67] suggests that this host is undoubtedly abnormal or accidental, the true host probably being vizcachas (as in the case of *T. titchacki* Wagner, 1937) since the cat from which the specimens of *T. bella* were taken was observed hunting vizcachas. The genus currently has three species from which *T. bella* is distinguished by the lack of a membranous flap covering the second antennal segment, the base of the sinuous helmet comb and the small bristles present posteriorly on the third or fourth dorsal helmet spine.

80. *Tiarapsylla titchacki* Wagner, 1937

Host: *Lagidium viscacia* (G. I. Molina, 1782); “felino”.

Distribution in Peru: Recuay, **Ancash**; Capillsa, **Junín**; Tayapampa, **La Libertad**; Picotani, **Puno**.

Specificity: Euryxenous (Rodentia and Carnivora).

Reference: [13,21,67].

Distributed in the Andean region of Peru. Hastriter et al. [21] mention that this species of flea has as host preference *L. viscacia* and that the reported feline is abnormal or accidental due to its association as a predator of the vizcacha. It differs from the other species of the genus by lacking a membranous flap covering the second antennal segment, convex base of the helmet comb and small bristles present behind the second dorsal spine of the helmet.

Family Tungidae.

81. *Hectopsylla eskeyi* Jordan, 1933

Host: *C. familiaris*; *C. aperea*; *G. musteloides*; *G. gallus*; *R. norvegicus*; *R. rattus*.

Distribution in Peru: Yura, **Arequipa**; Trujillo, **La Libertad**; Huacho, **Lima**.

Specificity: Euryxenous.

Reference: [12,13].

It is distributed in the Andean subregion and has also been reported in central, southern and western Ecuador and La Paz, Bolivia [12,55]. The males of most *Hectopsylla* species are differentiated by the presence of rows of 3 setae on tergites V and VI [123]. Likewise, in the male genitalia, *H. eskeyi* has the dorsal lobe (DA9) without lateral setae, unlike *H. cypha*, and four pairs of lateral setae on the fifth tarsal segment, unlike *H. suarezi*.

82. *Hectopsylla psittaci* Von Frauenfeld, 1860

Host: *Didelphis* sp., *Eptesicus* (*Histiotus*) *montanus* (Philippi & Landbeck, 1861).

Distribution in Peru: Trujillo, Huaura, **La Libertad**; Campiña, Huacho, **Lima**; Hacienda Las Vegas (Loreta, Barranca), **Loreto**.

Specificity: Euryxenous.

Reference: [13,21,55].

Although the genus *Hectopsylla* is common in mammals, this species is mainly associated with birds. In Peru, it was reported in birds and also on a marsupial didelphid in Trujillo [55]. It has a distribution in the Andean and Brazilian subregions.

83. *Hectopsylla suarezi* C. Fox, 1929

Host: *Aegialomys* sp.; *C. aperea*; *C. porcellus*; *R. norvegicus*, *R. rattus*; *S. peruanus*.

Distribution in Peru: Progreso, Huari, Chimbote, **Ancash**; Chinchá, **Ica**; Trujillo, **La Libertad**; Ucupe, **Lambayeque**; Huacho, **Lima**; Huancabamba, **Piura**; **Tumbes**.

Specificity: Polyxenous.

Reference: [12,13,21,55].

This species is distributed in the Andean subregion. It has also been reported in Ecuador, on *M. musculus* and *C. aperea* [124,125], and Chile [126]. It is distinguished from other *Hectopsylla* species by having five pairs of lateral setae on the fifth tarsal segment.

84. *Hectopsylla pulex* Haller, 1880

Host: *Artibeus obscurus* (Schinz, 1821); *Eptesicus* (*Histiotus*) sp.; *Molossus* sp.; *T. brasiliensis*.

Distribution in Peru: Quince Mil, **Cusco**; Río Chinchao, Huánuco; Campiña, Huaura, Huacho, **Lima**; Santo Domingo, **Puno**.

Specificity: Polyxenous.

Reference: [12,13,21,127,128].

This species was recorded in bats, but under the name of its synonyms *Rhynchopsyllus megastigmata* Traub & Gammons, 1950 and *Rhynchopsyllus pulex* Haller, 1880. It has a distribution in the Amazon subregion, the Brazilian subregion and the Patagonian subregion. It has been reported in Colombia, Panama, Argentina, Brazil, Bolivia, Chile, Ecuador and Venezuela [129–131].

85. *Tunga penetrans* Linnaeus, 1758

Host: *C. familiaris*; *Cavia* sp.; *F. catus*; *G. gallus*; *H. sapiens*; *Rattus* sp.; *S. scrofa*.

Distribution in Peru: Valle del Río Santa, Choquechaca, Hauzlas, Chimbote, Pomabamba, Pomabamba, **Ancash**; **Cajamarca**; **Ica**; Huacho, **Lima**; **Piura**.

Specificity: Euryxenous.

Reference: [12,13,21].

Macchiavello [12] reports this species throughout the Pacific coast in humans, dogs and pigs. It is also reported throughout the Amazon subregion, the Antilles, the Brazilian subregion, the Caribbean subregion, East America and West America.

86. *Tunga trimamillata* Pampiglione et al., 2002

Host: Cattle, sheep and goats.

Distribution in Peru: Suyu, Ayabaca, **Piura**.

Specificity: Euryxenous.

Reference: [132].

This is a species that was reported only in Ecuador and northern Peru [133]; however, in 2013, it was reported for the first time in Brazil, in the states of São Paulo, Felixândia and Minas Gerais [134].

3.2. Flea–Host Interaction Network

The flea–host interaction network exhibited a modular structure, with a significant modularity (Q) and non-significant nestedness (NODF), and no internal nestedness within modules (non-significant NODF_{sm}) (Table 1, Figure 6A). Modular structure grouped some phylogenetically related flea species, which can be more clearly observed for the genera *Polygenis* and *Ectinorus* (Figure S1). However, hosts are apparently more dispersed in this regard (Figure S1).

Table 1. Structural properties of the national-scale interaction network between fleas and their hosts in the Peruvian territory. Metric include modularity (Q) and nestedness for the entire network (NODF_{total}), pairs of species from the same module (NODF_{sm}) and pairs of species from different modules (NODF_{dm}). Significance values (z-scores and p -values) are shown for both null models: free null model (free) and restricted null model (rest). Significant p -values are in bold.

Network Metric	Value	z-Score (Free)	p -Value (Free)	z-Score (Rest)	p -Value (Rest)
Q	0.57	9.52	<0.001	NA	NA
NODF _{total}	10.57	−0.56	0.69	1.54	0.05
NODF _{sm}	33.26	14.36	<0.001	0.71	0.30
NODF _{dm}	5.00	−6.66	<0.001	2.17	<0.001

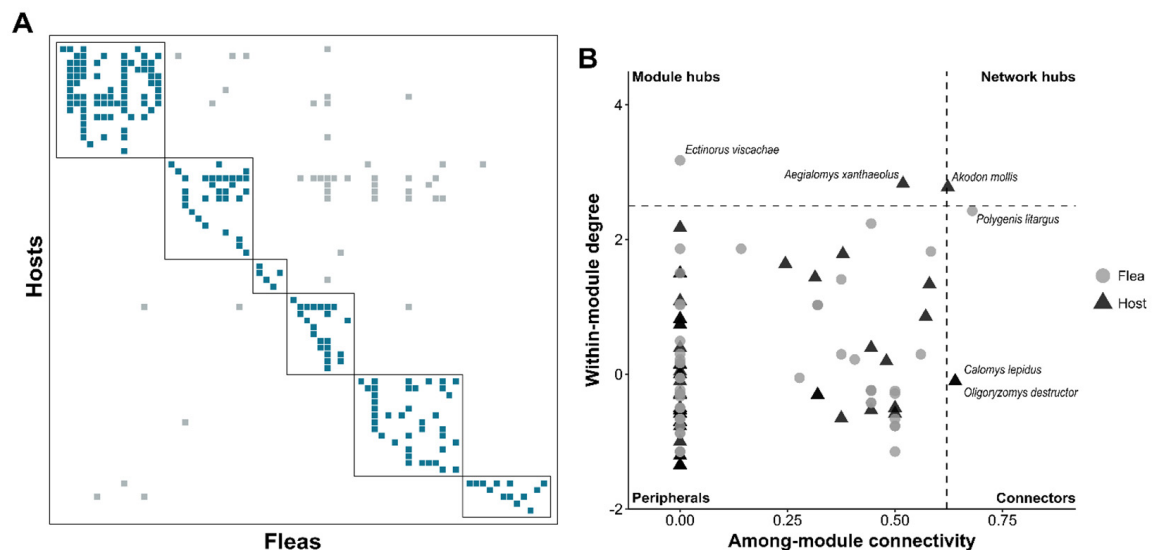


Figure 6. (A) Modular structure of the national-scale interaction network between fleas and their hosts in the Peruvian territory and (B) the roles of the species in this structure. Interactions among species from different modules in Figure A are in gray.

Within this modular structure, two sigmodontine rodents (*C. lepidus* and *O. destructor*) and one rhopalopsyllid flea (*P. litargus*) acted as connectors between modules; one sigmodontine rodent (*A. xanthaeolus*) and one rhopalopsyllid flea (*E. viscachae*) served as module hubs, while only one sigmodontine rodent functioned as a network hub (*A. mollis*) (Figure 6B). Without considering the modular configuration, four flea species and three rodent species demonstrated high interaction counts and connectivity across the entire network: *P. litargus* (Rhopalopsyllidae), *P. irritans* (Pulicidae), *N. crassispina* (Hystrichopsyllidae), *C. townsendi* (Stephanocircidae), *A. mollis* (Cricetidae), *R. norvegicus* (Muridae) and *P. andium* (Cricetidae) (Table 2).

Table 2. Normalized degree centrality and betweenness centrality of species at the entire national-scale interaction network between fleas and their hosts in the Peruvian territory. Only the 10 highest-ranked species in both metrics are displayed. Species present in both top 10 lists are in bold.

Normalized Degree Centrality		Betweenness Centrality	
Species	Value	Species	Value
<i>Akodon mollis</i>	0.254	<i>Akodon mollis</i>	0.200
<i>Polygenis litargus</i>	0.250	<i>Neotyphloceras crassispina</i>	0.153
<i>Pulex irritans</i>	0.203	<i>Rattus norvegicus</i>	0.128
<i>Rattus rattus</i>	0.194	<i>Phyllotis andium</i>	0.124
<i>Neotyphloceras crassispina</i>	0.188	<i>Polygenis litargus</i>	0.123
<i>Cleopsylla townsendi</i>	0.188	<i>Pulex irritans</i>	0.123
<i>Echidnophaga gallinacea</i>	0.188	<i>Aegialomys xanthaeolus</i>	0.107
<i>Rattus norvegicus</i>	0.164	<i>Cleopsylla townsendi</i>	0.099
<i>Phyllotis andium</i>	0.149	<i>Phyllotis amicus</i>	0.089
<i>Ctenocephalides canis</i>	0.141	<i>Tiamastus cavicola</i>	0.077

4. Discussion

4.1. Parasite–Host Checklist

In Peru, fleas are predominantly found in mammals, particularly rodents of the family Cricetidae. This was expected because a large percentage of the diversity of fleas in the world are associated with mammals (more than 94% of the species), while their relationship with birds is much less common [135]. Similarly, analyses of fleas and mammalian hosts showed that 70% involved rodents [136,137], and, within the mammalian group, rodents represent 82% of the reported hosts for fleas [41]. This flea–rodent association is dominant in all parts of the world (except Australia, where the main hosts are marsupials). Flea hosts in the Neotropics are usually sigmodontine rodents (Cricetidae) and caviomorphs (Caviidae, Chinchillidae, Capromyidae, Octodontidae) [7].

Flea species infesting birds in Peru only comprised 4.8% of the total number of hosts recorded. In the global diversity, 214 flea species are known to infest birds, although only 60 species (approximately 3% of the total number of flea species) are considered specific parasites of birds [138,139]. We found no references to fleas infesting other vertebrates, such as reptiles. Flea infestations in reptiles are accidental, although they are capable of digesting the blood of these hosts [140]. Most flea species are relatively specific parasites, and may occasionally be found on hosts other than their preferred and/or primary hosts, and host selection appears to be influenced by environmental ecological factors, such as nests and burrows [141]. This could explain what happened with the species *P. (Polygenis) litargus*, *P. irritans*, *C. canis* and *E. gallinacea*, which were found parasitizing a larger number of hosts in Peru. Another reason why we might find fleas on non-specific hosts is that it is common to observe mammal species (usually mice) occupying the burrows of other animals. For example, mice can occupy bird nests, bat can invade mouse burrows, and vice versa. Those occupying the site abandoned by another species often become infested with the fleas that were there, since the immature forms of the fleas remain in their habitats. In such circumstances, the presence of fleas on an animal may be purely accidental and the association could be considered illegitimate [25,26].

Regarding the spatial distribution of fleas, unlike most free-living species, the spatial distribution of parasites is not continuous, but consists of a set of “islands” or inhabited patches roughly, uniformly represented by host organisms, while the environment between these patches is decidedly unfavorable [22]. In most fleas, a “habitat patch” also includes the host burrow, nest, or den. However, this does not negate the fragmented character of the spatial distribution of a flea assemblage. This assemblage is fragmented between (a) host individuals; (b) host species within a location; and (c) locations [22]. The main countries in

South America that have addressed this problem were Brazil [142–144], Argentina [145,146] and Chile [147].

4.2. Flea–Host Interaction Network

The modular structure of the flea–host interaction network assembled for the Peruvian territory indicates the specificity of these parasitic interactions. The absence of nestedness at both the network and module scales supports this specificity, as there are no notable flea or host generalists. This modular structure aligns with patterns observed in various host–parasite interaction networks, which tend to exhibit modularity due to the selective behavior of parasites [27,148]. Future studies could constitute a more diverse network that probably would maintain the modular configuration but with internally nested modules, as has been observed in other large-scale host–parasite networks [45]. In a more comprehensive network, it would be possible to further explore these interactions considering phylogenetic relationships [44].

Five flea species emerged as central to the network’s structure, with *P. litargus* being particularly significant in both the overall network and its modular configuration. Among the hosts, rodents were the primary key species, predominantly from the Sigmodontinae subfamily, with *A. mollis* being crucial in both the overall network and the modular structure. This suggests that only a few flea species have the potential to infect a wide range of hosts, while certain host species are more likely to disperse fleas among multiple hosts. These species warrant further ecological research as they may drive flea diversity within Peruvian ecosystems [149,150]. Additionally, these species may play a significant role in the transmission of diseases that could eventually affect humans [151]. This could be particularly important for *P. litargus*, which has been considered a vector of plagues and can feed occasionally on humans in Peru. Therefore, this network-based information is essential for advancing parasite ecology studies in such a biodiverse region [152].

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/d16120762/s1>, Table S1: summary of hosts and their fleas recorded in Peru; Figure S1: details on the modular structure of the national-scale interaction network between fleas and their hosts in the Peruvian territory.

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