

Identification and morphological characterization of two human and dog fleas species in Al-Wusita- Libya

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Abstract

Fleas (Siphonaptera) are holometabolus, flat-topped, wingless insects that are highly specialized as ectoparasites. Both adult sexes are blood-sucking ectoparasites that live on mammals and birds. As parasites and disease vectors, fleas are crucial to maintaining public health. Only a small portion of the 2.574 flea species that have been described live in close proximity to people. From it, only fifteen species have been recorded in Libya. The study was carried out in different locations in the Al-Wusita area, which is located north of Al-Bayda city in the Al-Jabal Al-Akhder area in North-Eastern Libya. A total of 56 fleas were collected randomly from different hosts (goats and dogs), whereas the examined cats had no fleas. All specimens were adults (32% males and 68% females) that belonged to two species: *Pulex canis* and *Ctenocephalides canis*. Among those, *C. canis* (79%) was collected from both goats and dogs, while *P. irritans* (21%) was collected from dogs. A microscopic examination of the morphological characteristics of *P. irritans* and *C. canis* revealed typical characteristics of both species; after matching it with the classification keys and previous studies that were conducted. Both species have medical and veterinary importance. Therefore, we must pay attention to fleas and prevent diseases transmitted by them by controlling dogs and vaccinating goats and other grazing animals.

Keywords: Human flea, *Pulex irritans*, dog flea, *Ctenocephalides canis*, morphology, identification, Al-Wusita area.

Introduction

Fleas (Siphonaptera) are holometabolus, flat-topped, wingless insects that are highly specialized as ectoparasites. Both adult sexes are blood-sucking ectoparasites that live on mammals and birds. As parasites and disease vectors, fleas are crucial to maintaining public health (1). Only a small portion of the 2,574 flea species that have been described, which are divided among 238 genera and 16 families, live in close proximity to people (2). Fleas are clinically important parasites for human health; they cause allergic dermatitis or other conditions through their feeding activities. But more importantly, they also act as carriers of important pathogens. The plague bacterium can be carried by the human flea. *Yersinia pestis* is a bacterium that causes plague, a disease that affects both humans and other mammals. In Libya, the plague epidemic was recorded, after its disappearance for a period of 25 years. In last time, Libya has experienced several outbreaks of plague, resulting in deaths in several cities (3). Millions of people were killed by the plague in Eurasia during the Middle Ages, which was notorious. The disease can lead to serious illness or even death if not treated quickly. Although human plague infections still happen occasionally in western the United States, there are noticeably more cases in some regions of Africa and Asia (4-6). Fleas, predominantly species of the genus *Ctenocephalides*, are communal ectoparasites of dogs and cats throughout the world (7-9). Some species that belong to the genus *Ctenocephalides* are known vectors for *Bartonella henselae*, *Bartonella clarridgeiae*, and *Rickettsia felis*, and can cause cat flea typhus in humans (10-12). Dog and cat fleas are known as intermediate hosts for *Dipylidium caninum*, which can be transmitted to livestock and humans (13, 14). Pets such as dogs, cats, or other domestic animals can play an important role as bridge hosts for fleas from a variety of wild, domestic animals, and human species. This is because their searching behavior involves coming into contact with different animals and acquiring fleas from different animals (15). Flea infestations can cause severe irritation to animals and humans and lead to serious illnesses such as anemia and skin problems. This is because repeated infestations in dogs and cats can lead to hypersensitivity to components of flea saliva, leading to flea allergic dermatitis (10, 16, 17). This study was conducted to describe the morphology of adult fleas, according to the available literature; no study was conducted to describe dog and human fleas in the study area.

Materials and Methods:

Description of the Study Area:

The study was carried out in different locations in the Al-Wusita area, which is located at 21° 46' 32.73" E, 32° 49' 24.30" N, which is located north of Al-Bayda city - Al-Jabal Al-Akhder area in North-Eastern Libya, 200 km east of Benghazi city. This region is characterized by great diversity in vegetation, which contains more than 1,350 species of plants (18), with an annual mean temperature of 18.0° C and monthly rainfall ranging from 0 to 200 mm. The climate is markedly diverse during the year, with a dry season from mid-April to mid-October and a rainy season for the rest of the year.

Handling of animals during collection:

Samples were collected from cats, dogs and domesticated goats with the help of their owners. As for stray animals, they were restrained by using a mask for dogs during the examination and collection of samples.

Sample collection:

Samples were collected from September to December 2022 from different parts of the animal's body, including the head, ear, armpits, abdomen and both sides. Fleas were collected by handpicking, and forceps. Collected fleas were stored in vials, with labels, and the collection data was recorded in a special notebook. Flea samples were transported to the laboratory of parasitology at the Zoology Department, Faculty of Science, Omar Al-Mukhtar University, Al-Bayda city. The collected fleas were kept in 70% ethanol, for preservation. The samples were identified by using a light microscope and a dissecting microscope for examining different parts of fleas' specimens.

Sample preparation:

The samples were prepared in three steps according to the method of Yakub, Amrito, Abdullah, Saiful and Uday (19). Flea samples were cleared by softening in a 10 % potassium hydroxide (KOH) solution overnight at room temperature to allow crossing light to pass through the specimen. After this step, specimens were returned to distilled water. Specimens were reserved in Hematoxylin overnight. The sample becomes darker the longer it is placed in the dye, but the excess dye can be removed when the samples are passed through the drying stage by grading the concentrations of ethanol. Finally, the water was removed (dehydration) from the samples because its presence in the samples

increases the difficulty of seeing and thus prevents seeing the external structures important in the identification of fleas. Also, the water causes damage to the samples due to the increase in bacteria growth and tissue decomposition. During this stage, the samples were passed through graduated concentrations of ethanol until placed in 100% ethanol over a period of 30 minutes for each concentration. The specimens were dehydrated in 100 % ethanol and then soaked in xylene before mounting on slides. The thickness of the specimen determines how long it takes to complete each step. Just before mounting in Canada balsam medium, the dehydrated specimen was examined under a microscope to check for cleaning. The specimen was returned to earlier stages of the dehydration series if clouding was visible. The specimens were mounted on slides and left to dry for several days. During the mounting process, the specimens were handled delicately. The specimens were handled during the mounting process using fine forceps, needles, and insect pins.

Morphological examination of flea specimens:

Several keys were used for the microscopic identification of fleas at the species level (20-22) by examining all samples under a dissecting microscope and a light microscope by objective lens 10x in the laboratory.

Results:

This study was carried out from September to December 2022. A total of 56 fleas were collected randomly from different hosts (goats, dogs). The examined cats had no fleas. All specimens were adults (32% males and 68% females) that belonged to two species: *Pulex irritans* and *Ctenocephalides canis*. Among those, *C. canis* (79%) was collected from both goats and dogs, while *P. irritans* (21%) was collected from dogs (Fig. 1).

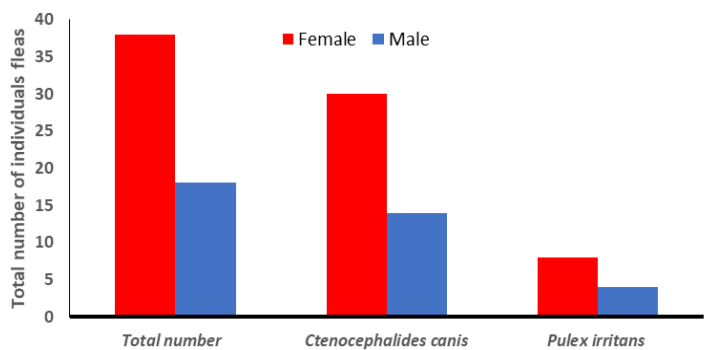


Figure 1: The total number of each flea species collected from the Al-Wasita area during September and December 2022.

The first species identified in this study is *Pulex irritans* Linnaeus, 1758. This species appear as light-brown fleas. Microscopic examination of the head in this adult species is that neither pronotal nor genal comb is present, there is a single bristle (br) presence under the eye (Fig. 2A), the labial palp (lp) is stiff, frons smoothly rounded, and lacking tubercle (Fig. 2A), while Pleural rod of mesothorax (mt) absent (Fig. 2B), metanotum (me) nearly as long as abdominal tergum I (tel) (Fig. 2C), Also, spermatheca (sp) (sperm storage vessel) in females appeared in the form of a comma (Fig. 2D); While the males were characterized by having noteworthy sexual apparatus (the aedeagus) (Fig. 2E)..

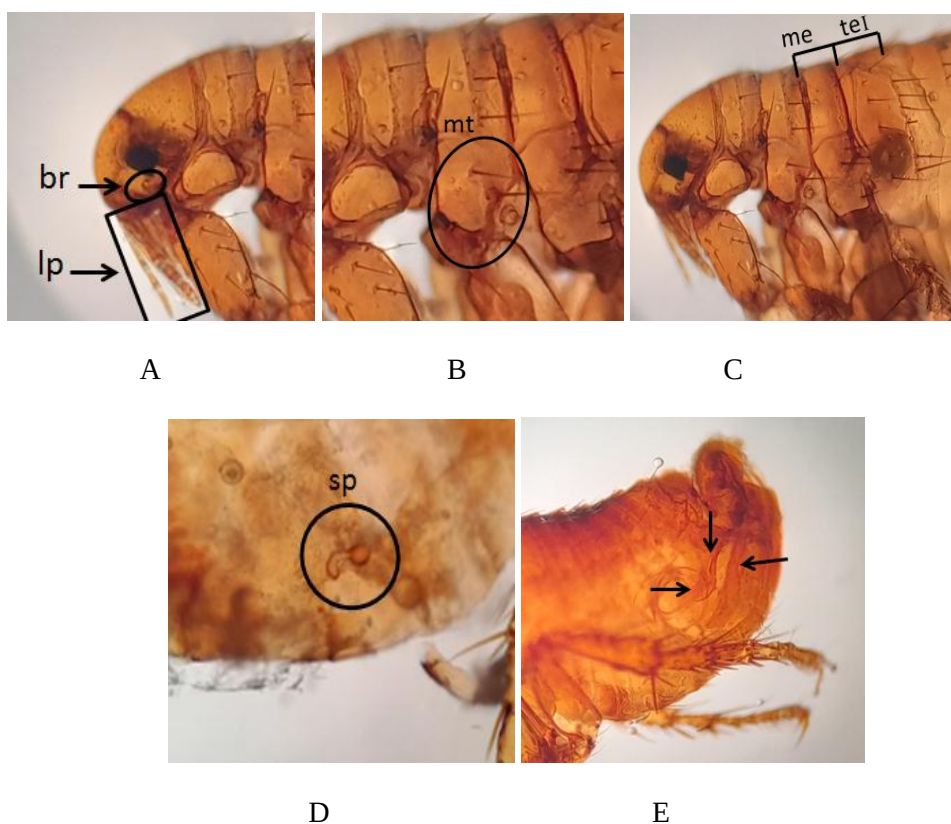


Figure 2: Morphological features of *Pulex irritans* Linnaeus, 1753; A- The shape of the head shows the absence of pronotal and genal comb; a- bristle under the eye, b- the quality of the mouth parts; B- mesothorax shape; C- metanotum size compared to the abdominal tergum I; D- female spermatheca shape; E- aedeagus (arrows) shape in mal.

The other species identified in this study is *Ctenocephalides canis* Curtis, 1826. The microscopic examination of adult *C. canis* showed the shape of the head length (hl) is not twice the height of the head, both pronotal and genal combs are present, and it is genal comb more than six spines that have pointed apically, the length of the first spine (thin arrow) of the genal comb is half as long as the second spine (thick arrow) (Fig. 3A), on the other hand, Numbers of bristles on the lateral metanotal area (LMA) are three (Fig. 3B), whereas Number of notches on tibiae of all six legs have 7 to 8 notches (arrows) with two single bristles present between long postmedian and apical bristles of the dorsal margin of hind tibia (Fig. 3C), and the length of hilla of spermathica in the female is comparatively long and globular (Fig. 3D), In addition, to the shape of the manubrium the clasper in males has expanded apically (Fig. 3E. arrow).

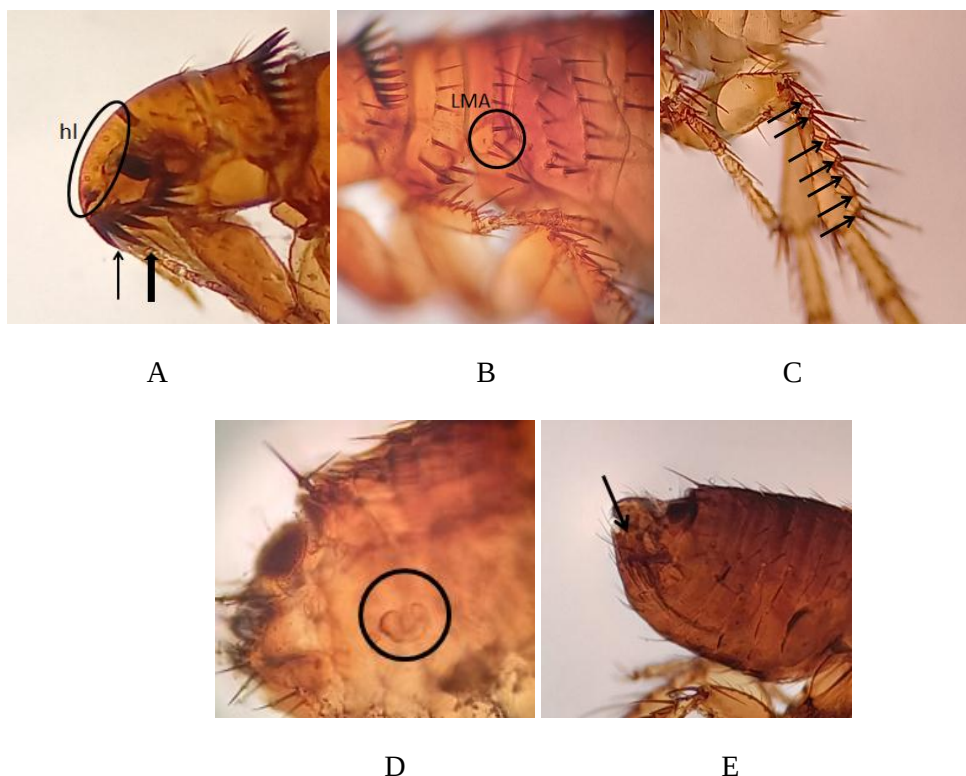


Figure 3: Morphological features of *Ctenocephalides canis* Curtis, 1826; A- The head region shows the presence of pronotal and genal comb, hl: shape of the head, Length of the 1st (thin arrow) and 2nd (thick arrow) spine genal comb; B- Number of bristles on the

LMA; C- Number of notches on tibiae (arrows); D- female spermatheca shape (circle); E- clasper's manubrium of the male (arrow).

Discussion:

For a long time, most studies in Libya with respect to medical and veterinary entomology have centered on mosquitoes and ticks. Even if studies were conducted on fleas, they were conducted as survey studies to determine the species and their hosts, or their density and abundance (23-29). According to the available literature, this is the first morphological study conducted on flea species in the Al-Jabal Al-Akhder area of Libya.

In the present study, two species of fleas were identified: *C. canis* and *P. irritans*. These species were among the fifteen species already recorded in Libya (23-29). The present study showed that all samples of *C. canis* were collected from dogs and goats, while all samples of *P. irritans* were collected from dogs only. In several studies conducted in Libya, *C. canis* was recorded in dogs and hedgehogs (25, 28). On the other hand, studies conducted in Nigeria and Southern Ethiopia showed that *C. canis* was collected from goats and sheep (30, 31). While *P. irritans* it was found in Libya, Greece and in Spain infesting dogs, goats, sheep and porcupines (25, 27, 29, 32, 33). Apparently, both species have low host specificity. The study showed that all of the cats checked were without fleas. This might be as a result of their owners' proper management and supportive care.

The present study showed that more female fleas were recorded on animals. The present finding agreed with previous studies conducted on dogs and cats in Bangladesh and Ethiopia (19, 34). The reason for this may be that female individuals ordinarily have a longer life expectancy than male individuals (19). On the other hand, male individuals to spend more time off the host and are, in this manner, more inclined to predation or starvation than female individuals (35). And this was proven in a study conducted on the interhost movement between fleas, in which it appeared that essentially fewer female cat fleas were transmitted from one host to another compared to males (36).

In the present study, two species belonging to different genera, *Pulex irritans* and *Ctenocephalides canis*, were found in both goats and dogs.

Individuals of *Pulex irritans* observed on dogs from the Al-Wasita area presented typical characteristics of this species: the shape of the head shows the absence of pronotal and genal comb, bristles under the eye, the quality of the mouth parts, the mesothorax shape, the metanotum size compared to the abdominal tergum, the female spermatheca shape, and the aedeagus shape in

mal. Morphological characteristics of the last parts were agreed upon by Lewis (20), Panagiotakopulu (37), O'Donnell and Elston (38) and Azarm, Dalimi, Pirestani, Mohammadiha, Zahraei-Ramazani, Marvi-Moghaddam and Amiri (39). On the other hand, individuals of *Ctenocephalides canis* observed on goats and dogs in the study area showed typical characteristics of this species: the head region has pronotal and genal comb, the shape of the head; length of the 1st and 2nd spine genal comb; the number of bristles on the LMA, number of notches on tibiae, female spermatheca shape; and clasper's manubrium of the male. Morphological characteristics of the last parts were agreed upon by Lewis (20), Linardi and Santos (40), Lawrence, Hii, Jirsová, Panáková, Ionică, Gilchrist, Modrý, Mihalca, Webb and Traub (41), Ahn, Huh, Seol, Kim, Suh and Shin (42), Yakub, Amrito, Abdullah, Saiful and Uday (19).

Conclusion

Two species were recorded in the present study include *Ctenocephalides canis* and *Pulex irritans*. Both species have medical and veterinary importance. Therefore, we must pay attention to fleas and prevent diseases transmitted by them by controlling dogs and vaccinating goats and other grazing animals.

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الصفات التعريفية و المورفولوجية لنوعين من براغيث الانسان و الكلاب في منطقة الوسيطة - ليبيا

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المستخلص العربي

تعتبر البراغيث من رتبة الحشرات عديمة الأجنحة مسطحة الجانبين ذات تحول كامل، متخصصه بشكل كبير على العيش كطفيليات خارجية في جنسيتها الذكور و الإناث على الثدييات و الطيور. فهي حشرات مهمة جدا في الحفاظ على الصحة العامة فهي تعتبر طفيل و ناقل للأمراض في ان واحد. فهناك حوالي 2574 نوع من البراغيث تم وصفها على أنها تعيش في البيئات التي يعيش فيها الإنسان. و من هذه الأنواع هناك 15 نوع تم تسجيله في ليبيا. تم إجراء هذه الدراسة في منطقة الوسيطة شمال مدينة البيضاء بمنطقة الجبل الأخضر شمال شرق ليبيا. حيث تم فحص كل من القطط و الكلاب و الماعز و تم جمع 56 فرد من البراغيث بشكل عشوائي من الماعز و الكلاب، بينما كانت القطط خالية تماما من البراغيث. جميع العينات التي تم جمعها كانت بالغات (32% ذكور و 68% إناث) تم تعريفها و تصنيفها إلى نوعين و هما: *Ctenocephalides canis* بنسبة (79%) حيث سجل على كل من الكلاب و الماعز، بينما النوع الثاني *Pulex irritans* بنسبة (21%) حيث تم تسجيله فقط على الكلاب. كما أظهر الفحص المجهرى للصفات المورفولوجية لكلا النوعين وجود كل الخصائص الوصفية للنوعين *Ctenocephalides canis* و *Pulex irritans* بعد مطابقتها مع مفاتيح التصنيف و الدراسات السابقة التي أجريت عليها، فكلا النوعين لديهما أهمية طبية و بيطرية لذلك يجب مكافحتها و الوقاية من الأمراض التي تنتقل عن طريقها و ذلك عن طريق مكافحة الكلاب الضالة و تحصين الماعز و الحيوانات الرعوية الأخره.

الكلمات المفتاحية: برغوث الانسان، برغوث الكلاب، الشكل الظاهري، تعريف، منطقة الوسيطة