Dominance and Frequency of Mite Species Associated with Poultry Droppings

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Abstract

The present study was carried out on Al-Saqlawiya poultry farm's soil (Anbar, Iraq) for the period of 8 months (November 2018- June 2019). A total of 75 samples of poultry droppings were collected randomly. 552 individuals of mites, belonging to 3 orders and 8 families representing 15 species, were found. These species were: Acarus gracilis, Acarus siro, Caloglyphus berlesi, Androlaelaps casalis, Sejus temperaticus, Parasitus paraconsanguineus, Eugamasus butleri, Macrocheles medarius, Macrocheles glaber, Macrocheles muscaedomesticae, Macrocheles matrius, Kleemannia plumosus, Cheyletus eruditus, Cheyletus malaccensis, and Pyemotes herfsi.

The highest population density belonged to order Astigmata, followed by orders Mesostigmata and Prostigmata, respectively. The dominance and frequency of mite species were linked to the availability of appropriate conditions in terms of food source and temperatures registered in the Iraqi Meteorological Directorate. The highest mite population densities were recorded during the winter months compared to the summer months.

Keywords: Acari, Dominance, Frequency, Mites, Poultry droppings.

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Introduction

Many organisms are found in animal feces, including arthropods such as insects and mites, of which hundreds species belonging to 25 families were recorded. Some of these species are predatory on other species of mites or other arthropods such as insects. On the other hand, some species feed on organic materials, fungi, and bacteria in the poultry droppings [1, 2].

It is well known that soil arthropods are one of the major contributors to biological fertility of the soil. Their activity contributes greatly to the synthesis of humus, organic decomposition, the restitution of biogenic elements, and the stimulation of bacterial and fungal metabolism [3].

Mites are one of the most diverse organisms in nature. Mites who live in organic materials play an important role in the biological cycle of normal and cultivated soil. Dung fauna is very important to understand function, dynamics, and structure of an ecosystem. The presence and diversity of arthropods, especially insects and mites, was reported in places where animal droppings are collected, including poultry droppings which are important for the stability of different ecosystems and natural balance [4, 5].

The most serious health risks to human life happen either from inhaling the fungal spores of infectious organisms which grow in the nutrient-affluent accumulations of poultry droppings or from direct contact. Poultry droppings can transport over 60 diseases, many of them are airborne and can be transferred to humans just by being around them [6].

Mites, as a group of population, are widespread; some of them feed on their neighborhoods. Many of these neighborhoods infect plants with their various parts and cause significant economic damage, whereas some of them feed on stored food to which they can cause damages. Other mites infect humans and cause different diseases such as scabies, typhus itch, skin allergies, and respiratory or asthma diseases in some people who have hypersensitivity [7].

The mites of small arthropods range in length between 0.1 and 7.0 mm. They are one of the most diverse arthropods in biological terms. Mites lack the phenomenon of external division, which is considered as a characteristic of arthropods; these arthropods possess four pairs of legs in full phase and therefore can be easily distinguished from insects. Mites are generally characterized by their ability to spread and live in different environments, including all aquatic and terrestrial environments. They are widespread in tropical, subtropical and temperate regions of the world where there are animal dropping collections [7, 8].

The order Astigmata includes a variable group of small mites belonging to more than 70 families and nearly 5000 species. The mites of this group are either free-living or parasitize on the incomplete phases of insects of the orders Diptera, Hymenoptera, and Coleoptera [9].

This family Acaridae includes two important species, namely Acarus siro and Acarus gracies, with the former being the most studied species [10].

The order Prostigmata include many families. The families Cheyletidae and Pycnotidae (Acariformes: Cheyletidae) currently have more than 440 species belonging to 75 genera, 78% of which are predators and some live in organic matter clusters and in soil. It is a very common group which parasitizes on vertebrates, invertebrates, and insects. Some of them parasitize birds and mammals, while other species of this family cause agricultural damages and affect the health of domestic animals and humans [11, 12]. Some species of this family use insects for transmission [13].

The Order Mesostigmata is the largest order of mites as it includes about 11,500 species, representing about 20% of the recorded mites' species [14].

Macrocheles family from order Mesostigmata includes many species that feed on the eggs and larvae of the first stage of the house fly, whereas they feed on small arthropods, nematodes, and jumping species of order Collembola, as an alternative food in the absence of immature stages of flies. This family is one of the most numerous families in terms of numbers of individuals and species. It includes the predatory mites, which live in clusters of organic matter of decomposing animals and plants [15-17].
Al-Ani [18] reported that this species of mite is an external parasite on the eggs and larvae of house flies where it can reduce their population density by feeding on their larvae and eggs.

The aims of this study were to isolate and identify mites in poultry droppings, and to obtain knowledge of their dominance and frequency. In addition, we aimed to evaluate the effects of some environmental factors on the population density of mites throughout the duration of the research.

Materials and Methods

A total of 75 samples were collected from Al-Saqlawiya poultry farm’s soil in Fallujah twice a month over a period of 8 months, from November 2018 to June 2019. All samples were taken from a depth of 5-10 cm. These samples were kept in transparent nylon bags, which were closed well and then brought to the lab. These samples were individually extracted in the laboratory through a modified Tullgren funnels extractor.

A total of 552 individuals of adult mites were isolated (224 in November, 277 in December, 30 in February, and 21 in April). Meanwhile, no individuals were isolated during January, May, and June. Mites were isolated from soil samples using a dissecting microscope. The isolated mites were cleared and purified by heating in 50% Lactic acid, then mounted in Hoyer’s medium by transferring the specimens on glass slides. The loaded slides were placed on a hot plate to dry the loading medium and to isolate the final form to be examined under a compound microscope. Mites were classified by a specialist in Acarology, using the taxonomic keys [19-21].

Dominance and Frequency

Dominance

The following equations were used to calculate percentages of dominance and frequency, which were then categorized according to the classes described below [7, 22]:

\[ D = \frac{\text{No. of individuals}}{\text{Total No. of mites}} \times 100 \]

- **Dominant**: 5% or more of the total number of individuals.
- **Influent**: the percentage is higher than 2% and less than 5% of the total number of individuals.
- **Resident**: 2% or less of the total number of individuals.

Frequency

\[ F = \frac{\text{No. of positive samples}}{\text{No. of total samples}} \times 100 \]

- **Constant**: species occurs in more than (50)% of the samples.
- **Accessory**: species occurs in (25-50)% of the samples.
- **Accidental**: species occurs in less than (25)% of the sample

Results

In this study, 75 samples of poultry droppings were examined. 552 individuals of mite, belonging to 3 orders and 8 families representing 15 species, were found. Three species belonged to the order Astigmata which has no-respiratory apertures, 9 species belonged to the order Mesostigmata which has middle respiratory apertures, and 3 species belonged to the order Prostigmata which has front ventilation openings (Table-1).
Table 1—Recorded mite species in poultry droppings during the duration of the study (November 2018—June 2019)

| Order          | Family       | Genus  | Species      |
|----------------|--------------|--------|--------------|
| Astigmata      | Acaridae     | Acarus | A. gracilis  |
|                |              | Acarus | A. siro      |
| Mesostigmata   | Laelapidae   | Carus  | C. berlesi   |
| Sijidae        |              | Sejus  | S. temperaticus |
| Parasitidae    |             | Parasites | P. paraconsanguineus |
|                |              | Eugamasus | E. butleri |
| Macrochelidae  |              | Macrocheles | M. medarius |
|                |              | Macrocheles | M. glaber |
|                |              | Macrocheles | M. muscaedomesticae |
| Ameroseiidae   |              | Kleemannia | K. plumosus |
| Prostigmata    | Cheyletidae  | Cheyletus | C. eruditus |
|                |              | Cheyletus | C. malaccensis |
| Pyemotidae     |              | Pyemotes | P. herfsi |

Figure 1—Light microscopic image of *Caloglyphus berlesi* (100X).

Figure 2—Light microscopic image of *Acarus gracilis* (100X).
Table 2-Dominance and frequency of mite species recorded in poultry droppings.

| Order       | Family      | Species                        | D  | F        |
|-------------|-------------|--------------------------------|----|----------|
| Astigmatia  | Acaridae    | *Acarus gracilis*              | 15.2 | 6.66     |
|             |             | *Acarus siro*                  | 1.26 | 5.33     |
|             |             | *Caloglyphus berlesi*          | 68.29 | 26.66    |
| Mesostigma  | Laelapidae  | *Androlaelaps casalis*         | 0.90 | 4        |
|             | Sijdidae    | *Sejus temperaticus*           | 0.36 | 2.66     |
|             | Parasitidae | *Parasitus paraconsanguineus*  | 0.90 | 2.66     |
|             |             | *Eugamasus butleri*            | 0.90 | 4        |
|             | Macrochelida| *Macrocheles medarius*         | 1.26 | 4        |
|             |             | *Macrocheles glaber*           | 3.98 | 6.66     |
|             |             | *Macrocheles muscaedomesticae* | 3.26 | 8        |
|             |             | *Macrocheles matris*           | 1.63 | 6.66     |
|             | Ameroseiidae| *Kleemannia plumosus*          | 0.90 | 1.33     |
| Prostigama  | Cheyletidae | *Cheyletus eruditus*           | 0.54 | 1.33     |
|             |             | *Cheyletus malaccensis*        | 0.36 | 1.33     |
|             | Pyemotidae  | *Pyemotes herfsi*              | 0.18 | 1.33     |

Table-2 shows the dominance and frequency of the species that appeared in poultry droppings during the study. Two dominant species, *Caloglyphus berlesi* and *A. gracilis* (Figures - 1 and 2) belonged to the order Astigmatia. Their dominance values were 68.29% and 15.2%, respectively. Two influential species, *M. glaber* and *M. muscaedomesticae* belonged to the order Mesostigma (Figures- 3 and 4), with dominance values of 3.98%, 3.26%. While the remaining species were resident. One constant species, *Caloglyphus berlesi*, belonged to the order Astigmatia with a frequency of 26.66%. Moreover, one species, *Macrocheles muscaedomesticae*, belonged to the order Mesostigma and had a frequency of 8%. All the remaining species were accidental.

Figure 3-Light microscopic image of *Macrocheles glaber* (100X).

Figure 4-Light microscopic image of *Macrocheles muscaedomesticae* (100X).
Figure-5 shows the monthly average temperatures during the study months (November 2018-June 2019) registered in the Iraqi Meteorological Directorate in Fallujah. The lower average temperature, 10°C, was recorded in November. The average temperature during December was 12.25°C, while it was 13.5°C during January. In February and March, the temperature reached 15°C and 18.75°C, respectively. Then, the temperature increased during April and May, with values of 28.25°C and 33°C, respectively. The highest temperature rate, 34.5°C, was recorded in June.

![Figure 5: Average temperatures during the study months (November 2018- June 2019).](image)

Table-3 presents the population density of mite species in poultry droppings. The highest population density was recorded during the winter months. On the other hand, the number of recorded species was very low during the summer months. In addition, Caloglyphus berlesi recorded the highest population density in December, which was 216 individuals. Meanwhile, M. matrius (Figure-6) showed the lowest population density in April, which was 4 individuals. However, there were no species of mites in poultry droppings during the months of January, March, May, and June.

![Figure 6: Light microscopic image of Macrocheles matrius(100X).](image)
Table 3—Population density of mite species individuals of poultry droppings during the study months (November 2018–June 2019)

| Species                     | Number of mite species individuals during the study months |
|-----------------------------|----------------------------------------------------------|
|                             | Novembrer | December | January | February | March    | April    | May      | June     |
| A. gracilis                 | 68        | 5        | 0       | 11       | 0        | 0        | 0        | 0        |
| A. siro                     | 0         | 2        | 0       | 1        | 0        | 4        | 0        | 0        |
| C. berlese                  | 154       | 216      | 0       | 7        | 0        | 0        | 0        | 0        |
| A. casalis                  | 0         | 0        | 0       | 5        | 0        | 0        | 0        | 0        |
| S. temperaticus             | 0         | 2        | 0       | 0        | 0        | 0        | 0        | 0        |
| P. paraconsanguineus        | 0         | 5        | 0       | 0        | 0        | 0        | 0        | 0        |
| M. medarius                 | 0         | 7        | 0       | 0        | 0        | 0        | 0        | 0        |
| M. glaber                   | 2         | 20       | 0       | 0        | 0        | 0        | 0        | 0        |
| M. muscaedomesticae         | 0         | 15       | 0       | 3        | 0        | 0        | 0        | 0        |
| M. matrius                  | 0         | 5        | 0       | 0        | 0        | 4        | 0        | 0        |
| K. plumosus                 | 0         | 0        | 0       | 0        | 0        | 5        | 0        | 0        |
| E. butleri                  | 0         | 0        | 0       | 2        | 0        | 3        | 0        | 0        |
| C. eruditus                 | 0         | 0        | 0       | 0        | 0        | 3        | 0        | 0        |
| C. malaccensis              | 0         | 0        | 0       | 0        | 0        | 2        | 0        | 0        |
| P. herfsi                   | 0         | 0        | 0       | 1        | 0        | 0        | 0        | 0        |
| Total individuals           | 224       | 277      | 0       | 30       | 0        | 21       | 0        | 0        |
| Number species              | 3         | 9        | 0       | 7        | 0        | 6        | 0        | 0        |

Discussion

Through the results, the most prevalent species of mites belonged to the order Astigmata (Table-2). The two most dominant species were *C. berlese* and *A. gracilis* (68.29% and 15.2%), respectively. This may be due to the availability of food as most of these species feed on fungi that needs adequate temperature and high humidity to grow, which is agreement with the results obtained in a previous research [7]. Meanwhile, two abundant species (*M. glaber* and *M. muscaedomesticae*, order Mesostigmata) were found. The dominance values of them were 3.98% and 3.26%, respectively (Table-2). This may be due to the availability of food (prey) from other mite species and the suitable environmental conditions. This conclusion is in agreement with the results obtained in previous studies [8, 18].

The species of the order Prostigmata were resident and less visible. This might be due to insufficient food sources from insects and the lack of suitable conditions of temperature and humidity, which led to their disappearance during winter and appearance during summer. In April, two species *C. eruditus* and *C. malaccensis* were isolated, which indicates that the endurance to the extreme environmental conditions of the order Prostigmata individuals is higher than that of the orders Astigmata and Mesostigmata. This is consistent with the results of other researchers [8, 13] who reported that insects are good prey for a mite species from Prostigmata.

As we can observe in Table-3, the species *C. berlese* from order Astigmata recorded the highest number of mites in poultry droppings in December (216 individuals), followed by the species *A. gracilis* in November (68 individuals). This is because some species in this order appear when the temperatures are relatively low and humidity is relatively high, as it depends on fungi as a food, that need high humidity to grow. The inadequate conditions for growth during summer include high temperature and low relative humidity. This result is in agreement with those obtained in previous studies [7, 8].

The number of species belonging to Mesostigmata appeared as lower than that of the order Astigmata and higher than that of the order Prostigmata. The species *M. glaber* recorded 20 individuals in December, *M. muscaedomesticae* recorded 15 individuals during December, *M. Medarius* recorded 7 individuals in December, and the other species recorded a few different numbers, as shown in Table-
This is due to the availability of food (prey) for species of Mesostigmata as well as the occurrence of another source of food from insects larvae that appeared in mites isolated from samples. This is in agreement with the results obtained in previous researches [8, 18]. The lowest number of species (3) of order Prostigmata appeared in two poultry dropping samples only, as compared to other individuals that appeared from the mites that belong to the orders Astigmata and Mesostigmata. C. eruditus recorded 3 individuals in April, followed by C. malaccensis which recorded 2 individuals during the same month. Meanwhile, P. herfsi recorded only one individual during the month of February (Table-3). This is because the individuals of this order are parasitic or predatory and depend in their food on some species of mites and insects. This conclusion agrees with the results of other researchers [8, 23]. The highest total number of individuals (only adults were collected) was recorded during December, as it reached 277 individual mites, followed by November (224 individual mites). 30 individual mites were recorded during February. The lowest total number of individuals was recorded during April (21 individuals). This may be due to the availability of appropriate environmental conditions such as temperature, humidity, and the availability of an appropriate nutritional source for each species. Other factors can include the suitability of soil properties in which poultry droppings are present, including, temperature and wet weight of sample during the study period, as well as suitable PH. These results are in agreement with the results obtained in previous studies [3, 7].

Conclusions

Our results showed the population density of the mites, recorded in terms of both number of species and individuals. The Mesostigmata and Prostigmata mites' density was associated with the density of their prey of incomplete phases of fly insects in poultry droppings. Finally, we conclude that the high temperatures that lead to the drying of poultry droppings are one of the most important determinant factors of the mites found in that environment.

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