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Morphological characteristics of *Dermanyssus gallinae* (Mesostigmata, Dermanyssidae)

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The red mite *Dermanyssus gallinae* (De Geer, 1778), a dangerous parasite of poultry which causes significant economic losses to poultry farming, is widespread, including in economically developed countries. These mites are transient blood-sucking parasites that can attack not only birds and other mammals, but also humans, causing itching and dermatitis. A deeper understanding of the morphology and identification of *D. gallinae* will allow us to avoid complications in their differentiation from similar dermanyssid parasites, which may share the host species and environment. The aim of the research was to describe the morphological features and metric parameters of gamasid mites of the species *D. gallinae*, isolated from chickens in Ukraine. Morphometric studies have identified 30 parameters in male and 40 indicators in female mites, which characterize the general structure of the body, species-specific morphological features, as well as characters of sexual dimorphism. In male and female mites, the structure and dimensions of the body, gnathosoma, idiosoma, tagmas, dorsal shield, specific arrangement of dorsal setae, length of adanal and postanal setae, as well as the distance between sternal setae st1–st1, st2–st2, st3–st3, st1–st2, st1–st3, metasternal setae mst–mst, ventral setae vl1–vl1, adanal setae ad–ad are described. A characteristic feature of females of *D. gallinae* is the presence of a stylet-like second cheliceral article, while in males there are no cheliceral articles of a stylet-like shape. In males, the dimensions of the sternogenital and ventroanal shields are additionally described and determined. In females, the dimensions of the sternal, genitoventral and anal shields, the genitoventral valve, the length of the setae st1, st2, st3, mst, and the distance between the setae st1–mst were additionally described and determined. For the first time, the dimensions of females with a formed egg in their body cavity were described and compared with the dimensions of female mites without eggs. The data obtained in this study expands existing data on the morphometric characteristics of male and female *D. gallinae*.

Keywords: mite; Gamasida; dermaniasis; ectoparasites; chickens; identifying characters; metric indicators.

Introduction

Global industrial poultry farming is characterized by dynamic development and a high level of intensification. Among a number of environmental consequences caused by the rapid development of poultry production, the spread of ectoparasites in poultry farms, in particular the gamasid mite *Dermanyssus gallinae* (De Geer, 1778), still remains relevant (Sparagano et al., 2009; Sparagano et al., 2014; Hartmann et al., 2024). The red mite is considered the most harmful parasite of laying hens worldwide. Poultry infestation leads to significant economic losses, which are characterized by a decrease in poultry productivity, survival of young animals, and in the quality of the resulting products, and a deterioration in the hatching qualities of eggs (George et al., 2015; Pritchard et al., 2015; Faraone et al., 2019).

According to monitoring studies conducted in Europe, 83% of chicken farms are infested by *D. gallinae*. In the Netherlands, Germany and Belgium, the infestation of chickens with the red mite reaches 94% (Sigognault Flochlay et al., 2017). The prevalence of red mite disease on poultry farms, regardless of the method of keeping, is 50%in Kosovo, 56% in France, 60% in the UK, 68% in Denmark (Hamidi et al., 2011; Gharbi et al., 2013). A significant prevalence of red mite infection of chicken was found on farms in Palestine (18.3–47.3%), Turkey (72.39%), and Iran (92.86%) (Othman et al., 2012; Yakhchali et al., 2013; Konyalı & Savaş, 2021).

Dermanyssus gallinae is also a vector of animal and human pathogens (Moro et al., 2005; Schiavone et al., 2022). According to studies, red mite can mechanically transmit *Salmonella enterica* subsp. *enterica* serovar *typhimurium*, *Escherichia coli*, and Newcastle disease virus (Cocciolo et al., 2020; Schiavone et al., 2020). The authors have proven in experimental studies the indirect transmission of pathogens such as *Borrelia burgdorferi sensu lato*, *Coxiella burnetii*, *Mycoplasma gallisepticum*, *M. sinoviae*, *Plasmodium* sp. (Hubert et al., 2017; Raele et al., 2018; Ciloglu et al., 2020).

Currently, various methods are used worldwide to identify *D. gallinae*. Molecular genetic methods have revealed that recently, due to the use of acaricides in the control of red mite infestations, resistant strains of mites have appeared, which indicates genetic variability among *D. gallinae* populations (Marangi et al., 2009; Roy & Chauve, 2009; Marangi et al., 2014). Such genetic variations in *D. gallinae* mites may increase their tolerance to adverse environmental conditions, namely, they may be the result of acquiring resistance to prolonged and excessive use of chemicals (Sokół et al., 2019; Koziatek-Sadłowska & Sokół, 2022). In particular, molecular epidemiological studies have identified different haplogroups of *D. gallinae* in countries such as Sweden, Norway, Italy, and France. A phylogenetic study of *D. gallinae* conducted in different regions of Italy revealed the presence of two main haplogroups A and B, and scientists from Norway and Sweden, when conducting a phylogenetic analysis of *D. gallinae*, found 32 haplotypes that occur in the two main haplogroups A and B (Øines & Brännström, 2011; Chu et al., 2015).

The morphological identification of these mites is also important, facilitating diagnosis. For this purpose, scientists use light microscopy and scanning electron microscopy (Moss, 1978; Bhowmick et al., 2020). Of the 25 species of the genus *Dermanyssus*, 14 species are known to have morphological similarities to *D. gallinae*, which sometimes leads to misidentification as the red poultry mite (Gruianu et al., 2016). In addition, the identification of *D. gallinae* can be complicated by the presence of similar dermanyssid parasites, such as *Ornithonyssus sylviarum*, which share the same host species and habitat (Di Palma et al., 2012).

Most scientists note that for the identification of mites of the species *D. gallinae*, the most useful are the features of chaetotaxy on the dorsal shield (presence or absence of setae, their location) and on the legs of mites (Moss, 1968; Moss, 1978; Di Palma et al., 2012). Other scientific works report the importance of other morphological features for the identification of these mites, such as the structure of the idiosoma, body size, and shields (Baker, 1999; Alghamdi, 2024). Therefore, further study of the morphological identification features of *D. gallinae* mites, taking into account their metric parameters, is relevant. The aim of the research was to describe the morphological features and metric parameters of gamasid mites of the species *D. gallinae* isolated from chickens in Ukraine.

Materials and methods

The work was carried out in the Department of Parasitology and Veterinary and Sanitary Examination of the Poltava State Agrarian University (Ukraine) and the parasitology sector of the Institute of Veterinary Medicine of the National Academy of Agrarian Sciences of Ukraine in 2024. The research protocol of the current study was approved by the Ethics Committee of the Poltava State Agrarian University (Approval number: 2023/6).

Mites were isolated on the farm "Ptashyny dvory Poltavshchyny" of the Poltava district of the Poltava region. For this purpose, mini-traps made of corrugated cardboard, 10 × 10 cm, were used. The traps were fixed in poultry houses on various structures. They were removed 24 hours after installation. After collecting the mites from the mini-traps, they were placed in Petri dishes and fixed with 70% ethyl alcohol. Species identification was carried out according to the keys (Moss, 1968; Bregetova, 1956).

The morphometric parameters of male and female red mites (n = 15) were studied using ImageJ for Windows® software (version 2.00) in interactive mode. Microphotography was carried out using a Sigeta M3CMOS 14000 14.0 MP digital camera (China).

Statistical processing of the experimental results was carried out using Statistica 10 (StatSoft Inc., USA) software. Standard deviation (SD) and average values (x) were calculated.

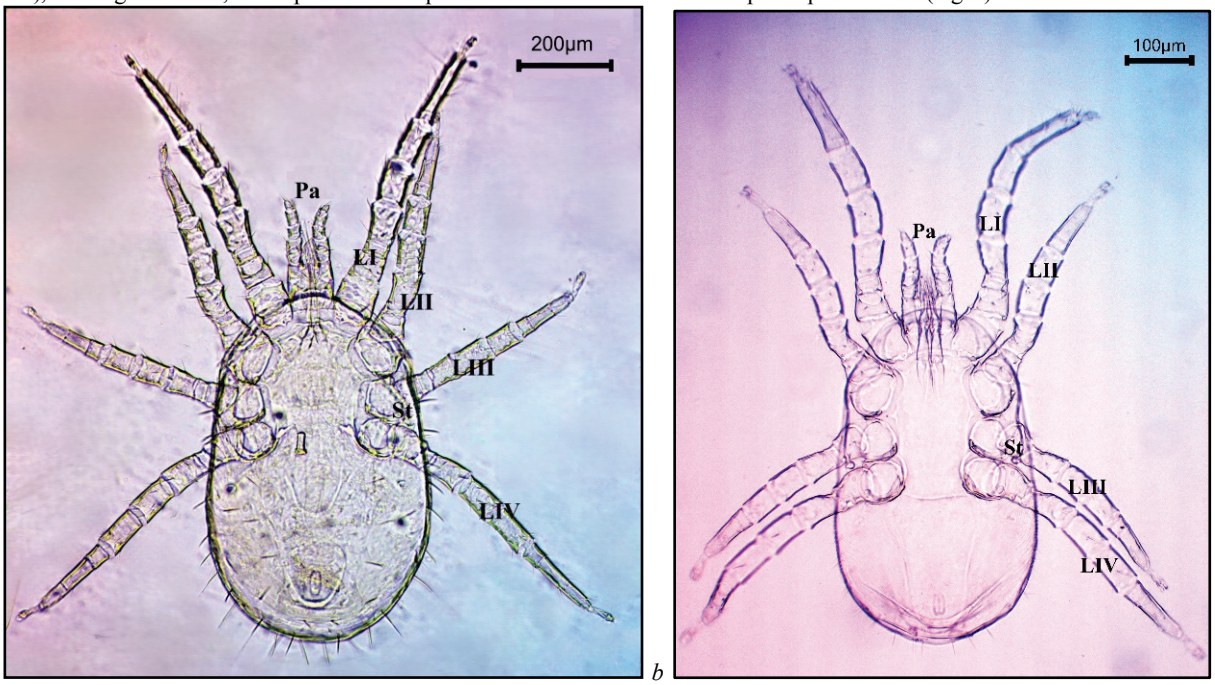
Results

The studied mites had an elongated-oval body shape, clearly divided into an idiosoma, which bears four pairs of long, elongated legs (LI–LIV), and a gnathosoma, a complex of mouthparts. Sexual dimorphism is well expressed, females are visually much larger (Fig. 1a) than males (Fig. 1b). The idiosoma is widely rounded posteriorly. There are clearly visible stigmata above the LIII trochanters. On the dorsal side, in both males and females, the propodosomal and hysterosomal shields are connected, forming a single large sclerotized dorsal shield, which narrows downwards. Its surface has a reticular structure with serrated scales (Fig. 2). The gnathosoma includes five-segmented palps, which end with a toothed bristle-like apotele. In females, the second article of the chelicera is greatly elongated and has the appearance of a stylet. The first cheliceral article is significantly reduced and mobile (Fig. 3a). In males, the cheliceral articles do not contain a stylet-like formation (Fig. 3b). The leg consists of coxa, trochanter, femur, stifle, tibia, tarsus with an ambulacrum. The ambulacrum has a pair of claws and pulvillae. The legs of *D. gallinae* are elongated (Fig. 4).

In *D. gallinae* males, the body length and width is 752.4 x 354.6 µm, their ratio is 2.1 : 1. The length and width of the gnathosoma are 180.2 x 89.8 µm, their ratio is 2.0 : 1. The length and width of the dorsal shield are 543.5 x 230.2 µm (Table 1).

The setae j1, j2, j4, j5, j6 and J1– J4 are clearly visible on the dorsal shield of males. At the same time, the seta j3 is absent. The setae s1 are located on the dorsal shield (Fig. 5). On the ventral side of males there are 2 shields that are close together – sternogenital and ventroanal, the border between which is located in the middle of the body. The length and width of the sternogenital shield are 255.5 x 124.6 µm, the ventroanal shield – 222.7 x 144.3 µm. Paired setae are located on the sternogenital shield: sternal (st1–st3), metasternal (mst) and ventral (vl1). The ventroanal shield bears a pair of adanal setae (ad) and 1 unpaired postanal seta (pa) (Fig. 6). The distance between the setae is: st1–st1 93.4 µm, st2–st2 93.4 µm, st3–st3 88.3 µm, st1–st2 65.2 µm, st1–st3 109.2 µm, mst–mst 90.4 µm, vl1–vl1 58.9 µm, ad–ad 42.1 µm. Length of ad 25.6 µm, of pa 19.1 µm (Table 1).

The setae j1, j2, j4, j5, j6 and J1– J4, z2, z4–z6 are also clearly visible on the dorsal shield of females of *D. gallinae*. The seta j3 is also absent, and the setae s1 are located on the dorsal shield (Fig. 7). On the ventral side of females there are 3 shields: sternal, genitoventral and anal. The sternal shield is located between legs II and III, narrowed, wider and shorter. It has 2 pairs of sternal setae, and the third pair is located behind and clearly separated from the others. The genitoventral shield is rounded towards the bottom, contains 1 pair of setae with 1 pair of epigynal pores. The anal shield is large and almost as wide as the genitoventral shield, containing a pair of adanal setae and 1 unpaired postanal seta (Fig. 8).



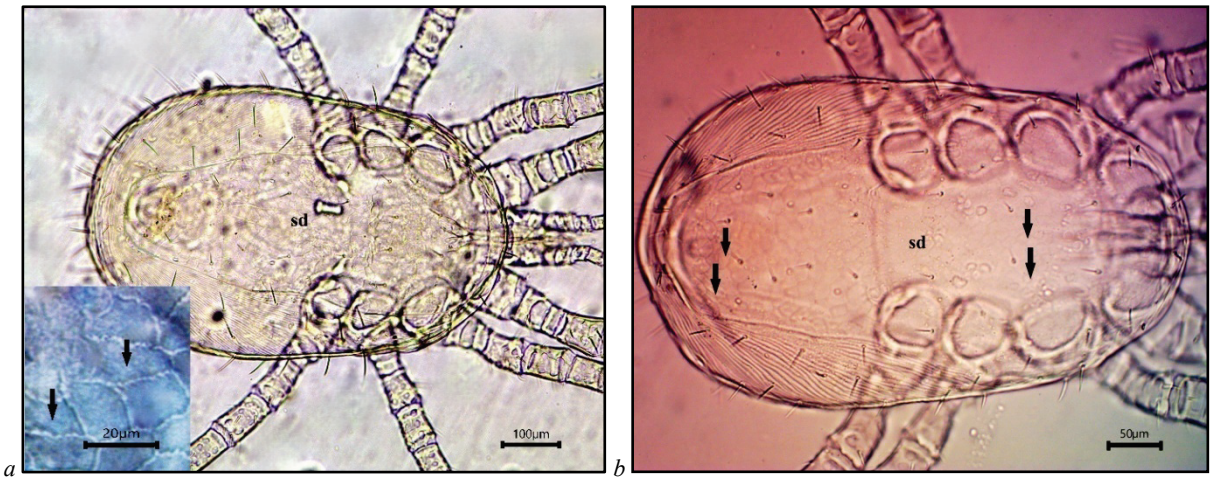
a *b*

Fig. 1. *Dermanyssus gallinae*: *a* – female, *b* – male; *Pa* – pedipalp, *st* – stigmata, LI–LIV – legs

Table 1
Metric parameters of male *Dermanyssus gallinae* mites, n = 15 (x ± SD, min – max)

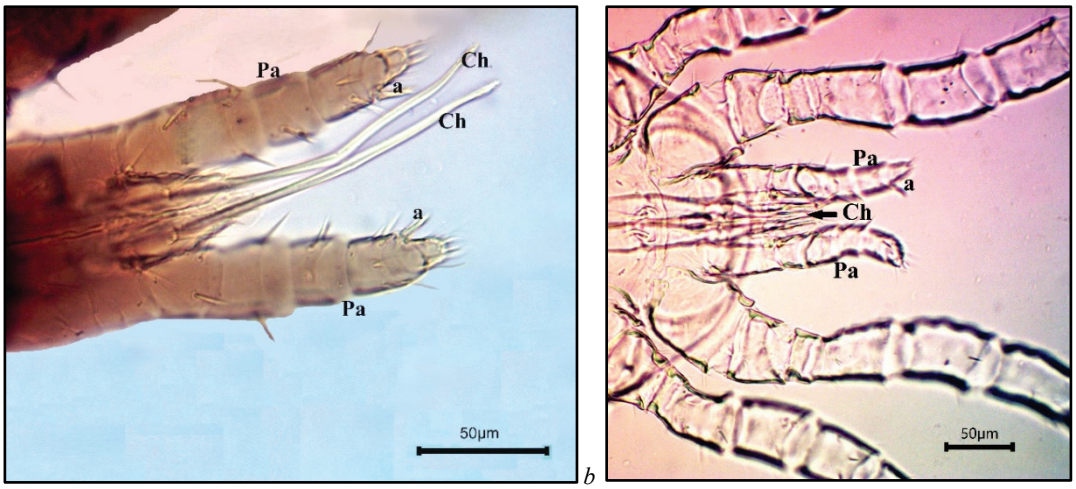
Parameters, μm	Examined specimens	Bregetova (1956)	Evans & Till (1962)	Evans & Till (1966)
Length of body	752.4 ± 42.6 (705.7–881.9)	600–630	650	–
Width of body	354.6 ± 34.3 (318.1–465.4)	320	350	–
Length to width of body ratio	2.1 : 1 (1.9 :1; 2.3 : 1)	–	–	–
Length of gnathosoma	180.2 ± 12.9 (162.3–202.9)	–	–	–
Width of gnathosoma	89.8 ± 3.9 (85.3–100.7)	–	–	–
Length to width of gnathosoma ratio	2.0 : 1 (1.8 :1; 2.3 : 1)	–	–	–
Length of idiosoma	572.1 ± 36.5 (518.8–680.3)	–	–	–
Length of podosoma	333.2 ± 18.8 (284.0–359.4)	–	–	–
Length of propodosoma	189.6 ± 16.3 (151.0–211.9)	–	–	–
Length of metapodosoma	143.5 ± 6.9 (130.9–152.0)	–	–	–
Length of hysterosoma	382.5 ± 37.5 (310.9–47.9.1)	–	–	–
Length of opisthosoma	239.0 ± 40.6 (160.6–348.3)	–	–	–
Length of proterosoma	369.9 ± 22.9 (338.7–404.0)	–	–	–
Length of prosoma	513.4 ± 23.2 (471.7–551.6)	–	–	–
Length of dorsal shield	543.5 ± 22.6 (498.5–582.1)	–	–	636
Width of dorsal shield	230.2 ± 17.5 (204.8–265.9)	–	–	276
Length of sternogenital shield	255.5 ± 12.1 (234.0–272.6)	–	–	–
Width of sternogenital shield	124.6 ± 7.4 (111.3–138.0)	–	–	–
Length of ventroanal shield	222.7 ± 4.8 (215.4–234.5)	–	–	–
Width of ventroanal shield	144.3 ± 7.6 (130.2–156.8)	–	–	–
Distance between setae st1–st1	53.7 ± 1.9 (50.1–56.9)	–	–	63
Distance between setae st2–st2	93.4 ± 1.9 (91.1–96.7)	–	–	–
Distance between setae st3–st3	88.3 ± 1.8 (84.7–90.9)	–	–	–
Distance between setae st1–st2	65.2 ± 1.0 (63.2–66.5)	–	–	–
Distance between setae st1–st3	109.2 ± 2.4 (104.7–112.7)	–	–	110
Distance between setae mst–mst	90.4 ± 2.0 (86.0–93.5)	–	–	–
Distance between setae vl1–vl1	58.9 ± 1.9 (55.6–61.9)	–	–	–
Length of adanal setae ad	25.6 ± 1.8 (22.3–28.5)	–	–	27
Distance between adanal setae ad–ad	42.1 ± 2.3 (39.6–46.3)	–	–	–
Length of postanal seta pa	19.1 ± 1.1 (17.0–21.4)	–	–	18

Note: "–" – parameters were not defined.



a *b*

Fig. 2. Reticular structure of dorsal shield (*sd*) of *Dermanyssus gallinae*: *a* – female, *b* – male



a *b*

Fig. 3. Gnathosoma of *Dermanyssus gallinae*: *a* – female, *b* – male; *Ch* – chelicerae, *Pa* – pedipalp, *a* – apotele

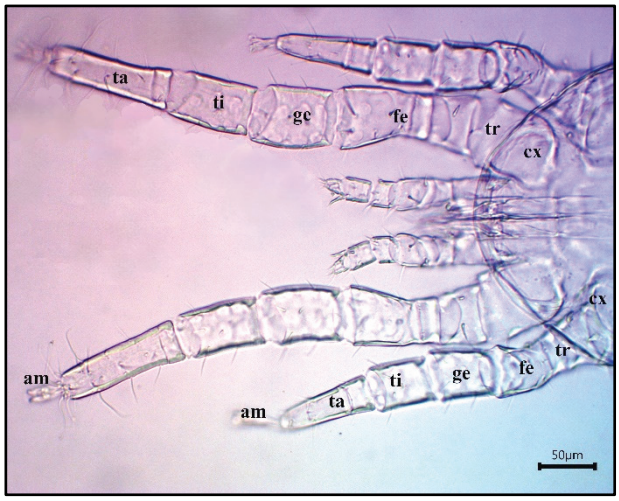


Fig. 4. Leg structure in *Dermanyssus gallinae*: *cx* – coxa, *tr* – trochanter, *fe* – femur, *ge* – genu, *ti* – tibia, *ta* – tarsus, *am* – ambulacrum

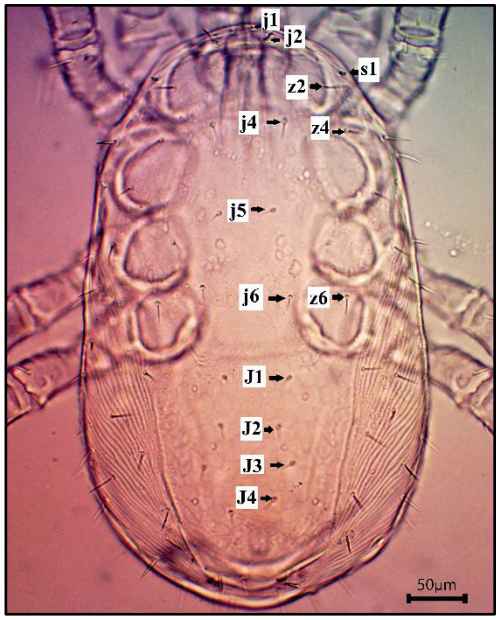


Fig. 5. Location of setae on the dorsal shield of male *Dermanyssus gallinae*

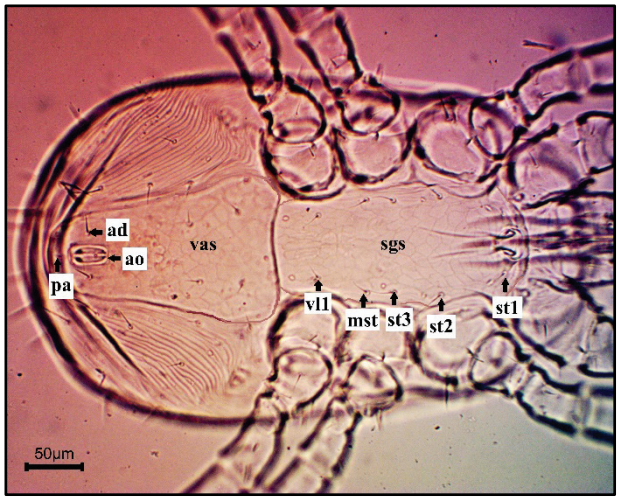


Fig. 6. Males of *Dermanyssus gallinae* (ventral view): *vas* – ventrianal shield, *sgs* – sternogenital shield, *st1–st3* – sternal setae, *mst* – metasternal setae, *vl1* – ventral setae, *ao* – anal opening, *ad* – adanal setae, *pa* – postanal seta

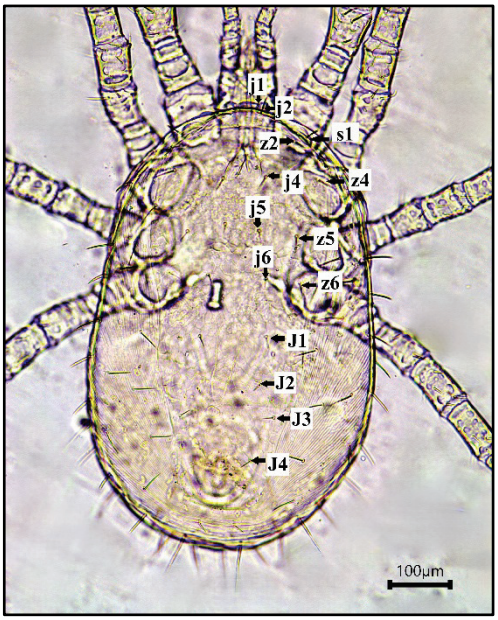


Fig. 7. Location of setae on the dorsal shield of female *Dermanyssus gallinae*

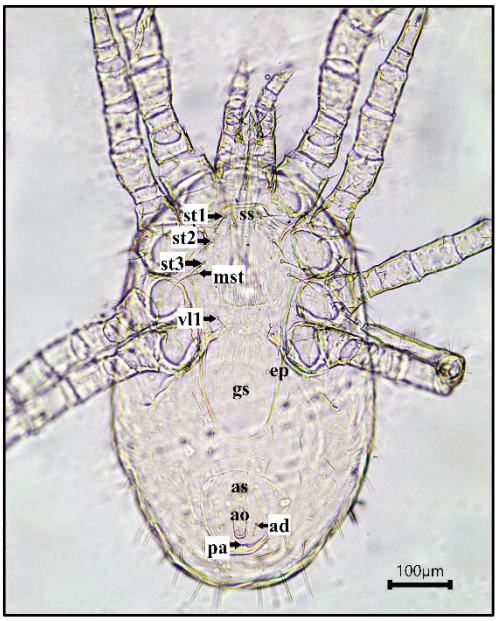


Fig. 8. Female of *Dermanyssus gallinae* (ventral view): *ss* – sternal shield, *gs* – genitoventral shield, *as* – anal shield, *ep* – epigynal pores, *st1–st3* – sternal setae, *mst* – metasternal setae, *vl1* – ventral setae, *ao* – anal opening, *ad* – adanal setae, *pa* – postanal seta

The size of *D. gallinae* females depended on their biological state. Females that contained an egg in the body cavity were larger than those that did not contain eggs. In particular, the length and width of the body of females that contained an egg in the body cavity was 1155.8 x 617.5 µm, their ratio is 1.9 : 1. The length and width of the gnathosoma was 243.2 x 104.8 µm, their ratio was 2.3 : 1. The length and width of the dorsal shield was 741.0 x 337.4 µm. At the same time, the body length and width of females that did not contain an egg in the body cavity were 912.6 x 465.2 µm, their ratio was 2.0 : 1. The length and width of the gnathosoma were 213.3 x 100.6 µm, their ratio is 2.1 : 1. The length and width of the dorsal shield were 716.7 x 314.9 µm (Table 2).

The length and width of the sternal shield of females that contained an egg in the body cavity were 26.3 x 176.8 µm, the genitoventral shield was 239.1 x 121.8 µm. The length of the setae st1 46.4 µm, st2 53.1 µm, st3 61.4 µm, mst 67.8 µm. The distance between the setae: st1–st1 63.7 µm, st2–st2 134.2 µm, st3–st3 102.2 µm,

st1–st2 40.8 μm, st1–st3 102.2 μm, mst–mst 185.9 μm, vl1–vl1 95.3 μm, st1–mst 127.8 μm, ad–ad 56.9 μm. Length of ad 31.6 μm, of pa 22.2 μm. At the same time, the length and width of the sternal shield of females that did not contain eggs in the body cavity were 21.3 x 156.7 μm, and the genitoventral shield was 222.9 x 105.9 μm. Seta length st1 43.8 μm, st2 47.5 μm, st3 58.5 μm, mst 65.1 μm. Distance between setae: st1–st1 59.7 μm, st2–st2 106.0 μm, st3–st3 135.1 μm, st1–st2 38.7 μm, st1–st3 94.1 μm, mst–mst 185.9 μm, vl1–vl1 92.3 μm, st1–mst 115.7 μm, ad–ad 57.7 μm. Length of ad 30.9 μm, of pa 20.8 μm (Table 2).

Table 2

Metric parameters of female *Dermanyssus gallinae* mites, n = 15 (x ± SD, min – max)

Parameters, μm	Examined specimens		Bregetova (1956)	Evans & Till (1962)	Evans & Till (1966)
	females with egg	females without egg			
Length of body	1155.8 ± 82.1 (1021.6–1352.0)	912.6 ± 60.8 (819.4–1020.8)	750–840	–	–
Width of body	617.5 ± 58.0 (529.5–714.8)	465.2 ± 38.2 (398.5–523.8)	400	–	–
Length to width of body ratio	1.9 : 1 (1.7 :1–2.1 : 1)	2.0 : 1 (1.8 :1–2.2 : 1)	–	–	–
Length of gnathosoma	243.2 ± 29.3 (195.6–301.2)	213.3 ± 14.9 (190.8–241.7)	–	–	–
Width of gnathosoma	104.8 ± 4.9 (97.6–116.2)	100.6 ± 8.4 (89.5–114.9)	–	–	–
Length to width of gnathosoma ratio	2.3 : 1 (1.9 :1–2.8 : 1)	2.1 : 1 (1.7 :1–2.3 : 1)	–	–	–
Length of idiosoma	912.6 ± 74.2 (751.9–1050.8)	699.3 ± 58.6 (613.9–801.0)	–	–	–
Length of podosoma	381.6 ±24.9 (335.0–417.2)	370.8 ± 12.0 (350.4–395.5)	–	–	–
Length of propodosoma	204.2 ± 14.6 (180.7–232.6)	201.8 ± 11.5 (181.7–220.8)	–	–	–
Length of metapodosoma	177.4 ± 14.7 (148.4–201.5)	169.0 ± 5.6 (160.2–178.2)	–	–	–
Length of hysterosoma	708.4 ± 75.6 (562.3–864.2)	497.5 ± 57.0 (402.7–604.0)	–	–	–
Length of opisthosoma	531.10 ± 83.8 (386.0–715.8)	328.5 ± 56.3 (232.6–425.8)	–	–	–
Length of proterosoma	447.4 ± 22.1 (404.4–487.9)	415.1 ± 13.0 (393.5–444.6)	–	–	–
Length of prosoma	624.8 ± 17.1 (589.8–650.6)	584.1 ± 13.1 (565.7–615.8)	–	–	–
Length of dorsal shield	741.0 ± 12.2 (718.5–764.3)	716.7 ± 10.6 (698.5–732.1)	–	810	756
Width of dorsal shield	337.4 ± 10.9 (320.3–354.0)	314.9 ± 11.7 (298.7–341.3)	–	360	300
Length of sternal shield	26.3 ± 3.8 (20.1–33.8)	21.3 ± 1.9 (18.6–24.7)	–	–	24
Width of sternal shield	176.8 ± 6.2 (165.9–187.7)	156.7 ± 6.5 (148.9–167.3)	–	–	150
Length of genitoventral shield	239.1 ± 10.5 (222.8–254.9)	222.9 ± 11.8 (209.2–240.8)	–	–	198
Width of genitoventral shield	121.8 ± 3.9 (115.2–126.8)	105.9 ± 5.0 (99.5–115.1)	–	–	126
Length of anal shield	141.6 ± 7.7 (130.7–152.4)	132.7 ± 8.9 (120.7–153.2)	–	155	140
Width of anal shield	148.6 ± 8.7 (127.7–163.0)	126.4 ± 6.7 (117.7–142.0)	–	150	123–150
Distance from anal shield to distal part of idiosoma	181.4 ± 33.9 (120.8–239.3)	61.4 ± 10.3 (45.0–81.3)	–	–	–
Length of genital valve	124.5 ± 10.1 (107.7–138.6)	115.8 ± 16.8 (95.5–134.4)	–	–	–
Width of genital valve	134.3 ± 7.7 (113.4–142.6)	114.9 ± 8.1 (101.7–134.4)	–	–	–
Length of setae st1	46.4 ± 2.6 (42.9–51.2)	43.8 ± 3.0 (40.6–50.8)	–	–	–
Distance between setae st1–st1	63.7 ± 5.3 (52.6–73.3)	59.7 ± 1.9 (55.6–63.0)	–	–	78
Distance between st2	53.1 ± 3.2 (48.4–60.8)	47.5 ± 2.3 (43.5–51.3)	–	–	–
Distance between setae st2–st2	134.2 ± 14.7 (101.9–160.4)	106.0 ± 6.9 (98.2–116.9)	–	–	–
Length of setae st3	61.4 ± 3.1 (55.2–67.3)	58.5 ± 5.1 (49.9–65.2)	–	–	–
Distance between setae st3–st3	161.9 ± 6.0 (150.3–168.5)	135.1 ± 8.0 (128.3–158.0)	–	–	–
Length of setae mst	67.8 ± 5.2 (53.8–74.6)	65.1 ± 4.6 (58.2–71.4)	–	–	–
Distance between setae mst–mst	185.9 ± 6.1 (177.2–196.1)	169.4 ± 9.2 (154.2–183.9)	–	–	–
Distance between setae st1–st2	40.8 ± 2.5 (36.5–46.0)	38.7 ± 2.5 (35.3–43.2)	–	–	–
Distance between setae st1–st3	102.2 ± 5.1 (94.6–110.3)	94.1 ± 4.0 (89.2–102.5)	–	–	88
Distance between setae st1–mst	127.8 ± 3.8 (120.0–132.2)	115.7 ± 5.9 (107.6–125.2)	–	–	–
Distance between setae vl1–vl1	95.3 ± 4.3 (84.7–102.6)	92.3 ± 8.5 (82.2–105.8)	–	–	–
Length of adanal setae ad	31.6 ± 2.6 (28.3–36.1)	30.9 ± 4.4 (20.1–39.5)	–	–	36
Distance between adanal setae ad–ad	56.9 ± 3.4 (52.4–61.5)	57.7 ± 6.4 (49.3–70.4)	–	–	–
Length of postanal seta pa	22.2 ± 2.1 (19.3–26.2)	20.8 ± 1.8 (18.1–24.2)	–	–	20
Length of egg	442.1 ± 11.2 (421.1–456.9)	–	–	–	–
Width of egg	264.8 ± 16.2 (241.3–293.5)	–	–	–	–

Note: "–" – parameters were not defined.

The eggs found in the body cavity of *D. gallinae* females were oval-rounded, transparent with a well-defined shell and filled almost half of the female posterior (Fig. 9). The size of the eggs in the body of female mites was determined to be 442.1 μm long and 264.8 μm wide. Thus, the metric parameters of females with a formed egg in their body cavity and their comparison with the size of female mite without eggs are described in this study for the first time.

Discussion

Poultry farming is the most dynamically developing branch of the agricultural sector and allows for the short-term production of dietary food products – eggs and meat (Boiko et al., 2016; Dyak, 2016; Iatsiv, 2021). One of the important problems that reduces the profitability of poultry farming is the parasitism of domestic chickens by ectoparasites of *D. gallinae* (Sparagano et al., 2020; Petersen et al., 2021).

For successful control of the red poultry mite, timely and accurate diagnosis of the disease, based on identification of the pathogen, is important. Differentiation of mites of the genus *Dermanyssus* is based mainly on the morphological structure of the chelicerae, which is associated with the hematophagous lifestyle (Phyllis, 2006; Roy & Chauve, 2007). This distinguishes Dermanyssidae from other families in Dermanyssoidea.

Since 1834, at least 56 species have been included in the genus *Dermanyssus*. For some species, there are clearly defined identifying characters (Evans & Till, 1962; Moss, 1968, 1978; Moss et al., 1970). At the same time, some researchers note that the characters that have so far been most often used to characterize *Dermanyssus* species are ambiguous and not always reliable (Roy & Chauve, 2010). Also, in connection with the conducted molecular genetic studies of *D. gallinae* mites, their genetic variations have been identified, which are the result of acquiring resistance to prolonged and excessive use of acaricides (Marangi et al., 2014; Sokół et al., 2019; Koziatek-Sadłowska & Sokół, 2022). In this regard, the study of morphometric characteristics of *D. gallinae* mites, which may facilitate their identification, remains relevant.

Morphological studies of male and female *D. gallinae* mites have shown that species-specific characters include the location and presence of setae on the dorsal shield, where the j3 setae are absent, and s1 are located. In females, the second article of the chelicera is greatly

elongated and has the appearance of a stylet. The first article of the chelicera is significantly reduced and mobile. On the ventral side of males, sternogenital and ventroanal shields are close together, the border between which is in the middle of the body. On the sternogenital shield there are paired setae st1–st3, mst and vl1. In males and females, on the anal shield there is a pair of adanal setae and 1 unpaired postanal seta. In female *D. gallinae*, on the ventral side there are three shields: sternal, genitoventral and anal. The sternal shield is located between legs II and III, narrowed, wider and shorter. It bears 2 pairs of sternal setae. The genitoventral shield is rounded towards the bottom, contains 1 pair of setae. The anal shield is large and almost equal in width to the width of the genitoventral shield. Such differential signs of mites of the species *D. gallinae* are described in various scientific works, where attention is paid to the specific structure of chelicerae in females, the structure and location of the shields in males and females, the peculiarities of chaetotaxy on the dorsal shield and on the ventral surface of the mites (Evans & Till, 1965; Moss, 1968; Di Palma et al., 2012; Pezzi et al., 2017).

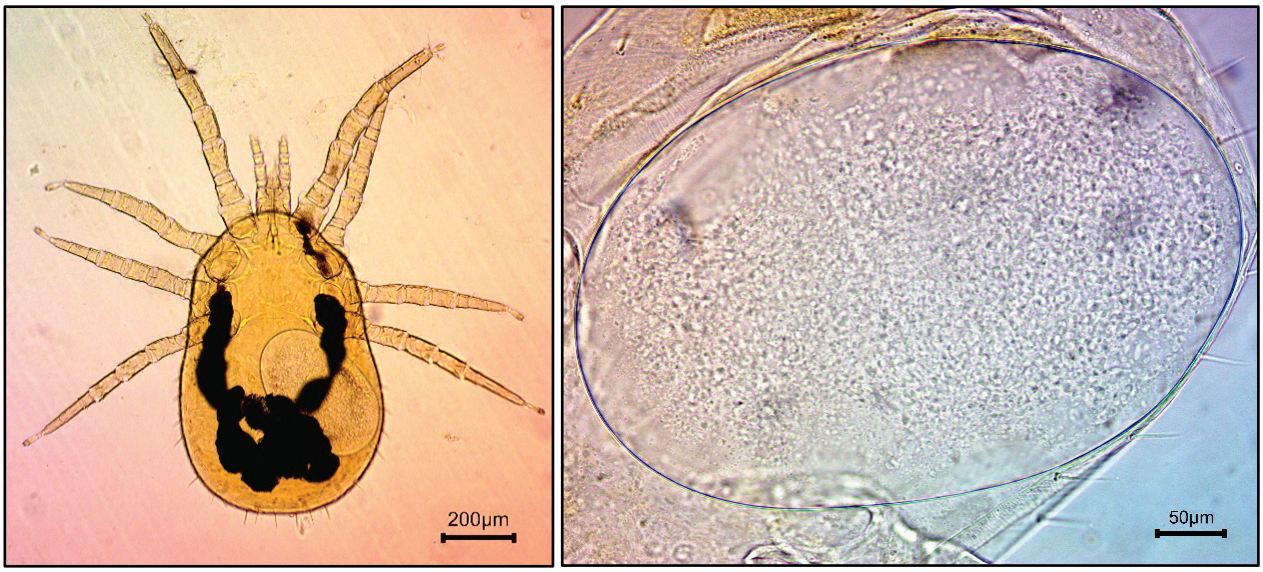


Fig. 9. An egg in the body cavity of female *Dermanyssus gallinae*

When studying the morphometric characteristics of the male *D. gallinae* mites, 30 parameters were determined that describe the general structure of the body, namely: total length, body width and their ratio, length, width of the gnathosoma and their ratio, length of the idiosoma, podosoma, propodosoma, metapodosoma, hysterosoma, opisthosoma, proterosoma, prosoma, length and width of the dorsal shield, sternogenital shield, ventroanal shield, distance between setae st1–st1, st2–st2, st3–st3, st1–st2, st1–st3, mst–mst, vl1–vl1, ad–ad, length of setae ad, pa. In the literature available to us, the authors determined from 2 to 6 indicators in males of this species, characterizing the length and width of the body, dorsal shield, the distance between the setae st1–st1, st1–st3, vl1–vl1, and the length of the seta pa (Bregetova, 1956; Evans & Till, 1962; Evans & Till, 1966). Their data are consistent with the results of our studies.

When studying the morphometric characteristics of the female *D. gallinae* mites, 40 indicators were determined, which, like in males, describe the general structure of the body and its parts, the size and location of the sternal, genitoventral and anal shields, the genitoventral valve, the distance between the setae st1–st1, st2–st2, st3–st3, st1–st2, st1–st3, mst–mst, vl1–vl1, ad–ad, st1–mst, the length of the setae st1, st2, st3, mst, ad, pa. Additionally, the sizes of the mite eggs were determined. The eggs are located in the body cavity of females. In the literature available to us, the authors determined from 2 to 12 indicators in females of this species, characterizing the length and width of the body, dorsal, genitoventral and anal shields, the distance between the setae st1–st1, st1–st3, the length of the setae ad, pa (Bregetova, 1956; Evans & Till, 1962; Evans & Till, 1966). Moreover, the data we obtained on individual parameters differ from the results of the studies of other scientists, which, in our opinion, is due to the type of females that were subjected to measurement. We have for the first time compared and determined the sizes of the morphological structures of gravid female *D. gallinae* mites, and females without eggs. A significant difference in their morphometric indicators was found.

The scientific data obtained in this study expands existing data on the morphometric characteristics of gamasid mites of the species *Dermanyssus gallinae* (Arthropoda: Dermanyssidae).

Conclusion

Morphological and metric studies of mites of the species *D. gallinae* isolated from chickens in Ukraine described and determined 30 parameters in males and 40 parameters in females, which characterize the structure and dimensions of the body, its parts, dorsal shield, location of dorsal setae (j1, j2, j4–j6, J1– J4, z2, z4–z6), length of adanal and postanal setae, as well as the distance between sternal (st1–st1, st2–st2, st3–st3, st1–st2, st1–st3), metasternal (mst–mst), ventral (vl1–vl1), adanal (ad–ad) setae. In male mites, the dimensions and location of the sternogenital and ventroanal shields were also determined. In female mites, the sizes and locations of the sternal, genitoventral and anal shields, the genitoventral valve, setae st1, st2, st3, mst, and the distance between setae st1–mst were determined. It was determined that the sizes and features of the location of morphological structures of the body of gravid females are significantly different from females that do not have eggs in the body cavity, which must be taken into account when performing species differentiation.

The research was carried out within the framework of the initiative topic of scientific work: "Ecological-faunistic monitoring and development of modern methods of diagnosis, measures to combat and prevent parasitic diseases in birds" (state registration No. 0121U107882), Ukrainian Institute of Scientific and Technical Expertise and Information, Ukraine; "Monitoring and improvement of means of diagnosis, treatment and prevention of infectious diseases of animals and poultry" (state registration No. 0123U101067), Ukrainian Institute of Scientific and Technical Expertise and Information, Ukraine.

The authors state that there is no conflict of interest.

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