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Morphological and Morphometrical Study of the Stink Bug *Mustha spinulosa* (Lefebrve, 1831) (Hemiptera: Pentatomidae) from Erbil – Iraq

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Abstract

All life stages of the pentatomid stink bug *Mustha spinulosa* (Lefebrve, 1831) (Hemiptera: Pentatomidae) collected from several types of trees in Erbil Governorate, North Iraq, along with their morphometrical description, were illustrated. Eggs are barrel in shape, green in color when freshly laid, and usually deposited in clusters that contain 14 eggs each (sometimes 12). Nymphs complete their stage through 5 instars. Head, pronotum, and connexivum of the adults and instars are with pale pink and gray spines; female is slightly larger than male; female is 27.30 mm long and 12.80 mm wide, while male is 25.80 mm long and 11.98 mm wide. Labium proboscis is1.25 ± 0.01 cm long, with brown blackish color. A pair of scent glands are located on the underside of thorax between second and third leg base. All body parts, especially head, thorax, and abdomen are densely covered with setae.

Keywords: Morphological, Morphometrical, *Mustha spinulosa*, Pentatomidae, Stink bug

دراسة مظهرية وقياسية للبق النتن ***Mustha spinulosa*** **(Lefebrve, 1831) (Hemiptera: Pentatomidae) من اربيل–العراق**

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الخلاصه

وضحت جميع ادوار حياة البق النتن *M. spinulosa* التي تعود الى عائلة Pentatomidae رتبة Hemiptera مع الوصف المظهري والقياسي للأدوار المختلفة. البيض برميلي الشكل ، اخضر اللون ويوضع على شكل كتل ، كل كتلة تحتوي على 14 بيضة (احيانا 12). يكمل الطور الحوري خلال خمسة اعمار. الراس ,الصدر وحافة البطن في الكاملات والحوريات ذات اشواك وردي باهت الى رصاصي اللون. الانثى اكبر قليلا من الذكر، حيث طول الانثى 27.3 ملم وعرض 12.80 ملم بينما الذكر طوله 25.80 ملم وعرضه 11.98ملم. للحشرة اجزاء فم قهوائي الى اسود اللون ذو طول 1.25 ± 0.01 سم، كما يمتلك زوج

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من غدد تفرز رائحة كريهة تقع في السطح البطني للصدر بين قاعدتي الرجل الاوسط والخلفي. كل اجزاء جسم الحشرة خاصة الراس ، الصدر ، البطن مغطاة بشعيرات.

1. Introduction

The phytophagous stink bug *M. spinulosa* which belongs to family Pentatomidae (Order Hemiptera) is attacking several kinds of fruit trees such as plum, apricot, apple, olive, almond, fig, and pear, as well as forest trees viz. poplar, pine, planetree, and willow [1]; both nymphs and adults feed by sucking plant sap from leaves and stems [2]. Most studies that recorded *M. spinulosa* bug were focusing on its distribution based on surveys [3- 5]. According to an earlier work [6], the genus *Mustha* Amyot & Serville, 1834 had six species, almost all from Persia (Iran). Two other new species were added to the list, one (*M. spinulosa*) is from Pakistan [7], and the other (*M. vicina*) is from Iran [8]. An annotated catalog of the Iranian Pentatomoidea (Hemiptera: Heteroptera: Pentatomomorpha) was published, including general and local distribution of *M. spinulosa* with references to its host plants [9]. A revision made for berry bug of Indo-Pakistan subcontinent provided a short description for adults of 5 species that belong to the genus *Mustha*, with a very short note on species *Mustha spinulosa* [10]. On the other hand, a key was made to the global species of the genus *Mustha* [11]. Only *Mustha spinulosa*, among the species of this genus, distributes along a wide area in Europe as well as Asia and North Africa [12]. While in Iraq, the species *M. spinulosa* was recorded in an earlier study [13] and mentioned by others [14- 17]. Recently, it was reported that it attacks fruit trees in Erbil city [18]. Because the life cycle and biology of this bug were unknown, we attempted to provide a description to all its developmental stages, supported with figures and measurements, which represents the first study of its kind in Iraq.

2. Materials and Methods

2.1 Specimens collection

All stages of insects were collected from different locations at the sampling area within two main parks in Erbil city during the period from January till September 2018. Specimens were collected from the surfaces of the main stem, branches, and leaves of the following trees: *Pinus* sp., *Casuarina* sp., *Poplus* sp., and *Platanus* sp., samplings were made by using hand. Collected specimens were put into jars, covered with muslin, tided with rubber band, and then transferred to the laboratory. The morphological description and measurements of all the stages of *M. spinulosa* were distinct and clarified by using a dissecting microscope (OPTIKA, Italy). For this purpose live individuals and preserved specimens in alcohol 70% (only for two days) were used. Ten specimens were selected for each stage and instars. The measurements included length and width of the body, head (across the eyes and between the eyes), scutellum, and legs, as well as length of antennal segments.

2.2 Specimens identification

"For identification, the specimens were sent to Dr. Rauno E. LINNAVUORI the experts in stink bugs at the University of Saukkokuja, Raisio, Finland", while the host plants were identified in the Herbarium section, College of Science, University of Salahaddein, Erbil.

3. Results and Discussion

Egg stage: Eggs are barrel-shaped, with an average length of 1.53 ± 0.01mm and 0.65 ± 0.01mm in width. Eggs are bright green in color when freshly laid, then turn to transparent after hatching (Figure 1- a), indicating their viability, while the parasitized eggs usually turn to blackish (Figure 1-b). In some instances, eggs are transparent when there is no embryo inside. Eggs are usually laid in clusters (12-14 eggs) arranged in two regular lines, each with seven eggs and, sometimes, they are laid irregularly on the branches of pine trees only.

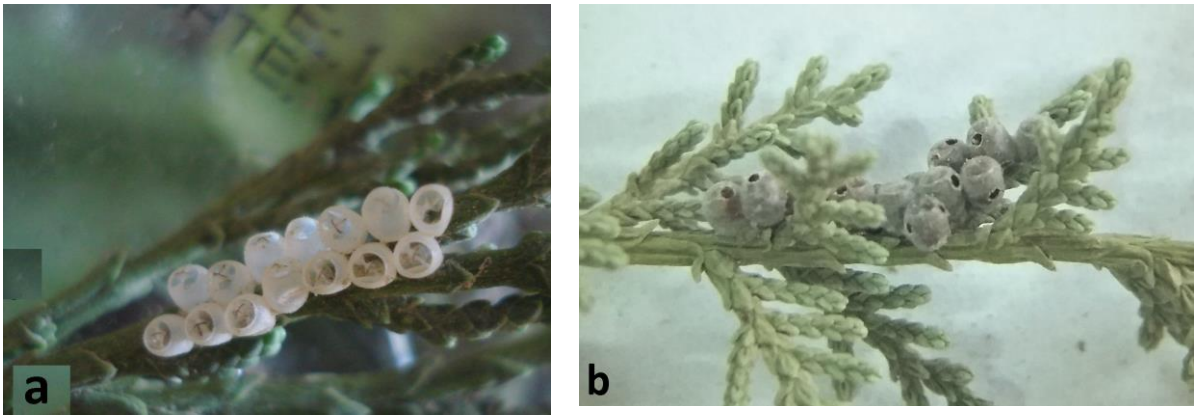


Figure 1- Egg stage of *Mustha spinulosa* collected from parts of trees in Erbil, North Iraq; (70X) a) Newly egg mass hatched. b) Infected egg mass with parasitoids.

Nymph stage

First instar: The average length of head is 0.57 ± 0.01 mm while the width is 0.94 ± 0.01 mm. Lengths of antennal segments are 0.16 ± 0.01, 0.40 ± 0.01, 0.32 ± 0.01, and 0.60 ± 0.01 mm for I, II, III, and IV segments, respectively. Body is oval shaped, with an average of 2.9 ± 0.05 mm length and 2.7 ± 0.05 mm width, while the maximum width approaches the second abdominal segment. Antennae have a filiform type, each consisting of four segments. Tylus and juga are visible dorsally. Eyes are compound, sessile, and spherical. Rostrum reaches to the base of abdomen. Head is pale yellow, while tylus and base of head are pale green. Antennal segments are transparent, and rostrum has the same colors. Pro, meso, and metanotum are pale green with brown or black areas. Legs are transparent or pale orange with some dark brown areas. Abdominal segments are pale green with brown spots, whereas sternum is green with reddish-orange. Margin of body is with small setose (Figure 2- a).

Second instar: Oval, with maximum width across abdominal segment III; body with has an average length of 6.86 ± 0.01 mm and 5.1± 0.01 mm width, convex, slightly flattened dorso-ventrally. Head length is 1.23 ± 0.01 mm whereas the width across the eyes is 1.83 ± 0.01 mm. The lengths of antennal segments are 0.40 ± 0, 1.78 ± 0.01, 1.24 ± 0.01, and 1.28 ± 0.01mm for I, II, III, and IV segments, respectively. Eyes are black, spherical in shape and slightly separated from pronotum; some spines project from the two sides of head in front of eyes; pronotum possesses pale pink spines. Antennal segments I and II are gray, while segments III to IV are dark gray with pink at base; ventral surface of head, labium, and most of femora and tibiae is gray. Dorsum of abdomen is gray with punctuate and pale pink spines on the margin. Ventral side of abdomen is pale gray with pale brown rectangular macules on midline of sternites V to VIII. Connexivum is with pale pink and gray spines (Figure 2- b).

Third instar: Oval, with an average length of 10.42 ± 0.02 mm and 7.9 ± 0.01 mm width; head length is 1.4 ± 0.01 mm whereas the width across the eyes is 2.0 ± 0 mm. The lengths of antennal segments are 0.46 ± 0.01, 1.9 ± 0.01, 1.4 ± 0, and 1.32 ± 0.01mm for I, II, III, and IV segments, respectively. Head, pronotum, and connexivum are with pale pink and gray spines; eyes are black and well developed. Antennal segments I and II are gray, while the remainder segments are gray with pink at base and the ventral surface of head and labium is gray. Pro, meso, and metanotum are pale gray; legs are pale gray, except the mid tibiae of middle and hind legs which are pale orange. Abdomen convex dorso-ventrally, with a maximum width at the second abdominal segment; the dorsal side of abdomen is with sparse black punctures; body segmentation is easily distinguished (Figure 2c).

Fourth instar: The individuals are found in two different colors, one is pale pink and the other is dark gray. The first form was observed on trees with stems that have pale color (ex. *Eucalyptus* sp., *Olea* sp., *Platanus* sp.), while the second form was found on trees with stems

of dark color (ex. *Prunus amygdalus* and *Prunus* sp.). This might be due to feeding behaviors on their hosts, using color as a camouflage to hide from enemies (Figure 2- d, e). Body is oval, convex dorsally, 17.37 ± 0.01 mm length and 9.1 ± 0.01 mm width, with maximum width across abdominal segment III, average length of head is 1.96 ± 0.01 mm; whereas the width across eyes is 2.21 ± 0.01 mm and between them is 1.5 ± 0 mm; lengths of antennal segments are 0.63 ± 0.01, 2.45 ± 0.01, 1.57 ± 0.01, and 1.66 ± 0.01 mm for I, II, III, and IV segments, respectively. Margin of head, pronotum, and connexivum are with pale pink spines. Head is declivitous and eyes are black; ocelli are not clear, antennae are dark gray with pale pink at the base; scutellum reaches to base of metanotum. Abdomens are with numerous dark gray punctures.

Fifth instar: Individuals appear in two different colors as in the previous instar (Figure 2, f &g), oval shaped, convex dorsally, with 22.12 ± 0.01 length and 12.20 ± 0.01 mm width. The average length of the head is 2.0 ± 0 mm, whereas the width across the eyes is 2.31 ± 0.01 mm and between the eyes is 1.65 ± 0.01 mm. The lengths of antennal segments are 0.71 ± 0.01, 2.84 ± 0.01, 1.63 ±0.01, and 1.74 ± 0.01 mm for I, II, III, and IV segments, respectively. Head is well developed, gray in color; ocelli are not clear; black strips are found between eyes, and their margin is with numerous spines. Antennae consist of four segments and have gray color, except the base of each segment which has reddish color.

A

B

C

D

E

F **G**

Figure 2-*Mustha spinulosa* (Lefebrve, 1831) nymphal stage collected from parts of trees in Erbil, North Iraq. A) First instar (250X), B) Second instar, C) Third instar, D) Fourth instar light color, E) Fourth instar dark color, F) Fifth instar light color, G) Fifth instar dark color.

Pronotum is large, gray, and its margins are with spines; wing pad is clear and reaches to the end of the second abdominal segment, with gray color. Scutellum is wider than its length, gray, and its apex has a triangle shape, reaching the end of the second abdominal segment. Legs are gray to black, except the mid portion of tibia of middle and hind legs which has pale-gray color; tarsus is black**.** Two different areas in color are noticed on the dorsal side of the abdomen; the middle line and area near to body margin are with dark gray, while the rest is pale gray that punctuates with black spots**.** The abdomen margins are with pale pink and gray spines.

Adult: Larger than nymphs, total length of male body is 25.80 ± 0.01 mm with 11.98 ± 0.01 mm width, while female body is 27.30 ± 0.01 long and 12.80 ± 0.01 mm wide (Figure 3).

Figure 3-*Mustha spinulosa* (Lefebrve, 1831) Adult, ventral and dorsal view of female, collected from parts of trees in Erbil, North Iraq

Lateral margins are straight with 4.9 ± 0.01 mm length and 3.0 ± 0.01 mm width; its lateral spines range 17-19 in number, being as long as those of abdomen. All body parts, especially head, thorax, and abdomen are densely covered with setae. Head is with two compound brown eyes and three dark red ocelli; interocular distance is 2.7 ± 0.01 mm and head width across eyes is 4.0 ± 0.01 mm. Antennae are five-segmented, where the first antennal segment is not reaching apex of head, the fourth segment is longer than the others, and the last 2 segments are reddish. Lengths of antennal segments are 1.0 ± 0.01 mm, 1.3 ± 0.01 mm, 2.0 ± 0 mm, 3.0 ± 0 mm, and 2.8 ± 0.01 mm for segments I, II, III, IV, and V respectively (Figure 4). Labium proboscis is 1.25 ± 0.01 cm long, with brown blackish color reaching up to end of first abdominal sternite; a pair of scent glands are located on the underside of thorax between second and third leg bases (Figure 5).

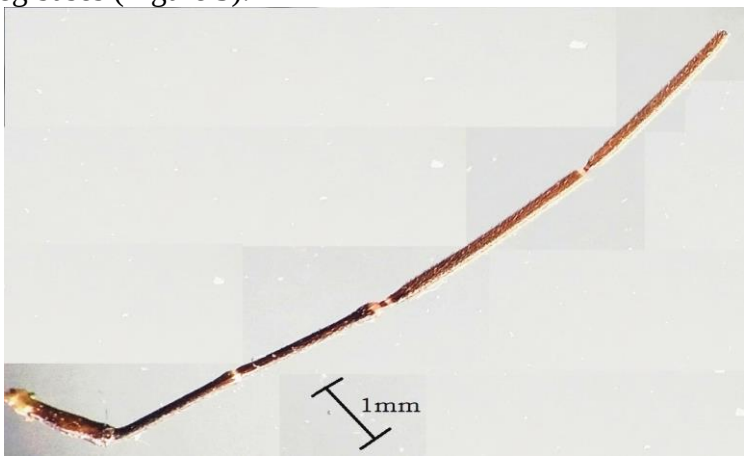


Figure 4- Antenna of *Mustha spinulosa* collected from parts of trees in Erbil, North Iraq

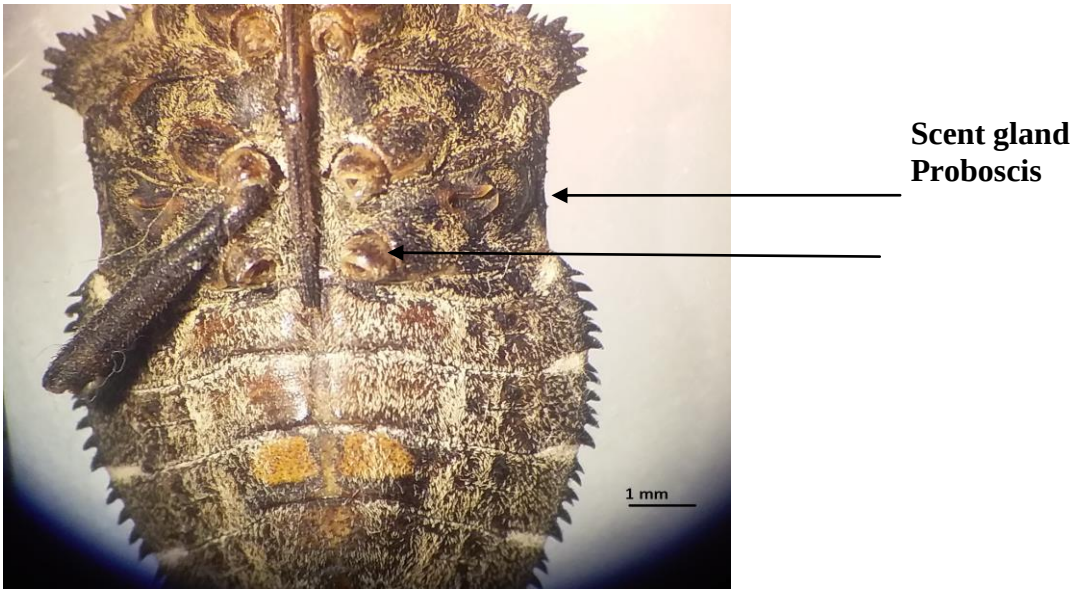


Figure 5- Labium proboscis with scent gland of *Mustha spinulosa* collected from parts of trees in Erbil, North Iraq

Pronotum length is 6.0 ± 0 mm, while width across humeral angles is 11.0 ± 0 mm. Scutellum are with 8.0 ± 0 mm length and 6.0 ± 0 mm width (Figure 6). Fore and middle legs have the same length but they differ from hind legs in length; they bear setae with downward direction; tibia in fore leg is wide, while it is cylindrical in mid and hind legs. Femur and tibia are 1.6 ± 0.01 mm long, tarsus has 5 segments with 2.1 ± 0.01 mm; the 1st segment is longer than the rest; hind leg femur is 7.3 ± 0.01 mm and tibia is 9.0 ± 0 mm (Figure 7).

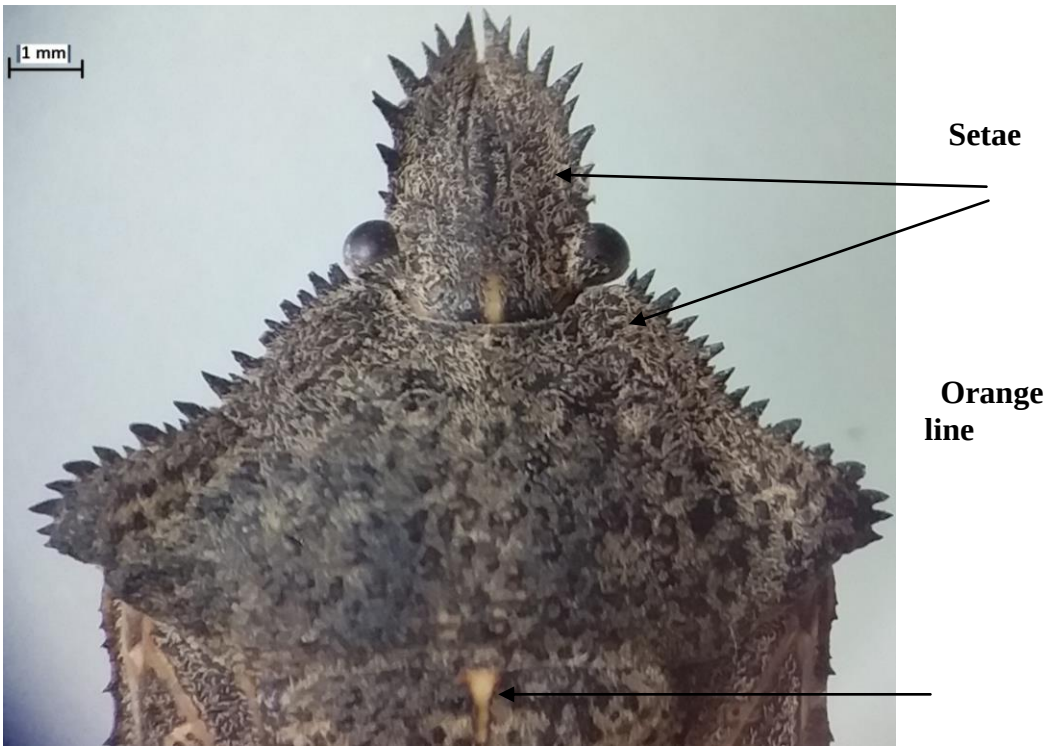


Figure 6-Setae on the head and pronotum of *Mustha spinulosa* collected from parts of trees in Erbil, North Iraq

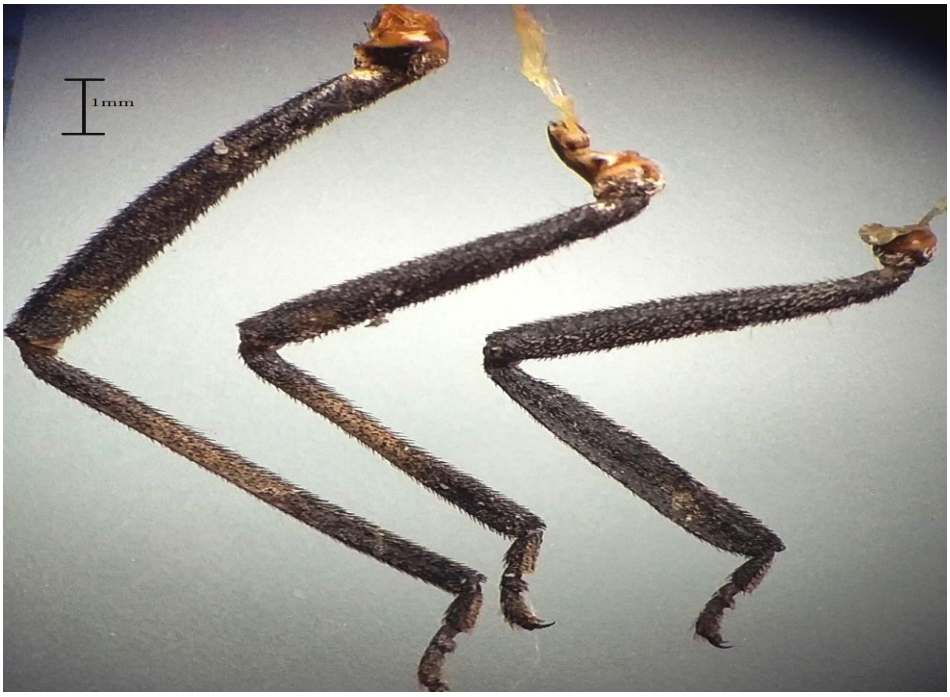
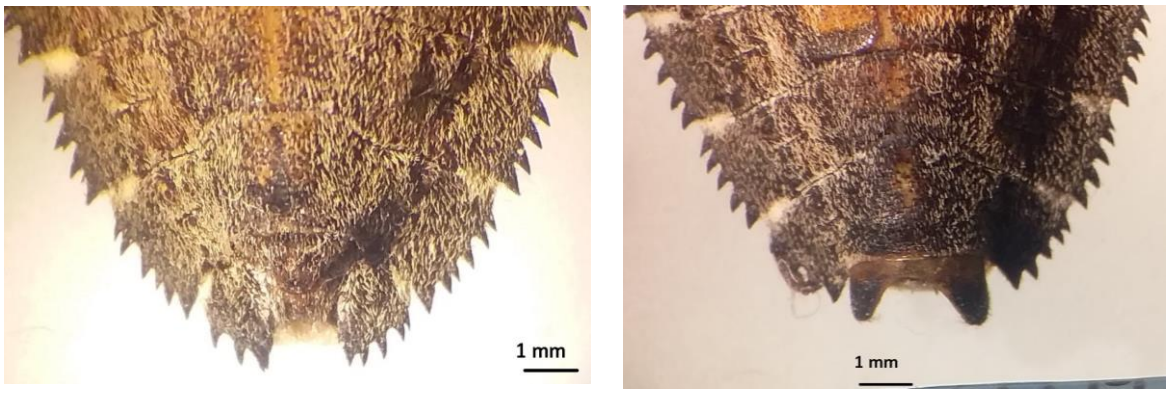


Figure 7-Fore, mid and hind legs of *Mustha spinulosa* collected from parts of trees in Erbil, North Iraq

Head is sharply triangular, strongly narrowed apically, relatively broad in the base, distinctly shorter than pronotum. Pronotum width is distinctly longer than head; lateral margins are convergent, distinctly with humeral angles armed with 38 spines; lateral spines of pronotum are shorter than the transversal diameter of an eye, almost all being long except few that are very short.

The entire pronotum and scutellum, except their margins, are gray, thickly and densely speckled with black spots; corium is a mix of brown-gray, punctuated with small light brown circles that have a black center; apex of scutellum has some brown punctuates with one longitudinal median spot; legs are gray with small dark brown spots and punctures, except the mid of tibiae of middle and hind legs which are reddish brown; the hemelytra membrane is dark brown; connexiva is gray but in equal distances has white setae seen in general appearance as strips; scutellum is distinctly longer than its width at base, apex is sub-rounded; in the female, an orange line with 1 mm length is extended from center of the base of scutellum to the back direction (Figure 6); the membrane of hemelytra is almost equal to the last segment of abdomen in both males and females.

Abdomen connexiva is well exposed at repose, with joints that are acutely produced and lateral margins armed with acute spines that are ranged 56-60 in number. The ventral side of abdomen has orange spotted strips that exist on both sides parallel to the margins; also, deep sulcation occurs as an accommodated long labium. Males are distinguished from females by their small size and the end of abdomen (Figure 8, a, b).



A b

Figure 8-Ventral view of end of abdomen in *Mustha spinulosa* collected from parts of trees in Erbil, North Iraq; (a) Female, (b) Male

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