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Illustrate the morphologic characters of Colorado potato beetle, *Leptinotarsa decemlineata* say, 1824 (Coleoptera: Chrysomelidae)

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Abstract

A morphological study of the *Leptinotarsa decemlineata* Say, 1824 (Coleoptera: Chrysomelidae) has been done for specimens were collected from potato and eggplant fields of some villages in Erbil Governorate- Kurdistan region- Iraq, from the period of August- September / 2016. The adults described in detail, important body parts such as mouthparts, antenna, thorax, wings, legs, male and female genitalia parts were illustrated by a digital microscopic camera with their scales. Hosts, localities and date of collection were provided. Results indicated that this species is quite differ from all other its familiar in the genus by its morphological shape and habitat and host.

Keywords: Coleoptera, Chrysomelidae, *Leptinotarsa decemlineata* say

Introduction

Chrysomelidae Latreille, 1802 commonly known as leaf beetles is the second largest phytophagous family of beetles within Chrysomeloidea Latreille, 1802, with seventeen subfamilies [1]. Its species widely distributed worldwide, having approximately 50 000 species in over 2000 genera [2]. Chrysomelidae feed on plants and some of them are regarded as pests in agriculture and forestry [3]. Chinery [4] mentioned that this family is the largest of three families comprising the Chrysomeloidea, with more than 25,000 species. Urban [5] mentioned that there are over 25 thousand species of this family in the world, where Jolivet *et al.*, [6] mentioned that about 30000– 50000 species are known, and Jolivet and Hawkeswood [7] mentioned that over 50,000 species distributed throughout the world, while Reid [8] mentioned that more than 60,000 species according to more progressive ones. Some species of the family are known to transmit plant viruses and some of these viruses are great commercial importance [9]. Four exotic genera have been introduced in the last 50 years for biological control of weeds (Julien & Griffiths 1998) Cited in: [10]. The family is usually classified into 19 Subfamilies [6]. Suzuki [11] divided the family into 20 subfamilies. The recent catalogue of Palaearctic Coleoptera Vol. 6 listed the existence of 28,560 taxa within the Chrysomeloidea (including Cerambycidae and Bruchinae as subfamily of Chrysomelidae) [12]. Seno and Wilcox [13] mentioned that over 38 000 species occur within this family. The adults of leaf beetle feed on leaves, flowers, pollen and young shoots, and their larvae feed mainly on leaves or roots [14]. Adults and larvae of many species are serious pests of cultivated plants [3]. Pierce [15] raised the family to the rank of superfamily (Chrysomeloidea) in the Phytophaga on the basis of the characters of the tarsi, maxillary palpi, submentum and antennae of the adults. According to [16] the family divided into 17 subfamilies. [Mani (1968) put subfamily Chrysomelinae in the level of family Chrysomelidae] Cited in: [17]. Many scientists [4, 16, 18] agree that the general characteristics of the family are as follows:

1. Body shape diverse, usually robust, oval, or cylindrical, often brightly colored, spotted and striped.
2. Small to moderate sized, length 1.5- 22 mm.
3. Head prognathous or hypognathous, some deflexed.
4. Antennae rarely extending past middle of body, filiform, moniliform, weakly serrate or thickened apically, with no obvious 3- segment club.
5. Eyes rounded or emarginated.
6. Pronotum with or without defined margins.
7. Elytra usually covering abdomen.

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8. Tarsal segmentation formula 5- 5- 5, but appears 4- 4- 4 (Pseudotetramerous) which is the most outstanding characteristics.

Many researchers [19, 20, 21] studied the life cycle of different species of the family which have complete metamorphosis include, eggs- larvae- pupa- adult. Chrysomelinae Latreille, 1802 is a fifth largest subfamily of leaf beetles Chrysomelidae, more than 2000 species were found, with worldwide distribution [22], where Lopatin [23] mentioned that the subfamily Chrysomelinae comprises more than 130 genera and approximately 3,000 species throughout the world. Kasap [24] described some Chrysomelinae species belong to *Leptinotarsa*, *Crosita* and *Chrysomela* in Turkey. Kryzhanovskij [25] show that some species of Chrysomelinae are pests of cultivated plants others are apparently restricted to Dicotyledons while some feed on herbaceous plants others are confined to shrubs or tree. Booth *et al.*, [2] indicated that the adult and larvae almost feed openly, sometimes gregariously on the same host plants causing similar damage to foliage and herbaceous stems. Maican [26] studied some Mediterranean Chrysomelid Species newly entered in the collections of "Grigore Antipa" national museum of natural history, as results of the expeditions from Turkey and Tunisia during 2005-2006. Rozner and Rozner [27] organized ten collecting trips to record data to the leaf-beetle fauna of Macedonia and they have found 213 species (including *Leptinotarsa decemlineata* Say) of 61 genera of the Chrysomelidae. Aston [28] studied the Chrysomelidae of Hong Kong and provides an introduction and a key to 13 subfamilies belong to this family. Bukejs [29] studied some species of this family mistakenly reported for the Latvian fauna and deleted them from the check-list of Latvian Coleoptera and also provides general information on these species. Ghahari and Hawkeswood [30] studied the Chrysomelidae of Kurdistan province and adjacent areas, western Iran and collected a total of 25 species from 14 genera and 5 subfamilies. Bouchard *et al.*, [31] prepared a catalogue of Family-group names in Coleoptera including 862 names of Chrysomeloidea which included seven families including Chrysomelidae with 13 subfamilies. Hazmi *et al.*, [32] prepared a revision of Oriental *Monolepta* species and related groups within Chrysomelidae, they also redescribe the valid species and define the species limits. Ghahari and Jędryczkowski [33] dealt with the fauna of Chrysomelidae from the Arasbaran biosphere reserve and its neighboring areas in the Northwestern Iran, in a total 34 species from 20 genera and 5 subfamilies including this species were collected. Gavrilović and Čurčić [34] studied the diversity of the Chrysomelidae of the Obodska Bara Special Nature Reserve (Vojvodina Province, Serbia) and provide a special reference to the host plants. Slipinski [35] prepared a national diagnostic protocol number 22 for Colorado Potato Beetle, *Leptinotarsa decemlineata* Say and included an introduction, taxonomic information, detection, identification, contact points for further information, references and an appendix. In Iraq, Derwesh [36] listed seven species within Chrysomelidae. Abdul-Rassoul [37] recorded three species of this family. El-Haidari *et al.*, [38] recorded one species within this family. Swailem and Amin [39] recorded *Aulacophora foveocollis* Lucas within this family. Shalaby *et al.*, [40] listed five species of this family. AL- Ali [41] recorded three species of Chrysomelidae. Hassan [21] Studied the live cycle of Poplar leaf beetle *Melasoma* (= *Chrysomela*) *populi* L. within this family in Duhok, Iraq. Hamamurad [17] studied the taxonomy of some subfamilies of this family and recorded 19 species including

Leptinotarsa decemlineata Say within 14 genera belong to six subfamilies in Erbil, Iraq. The aim of this study is to re-describe *Leptinotarsa decemlineata* Say in detail with drawing of important parts.

Material and Methods

The study depends on ninety specimens which were collected from fields of potato *Ipomoea beratas* Poir. and eggplant *Solanum melongena* L. in some villages of Erbil Governorate from the period August- September / 2016. The specimens were killed by freezing for 48hrs, and then preserved after fixing their information in the insect collecting box, which treated with Seven 85% and Naphthalene balls. The morphology of the adults were studied by using dissecting microscope, while the minute parts were studied by the preparation of microscope slides by putting them in a beaker 100ml contains 50ml water and warming it to boiling temperature on a calm fire for 15 minutes to softening their parts and prevent their from breaking. For preparation of slides for microscopic examination, the adults dissected by using two fine pins, then the required parts (the head and abdomen) put in a beaker 100 ml contains 50ml water with KOH 10% and placed on a calm fire again with shaking for about ten minutes for dissolving of lipids mater of the body parts and destroying the muscles, after that they were placed in distilled water for 5 minutes twice in order to reduce the effect of the alkali. Mouthparts and abdomen were placed in ethyl alcohol 25% and dissected under microscope to obtain the different parts, then transferred to ethyl alcohol 50%, 75% and 100% respectively for two minutes for each concentrations to dehydration of water, then placed in Xylol for two minutes, for translucency, then prepared slides of each part by dropping some drops of Canada balsam and covered with a cover slide for examination under binocular dissecting microscope, also we used compound microscope and digital computerized microscope for studying the minute parts of the body, after that photos of these parts with their scales were taken by a digital computerized microscope and drawn by using of ocular micrometer and the length of the parts were measured by using a linear micrometer and a stage micrometer and a digital computerized microscope.

Results

Leptinotarsa decemlineata Say, 1824

Body (figs. 1a and b)

Large sized, about 11.1-11.2 mm long, 6.1- 6.2 mm wide, broadly oval shaped, strongly convex dorsally, nearly striated ventrally, bright yellow colored, vittated with black stripes extending along their forewing and black patches on the pronotum and the abdominal sternites.

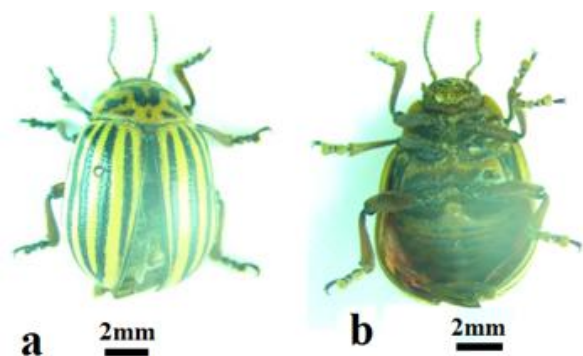


Fig 1: Body of *Leptinotarsa decemlineata* Say; a. (Dorsal view); b. (Ventral view)

Head (figs. 2a and b)

Prognathous type, nearly oval shaped, yellow colored with median-frontal black spot, about 1.9-2.1 mm long, 2.6-2.7 mm wide; Compound eyes black, elongate-round shaped, inner margin depressed, more-far distance between them about 1.9- 2.1 mm, nearest distance about 1.5- 1.6 mm; Vertex flat, with two big dark black spots laterally, with low small punctures; Frons yellow colored, flat, with close punctures and one black triangular central spot; Antenna (fig. 2c) nearly moniliform, with eleven antennomeres, collectively about 3.5-4.0 mm long, not extending beyond the prothorax, first four antennomeres nearly without hairs and pale brown but the remainder are haired and brown colored, 1st antennomere cup shaped, longer than the 2nd antennomere which is nearly cup shaped, antennomeres 3-5 tube-like, antennomeres 6-7 cup shaped, antennomeres 8-10 nearly rectangular shaped, antennomere 11th oval shaped, longer than the 10th antennomere; Clypeus (fig. 2d) flat, semi-circular shaped, with small punctures and pale yellow setae, about 0.4-0.6 mm length; Labrum (fig. 2e) small, nearly rectangular shaped, distal margin concave, with small punctures and moderately haired, yellow– brownish colored, about 0.4- 0.6 mm length; Mandible (fig. 2f) big, black colored, high sclerotized, 0.9- 1.3 mm length, apical part with two dents, the inner shorter than the outer, dorsal surface with few pale yellow setae; Maxilla (fig. 2fg) big, with four digitiform palpomeres palpus, palpomeres long are: 0.1, 0.3, 0.3, 0.2 respectively, 1st tubular, 2nd and 3rd wide cup-shaped, brown colored and the 4th truncated, shorter than the 3rd and black colored, lacinia covered by moderately dense of golden setae, galea two pieces covered by moderately dense of golden setae, both the inner and the outer are nearly tubular shaped; Labium (fig. 2h) small, with three palpomeres palpus, pale brown colored except for the 3rd palpomere which is dark brown, prementum nearly oval shaped, 2nd palpomere of labial palpus nearly cup shaped, swollen and bigger than the 1st and the 3rd palpomeres.

Thorax (figs. 3a, b, c and d)

Pronotum (fig. 3a) wider than long, about 2.6-2.8 mm long and 5.1-5.3 mm wide, convex dorsally, with black spots, the two median spots elongated and convergent basally, yellow-brownish, nearly rectangular shaped, anterior margin concave, posterior margin rounded with high density of pale yellow setae, anterior and posterior angle rounded, procoxal cavities open behind, prosternum (fig. 3b) narrowed, about 0.7-0.9 mm long and 2.7-2.9 mm wide, with a fitting cavity of the antennae, Prosternal process nearly oval shaped, with high density of irregular punctures; Mesonotum (fig. 3c) slightly convex, scutellum small, wider than long, about 0.9-1.1 mm long and 1.6-1.8 wide, triangular shaped, brown colored, with high density of small punctures; Mesosternum (fig. 3d) flat, mesocoxal cavities big; Metanotum (fig. 3c) nearly convex, metasternum (fig. 3d) flat, metacoxal cavities opened between the metasternum and the anterior margin of 1st abdominal sternite; Forewings (fig. 3e) big, stout, convex, covering all abdominal segments, yellow colored, vittated with four longitudinal punctuated black wide irregular vitae, the 2nd and 3rd vittae confluent apically; Hind-wings (fig. 3f) leathery, with clear venation, pale orange colored, cross veins rp-mp2, cu-a1-mp4 present; Legs (fig. 3g, h, i and j) pale yellow to brown colored, joints and tarsomeres brown to black, femura nearly oval elongated at the middle, tibiae slightly cylindrical shaped, tarsi (fig. 3h) five tarsomeres the 1st three nearly as the same size and are bi-lobed to enclose the next tarsomere,

the 4th very small and hidden within the 3rd tarsomere (Pseudotetramerous), the 5th tarsomere is tubular and swollen apically and as twice as long of the 3rd, claws two divergent hooks, black colored.

Abdomen (figs. 4a, b, c and d; figs. 5a and b)

Male abdomen (figs. 4a and b) slightly oval shaped, with seven obvious poorly sclerotized rectangular tergites dorsally, the 1st is the narrowest and the 2nd is the widest, last visible abdominal tergite (fig.4c) rounded at apex, with five obvious sclerotized rectangular sternites ventrally, 1st sternite anterior margin depressed to fit the coxae which separated medially by wide projection, last visible abdominal sternite (fig.4d) straight at apex with two small projections, about 4.3-5.1 mm long and 5.1-5.4 mm wide, pale brown colored, 1st- 5th sternites with black spot at lateral margin, 1st- 4th sternites with black, oblong spots on either side of midline, either side of the 5th sternite with two black spots, connexivae wide. Female abdomen (figs. 5a and b) resemble to male in outlines except for its bigger size and the sternites black spots are smaller and last visible abdominal sternite rounded at apex and either side of the 5th sternite with one black spot.

Male Genitalia (figs. 4e, f, g and h)

Aedeagus (fig. 4e) is a median tubular piece, banana shaped, brown colored, length about 3.0- 3.4 mm, its apical part rounded, its basal hood shaped, pale brown, slightly sclerotized; paramere (fig. 4f) is a chitinized part of the genital pocket near the middle of the aedeagus Brown colored, Y- shaped, present at the apical part of aedeagus and which is surrounds it with its lateral folds extending around the aedeagus from below while the remainder projects anteriorly below the aedeagus, this Y-shaped structure forms the paired, lateral lobes spiculum gastrale (fig. 4g), it serves as an attachment for the powerful muscles which control the copulatory apparatus. At its apical end, the aedeagus possesses an opening called the apical orifice or median aperture. An internal sac (fig. 4h) lies within the aedeagus and is continuous posteriorly with it at its apical orifice.

Female Genitalia (figs. 5c, d and e)

Female genitalia is appendages of 8th and 9th abdominal segments which forming elongate telescopic ovipositor, slightly sclerotized excepted highly sclerotized of posterior and anterior margin, 8th abdominal sternite (fig. 5c) small, the anterior margin with slightly invagination at the middle, 9th sternite (fig. 5c) large, oval shaped, moderately sclerotized, anterior margin nearly straight, posterior margin concave at the middle with slightly invagination at 1/3 of posterior part, its surface covered by moderate dense of short-long, pale setae and low dense of small punctures, 9th tergite (fig.5d) with two short, semi-triangular, sclerotized, separated plates, styli absent. Flowers and Eberhard [42] studied the female genitalia in many Chrysomelidae.

Spermatheca (fig. 5e)

The spermatheca is slightly sclerotized, its capsule and neck curved, brown color, smooth, ramus and collum are separated, cornu and nodulus are fused, the spermathecal duct is long, narrow and weakly coiled and enters the capsule at the collum, the spermathecal gland opens into the ramus. Varma [43] used the shape and size of the spermatheca capsule to separate many species of the Chrysomelidae.

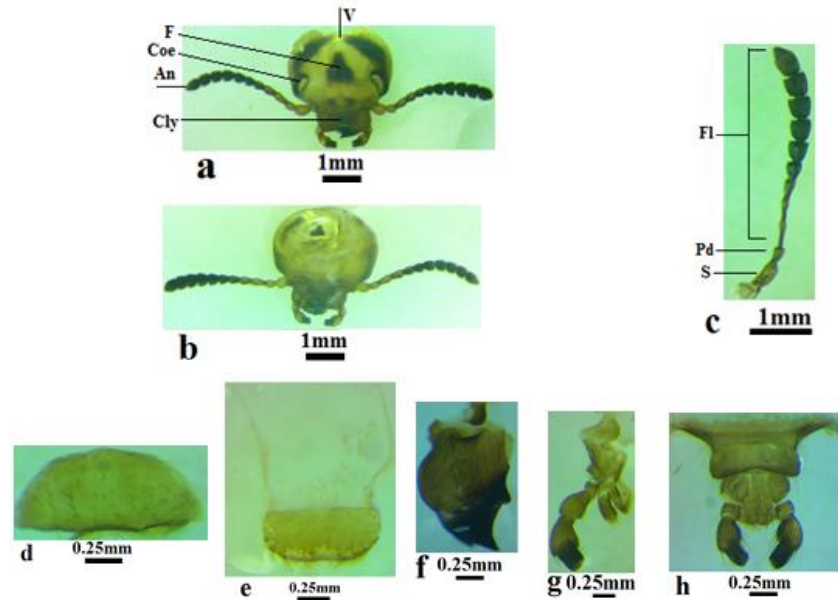


Fig 2: Head and its parts of *Leptinotarsa decemlineata* Say

a. Head (Dorsal view); b. Head (Ventral view); c. Antenna d. Clypeus; e. Labrum; f. Mandible; g. Maxilla; h. Labium
An: Antenna; Coe :Compound eye; Cly: Clypeus; F: Frons; Fl :Flagellum; Pd: Pedicel; S :Scape; V: Vertex

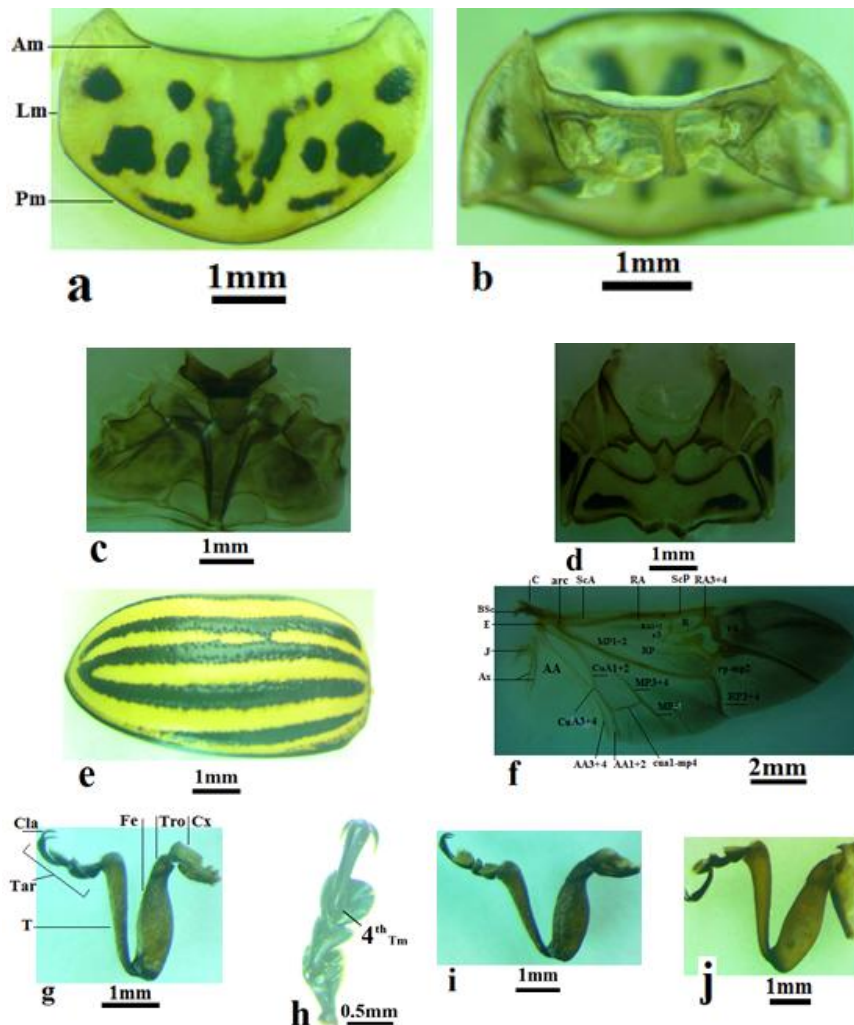


Fig 3: Thorax and its appendages of *Leptinotarsa decemlineata* Say

a. Prothorax (pronotum); b. Prothorax (prosternum); c. Meso-metanotum; d. Meso-metasternum e. Fore-wing; f. Hind wing; g. Foreleg; h. Tarsi; i. Midleg; j. Hindleg

AA: Anal Anterior vein; Am: Anterior margin; arc: arcus; C: Costa; Cla: Claw; Cx: Coxa; CuA3+4: Cubitus Anterior vein 3+4; cua1-mp4: Cubitus anal 1- median posterior 4; E: Empusal; Fe: Femur; J: Jugal; MP1+2: Media posterior vein 1+2; MP3: Media Posterior vein 3; Pm: Posterior margin; R: Radial cell; rp-mp2: radial posterior vein – media posterior vein 2; RP: Radial Posterior vein; RP3+4: Radial Posterior vein 3+4; r3: Radial transversal vein 3; r4: Radial transversal vein 4; RA: Radial Anterior vein; Sc: Subcostal vein; Tar: Tarsi; T: Tibia; 4th Tm: 4th tarsomere; Tro: Trochanter

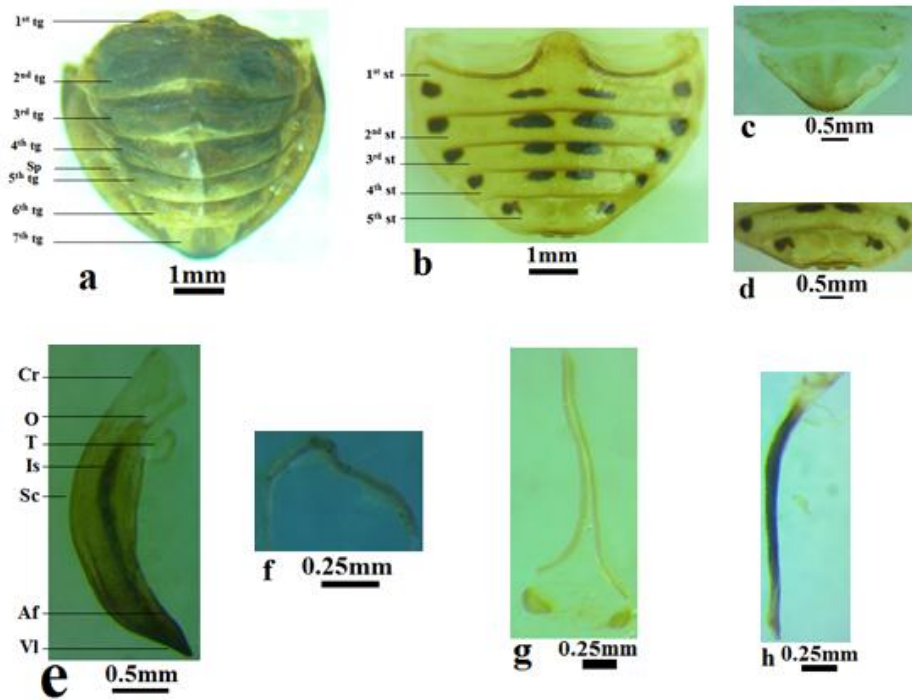


Fig 4: Male abdomen and its appendages of *Leptinotarsa decemlineata* Say

a. Male abdomen (Dorsal view); b. Male abdomen (Ventral view); c. Last visible abdominal tergite; d. Last visible abdominal sternite; e. Aedeagus (Median lobe) (Lateral view); f. Tegmen (Lateral lobe) (Paramere); g. Spiculum gastrale; h. Internal Sac
 1st - 7th tg: 1st - 7th Tergites; 1st - 5th st: 1st - 5th sternites; Af: Apical flap; Cr: Crest of median lobe; Is: Internal sac; O: Basal orifice; Sc: Sclerite of the internal sac; Sp: Spiracle; T: Tegmen; VI: Ventral lobe

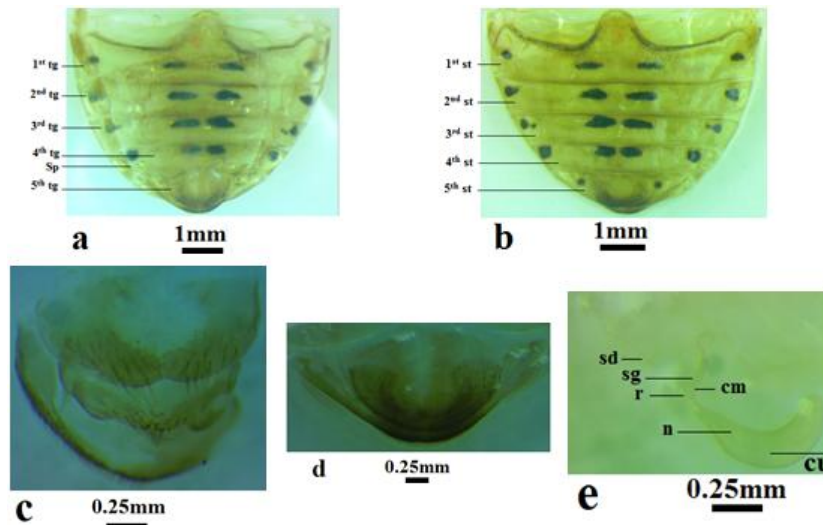


Fig 5: Female abdomen and its appendages of *Leptinotarsa decemlineata* Say

a. Female abdomen (Dorsal view); b. Female abdomen (Ventral view); c. Female genitalia (Posterior view); d. Female genitalia (Dorsal view); e. Spermtheca.
 1st - 6th tg: 1st - 6th Tergites; 1st - 5th st: 1st - 5th sternites; Sp: Spiracle; cm: collum; cu: cornu; n: nodulus; r: ramus; sd: spermathecal duct; sg: spermathecal gland

Material Examined: Ainkawa: 26/6/2014, 12♂13♀; Ainkawa: 19/4/2015, 15 ♂13♀; Shamamk, 5/8/2016, 18♂16♀; Shamamk: 17/8/2016, 15 ♂16♀; Shamamk: 1/9/2016, 25 ♂28♀; Qushtappa: 5/9/2016, 35♂41♀.

Discussion

This species differs from the nearest species from it the false potato beetle *Leptinotarsa juncta* (Germar) which feed on horse nettle- *Solanum carolinense*, by 2 black spots on clypeus and A-shaped spot on frons, sometimes interrupted into 2 or 3 spots, pronotum marked with numerous black spots, 2 median spots more elongate, each elytron with 5 black vittae, 3rd and 4th connected apically, space between

them black. elytral strial punctures in regular rows, vita 2 does not reach apex of elytra, black spot on outer margin of femur, Abdomen: sterna I-V with 6 black discoidal spots and sterna VI with 2 black spots, length 10.2-11.9 mm, width 6.7-8.4 mm. And differs from the *Leptinotarsa haldmani* (Rogers) by its color is uniform blue or green, elytra lacking vittae. And differs from the *Leptinotarsa defecta* (Stål) [Synonyms: *Myocorina defacta* Stål, 1859, *Chrysomela defect* (Stål), 1859] by its only 2 shortened vittae present on each elytron, coarse elytral punctures in very regular rows, dark spots are present on legs, especially on femora, hosts *Solanum eleagnifolium* L. – and horse nettle; *Solanum tridynamum*. And differs from the *Leptinotarsa texana* Schaeffer by each

elytron with 4 vittae, vitta 1 is shorter than the others, coarse elytral punctures in very regular rows outlining vittae; rows 2 to 9 bordering vittae; row 10 does not border a vitta near lateral margin, legs flavous, without dark spots on femora, or darkened joints and tarsi; host: *Solanum eleagnifolium* Cavanilles. And differs from the *Leptinotarsa tumamoca* Schaeffer, by head immaculate, reddish-brown, abdomen unicolorous, reddish-yellow, legs unicolorous, reddish-yellow, only known host: *Physalis acutifolia* Gray, common name: sharp-leaf ground-cherry, an invasive weed of arid lands. And differs from the *Leptinotarsa undecimlineata* (Stål) by vitta 1 shorter than other 4 and adjacent to the sutural margin, vitta 2 joins the sutural margin $\frac{3}{4}$ the way down the elytron, legs unicolorous, black, abdomen unicolorous, black, hosts: *Solanum mitlense*, *S. lanceolatum* Cav., *S. ochraceoferrugineum* (Dunal).

References

- Cox ML. The taxonomy and biology of the British Chrysomelidae. Ph. D. thesis, Faculty of Agriculture, New Castle upon Tyne University. 1976, 140.
- Booth RG, Cox LM, Madge BR. The guides to insects of importance to man, 3. Coleoptera. Printed in the UK at the University press, 1990, 384.
- Özdikmen H, Aslan K. First records of some leaf beetles for Mediterranean region in Turkey and South Turkey (Coleoptera: Chrysomelidae). Muni. Entomol. Zool. 2009; 4(1):276-279.
- Chinery M. A field guide to the insects of Britain and Northern Europe. William Collins Sons and Co Ltd Glasgow, 1982, 352.
- Urban J. Occurrence, bionomics and harmfulness of *Chrysomela populi* L. (Coleoptera, Chrysomelidae). Journal of Forest Science, 2006; 52(6):255-284.
- Jolivet P, Petitpierre E, Hsiao TH. Biology of the Chrysomelidae. Dordrecht: Kluwer Academic publishers, 1988, 615.
- Jolivet P, Hawkeswood T. Host- Plants of the Chrysomelidae of the World Backhuys. Leiden, The Netherlands, 1995, 281.
- Reid CAM. Acladistic analysis of subfamilial relationships in the Chrysomelidae *Sensulato* (Chrysomeloidea) In: J. Pakluk, and Slipinski, S. A. (eds.). Biology, Phylogeny and Classifications of Coleoptera. Papers Celebrating the 80th Birthday of Roy A. Crowson. Museum Institut Zoologii PAN, Warszawa, Poland, 1995, 559- 631.
- Selman BJ. Beetles- Phytophagous Coleoptera. In: A. J. Gibbs (ed.); Viruses and invertebrates. North Holland, American Elsevier, Amsterdam, New York. 1973, 157-177.
- Reid CAM. A taxonomic revision of the Australian Chrysomelinae, with a key to the genera (Coleoptera: Chrysomelidae). *Zootaxa*, 2006; 1292:1-119.
- Suzuki K. Higher classification of the family Chrysomelidae (Coleoptera) - In: Jolivet P. H., M. L. Cox (Eds.): Chrysomelidae Biology, The Classification, Phylogeny and Genetics. Amsterdam (SPB Academic Publishing BV), 1996; 1:3-54.
- Löbl I, Smetana A. Catalogue of Palaearctic Coleoptera. Chrysomeloidea. Apollo Books, Stenstrup, 2010; 6:924.
- Seeno TN, Wilcox JA. Leaf beetle genera (Coleoptera: Chrysomelidae), Entomography pub., Sacramento, California, 1982, 221.
- Jolivet P, Verma KK. Biology of leaf beetles. Intercept Ltd., USA, 2002.
- Pierce WD. Chrysomeloidea, a superfamily. Proc. U. S. Natn. Mus. LI, [(Cited in: Cox, 1976)], 1917.
- Borror DJ, Delong DM, Triplehorn CA. An introduction to the study of Insects. 5th Ed. Holt, Rinehart and Winston, New York. 1981, 827.
- Hamamurad HQ. Taxonomic study of some subfamilies of the leaf beetles Chrysomelidae (Insecta: Coleoptera) in some localities of Kurdistan Region- Iraq- MSc. Thesis- College of Agriculture- University of Salahaddin- Erbil, Iraq, 2014.
- Ross HH. A Textbook of Entomology. 3rd Ed. Wiley and Sons, New York. 1965, 539.
- Al-Azawi AF. General and Applied Entomology. Ministry of Higher Education and Scientific Research. Offit house/ star./ Baghdad. 1980, 540.
- Kaddou IK, Ali HA, Hamadi MK. General Entomology. Book house for publishing and printing. 1980, 395.
- Hassan FR. Studies in Poplar leaf beetle *Melasoma* (= *Chrysomela*) *populi* L. (Chrysomelidae, Coleoptera) in Dohuk Region. 2002, 101.
- Windsor DM, Dury GJ, Frieiro-Costa FA, Lankowsky S, Pasteels JM. Subsocial Neotropical Doryphorini (Chrysomelidae, Chrysomelinae): new observations on behavior, host plants and systematic. Zool. 2013; 332:71-93.
- Lopatin IK. Leaf-beetles (Chrysomelidae) of central Asia and Kazakhstan. Leningrad, Nauka, 1977, 1-270.
- Kasap H. A list of some Chrysomelinae from Turkey. Part1. *Leptinotarsa*, *Crosita* and *Chrysomela* (= *Chrysolina*). Turk. Entomol. Derg. 1988; 12(1):23-31.
- Kryzhanovskij OL. (ed.). Insects and ticks, the pests of agricultural cultures. II. Coleoptera. Leningrad, Nauka, 1974, 1-336.
- Maican S. Some Mediterranean Chrysomelid species (Coleoptera: Chrysomelidae) newly entered in the collections of "Grigore Antipa" National Museum of Natural History [Results of the expeditions from Turkey and Tunisia, 2005- 2006]. Travaux du Muséum National d'Histoire Naturelle Grigore Antipa, 2007; 50:421- 429.
- Rozner I, Rozner G. Data to the leaf- beetle fauna of Macedonia (Coleoptera, Chrysomelidae). Natura Somogyiensis. 2008; 12:111-131.
- Aston P. Chrysomelidae of Hong Kong part 1; Introduction and key to subfamilies. Hong Kong Entomol. Soc. 2009; 1(2):2-5.
- Bukejs A. Some leaf-beetles species (Coleoptera: Chrysomelidae) mistakenly reported for the Latvian fauna. Acta Biol. Univ. Daugavp. 2010; 10(1):71-75.
- Ghahari H, Hawkeswood TJ. A study on the Chrysomelidae (Coleoptera) from Kurdistan province and adjacent areas, western Iran. Calodema, 2011; 195:1-6.
- Bouchard P, Bousquet Y, Davies AE, Alonso- Zarazaga MA, Lawrence JF, Lyal CHC *et al.* Family-group names in Coleoptera (Insecta). ZooKeys, 2011; 88:1-972.
- Hazmi IR, Wagner Th, Bernhard M. Revision of Oriental *Monolepta* and related groups of leaf beetle (Coleoptera, Chrysomelidae, Galerucinae). Dissertation, Zur Erlangung des akademischen Grades Eines Doktors der Naturwissenschaften Des Fachbereich 3: Mathematik/Naturwissenschaften Der Universität Koblenz-Landau. 2012, 200.
- Ghahari H, Jędrzykowski WB. A Contribution to the Knowledge of Leaf Beetles (Coleoptera: Chrysomelidae) from Arasbaran Biosphere Reserve and its Neighboring

- Areas (Northwestern Iran). Acta zool. bulg., 2012; 64(4):347-352.
34. Gavrilović BD, Ćurčić SB. The Diversity of the Family Chrysomelidae (Insecta: Coleoptera) of the Obedska Bara Special Nature Reserve (Vojvodina Province, Serbia), with Special Reference to the Host Plants. Acta zool. bulg. 2013; 65(1):37-44.
 35. Slipinski A. National Diagnostic Protocol for Colorado potato beetle, *Leptinotarsa decemlineata*. Systematics Identity and Relationships, CSIRO Ecosystem Sciences-Black Mountain, ACT, Australia. Prepared for the Subcommittee on Plant Health Diagnostic Standards (SPHDS). 2013, 23.
 36. Derwesh AI. A preliminary List of Identified Insects and some Arachnids of Iraq. Direct. Gen. Agr. Res. and Agr. Proj. Baghdad, Iraq. Bull. 1965; (112):123.
 37. Abdul-Rassoul MS. Checklist of Iraq Natural History Museum Insects Collection, Nat. Hist. Res. Cent. University of Baghdad, Ministry of Higher Education and Scientific Researches, Iraq, Pub. No. 1976; 30:44.
 38. El-Haidari H, Fattah YM, Sultan JA. Contribution to the insect fauna of Iraq. Part4. Direct. Gen. Plant prot. Iraq, Bull. no. 1972; 18:17.
 39. Swailem SM, Amin AH. Recorded one species, *Podagrica malvae* Ill.; *Exosoma thoracta* Redt. and *Aulacophora fovecollis* Lucas of each families respectively, Haticidae, Glaerucidae and Chrysomelidae, 1974.
 40. Shalaby F, El-Haidari H, Derwesh AI. Contribution to the insect fauna of Iraq, Min. of Agriculture. Directorate general of research and projects Agric. Extension press. Part2, Bull. 1976; (165):1-14.
 41. AL-Ali AS. Phytophagus and entomophagus insects and mites of Iraq Nat. Hist. Res. Cen. University of Baghdad, Ministry of Higher Education and Scientific Researches, Iraq. Pub. No. 1977; 33:16-17.
 42. Flowers RW, Eberhard WG. Fitting together: Copulatory linking in some Neotropical Chrysomeloidea. Revista de Biologia Tropical, 2006; 54(3):829-842.
 43. Varma BK. Taxonomic value of spermathecal capsules as subfamily characters among the Chrysomelidae. Ind. J. Entomol. 1955; 17(1):189-192.