Ctenolepisma almeriensis n. sp. of Lepismatidae (Insecta, Zygentoma) from south–eastern Spain

R. Molero–Baltanás, M. Gaju–Ricart & C. Bach de Roca

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Abstract

Ctenolepisma almeriensis *n. sp. of Lepismatidae (Insecta, Zygentoma) from south–eastern Spain*.— *Ctenolepisma almeriensis* n. sp., from the south–eastern part of the Iberian Peninsula is described. This species was determined previously as *Ctenolepisma lineata* (Fabricius, 1775), which is widespread over the south–western Palaeartic region. The main difference between the two species is the setation of thoracic sternites. In each bristle–comb of the mesosternum and the metasternum, macrosetae are arranged in a single row in *C. lineata* and in two parallel rows in *C. almeriensis* n. sp. In the prosternum, the first species shows 1–2 irregular lines of macrosetae per comb, and the new species shows 2–3 lines. Based on other parameters of setation, a discriminant analysis was carried out to separate a group of Spanish specimens of *C. lineata* from another group of specimens of the new species. This analysis demonstrated the validity of the occurrence of double or single lines of macrosetae in thoracic sternites to distinguish between the two species.

Key words: *Ctenolepisma almeriensis* n. sp., *Ctenolepisma lineata*, Spain, Thysanura, New species, Arid regions fauna

Resumen

Ctenolepisma almeriensis *sp. n. de Lepismatidae (Insecta, Zygentoma) de España suroriental*.— Se describe *Ctenolepisma almeriensis* sp. n., distribuida por el sureste de la Península Ibérica. Previamente esta especie se había identificado como *Ctenolepisma lineata* (Fabricius, 1775), extendida por el Paleártico suroccidental. La principal diferencia entre ambas especies reside en la quetotaxia de los esternitos torácicos: las macroquetas de cada peine de meso– y metasterno forman una sola fila en *C. lineata*, mientras que se disponen en dos líneas paralelas en *C. almeriensis* sp. n. En el prosterno, cada peine de *C. lineata* consta de 1–2 líneas irregulares, por 2–3 filas en la nueva especie. Se ha realizado un análisis discriminante para separar, con base en otros parámetros de la quetotaxia, un grupo de especímenes españoles de *C. lineata* de otro grupo encuadrable a priori en la nueva especie, demostrándose que la presencia de filas simples o dobles de macroquetas en los esternitos torácicos representa una característica válida para la diferenciación entre ambas especies.

Palabras clave: *Ctenolepisma almeriensis* sp. n., *Ctenolepisma lineata*, España, Thysanura, Especie nueva, Fauna de zonas áridas.

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Introduction

Ctenolepisma lineata (Fabricius, 1775) is a widespread species of Lepismatidae native to the south of Europe and introduced in other regions and continents. Following revision of material that had been determined as this taxon from different countries, notable variability has been detected, to the point that it is reasonable to state that *C. lineata* is not one but a group of species. Several forms have been found within the Iberian Peninsula, the most widespread considered here as the typical *C. lineata*. A different form which occurs in the south–east Spain is described here as a new species.

Material and methods

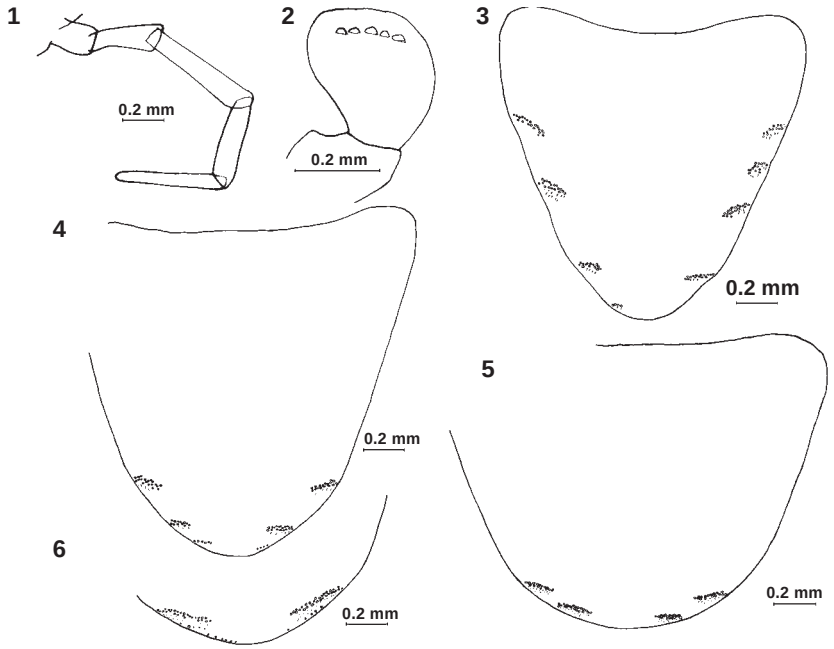
As usual in this order, specimens were fixed in alcohol, and many were dissected and mounted in Tendeiro medium for microscopic observation to verify identification. The studied material is deposited in the following institutions: MNCN. Museo Nacional de Ciencias Naturales (Madrid, Spain); UCO. Dept. de Zoología, Univ. of Córdoba (Córdoba, Spain).

Some specimens have been studied and published previously: (a) included in Molero–Baltanás et al. (1992) as *C. lineata;* (b) included in Molero–Baltanás et al. (1994), also as *C. lineata*.

To compare the new species with *C. lineata*, a total of 100 specimens were selected, 50 from each species (25 males and 25 females), each from a different sample and locality. Statistical analysis included six quantitative variables in each specimen, resulting in a total of 600 data.

A standardized principal component analysis was performed to obtain combinations of the six variables which account for most variability in the data. The most useful variables were then included in a discriminant analysis to determine whether *C. lineata* and *C. almeriensis* were significantly different. Mann–Whitney U–tests were also conducted to compare medians of the four groups.

Variables and their abbreviations used in the discriminant analysis for the differentiation between *C. lineata* and *C. almeriensis*: N–notum. Number of macrosetae of a posterolateral comb of the metanotum; N–pros. Number of macrosetae of a posterolateral comb of an antedistal comb of the prosternum; N–meso. Number of macrosetae of a posterolateral comb on the mesosternum; N–meta. Number of macrosaeta of a posterolateral comb on the metasternum; N–uro. Number of macrosetae of a lateral comb of the urosternite IV; D/a[Mt]. Ratio distance between lateral combs of urosternite IV / width of a comb.



Figs. 1–6. *Ctenolepisma almeriensis* n. sp., holotype: 1. Maxillary palp; 2. Distal article of the labial palp; 3. Prosternum; 4. Mesosternum; 5. Metasternum; 6. Metasternum of a paratypus from Valencia.

Figs. 1–6. Ctenolepisma almeriensis *sp. n., holotipo: 1. Palpo maxilar; 2. Artejo distal del palpo labial; 3. Prosterno; 4. Mesosterno; 5. Metasterno; 6. Metasterno, de un paratipo de Valencia.*

Results and discussion

Description of *Ctenolepisma almeriensis* n. sp.

Studied Material

Holotype: Almería, Dalías, Dos Hermanas Peak, Gádor Mountains, 1,800 m, 23 III 89, one male (MNCN, ref. 9493). Allotype: 1 female collected in the same locality and date, with 1 male, 2 females and a young specimen, all paratypes (UCO, ref. 0413) (a).

Other material studied (all paratypes):
Albacete: Hellín, 30 IV 92, 1 male (UCO, ref. Z1177).

Alicante: Alicante, Albatera (Crevillente mountains), 11 IV 92, 2 males and 1 female, (UCO, ref. Z1326); Jijona, 14 IV 92, 1 female (UCO, ref. Z1401).

Almería: Adra, Puente del Río, 23 III 89, 2 females (UCO, ref. Z0420); Alcolea, 19 III 92, 4 males (UCO, ref. Z0999); Mazarrulleque, 23 III 89, 6 males and 4 females (UCO, ref. Z0426) (a); Berja, 17 VIII 88, 1 male (UCO, ref. Z0375) (a); Berja (500 m), 23 III 89, 1 male and 4 females (UCO, ref. Z0437) (a); Berja (Gádor mountains, 1,150 m), 23 III 89, 2 males and 3 females (UCO, ref. Z0433) (a); El Ejido (Punta Sabinal), A. Tinaut leg., 06 X 92, 1 female (UCO, ref. Z1973); Enix (750 m), 23 III 89, 1 male and 1 female, ref. Z0432 (a); Gérgal (Filabres mountains, 900 m), 17 VI 91, 1 male, ref. Z0557; Huércal–Overa, 14 IV 76, 2 males and 4 females (UCO, ref. Z0478) (a); Lucainena de las Torres (500 m), 24 III 89, 1 young specimen (UCO, ref. Z0411) (a); Mojácar, near the beach, 10 IV 92, 3 males and 4 females (UCO, ref. Z0915); Nacimiento to Abla, 17 VIII 88, 1 female (UCO, ref. Z0379) (a); Níjar, Cabo de Gata, 20 V 86, 3 males and 1 female (UCO, ref. Z0317) (a); Níjar, Cabo de Gata, 23 III 89, 16 males and 10 females (UCO, ref. Z0430) (a); Níjar (300 m), 24 III 89, 2 males (UCO, ref. Z0412) (a); Níjar, San José, 24 III 89, 2 males and 4 females (UCO, ref. Z0424) (a); Níjar, Pozo de los Frailes, 24 III 89, 4 males and 1 female (UCO, ref. Z0505) (a); Níjar, Cabo de Gata, 30 III 89, 1 male (UCO, ref. Z1990); Níjar, Rodalquilar, 17 VI 91, 2 males and 3 females (UCO, ref. Z0561); Purchena, 21 VI 86, 2 males and 1 female (UCO, ref. Z0211) (a); Roquetas de Mar, 06 IV 85, 1 female (UCO, ref. Z0506); Serón to Los Menas, Filabres mountains, 25 III 89, 1 female (UCO, ref. Z0408) (a); Tabernas Desert, 15 IV 76, 1 male and 2 females (UCO, ref. Z0474) (a); Tabernas Desert, 17 VIII 88, 2 females (UCO, ref. Z0376) (a); Uleila del Campo (Filabres mountains), 17 VIII 88, 1 female (UCO, ref. Z0377) (a); Uleila del Campo (650 m), 24 III 89, 2 males and 1 female (UCO, ref. Z0399) (a); Uleila del Campo to Cantoria, Filabres mountains, 25 III 89, 1 male (UCO, ref. Z0401) (a); Dalías, Dos Hermanas Peak, Gádor Mountains (1,800 m), 23 III 89, 1 male, 3 females and 1 young specimen (UCO, ref. 0413) (a).

Murcia: Blanca, Pila mountains, 30 III 93, 1 male and 1 female (UCO, ref. Z2038); Mazarrón, 21 VI 86, 3 males and 2 females (UCO, ref. Z1417) (b); Mazarrón to Águilas, 21 VI 86, 1 female (UCO, ref. Z1421).

Valencia: Albaida, 2 XI 91, 2 females (UCO, ref. Z1469); Bicorp to Quesa, 26 IV 92, 2 males (UCO, ref. Z1543); Mogente, 28 V 88, 1 female (UCO, ref. Z1316); Mogente, 2 XI 91, 1 female (UCO, ref. Z1409); Mogente, 31 III 93, 3 females (UCO, ref. Z2039); pine–tree forest of El Saler, 11 IX 78, 10 males and 8 females (UCO, ref. Z1317).

Habitat and distribution

This species is found under stones and bark, at the base of pine–trees or *Juniperus* shrubs. The habitat is similar to that of *C. lineata* in Spain, but the new species appears to tolerate a higher degree of aridity. It is found from sea level to 2,000 m at Sierra de Gádor and Sierra de los Filabres in the province of Almería.

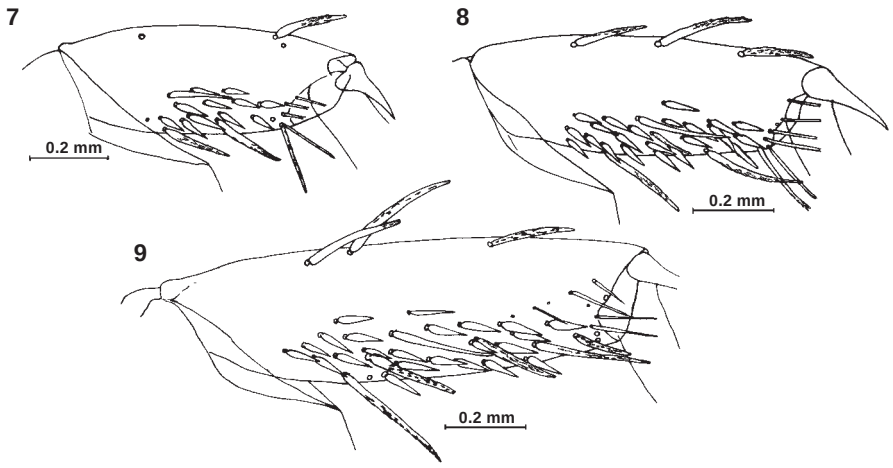
C. almeriensis n. sp. is mainly seen in the arid bio–geographic province named "Murciano—Almeriense" (Rivas–Martínez, 1987) in south–eastern Spain, being more frequent in the south (province of Almería) where the rainfall is lower. It spreads over the Spanish provinces of Almería, Murcia, Alicante and Valencia, always on the Mediterranean slope. The species takes its name from the province where it is most abundant.

Description

Body length of females up to 13.2 mm, males up to 12 mm. Fusiform and relatively robust body, thorax slightly wider (up to 3.5 mm) than the abdomen base. Faint to distinct epidermic pigment, usually violet–brown, with a variable pattern of distribution; this pigment can be more intense on the hind part of body, on the basal or distal parts of the articles of the appendages, and on the head, or it can be nearly uniformly extended (except for a lighter tonality ventrally). Scales dorsally brown, yellowish brown, dark greyish, silvery grey or greyish–brown, darkish and often with iridescence; they can draw an almost uniform pattern of distribution or can be arranged in alternately light (yellowish brown) and dark (greyish) longitudinal lines, as in other species of the genus.

Setation of head as usual for the genus. Eyes black, composed of about 12–13 ommatidia. Antennae longer than body, up to 15 mm (maximum preserved). Maxillary palp with long articles, the distal one 0.9–1.2 times longer than the antedistal and 4.7–9 times longer than wide (fig. 1). Distal article of the labial palp more or less unilaterally dilated, shorter to slightly wider at the apex than long; it always bears five sensory papillae arranged in a single row (fig. 2).

Pronotum with 8–9 + 8–9, mesonotum with (9)10–11 pairs and metanotum with 9–10 + 9–10 lateral bristle–combs of 3–7 macrosetae each. Trichobothrial areas of the nota situated on the last and penultimate lateral combs in meso– and metanotum, and on the last and the antepenultimate combs in the pronotum. Posterolateral bristle–combs usually with 7–12 macrosetae each.



Figs. 7–9. *Ctenolepisma almeriensis* n. sp., holotype. Tibiae showing distribution of plumose macrosetae and acute spines: 7. Tibia I; 8. Tibia II; 9. Tibia III.

Figs. 7–9. Ctenolepisma almeriensis *sp. n., holotipo. Tibias mostrando la distribución de las macroquetas plumosas y de las espinas agudas: 7. Tibia I; 8. Tibia II; 9. Tibia III.*

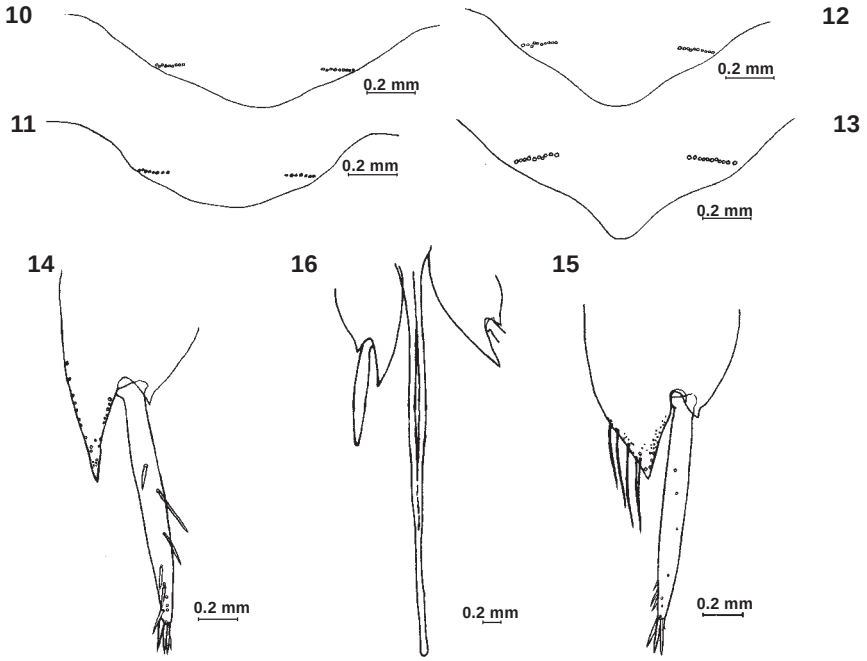
Thoracic sterna as shaped in figs. 3–6, very similar to those of *C. lineata*, except for the features observed in their fields of macrosetae. The word "field" of macrosetae is used here instead of comb, to emphasize that the setae are not arranged in a single row. In the prosternum they are arranged in 2–3 irregular almost parallel lines (fig. 3), and on the meso– and metasternum there are usually two more or less parallel and very close rows (figs. 4–5). The number of setae per "comb" is variable, but on the average it ranges from 8 to 20. The highest numbers of macrosetae are often observed in the antedistal combs. The number of combs on each sternite is also variable; there are usually 4–5 pairs in the prosternum, 2–3 pairs in the mesosternum and two pairs in the metasternum. However, the extension of these combs can produce a juxtaposition of the contiguous fields of macrosetae and therefore the number of perceptible combs is reduced. Consequently, in the metasternum it is possible to count only 1+1 large combs with more than 20 macrosetae each (fig. 6).

Tibiae I (fig. 7) 2.2–3.4 times longer than wide; metatibiae 3.4–4.5 times. Apart from usual setae, there are some plumose macrosetae whose length is shorter or equal to the diameter of the tibia. The number of such macrosetae is usually 2–4 dorsal and 3–6 ventral in all tibiae. On the inner side there are many lanceolate scales that are absent on the outer side. These scales have also been detected in the proximal article of the tarsi. Hyaline short spines are usually present ventrally on the outer side of the article (figs. 7–9), as in many specimens of *C. lineata* from the Iberian Peninsula, although these spines are more numerous and even shorter and stronger in this new species. Up to 25 spines have been observed on a hind tibiae (fig. 9), but in other specimens the spines are absent.

Apex of the outer side of the femora covered by elongate and lanceolate scales, the inner side with many scales shortened and with truncate or emarginated apex.

Urotergite I with 1+1 combs, II–VII with 3+3 combs and VIII with 2+2 combs. Submedian bristle–combs with 7–9 macrosetae each, lateral combs with 6–10 and sublateral with 7–15 macrosetae. Urotergite X subtriangular, short, with a rounded apex that can show an angled or rounded point, more or less prolonged (figs. 10–13). Urosternites I and II without setae, III–VIII with 1+1 lateral bristle–combs usually with 14–27 macrosetae each; young specimens may bear fewer than 14 and the largest specimens may bear more than 27 macrosetae, but this is not usual. In relation with the high number of setae per comb, the distance between the lateral combs of a urosternite is 2.7–5 times wider than the width of a comb.

Both sexes with two pairs of stylets. In males the inner process of the IXth coxite is slightly longer than wide (ratio length/width = 1.1–1.2) and about 3–3.5 times longer than the outer process (fig. 15). These two ratios are 2.5 and 2.5–4 in females. The stylets IX are about 2.6 times longer than the inner process of the coxites IX in males and about 2.3 times in females (fig. 14). Ovipositor very long, with 55–57 segments, reaching beyond the apex of the stylets IX up to 2–2.5 times the latter's length (fig. 16). Apices of gonapophises unsclerotized. Caudal filaments as long as body length or slightly longer (maximum preserved in a paracercus: 13.5 mm; cerci a bit shorter).



Figs. 10–16. *Ctenolepisma almeriensis* n. sp. Types: 10–13. Xth urotergites of different specimens showing the variability of the shape; 14. IXth coxite and stylet of the female. 15. Ibid, of the male; 16. Ovipositor in relation with IXth coxite and stylet.

Figs. 10–16. Ctenolepisma almeriensis *sp. n. Tipos: 10–13. Uroterguitos X de varios especímenes mostrando la variabilidad de su forma; 14. Coxito IX y estilo de la hembra; 15. Idem, del macho; 16. Ovipositor en relación con el coxito IX y el estilo.*

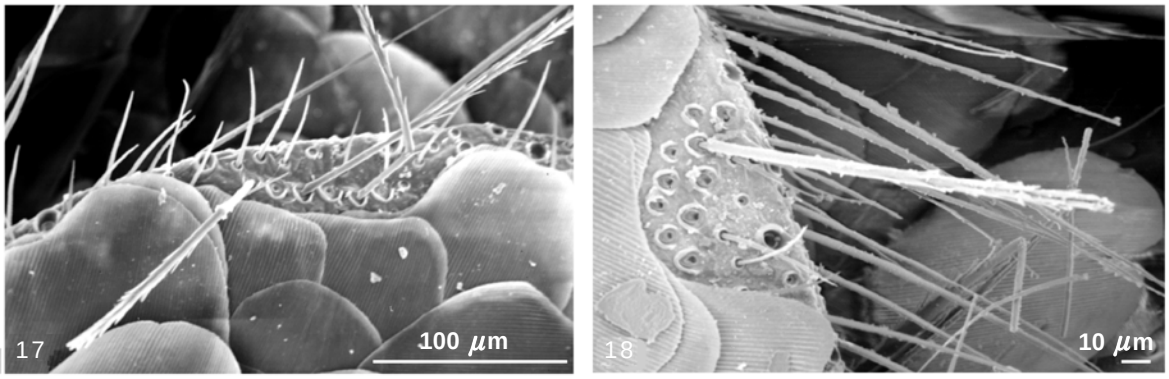
Comparing *C. almeriensis* n. sp. with other *Ctenolepisma* species

The main feature to distinguish this species from the other *Ctenolepisma* Escherich, 1905 from Europe, is the occurrence of double combs, i.e., fields of macrosetae on the thoracic sternites that are composed of two more or less parallel rows of plumose setae; in the prosternum these rows are more irregular and three rows can be observed in some fields. Some previously known species from other continents show these "double combs"; this finding is mentioned in the descriptions of South African *C. weberi* and *C. pretoriana* by Wygodzinsky (1955), and in that of *C. saxeta* (Irish, 1987), but no taxonomic significance was given to this feature. This character has been also detected in undescribed taxa from North Africa and the Near East (probably identified as *C. lineata*, without a fuller involving dissection of the specimens). *C. almeriensis* sp. n. is the only one of the available specimens from the West–Palaeartic region with double combs that bears only two pairs of stylets in both sexes. However, the occurrence of a double or single row in the aforementioned combs is specially useful for distinguishing between *C. almeriensis* n. sp. and *C. lineata* (respectively), two very similar taxa from the Iberian Peninsula (see figs. 17 and 18). The validity of this feature for distinguishing between both species is confirmed with a discriminant analysis (see below). More attention should therefore be paid to this feature for the future diagnosis of species of this genus.

Comparison of *Ctenolepisma lineata* and the new species

In comparison with the other European species belonging to the *lineata*–group, the new species described here is most similar to *C. lineata* as its tenth urotergite has the same shape, its legs show the same cover of scales and its abdominal setation is similar. For this reason, a detailed comparison of these two taxa is carried out here to elucidate the validity of the aforementioned character that is used to separate these two species.

Other differences can be found between specimens with double and single sternal combs, such as the number of macrosetae on the lateral and posterolateral combs of the nota, and on the combs of urotergites, thoracic sterna and urosternites. Even



Figs. 17–18. SEM photos of the apical part of the metasternum in *Ctenolepisma lineata* (17), showing a single row of macrosetae, and *Ctenolepisma almeriensis* n. sp. (18), with a double row (mainly insertions of macrosetae can be seen).

Figs. 17–18. Fotografías de MEB de la parte apical del metasterno en Ctenolepisma lineata *(17), mostrando una línea sencilla de macroquetas, y en* Ctenolepisma almeriensis *sp. n. (18), con una doble fila (se aprecian fundamentalmente las inserciones de las macroquetas).*

the ratio distance between combs / width of a comb in the metasternum and in the urosternites may differ. However, in these features the margins of variability overlap, so in some cases it is difficult to ascribe a certain specimen to *C. lineata* or to *C. almeriensis* if we do not see the combs of the thoracic sternites. A discriminant analysis may demonstrate whether *C. lineata* and *C. almeriensis* are significantly different on the basis of these variable features, thereby proving the validity of the "single/double rows of macrosetae" in the sternal combs.

The variables selected are detailed in Material and methods and were measured in 50 specimens of *C. lineata* and the same number of specimens belonging to the new species.

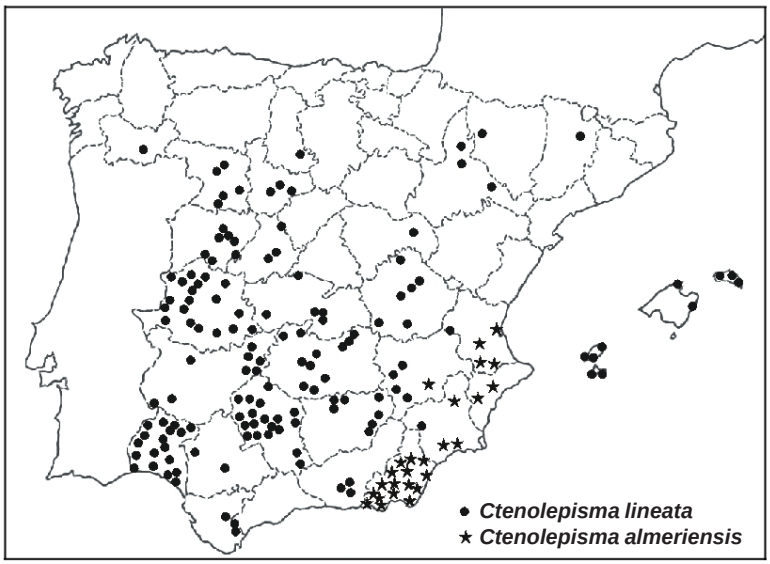


Fig. 19. Map showing the localities of Spain where the typical form of *Ctenolepisma lineata* and *C. almeriensis* n. sp. were collected.

Fig. 19. Mapa donde se indican las localidades de España donde se recogieron tanto la forma típica de Ctenolepisma lineata *como* C. almeriensis *sp. n.*

All the specimens of *C. lineata* were from Spain (localities nearest to the area where *C. almeriensis* is found, see map in fig. 19) and only specimens with two pair of stylets were selected, as it has been recently suggested that the variety *pilifera* (Lucas, 1840) with three pair of stylets is a different species (Molero–Baltanás, 1995).

As a result of a standardized principal component analysis (fig. 20), two components, 1 and 2, account for more than the 90% of variability. All the variables selected show a significant weight to explain this variability and therefore all of them are included in the discriminant analysis.

Taking into account the 600 data obtained from the total of 100 specimens (25 per predefined group), the following discriminant analyses were carried out: (1) comparison between males of the two predefined species; (2) comparison between females of the two predefined species; (3) and (4) Comparison between males and females within each one of the two species; and (5) comparison between the four groups

The results are shown in table 1 and in fig. 21.

This multivariate analysis forms two groups of specimens that exactly fit with the two predefined species, as can be seen in the biplot of the discriminant functions 1 and 2 (fig. 21), and in the classification variables (see material and methods). The analysis finds significant differences between species, but these differences are not found between sexes of a given species.

The results of the Mann–Whitney U–tests to compare the medians of the four groups are shown in table 2. They are highly significant when different predefined species were compared, and not significant when both sexes within a species were compared (except for one variable in *C. lineata*, which could have a significant value for sexual dimorphism).

Table 1. Classification table of the discriminant analysis: A. Actual SPSEX; S. Group size. Predicted SPSEX groups are the same as in fig. 21.

Tabla 1. Tabla de clasificación del análisis discriminante: A. SPSEX actual; S. Tamaño del grupo. Los grupos predefinidos SPSEX son los mismos que en la fig. 21.

		Predicted SPSEX			
A	S	1	2	3	4
1	25	19	6	0	0
2	25	6	19	0	0
3	25	0	0	14	11
4	25	0	0	8	17

These conclusions justify the differentiation between the two species and the validity of the double combs of macrosetae on thoracic sternites as a clear character to distinguish between them.

The specimens belonging to the new species have never been found within the area occupied by the typical *C. lineata*. The two species compared have never been found together in the same locality (they are probably vicarious; see fig. 19). The distribution area of *C. almeriensis* is mainly inside the limits of the biogeographic sector called “murciano–almeriense”, which is known in faunistic works for its importance as a centre of endemic species. The Penibetic mountain range

Table 2. Z values calculated by two–sample Mann–Whitney rank sum tests (U–tests): Sp1. *Ctenolepisma lineata* predefined groups; Sp2. *C. almeriensis* n. sp. predefined groups; M. Males; F. Females; * Significant evidence for different median values between the two groups compared (P value < 0.05).

Tabla 2. Valores Z calculados por los tests U de Mann–Whitney para dos muestras: Sp1. Grupos predefinidos como Ctenolepisma lineata*; Sp2. Grupos predefinidos como* C. almeriensis *sp. n.; M. Machos; F. Hembras; * Diferencia significativa entre los valores medios de los dos grupos comparados (valor de P < 0.05).*

Z adjusted value	Sp1M–Sp1H	Sp2M–Sp2H	Sp1M–Sp2M	Sp1H–Sp2H
N–notum	–2,77*	0,08	6,18*	5,91*
N–pros	–0,66	–0,47	6,17*	6,06*
N–meso	0,33	–1,27	6,01*	6,12*
N–meta	0,26	–1,15	5,86*	6,10*
N–uro	–1,37	1,28	5,38*	4,76*
D/a[Mt]	–0,76	–0,37	–4,29*	–5,88*

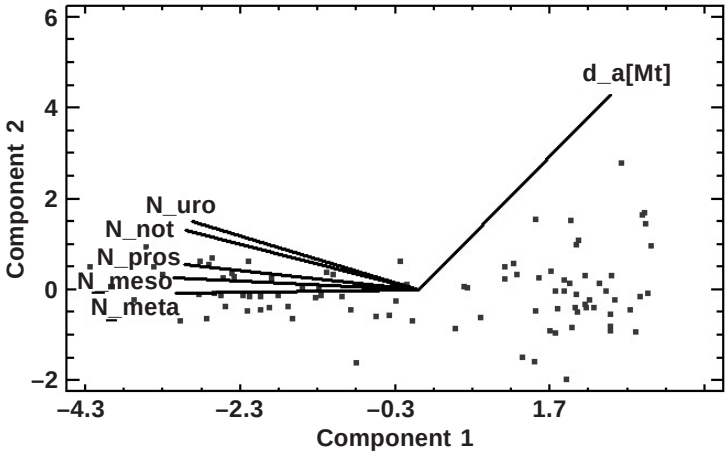


Fig. 20. Biplot of component principal analysis. Names of the variables are given in Material and methods.

Fig. 20. Gráfico del análisis de componentes principales. Los nombres de las variables se indican en Material and methods.

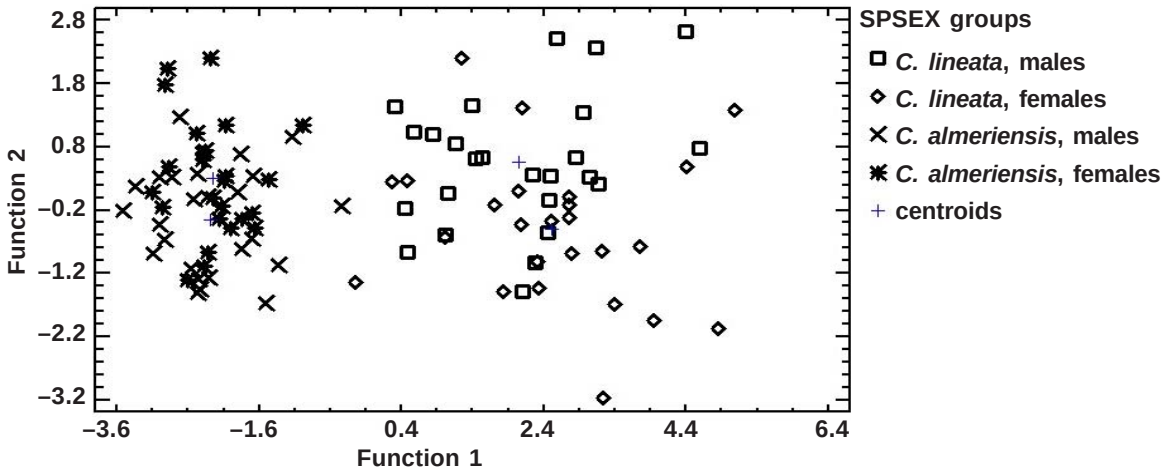


Fig. 21. Biplot of the discriminant analysis: SPSEX groups are established on the basis of sex and predefined species *Ctenolepisma lineata* and *C. almeriensis*.

Fig. 21. Gráfico del análisis discriminante: grupos SPSEX se han establecido en base al sexo y a la especie predefinida Ctenolepisma lineata *y* C. almeriensis*.*

acts as a barrier for the wet western winds and originates an arid region in this corner of the Peninsula. Therefore, the new form of *Ctenolepisma* seems to be geographically isolated. Such geographic evidence also justifies the differentiation between the two species. This may be supported by molecular evidence in the future but for the time being the findings in this work appear to be sufficient to maintain *C. almeriensis* as a good species, and subsequently to demonstrate the validity of the double combs of thoracic sternites as an anatomic characteristic with taxonomic importance in the genus *Ctenolepisma*.

References

Irish, J., 1987. Revision of the genus *Ctenolepisma* Escherich (Thysanura:Lepismatidae) in Southern Africa. *Cimbebasia* (A) 7 (11): 147–207.

Molero–Baltanás, R., Bach de Roca, C. & Gaju–Ricart, M., 1992. Los Zygentoma de Andalucía (Insecta: Apterygota). *Zool. Baetica*, 3: 93–115.

Molero–Baltanás, R., Gaju–Ricart, M., Bach de Roca, C. & Mendes, L. F., 1994. New faunistic data on the Lepismatidae of Spain (Insecta, Apterygota, Zygentoma). *Acta Zool. Fennica*, 195: 107–110.

Molero–Baltanás, R., 1995. Estudio taxonómico de los Zygentoma de España (Insecta: Apterygota). Ph. D. Thesis, Univ. of Cordoba.

Rivas–Martínez, S., 1987. Nociones sobre Fitosociología, Biogeografía y Bioclimatología. In: Peinado, M., Rivas–Martínez, S., Eds. *La vegetación de España*. Serv. de Publicaciones Univ. de Alcalá de Henares. Madrid: 19–45.

Wygodzinsky, P., 1955. Thysanura. *South. afr. anim. Life*, 2: 83–190.