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TWO NEW ARTHRONOTIC MITES FROM THE SOUTH OF SPAIN (ORIBATIDA, COSMOCHTHONIIDAE), WITH A NEW SUBGENUS AND SPECIES OF *COSMOCHTHONIUS* AND ONE NEW SPECIES OF *PHYLLOZETES*

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ABSTRACT — This work describes two new species of cosmochthoniids, including a new subgenus, originating from an olive grove in the South of the Iberian Peninsula: *Cosmochthonius* (*Nortonchthonius*) *oblongisetosus* **n. subgen.** and **n. sp.** and *Phyllozetes* *subiasi* **n. sp.** Within the genus *Cosmochthonius*, the original and substantial modification of some posterior hysterosomal setae characterizes the new subgenus *C. (Nortonchthonius)*. Within *Phyllozetes*, the erectile setae with strong dorsal and marginal spines are the specific character of *P. subiasi* **n. sp.**

KEYWORDS — Oribatida; Cosmochthoniidae; new subgenus; new species; Iberian Peninsula

INTRODUCTION

Michael (1885, p. 396, figure 11) described *Hypochthonius lanatus* as follows: "the segments are capable of a certain amount of telescopic extension and retraction, and in connection with this, it has a power of erecting the spines on its back (which are usually horizontal) as a porcupine does". Previously he remarks on "the division of the notogaster into four segments". Michael represents the habitus as monodactyl, and with four pairs of setae on the second abdominal row. Subsequently, Michael defines the generic dactylism: "The claws are monodactyl in all known species (Michael, 1888: p. 532)". In 1910, Berlese (p. 221) created *Cosmochthonius* from Michael's type and includes in the subgenus *C. (Cosmochthonius)* his new species *Cosmochthonius plumatus* and *Cosmochthonius emmae*. The genus is recognized as polydactylous

(Sellnick, 1928; Van der Hammen, 1959; Wallwork, 1960; Gordeeva, 1980; Lee, 1982; Ayyildiz and Luxton, 1990), and with two pairs of setae linked to the first notogastral furrow (Willmann, 1931: Figure 28) and with four setae in segment, according with the dorsonotal chaetotaxy of the family (Grandjean, 1947). Grandjean (1947: p. 224, figure 1C) includes within the family the oribatids of his major group Enarthronota, with four notogastral segments and with type-E scissures like in *Haplochthonius* Willmann, or the more differentiated type-S with intercalary sclerites that carry the erectile setae like in *Cosmochthonius* plus *Heterochthonius* (Berlese 1910). In 1953, Grandjean considering the heterogeneity of the family, separated *Heterochthonius* and subsequently, Van der Hammen (1959) had excluded the species with the *Haplochthonius* type. Hammer (1961) creates *Trichthonius* type species

Cosmochthonius pulcherrimus, that exhibits the first weak and incomplete notogastral furrow, distinct from the original type of Grandjean. Gordeeva (1980) includes in the family the genera *Trichthonius*, *Phyllozetes* Gordeeva, 1978 type species *Phyllozetes emmae* (Berlese, 1910) and the new genera *Krivolutskiella*, *Nipponiella* and *Gozmanyina* Balogh and Mahunka, 1983 (sin. *Marshallia* Gordeeva, 1980). In Gordeeva's key, the family was divided into two morphological groups: i) the *Cosmochthonius* type polydactyl group with *Phyllozetes* and *Krivolutskiella* and ii) the monodactyl group with three *Trichthonius* type notogastral segments with *Nipponiella* and *Gozmanyina*. This author also indicates that the sclerotization and the ventral chaetotaxy are homogeneous features between *Cosmochthonius* and *Phyllozetes*.

In accordance with the meaning of the family composition of Van der Hammen (*op. cit.*), Lee (1982) separates the monodactyl group in his Cohort Retrofissurae, keeping the Profissurae polydactyl group with the type family category within the Cosmochthonioidea Grandjean, 1947. In the same previous meaning, Norton *et al.* (1983), based on the *Cosmochthonius reticulatus* type fenestrated rostrum (Grandjean, 1962: Figure 3A) and the absence of other synapomorphies, gives to the polydactyl group the same ancestral family status separated within the superfamily.

The cosmochthoniids sensu Lee and Norton *et al.* (*op. cit.*) live in warm and dry environments. *Cosmochthonius* and *Phyllozetes* can be found in the hot upper layers of the soil beneath xerophytic vegetation (Gordeeva, 1980). This latter author also indicates that under these conditions, the adaptive mechanisms are the small body dimensions and that in the case of *Phyllozetes*, the large and foliar notochaetae could reduce the loss of water through the body's surface.

Consulting the catalogs of oribatids, Global of Subías (2013), Mediterranean (Subías and Gil-Martín, 1997; Penttinen and Gordeeva, 2010; Subías and Shtanchaeva, 2012b) and Iberian (Subías and Shtanchaeva, 2012a) and in accordance with hypotheses of Gordeeva (1980), the polydactyl group is common in the Mediterranean ecozone and, in

Spain there are 14/33 of the total species of *Cosmochthonius* with 5 endemics, 3/8 from *Phyllozetes* and 1/2 from *Krivolutskiella*.

This descriptive work is part of a study begun in 2012 on the oribatids diversity associated with the olive grove in a middle mountain habitat, in a transitional zone between the Subbetic Mountains and the Guadalquivir River Valley (Southern of the Iberian Peninsula).

MATERIALS AND METHODS

The samples were taken on May 23rd 2012, from a limo-calcareous soil with xeric humidity levels, typic Xerorthent (Soil Survey Staff, 2010), at a depth of 0-7.5 cm, below olive trees *Olea europaea* L., 'la Mina' agricultural land, IFAPA Center in Cabra (Córdoba, Spain; N 37°30.250', W 4°26.261'; altitude 547 m.). The mites were extracted using the Berlese Tullgren-method, collected in ethanol PG solution (Ethanol-Propylene glycol (1.2-Propanediol)-AD, 80-10-10), they were rinsed off and, described and drawn from lactic preparations for microscopic examination. All the material is deposited into vials with a PG solution in the Entomology Lab, IFAPA center in Alameda del Obispo in Córdoba, Spain.

The nomenclature and abbreviations of the hysterosomal segments, the notogastral plaques, and the hysterosomal chaetotaxy follow the terminology of Grandjean (1939: Figure 4; 1947: Figure 1).

New Species of Cosmochthoniidae Grandjean, 1947

Genus *Cosmochthonius* Berlese, 1910

Diagnosis — Oribatid mites, archoribatids, arthronotics, and holoids sensu Balogh and Mahunka (1979); belonging to Enarthronota (Grandjean, 1947, 1953: 428, 1969: 141). Cosmochthoniids with the original *Hypochthonius lanatus* type (Michael, 1885: 396), with the fenestrated rostral tectum (Grandjean, 1962; Norton *et al.*, 1983) and without prodorsal spots or eyes (Grandjean, 1953); notogaster orthotrichous with four completely divided segments, with setae in the *d*-series

linked to the first type-*E* scissure, pectiniform, non-foliate setae from the *e* and *f*-series, without pectinations in some species (Sarkar, 1983; Kahwash *et al.*, 1989), of the erectile-type, originating in the intercalary sclerites of the type-*S* scissures (Grandjean, 1947, 224; Van der Hammen, 1959: key p. 12); all legs polydactyl, heterodactylous with tarsal formula 2-3-3-3 (Van der Hammen, 1959; Gordeeva, 1980; Lee, 1982), exceptionally homobidactylous (Chakrabarti *et al.*, 1972).

***Cosmochthonius* (*Nortonchthonius*) n. subgen.**

Type species: *Cosmochthonius* (*Nortonchthonius*) *oblongisetosus* n. sp.

Diagnosis — Species belonging to the genus *Cosmochthonius* with the posterior pygidium truncated and the large dorsal setae that project far away from the margin of the hysterosomal plate in a 'skirt' fashion, the first setae of the hysterosomal segment *H* (*h1*) and first adanal (*ad1*) which are strongly modified, with the look of 'cabbage leaves' (Figure 1).

Remarks — This new subgenus, known solely by one species, shows the appearance and layout of the dorsal series of notochaetae *c-f* of *Cosmochthonius*. It differs from the other genera of the polydactyl group of *Cosmochthoniidae* in that the shelled expanded dorsal setae of *Krivolutskiella* and the erectil and foliar setae of *Phyllozetes* lack, and by the unguicular formulae, which are 2-2-2-3 in *Phyllozetes* and 2-2-2-2 in *Krivolutskiella*. Taking into account the body size and the growth of the erectile setae, the new subgenus occupies a position close to *Cosmochthonius* s. str. because they lack the body miniaturization and/or the reduction or regression of the erectile setae, that defines *Cosmochthonius* (*Nanochthonius*) Subías and Gil-Martín, 1995 type species *Cosmochthonius* (*Microchthonius*) *ruizi* Kahwash, Subías and Ruíz, 1989. The modification of the posterior hysterosomal setae in this species, particularly that of the *h1* and *ad1* setae justified the creation of the new subgenus *Cosmochthonius* (*Nortonchthonius*).

Etymology — The subgeneric '*Nortonchthonius*' name is dedicated to the North American acarologist Roy A. Norton.

***Cosmochthonius* (*Nortonchthonius*)
oblongisetosus n. sp.**

Description Adult (Figure 1) (n=2).

General aspect, measures and integument (Figure 1) — Small oribatids, the length of the idiosoma is 259-264 µm; the maximum width, measured in the transect between the third pseudoanal setae is 0.62-0.64 times the length of the body. The sides of the body diverge in a front-to-back direction and the pygidium is straight from behind, giving the mites a triangular appearance. Very clear ochre cuticle, almost colorless. In the center of the third notogastral plaque (NM2) there are five finely dotted spongy areas, similar to those located on *Cosmochthonius ponticus* Gordeeva 1980 (Figure 2,1), the rest of the body integument is smooth, without any traces of sculpture.

Prodorsum (Figure 1a) — The rostral tectum has a rounded margin and lies ventrally, the back shows elongated fenestrations in longitudinal rows composed of 1-3 alveoli. The proterosomatic setae show the arborescence and layout of the genus, with long pectinations with a spiniform appearance; the rostral setae (*ro*), anterior exobothridials (*exa*), posterior exobothridials (*exp*) and interlamellars (*in*) uniramous, lamellar setae (*la*) biramous, *ro* and *la* are the most robust; with muscular sigillae on both sides of the interlamellar region and in the posterior subbothridial region. Trichobothridium with a typical sensillum (*ss*), fusiform and moderately pubescent in the greater part of its length.

Notogaster (Figure 1a) — With four dorsal plates, the anterior (NA) is approximately 1.5 times thicker than the mid-anterior (NM1), 1.0 times the mid-posterior NM2 and 0.5 times the pygidium (PYG). The series of setae in NA (*c1*, *c2*, *c3* and *cp*) and NM1 (*d1* and *d2*) are typical setiform, with relatively short narrow pectinations, each seta projects over the origin of the previous seta. Setae *c1*, *c2*, and *d2* of similar length, shorter than *c3* and posterior *cp* and somewhat longer and more robust than *d*. In NA, the first three setae are equidistant in the same row in the midst of the plaque and *cp* in the posterior corners; *d*-row originates in the fold or broad evagination of the first notogastral furrow (*ar1*) and the distance between setae *d1* is approximately half

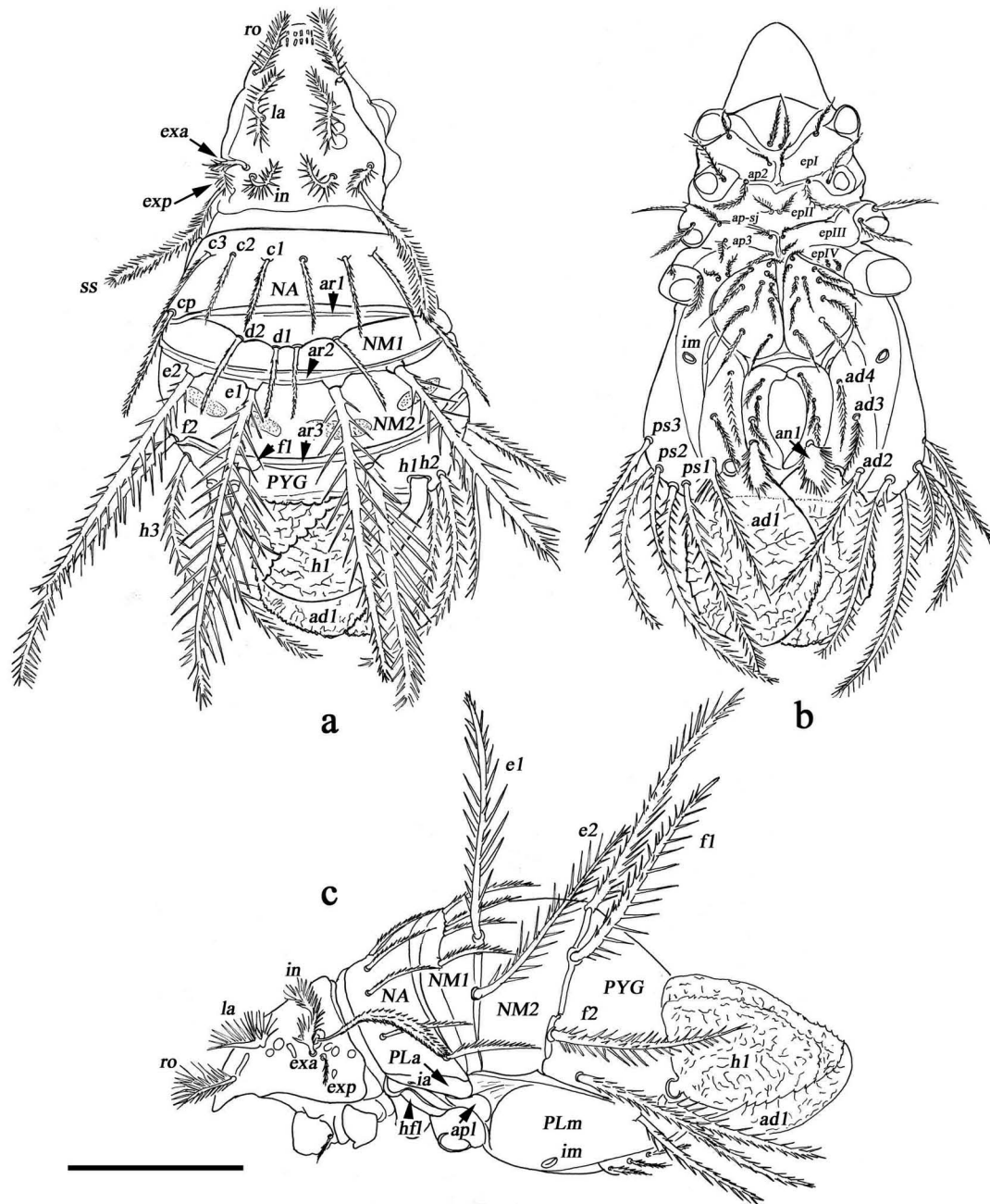


FIGURE 1: *Cosmochthonius (Nortonchthonius) oblongisetosus* n. subgen. and n. sp.; a – dorsal view, b – ventral view, c – lateral view; gnathosoma and legs not illustrated. Scale bar = 100 micrometers.

the distance $d1-d2$. The erectile setae (row e : $e1$ and $e2$ and row f : $f1$ and $f2$) are large and rigid and they project beyond the hysterosoma in more than half the setal length. These setae have a 'palm leaf' or 'fish spine' appearance with a thick and rigid stem, continued bilaterally by long and large spiniform setulae and other very short spinulae interspersed throughout the stem. The intercalary sclerites of second and third scissures ($ar2$ and $ar3$) are narrow and long. The first setae of the segment H ($h1$) are very large setae of the foliar type, oblong or orbicular, concave towards the sagittal plane of the body and they overlap; each seta has a strong and short stem, the surface of the leaf shows a fine irregular grid and a finely denticulated leaf margin. The second and third setae of the h -series ($h2$, $h3$) and the three pseudoanal setae ($ps1$, $ps2$, $ps3$) are shorter and finer than the erectile setae and they curve over $h1$.

Lateral View (Figure 1c) — Below plaque NA , the anterior pleural plate (PLa) is located with the anterior lyrifissure (ia). Below PLa and over the acetabulum III, is the humeral flap (hfl), a counterpart to that of *Cosmochthonius reticulatus* (Grandjean, 1962: Figure 3A-B); over the acetabulum IV, there is an accessory plate (apl), auriculiform and prominent in the dorso-ventral; the middle pleural plate (PLm) has the median cupule (im).

Venter (Figure 1b) — Second apodemes ($ap2$) and sejugal ($ap-sj$) complete, third apodemes ($ap3$) not very pronounced; non-coalescing first and third epimeral plates (epI , $epIII$), unique second ($epII$) and the fourth one ($epIV$) separated by the major anterior growth of the genitalia; coxisternal formula 2-2-3-4, the epimeral setae are long and they have fine, relatively large pectinations. Every genital valve has 10 genital setae similar to the epimeral setae, 6 on the medial longitudinal row, with one of the closer fourth or fifth setae somewhat displaced laterally and 4 lateral setae longer than the medial row. The anal plate is attached to the genital plate and with four setae on each valve, the three anterior pairs being similar to the genitals, the first posterior pair ($an1$) is thick and densely ciliated in a 'brush' manner. Adanal plate undivided, U-shaped, with four pairs of setae, the posterior ones and the first adanal ones ($ad1$) of the orbicular type with a length

approximately half of the abdomen and a thickness that is approximately 0.75 times its length, with a surface and margins similar to those of the $h1$ setae. The three anterior pairs of setiform adanal setae ($ad2$ to $ad4$) are setiform, stronger and longer than the anal ones.

Legs — All tarsi are polydactyl, tarsus I is bidactyl and tarsi II to IV have three claws and, in the lateral view of the pretarsi, the central claw is stronger than the laterals and with a 'sickle blade' appearance.

Specimens examined — Two females in a simple from soil below the coverage of an olive tree in production in a parcel of an organic olive grove, holotype code 2715-Hol/M14-20120523 and paratype code 2715-Par/M14-20120523.

Etymology — The specific name '*oblongisetosus*' refers to the appearance of some setae on the posterior margin of the body. Remarks - The new and type species of the new subgenus *Cosmochthonius* (*Nortonchthonius*) *oblongisetosus* differs from the rest of species of *Cosmochthonius* by the morphology of the setae $h1$ and $ad1$.

Phyllozetes Gordeeva, 1978

Diagnosis — Enarthronotic oribatids belonging to Cosmochthoniidae and with the type of *Cosmochthonius emmae* Berlese, 1910 (p. 222, Figure 49); with fenestrated rostrum; notogaster divided into four segments; setae in the d -series linked to the first type- E scissure; spear-like erectile setae $e-f$; polydactyl heterodactyl legs, tarsal formula 2-2-2-3.

Phyllozetes subiasi n. sp.

Diagnosis — Mite species belonging to *Phyllozetes*, with the rows of foliar notochaetae $e-f$ spiniform, with the margins and dorsal surface of the leaf covered by strong spines.

Description Adult (Figure 2) ($n=1$) General aspect, measures and integument (Figure 2) — Small and narrow oribatid, the idiosomal length is 264 micrometers, 2.30 times its maximum width. The cuticle is clear and colorless, the surface of the integument in the pygidium and the pleural plate is microfoveolated, rest of the integument apparently smooth.

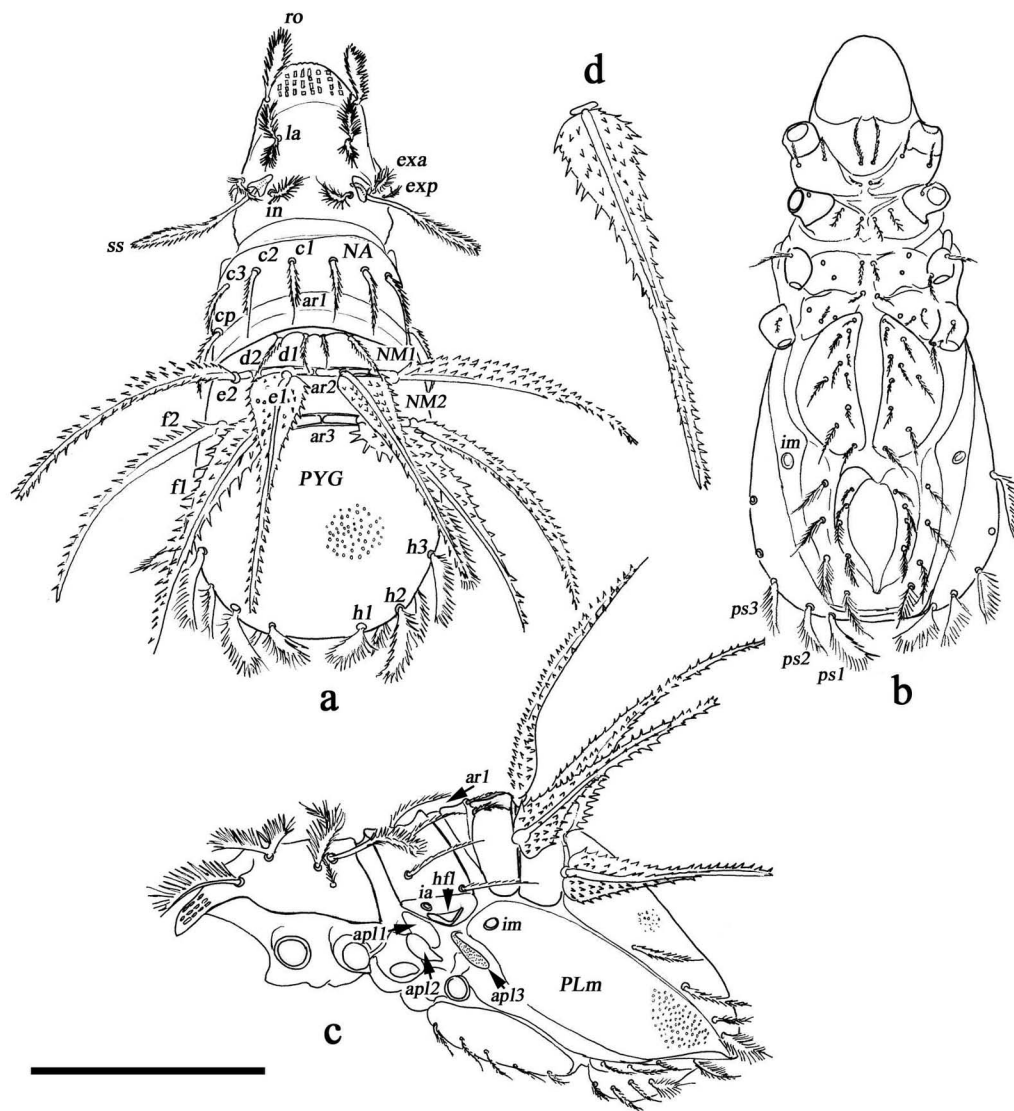


FIGURE 2: *Phyllozetes subiasi* n. sp.; a – dorsal view, b – ventral view, c – lateral view, d – detail of seta *e1*; gnathosoma and legs not illustrated. Scale bar (Figs. 2a-c) = 100 micrometers.

Prodorsum (Figure 2a) — Rostral tectum with small perforations in longitudinal rows of 1–4 alveoli. Setae of the proterosoma with the growth and pubescence typical of the genus. The rostral setae (*ro*) are the biggest ones, uniramous and densely pubescent. The lamellar setae (*la*) are biramous with a 'V' shape, the two pairs of exobothridial setae (*exa* and *exp*) are setiform with large pectinations, with *exp* being the lower prodorsal seta; the interlamellar setae (*in*) are in an interbothridial position next to the bothridia; the sensilli (*ss*) are typical of the family, fusiform and densely pectinated in its front half.

Notogaster (Figure 2a) — The anterior plate *NA* is approximately 1.5 times wider than posteriors (*NM1* and *NM2*) and 4 times narrower than the pygidium. The anterior notogastral fissurae *ar1* is the broadest and it shows a middle ridge or suture, which reflects an added extension of the anfiarthrosis at this level, as can be observed in the lateral view of the mite (Figure 2c). The setae on *NA* (*c1*, *c2*, *c3* and *cp*) are typically setiform in the genus, approximately equal in length. Each one projects towards the base of the posterior seta, *c1* to *c3* are equidistant and are aligned in the center of the segment and *cp* in the posterior corners. In *NM1*, the setae *d2* are somewhat shorter than those of *c*-series and *d1* is the shortest seta; pairs *d1* and *d2* are joined by a narrow crease in the first notogastral furrow, with the distance between *d1* being approximately half of the *d1*–*d2* distance. The erectile setae *e*–*f* originate from narrow intercalary sclerites: they are equally long and they end over the other side of the hysterosoma, they are spear-like, the base part quickly sharpens in the long narrow anterior part which occupies two thirds of the setal length, each seta possesses a strong central nerve which doesn't branch out, the margins and dorsal face of the setal sheet are densely covered by long, strong spines (Figure 2d). Setal rows *h* and *ps* are posterior and marginal in the pygidium, *h1*–*h3* shifted to dorsal position and *ps1*–*ps3* to ventral position, all setae are medium long and densely plumose.

Lateral View (Figure 2c) — Below the *NA* plate is located a small triangular plate *PLa*, with the lyrifissure *ia* and which includes a small concave triangular humeral flap (*hfl*). Below *hfl* and over the acetab-

ulum III, two small accessory plates are marked (*apl1* and *apl2*), auriculiform and prominent in the ventral view and with the inferior plate (*apl2*) overlapping the dorsal one (*apl1*). On top of the acetabulum IV, there is a small cribriform plate (*apl3*), whose surface appears to be dotted; below and attached to the two median notogastral plaques and pygidium there is the long plate *PLm*, which has the cupule *im* on its anterior angle and whose surface is covered with fine foveoles.

Venter (Figure 2b) — Epimeral plates separated; coxisternal formula I–IV: 3–2–3–4, the epimeral setae are relatively short and setiform, with separate pectinations. Large genital plate, each valve with 10 pairs of setae spread out in two longitudinal rows, 6 medial ones and 4 longer lateral ones with the third and fourth setae somewhat more medial in this row. Four pairs of anal setae similar to the genitals. Adanal plate, posteriorly coalescent with a 'U' shape and with four pairs of relatively long setae, more pubescent than the anal ones.

Legs — Tarsi I to IV with claw formula 2–2–2–3 and with the corresponding lateral claws thinner and slightly curved downward.

Specimens examined — One female, holotype cod. 2716-Hol/M43-20120523; in soil below the coverage of an isolated olive tree next to a small formation of holm oak trees (*Quercus ilex*), next to a plot of an organic olive grove.

Etymology — The specific name '*subiasi*' is dedicated to the Spanish oribatologist Lu s S. Sub as.

Remarks — The genus *Phyllozetes* possess a characteristic lanceolated erectile setae of fringed margins with cilia that is more or less long and narrow and a surface that is either smooth or covered with minute cilia. *Phyllozetes subiasi* n. sp. differs from the congeneric species as it is the only species that grows strong spines, both on the rims as well as the upper face of the setal sheet.

DISCUSSION

Morphofunctional remarks — In the oribatids, the erection capacity and modification of the dorsonotal setae is an early derivative adaption meant for

defense against predators (Norton, 2001; Seniczak *et al.*, 2011). The modification of the notogastral setae, starting from the pectiniform simple type to the foliar, has a parallel growth in arthronotic oribatids:

Atopochthonioidea has large fungiform setae, and in the cosmochthonioids,

1) *Trichthonius* has large notochaetae, phylliform and densely pubescent,

2) *Gozmanyina* has large, dilated erectile setae, densely pubescent dorsally and marginally covered by ballon-shaped setulae,

3) in *Krivolutskiella* the dorsonotal setae are dilated, lamellar and are very pubescent, the pseudoanal setae with the fan shape and the foliar setae of the serie-*h* (Gordeeva *et al.*, 2007) and,

4) in Phyllozetes, they are spear-like and, as in *P. subiasi* n. sp., they have a coverage made up of strong spines.

Cosmochthonius (*Nortonchthonius*) n. subgen. presents type of configuration in the posterior setae of the notogaster, which could be an example of an additional complementary mechanisms, which could be hypothesized as: Playing a role

-i) in the defense against predators (Norton, 2001; Seniczak *et al.*, 2011),

-ii) in water conservation in driest conditions of the habitat (Gordeeva, 1908) and/or

-iii) a vestigial and reminiscent structure, acquired by differentiation under the humid conditions of a primitive tropical habitat of the Subbetic Region, for keeping air bubbles inside when the mite is temporally submerged in water films.

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