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REDESCRIPTION OF *COSMOCHTHONIUS FOLIATUS* SUBIAS, 1982 AND SUPPLEMENTS TO THE DESCRIPTIONS OF *C. RETICULATUS* GRANDJEAN, 1947 AND *C. LANATUS* (MICHAEL, 1885) (ACARI: ORIBATIDA: COSMOCHTHONIIDAE)

Ritva PENTTINEN 1 & Elena GORDEEVA 2

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**SUMMARY:** The species *Cosmochthonius foliatus* Subias, 1982 is redescribed. The transverse ridge with cerotegumental collar is proposed as the most noticeable diagnostic feature of *C. foliatus*. The structure of the integument of the species is illustrated with Scanning Electron Micrography (SEM). The descriptions of *C. reticulatus* Grandjean, 1947 and *C. lanatus* (Michael, 1885) are complemented by data based on SEM analysis. Two species are synonymised; *C. trivialis* Sergienko, 1991 is confirmed as the junior synonym of *C. reticulatus*, and *C. novus* Sergienko, 1991 is considered a junior synonym of *C. lanatus*.

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The species, *Cosmochthonius foliatus* Subias, 1982, *C. reticulatus* Grandjean, 1947 and *Cosmochthonius lanatus* (Michael, 1885) are found in the Mediterranean region (Balogh & Mahunka, 1983; Gil et al., 1991; Gordeeva, 1980; Grandjean, 1947, 1962; Perez-Iñigo, 1989; Sergienko, 1991, 1994; Subias, 1982). These species are quite similar to each other. They are small and their prodorsal and notogastral setae are brush-shaped, plumose or ciliate. The cuticle is netlike, and the two former species have a thick cerotegument. The authors, AYYILDIZ & LUXTON (1990), GRANDJEAN (1947, 1962) and SUBIAS (1982) consider the pattern of the integument as one of the specific characters. However the identification of these species is not easy. GRANDJEAN (1947, 1962) illustrated the integument of *C. reticulatus* without cerotegument and emphasized the pattern of the cuticle whereas SUBIAS (1982) demonstrated the cerotegument of *C. foliatus* and considered the cerotegumental bands as a species-specific character. Information about the inte-
gument of *C. lanatus* is scarce and authors focus mainly on description of the alveoli of cuticle.

To date, descriptions of these species are based on study by light microscope, and the complex structure of the integument is not easy to recognize using this method. In the present work, species are examined by Scanning Electron Microscopy (SEM). The structure of the integument of three species is presented with and without cerotegument. Other characters of the species are also revealed by SEM micrographs. The species *C. foliatus* is redescribed, and descriptions of *C. reticulatus* and *C. lanatus* are completed. Diagnoses are presented for the three species.

**Material and Methods**

The study was based on the type material (*C. foliatus* Subias, 1982, *C. lanatus* Michael, 1885, *C. trivialis* Sergienko, 1991 and *C. novus* Sergienko, 1991) and on the fresh material collected in the Mediterranean region. Information about the sampling locality has been listed in context of the descriptions of the species.

In descriptions, the setal nomenclatures and other characters follow the terminology of Grandjean (1962). Specimens were studied by Scanning Electron Microscope (SEM, JEOL JSM-5200). Measurements were made by digital image recording system for the Scanning Electron Microscope (SemAfore 3).

**Cosmochthonius foliatus** Subias, 1982

Figs. 1-16.

**Cosmochthonius foliatus:** Subias, 1982

**Cosmochthonius foliatus:** Ruiz & Subias, 1984

**Cosmochthonius foliatus:** Ruiz et al., 1986

**Cosmochthonius foliatus:** Mingues & Subias, 1986

**Cosmochthonius foliatus:** Arillo et al., 1988

**Cosmochthonius foliatus:** Perez-Iñigo, 1988

**Cosmochthonius foliatus:** Perez-Iñigo, Jr., 1990

**Cosmochthonius foliatus:** Ruiz et al., 1991

**Cosmochthonius foliatus:** Gil, Subias & Candelas, 1991

**Cosmochthonius lanatus:** Perez-Iñigo, 1969

**Cosmochthonius lanatus:** Minguez, 1981

**Cosmochthonius lanatus:** Sergienko, 1987

**Cosmochthonius reticulatus:** Sergienko, 1994

**Material examined.** *Cosmochthonius foliatus* Subias, 1982, type material, University of Madrid, Spain.

SPAIN, Sierra de Mira (E Spain), L. S. Subias and A. Arillo leg., 5 exx (Subias & Arillo, 2000).


CANARY ISLANDS, Tenerife (North) Playa de Benijo, shore slope 14.1.1997 S. Koponen leg., 2 exx, ZMT.

**Description (Adult)**

**Color:** light brown

**Measurements.** Mean length and width: 279 × 160 µm (n = 8, Spain); 292 × 168 µm (n = 9, Ukraine.) *Lengths and widths according Gil et al. (1991):* 300-325 × 155-170 µm, 300-315 × 155-165 µm, 280-305 × 139-156 µm
**Integument.** Almost whole dorsal surface of body covered by thick netlike cerotegument (Figs.1-2). Cerotegument with most regular pattern on prodorsum; on area between interlamellar setae (il) and lamellar setae (la) and on notogaster, especially on pygidium (PY). Relief of cerotegument follows structure of underlying cuticle, comprising rounded foveae (5-7 µm) with interscalares (0.7-1.5 µm) giving a net-like pattern to upper cerotegument (Figs. 6 & 7). Meshes with thinner cerotegument resemble polygonal sieves (Figs. 2 & 6), whereas meshes with thick cerotegument are fused and swollen with big pore in middle (Figs. 1 & 5).

Longitudinal bands formed by cerotegument exist on pygidium in those specimens with thick cerotegument. Dense cerotegumental, transversal band on base of prodorsum and on posterior of notogastral segments (NA, NM₁ and NM₂). Transverse region almost without cerotegument present anterior to NA. Two broad, symmetrical depressions and one semicircular depression on posterior of pygidium (Fig. 3). Cerotegument folded on lateral region of notogaster (Fig.15). Ventral side of notogaster overlaid by thin and uneven cerotegument lacking regular pattern.

**Prodorsum.** Rostrum separated by semicircular, concave line (fa) from rest of prodorsum (Fig. 8). Anterior part of rostrum curved ventrally with triangular peak with 2-3 very small teeth on top and with 2-3 rows of longitudinal slots on margin (Fig. 9). Posterior of rostrum flat, with low, longitudinal carina medially, (Fig. 8). Transversal ridge between lamellar setae serves as border line between rostrum and flat, medial part of prodorsum (Figs. 1, 3 and 8). Ridge is without cerotegument.

Narrow, transverse ridge present on posterior of prodorsum, covered by round-angled cerotegumental “collar” (Figs. 1-4). In lateral view collar looks like shed providing protection for dorsosejugal scissure. Cuticule of scissure thin without pattern; folded basally and trapeze-shaped medially (Fig. 4).

All prodorsal setae, except posterior exobothridial setae (exp), brush shape, branched or foliate. Rostral setae (ro) elongate and foliate (Fig.8), with margins bristle-shaped, and upturned borders giving impression of channel. Lamellar setae bifurcate with long cilia; their anterior branches longer and stronger than posterior branches (Fig. 10). Il laterally compressed, narrow and curved; dorsal sides with forked bristles (Fig. 11). Setae exp short and pectinate whereas anterior exobothridial setae (exa) laterally compressed with bristles on margins (Figs.12). Sensillus (ss) with long stalk and wide brush shape head (Figs. 1 and 2).

**Notogaster.** Notogastral seta c, d, e and f simple, not widened. Setae c and d plumose with secondary barbs on margins; dorsally covered by short cilia (Fig.13). Both setae groups c and d laterally compressed. Setae c₁ as long as c₂, but shorter than c₂. Setae c₂ as long as c_p. Distance between setae c₁ - c₁ = c₁ - c₂ = c₂ - c₃. Setae d₁ shorter than setae d₂ and as long as setae c₁. Distance between setae d₁ - d₁ = ½(d₁ - d₂).

Erectile setae e and f plumose; their cross-section round. Dorsally e and f covered with minute cilia. Lateral hairs of e₁ and e₂ on base as long as 1.5 times diameter of stem whereas hairs of setae f₁ and f₂ twice longer than diameter of their stem (Fig.14). Hairs denser near base of setae and their length decreases distally on setae.

Setae e₁ as long as setae e₂. Setae f₁ longer than f₂. Distance between setae e₁ - e₁ as long as e₁ - e₂. Distance between f₁ - f₁ is 1.5 times longer than f₁ - f₂.

Setae h₁-₃ and p₁-₃ elongate, laterally compressed with long bristles on margins (Fig. 15).

**Ventral side.** Formula of epimeral setae I - IV: 3-2-3-4. Genital plate with 10 setae and both anal and aggenital plate with 4 setae.

**Legs.** Claws (I-IV): 2-3-3-3. Dorsal (d) and lateral setae (l) wide and strong with small spines along middle line. Ventral setae (v) narrow and pectinate (Fig.16).

Remarks. Specimens of _C. foliatus_ with thick cerotegument have longitudinal, cerotegamental bands on the pygidium. Between these there are depressions where the erectile setae lie when in rest position. These bands and depressions are considered species-specific characters in the description of _C. foliatus_ (Subias, 1982). Our SEM studies of numerous specimens of _C. foliatus_ demonstrate that these bands are a common feature only on those specimens with thick cerotegument. Similarly, these bands are only found on specimens of _C. reticulatus_ with thick cerotegument (see below). The thickness of cerotegument probably depends on the age of the specimens, living
Figs. 1-7. *Cosmochthonius foliatus*. 1, 2, 3. — Dorsal view (cer tegument removed in Fig. 3). 4. — Dorso-sejugal suture. 5, 6. — Cerotegument of specimens of the figs. 1 & 2 (respectively). 7. — Cuticle of the foveae on pygidium.
conditions and other physico-chemical factors. SEM studies also showed that the epicuticle of pygidium under these bands of cerotegument was the same throughout and those ridges and depressions were absent (Fig. 3). It seems that the cerotegumental bands are agglomerations accommodating the erectile setae, and cannot be considered diagnostic at the species level.

The transverse ridge with cerotegumental collar is a conspicuous character of *C. foliatus*. It is absent from other species of the genus *Cosmochthonius* we have examined, and we propose it as a diagnostic character of the *C. foliatus*.

SERGIENKO (1994) recorded *C. reticulatus* from the Odessa region (Ukraine) and from the steppe of the Kerch peninsula, Crimea. She illustrated the article with drawings (her Figs. 15.-3-8) and figure 3 illustrates the prodorsum with cerotegumental collar. Because this collar is diagnostic for *C. foliatus*, we suggest that these records are of *C. foliatus*, not *C. reticulatus*.

**Diagnosis.** Body with netlike thick cerotegument, except anterior of NA almost without cerotegument. Cuticle with shallow, rounded and sub-equal foveae. Prodorsum posteriorly with transverse ridge with cerotegumental collar. Cuticle of dorso-sejugal suture thin, without pattern. Basal part of this area folded; trapeze-shaped medially. Notogastral setae; $c_{1} < c_{3} < c_{2}$; $c_{2} = c_{p}$; $d_{1} = e_{1} < d_{2}$; $e_{1} = e_{2}$ and $f_{1} > f_{2}$. The setae $d$ and $l$ on legs strong and wide.

**Cosmochthonius reticulatus** Grandjean, 1947

Figs.17-28.

**Cosmochthonius reticulatus**, Grandjean, 1947

**Cosmochthonius reticulatus**: Grandjean, 1962

**Cosmochthonius reticulatus**: Balogh & Mahunka, 1983

**Cosmochthonius trivialis**, Sergienko, 1991

**Cosmochthonius trivialis**: Sergienko, 1994


SPAIN, Andalucia, Zahara de la Zierua 500m a.s.l., *Quercus* litter 14.9.2003, Ritva Penttinen leg.11 exx [ACA.ORI.PAL 0.047]ZMT Canary Islands, Lanzarote Haria/Teguise border, 500 m a.s.l., litter (mainly *Euphorbia*), 23.2.2004, Seppo Koponen leg., 1 ex, [ACA.ORI.PAL 0.082]ZMT. Lanzarote Haria, *Tamariscus* litter, 23.2.2004, Seppo Koponen leg., 2exx [ACA.ORI.PAL 0.081]ZMT.


Marmaris Icmeler, slope of mount, litter of deciduous trees, 8.6.1995, Ritva Niemi & E. Gordeeva leg., 11 exx [ACA.ORI.PAL 0.073] ZMT. Marmaris Turunc, moss, lichen and grass, 5 m a.s.l., 18.5.1995, Ritva Niemi & E. Gordeeva leg., 3 exx [ACA.ORI.PAL 0.074] ZMT.


Marmaris Icmeler, slope of mount, litter of deciduous trees, 8.6.1995, Ritva Niemi & E. Gordeeva leg., 11 exx [ACA.ORI.PAL 0.073] ZMT. Marmaris Turunc, moss, lichen and grass, 5 m a.s.l., 18.5.1995, Ritva Niemi & E. Gordeeva leg., 3 exx [ACA.ORI.PAL 0.074] ZMT.

**Description.** (Adult)

**Color:** yellowish.

**Measurements.** Mean length and width:
- 299 × 173 μm (n= 2, Spain);
- 289 × 165 μm (n= 4, Sardinia);
- 277 × 153 μm (n= 4, Crete);
- 287 × 172 μm (n=11, Rhodes);
- 279 × 168 μm (n= 3, Turkey);
- 266 × 152 μm (n= 15, Cyprus);
- 291 × 159 μm (n= 4, Ukraine).


**Integument.** Body covered by thick, reticular cerotegument dorsally (Figs. 17 & 20). Posterior margins of segments NA, NM₁ and NM₂ with transverse bands with close-textured cerotegument. Anterior of segment NA covered by thick, continuous cerotegument (cf. *C. foliatus*). Longitudinal, cerotegumental bands present on specimens with thick cerotegument (Figs. 17 & 20). Two shallow symmetrical depressions and one shallow semicircular depression present (Figs. 18 & 20). Cerotegumental folds present laterally on notogaster (Fig. 27). Body covered by thin and uneven cerotegument ventrally.

Netlike pattern of cerotegument most regular on PY, with meshes of net hexagonal, concave with sparse, big pores or with many pinholes (Figs. 21 & 22). Structure of meshes of whitish (young?) specimens more closed (Fig. 19). Cerotegumental structure reflects shape of underlying cuticle. Foveae (5-9 μm) with interscalares (0.5-1.2 μm) on cuticle polygonal or hexagonal shaped (Fig. 18).

**Prodorsum.** Rostrum curved ventrally, without distinctly elongated teeth (Fig. 24). Two-three rows of elongated slots on margin. Cerotegument thin, granulated in this region whereas structure porous on both sides of line *fa*. Strong, transverse ridge, without cerotegument present between setae *la* (Fig. 17). Cerotegument between setae *il* and *la* netlike. Ridge with cerotegumental collar on posterior of prodorsum absent. Dorsosejugal scissure wide, cuticle with thin, longitudinal furrows. All prodorsal setae similar to those of *C. foliatus* (Figs. 17, 23-25).

**Notogaster.** Notogastral setae similar in shape to those of *C. foliatus* (Figs. 17, 23, 26, 27). Setae *c₁* and *c₂* as long as *cₚ*, setae *e₁* shorter than other *e* setae. Distance *c₁ - c₂* shorter than distance of setae *c₁ - c₁* and distance *c₇ - c₈* as long as *c₂ - c₈*. Setae *d₁* shorter than *d₇* which shorter than *c₈*. Distance between *d₁ - d₂* is 2.5 times distance *d₁ - d₁*. Long, erectile setae *e* and *f* plumose; dorsally covered with minute cilia; cross-section of setae round. All setae equally thick. Setae *e₁* as long as setae *e₂* whereas *f₁* longer than *f₂*. Lateral, secondary hairs denser at base of setae, shorter distally. Basal barbs of *e₁* and *e₂* 1.5 times longer than diameter of stem whereas barbs of *f₁* and *f₂* about as long as setal diameter. Distance between setae *e₁ - e₁* as long as *e₁ - e₂* and distance between *f₁ - f₁* 1.5 times longer than *f₁ - f₂*. Setae *h₁₃* and *p₁₃* elongate, laterally compressed with long bristles laterally (Fig. 27).

**Ventral side.** Epimeral setal formula I-IV: 3-2-3-4. Genital plate with 10 setae and both anal- and aggenital plates with 4 setae.

**Legs.** Claws (I-IV): 2-3-3-3. The dorsal (*d*) and lateral setae (*l*) strong, but not wide (Fig. 28). Ventral setae (*v*) narrow and pectinate.

**Remarks.** In the description of this species by Grandjean (1962) setae *e₂* are thinner than setae *e₁*, but based on our SEM studies there are no clear difference between them. However, geographical variation in lengths of secondary hairs on erectile setae was evident.

**Diagnosis.** Whole body, including anterior of segment NA, covered with netlike cerotegument. Cerotegument reticulate, especially on pygidium. Foveae of cuticle shallow and polygonal or hexagonal. Cerotegumental collar absent. Cuticle of dorsosejugal scissure wide, with narrow, longitudinal furrows. Notogastral setae: *c₁ - c₂ = cₚ > c₈*, *d₁ < d₂ < c₁*; *e₁ =
**Cosmochthonius lanatus** (Michael, 1885)

Figs. 29-40.

**Hypochthonius lanatus**, Michael, 1885: 396; 1888: 541

**Cosmochthonius lanatus**: Willmann, 1931: 101

**Cosmochthonius domesticus** Grandjean, 1947: 354

**Cosmochthonius lanatus**: Subias, 1982

**Cosmochthonius lanatus**: Ayyildiz & Luxton, 1990

**Description.** (Adult)

**Color:** whitish - yellow

**Material examined.** Cosmochthonius lanatus (Michael, 1885), type material, Michael Collection of British Museum (Natural History, London, UK).

**Cosmochthonius novus** Sergienko, 1991, type material, University of Kiev, Ukraine.

**FINLAND,** Kylämäki, 671:24, litter on floor of barn, 10.4.1992, R. Niemi & V. Rinne, 14 exx ZMT

ITALY, Firenze, Boboli park, *Cupressus litter*, 9.7.1992, Matti Uusitalo leg., c.80 exx ZMT.

**Measurements.** Mean length and width $267 \times 149 \mu m$ ($n = 11$, Finland). Lengths $310 \mu m$ & $330 \mu m$, widths $155 \mu m$ & $165 \mu m$ (type material after AYYILDIZ & LUXTON, 1990). 290-310 $\mu m$ and 155-165 $\mu m$ (after SUBIAS 1982).

**Integument.** Body covered thin, granular, membrane-like cuticle (Fig. 30). Underlying cerotegument clearly visible because of thin cerotegument. Foveae present dorsally and on pleural plates; mainly round or oval and their sizes vary especially on pleural plates (Fig. 39). Single row of foveae on segment $NM_1$ and two rows on $NM_2$ (Figs. 29, 31 & 37). Largest foveae $(6 - 10 \mu m)$ with intercalares $(1.1 - 3.4 \mu m)$ on pygidium.

**Prodorsum.** Rostrum curved ventrally, with 4-5 pairs of longitudinal slots in 3-4 rows (Fig. 34). Prodorsal setae brush-shape, branched or foliate, except posterior setae exp short and pectinate (Fig. 35). Transverse ridge on basal part of prodorsum absent. Dorsosejugal scissure wide with striated cuticle (Fig. 36).

**Notogaster.** Notogastral seta $c$, $d$, $e$ and $f$ simple, not widened. Setae $c$ and $d$ plumose with secondary barbs short (shorter than in *C. reticulatus* or *C. foliatus*) (Fig. 37). Both setae groups ($c$ and $d$) laterally compressed; covered by short cilia dorsally.

Setae $c_1$ as long as $c_2$, $c_3$ and $c_4$. Distance $c_1 - c_2$ as long as $c_1 - c_2$ and shorter than distance $c_2 - c_2$. Setae $c_3$ closer to frontal margin of $NA_1$ than other $c$ setae. Setae $d_1$ shorter than $d_2$, which shorter than $e_1$. Distance between $d_1 - d_2$ 1.5 times distance $d_1 - d_2$.

Erectile setae $e$ and $f$ long, plumose (Figs. 29-31); covered with minute cilia dorsally; cross-section round. All setae equally thick. Lateral hairs denser near base and sparser distally. Basal hairs of $e_1$ and $e_2$ 1.5 times longer than diameter of setae whereas hairs of $f_1$ and $f_2$ about a half of diameter. Setae $e_1$ as long as setae $e_2$. Setae $f_1$ about a half of length of setae $e$ whereas setae $f_2$ about $1/3$ of length of setae $e$. Distance between setae $e_1 - e_2 = e_1 - e_2$, and distance $f_1 - f_2$ 1.5 longer than $f_1 - f_2$. Setae $h_{1,3}$ and $p_{1,3}$ elongate, laterally compressed with long bristles laterally (Fig. 33).
Two symmetrical depressions and one circular depression on posterior pygidium very noticeable (FIG. 33). Foveae (9-10) radially around openings of glands (?) .

**Ventral side.** Formula of epimeral setae I-IV: 3-2-3-4. Genital plate with 10 setae and both anal- and aggenital plate with 4 setae (Figs. 38-39).

**Legs.** Claws (I-IV): 2-3-3-3. Setae d, l and v pectinate, not wide (cf. *C. foliatus* (FIG. 40).

**Remarks.** Grandjean (1950) noticed similarities between the descriptions of *C. lanatus* and the species, *C. domesticus* Grandjean, 1947. Van der Hammen (1952) considered *C. domesticus* Grandjean, 1947 as a synonym of *C. lanatus* whereas Subias (1982) supposed *C. reticulatus* without cerotegument to be *C. lanatus* and *C. domesticus* to be a good species. Later Ayyildiz & Luxton (1990) confirmed *C. domesticus* as a synonym of *C. lanatus*.

**Diagnosis.** Cerotegument granular, membrane-like covering body. Cuticle with round or oval foveae dorsally and on pleural plates. The dorsosejugal scis- the body. Cuticle with round or oval foveae dorsally and on pleural plates. The dorsosejugal scis-

**Synonymy.** Sergienko (1991) described the species *Cosmochthonius novus* from Ukraine. Our investigation of the type material showed this species to be *C. lanatus* and this was confirmed by SEM examination of the paratype (see FIG. 32). Therefore we consider *Cosmochthonius novus* Sergienko, 1991 as junior synonym of *Cosmochthonius lanatus* (Michael, 1885).

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