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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)

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(Accepted november 2005)

**COSMOCHTHONIUS**, COSMOCHTHONIIDAE, TAXONOMY, SYNONYMY, MEDITERRANEAN REGION, CEROTEGUMENT, INTEGUMENT

**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*.


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, Ayvildiz & 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-
argument 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 × 165-165 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 notogastral, 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 over dorsosejugal scissure. Cuticle 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 widen. 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 c3, but shorter than c2, setae c2 as long as c p1. 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, cerotegumental 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 (certegument 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_3; _d_1 = _c_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 Ziera 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., 2 exx [ACA.ORI.PAL 0.081]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). Length: 300-340 µm (GRANDJEAN, 1947).

Integument. Body covered by thick, reticulate 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 distinct 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 c3 shorter than other c setae. Distance c1 - c2 shorter than distance of setae c1 - c1 and distance c1 - c2 as long as c2 - c3. Setae d1 shorter than setae d2 which shorter than c3. 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 h1,3 and p1,3 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 = c3, d1 < d2 < c1; e1 =
\[ e_2 \text{ and } f_1 > f_2. \] Setae \( d \) and \( l \) of legs strong, not wide.

**Synonymy.** Sergienko (1991) has described the species *Cosmochthonius trivialis* from Ukraine. The investigation of the type material showed that the species has the same characters as *C. reticulatus*. SEM examination of a paratype specimen also confirmed that characters are identical (Figs. 20). Therefore we considered *Cosmochthonius trivialis* Sergienko, 1991 a junior synonym of *Cosmochthonius reticulatus* Grandjean, 1947.

*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.


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

**Measurements.** Mean length and width 267 × 149 \( \mu \text{m} \) (n = 11, Finland). Lengths 310 \( \mu \text{m} \) & 330 \( \mu \text{m} \), widths 155 \( \mu \text{m} \) & 165 \( \mu \text{m} \) (type material after Ayyildiz & Luxton, 1990). 290-310 \( \mu \text{m} \) and 155-165 \( \mu \text{m} \) (after Subias 1982).

**Integument.** Body covered thin, granular, membrane-like cerotegument (Fig. 30). Underlying cuticle with foveae 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 \( \text{NM}_1 \) and two rows on \( \text{NM}_2 \) (Figs. 29, 31 & 37). Largest foveae (6 - 10 \( \mu \text{m} \)) with interscalares (1.1 - 3.4 \( \mu \text{m} \)) 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 \( \text{exp} \) 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 widen. Setae \( c \) and \( d \) plumose with secondary barbs short (shorter than in *C. reticulatus* or *C. folia tus*) (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 \( c_1 - c_1 \) as long as \( c_1 - c_2 \) and shorter than distance \( c_2 - c_2 \). Setae \( c_2 \) closer to frontal margin of \( \text{NA}_1 \) than other \( c \) setae. Setae \( d_1 \) shorter than \( d_2 \), which shorter than \( c_1 \). Distance between \( d_1 - d_2 \) 1.5 times distance \( d_1 - d_1 \).

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 \( f_j \) about a half of length of setae \( e \) whereas setae \( f_2 \) about \( 1/3 \) of length of setae \( e \). Distance between setae \( e_1 - e_1 = e_2 - e_2 \), and distance \( f_2 - f_2 \) 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 semicircular 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).


**Diagnosis.** Cerotegument granular, membrane-like covering body. Cuticle with round or oval foveae dorsally and on pleural plates. The dorsosejugal scisc covering body. Cuticle with round or oval foveae as a synonym of C. foliatus (Fig. 40).

**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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