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NOTULAE ORIBATOLOGICAE XLVI.

STEGANACARUS (TROPACARUS) CARINATUS (C. L. KOCH, 1841)
AND TWO NEW MEDITERRANEAN TROPACARUS SPECIES
(ACARIDA, ORIBATIDA) ¹

BY F. BERNINI and A. M. AVANZATI ²

ACARIDA
ORIBATIDA
STEGANACARUS
TROPACARUS
SOIL MITES
TAXONOMIC REVISION
MEDITERRANEAN FAUNA

ABSTRACT : This paper redescribes a classical species, Steganacarus (Tropacarus) carinatus (C. L. Koch, 1841), describes two new closely related North Mediterranean species, S. (T.) pseudocarinatus and S. (T.) balcanicus, and discusses their systematic relationships. Biogeographical and ecological notes are given for all three species.

RÉSUMÉ : Dans ce travail on redécrit une espèce classique, Steganacarus (Tropacarus) carinatus (C. L. Koch, 1841) et on décrit deux espèces nouvelles très voisines systématiquement, S. (T.) pseudocarinatus et S. (T.) balcanicus. Les Auteurs présentent des données écologiques et biogéographiques aussi et discutent la valeur taxonomique de quelques caractères diagnostiques.

INTRODUCTION

« Pour vérifier l’identité des espèces d’un ancien auteur, il est nécessaire de se procurer des exemplaires de la même localité et des mêmes habitats ou biotopes. Cette méthode me paraît fondamentale ». Unfortunately this simple concept expressed by Jacot (1936) has not always been taken into due consideration. For this reason many classical taxa are often confused and remain undeterminable and unavailable for ecological and biogeographical research. Sometimes vague morphological knowledge of them also creates confusion and uncertainty among supraspecific taxa or worse, false certainty. Steganacarus (Tropacarus) carinatus (C. L. Koch, 1841) is a rather common widespread species in

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Europe and Siberia (Balogh & Mahunka, 1983). It is easily identified by its continuous median aspal and notogastral ridges although other similar taxa have recently been described. Its systematic position is nevertheless debated (Bernini & Avanzati, 1986) because Tropacarus, the genus of which S. (T.) carinatus is the typus-generis (Ewing, 1917), has recently been merged with the genus Stegana­carus (Balogh, 1972; Balogh & Mahunka, 1983; Niedbala, 1986a, b) due to the inconsistency of the available diagnostic characters. Other authors (Parry, 1978; Bernini & Avanzati, 1986; Ber­nini et al., 1988a) maintain that the taxon Tropaca­rus, at least as a subgenus, should to be considered real by virtue of its morphological and above all biogeographic characters.

We shall adopt the latter position for the purpose of this series of studies dedicated to the solution of certain taxonomic problems of the Steganacaridae. The revision of classic and/or taxonomically crucial taxa (Bernini & Avanzati, 1986, 1988), the discovery and the study of other diagnostic characters (Bernini et al., 1988a) and the utilisation of the techniques of biochemical systematics (Bernini & Avanzati, 1987; Bernini et al., 1988b) are some of the measures proposed.

In the present paper we give a morphological redescription of Hoplophora carinata C. L. Koch on the basis of topotypic material from Regensburg using SEM analysis to check the conventional and some new diagnostic characters. The study of other western European and eastern Mediterranean popu­lations of this taxon then allowed us to define its geographic distribution and describe two interesting closely related species previously assigned to it.

The neotypus, the holotypi and some paratypi are kept in Bernini’s Collection at Siena. Other paratypi are preserved in Travè’s Collection at Banyuls-sur-Mer.

**STEGANACARUS (TROPACARUS) CARINATUS (C. L. Koch)**

neotypus here designated ।


*Hoploderma carinatum*, Michael, 1898, Das Tierreich, 3 : 79.


*Tropacarus carinatus*, Krivolutsky, 1975, In : Sarcoptiphormes, Ghilarov & Krivolutsky, 373, fig. 939.


**Diagnosis.**

Body microsculpture with high stellate tubercles and deep areolae. Aspal median ridge flanked by keels on both sides in the median third. Another long thin line runs laterally from the bothridium (I.1.). Short ciliate in and le setae (le 1/3 shorter than in); long slender sensillus. Evident anteromedian notogastral protuberance from which three (two antero-lateral and one median) expanded keels arise. Median keel interrupted at the p1 setal insertion. 15 pairs of rather short flagelliform notogastral setae; c1 setae inserted on the antero-lateral notogastral keel near the border. 2 pairs of notogastral lyrifissures (ia and im). 9 pairs of short subequal genital setae arranged in 5 + 4 pattern. Short subequal ano-adanal (x1-x4) setae not perfectly aligned.
REDESCRIPTION OF THE ADULT

For this redescription we utilized specimens collected in the locus typicus (topotypi) from Regensburg (Bavaria, Western Germany) and others from Italian localities. As the typical series is considered to be lost, we chose a neotypus among the topotypi from locality n° 7 in the list of collection sites in the paragraph "Material examined". It is kept in BERNINI's Collection in the Department of Evolutionary Biology of the University of Siena.

Measurements. The mean sizes found in 10 randomly chosen specimens are as follows:

Aspis, length 304.0 µm; width 228.5 µm; height 146.5 µm.
Notogaster, length 681.0 µm; width 421.0 µm; height 411.5 µm.

The dimensions of the neotypus are:

Aspis, length 335 µm; width 225 µm; height 160 µm.
Notogaster, length 700 µm; width 495 µm; height 475 µm.

The measurements were effected on open specimens before lactic acid treatment.

Colour. Brownish according to the age of the individuals.

Cerotegument. The whole body surface is covered with an evident waxy layer, the thickness of which varies from area to areas (Figs. 4, 8, 9, 11).

Cuticle. Most of the notogastral microsculpture can be defined as stellate-areolate (Figs. 1, 3, 4). The basilar type is constituted by deep areolae covering the whole surface and having borders which are confluent into more or less prominent, closely packed, star-shaped tubercles (Figs. 1, 3, 4, 8). On the anterior notogastral protuberance (Fig. 3) the surface is simply areolate as in the posterior, anterior and marginal notogastral regions (Figs. 2, 4) while on the centro-lateral dorsal areas the star-shaped tubercles are easily visible. Near the fin-shaped antero-lateral notogastral keels the tubercles are confluent to form parallel ridges (Figs. 4, 7). The surface of the notogastral keels is smooth, slightly areolate or punctate (Figs. 1, 4).

On the whole aspal surface and the ventral plates the microsculpture is clearly and exclusively areolate (Figs. 2, 9, 10, 11). However, beyond the lateral line (carène latérale of NIEDBAŁA, 1986a and here indicated as l.l.) the surface is quite smooth (Figs. 1, 14).

Sometimes, on the above-mentioned cuticular microsculpture a slight punctuation overlaps (Figs. 2, 7). In some parts of the leg surface slight dots are evident (Fig. 21).

Aspis. The rostral margin is roundish. Starting at a certain distance between the ro setal insertions and those of the in setae, a high and strong keel runs medially along the aspis and is flanked on both sides by two less prominent keels (Figs. 1, 2, 14). The median keel occupies the central third of the length of the aspis. In the lateral view, the aspal outline is triangular with a very steep frontal slope (Figs. 1, 2, 14). Behind the in-le setal insertions, marked by a deep transverse furrow, there are the usual longitudinal ridges which occupy the posterior third of the aspis (Figs. 2, 14). From the bothridium a thin lateral line (l.l.) runs forwards and downwards, attenuating near the lateral rim (Fig. 1).

The ro setae are relatively short and slightly ciliate like the le and in setae (Figs. 14, 16). The relative length of the le the in setae is less than 1/3-1/2. The ex setae are long, slender and apparently smooth (Fig. 14). The sensillus is long, thin, slender and cranked near the base; the head has the same thickness as the stem and carries a lateral longitudinal membrane indistinguishable by SEM analysis (Figs. 1, 2, 14, 15). The bothridial opening is encircled by a thickened border; as usual, from the bottom of the bothridium three long convoluted brachytracheae open (Fig. 15). In this species too, when the animal withdraws sensillar function seems maintained by the peculiar morphological adaptation of the channel (which we shall call sensillar channel) delimited by the sensillar notch (JACOT, 1930) and the bothridial scale (Fig. 2).

Notogaster. The antero-median notogastral border (the collar 3, sensu JACOT, 1930) always bears a protuberance (Figs. 1, 3, 13). From this structure three high strong keels arise: a high thin transparent median keel which when observed laterally 3. This term has been adopted in a different sense by VAN DER HAMMEN (1980) for the "collet", that is, the point of the epicuticular attachment to the setae. The old meaning seems to us particularly inappropriate for Tropacarus which has such a prominent anterior tectal border. Therefore these terms will not be used a all.
FIGS. 1-4: Steganacarus (Tropacarus) carinatus (Koch).

4. — Lateral view of the antero-inferior notogastral region (× 300).
Figs. 5-11: Steganacarus (Tropacarus) carinatus (Koch).

FIGS. 12-18: Steguncaratus (Troparcus) carinatus (Koch).

is continuous to the level of the \( p \) setal insertions (Figs. 1, 3, 4, 13). The other two more massive keels run along the antero-lateral notogastral margins as far as the genital plates (Figs. 4, 13) and are fin-shaped when viewed dorsally.

The 15 pairs of relatively short slender apically flagellate notogastral setae (Figs. 4, 5, 6) are disposed as illustrated in Fig. 13. In particular the \( c_3 \) pair is inserted on the internal slope of the lateral keel at the level of the sensillar notch.

The lyrifissures \( ia \) and \( im \) and the insertions of the \( f_1 \) and \( f_2 \) vestigial setae are readily visible (Fig. 13).

**Ventral region.** The epimeral formula is as follows: 1-0-1-1; these setae are slender, slightly ciliate and very long (Fig. 19). The genito-aggenital plates bear 1 pair of aggenital setae located in the antiaxial corner of the genital furrow and 9 pairs of genital setae (Fig. 13). These are situated in two rows of 5 and 4 pairs both close to the inner margin of the genito-aggenital plates. The \( g_{6-9} \) row is slightly divergent and more antiaxial than \( g_{7-8} \) (Fig. 12); all these setae are short, slightly barbed and subequal in length (Fig. 10). On the ano-adanal plates there are 5 pairs of setae, the most anterior of which, the \( ad \) pair, is submarginal whereas the other four \( (x_1-x_4) \) are aligned in a row close to the inner side of the ano-adanal plates (Figs. 9, 11). The second pair of this row, \( x_2 \), and sometimes also the last, \( x_4 \), are slightly displaced from perfect alignment (Figs. 17, 18). All these setae, \( ad \) included, are similar both in length and morphology.

Genital papillae are present with the usual phtihiracarid characteristics.

**Gnathosoma.** The infracapitulum bears the usual three long smooth slender pairs of setae. On the lateral lips three pairs of adoral setae are inserted, the first of which \( (or_1) \) is brush-like (Figs. 19, 20). The palpal formula is as follows: 2-2-7(1); the solenidium \( (o) \) (in parentheses) on the tarsus is long whereas the eupathidial seta \( (sul) \) is short and spine-like (Fig. 30).

The chelicerae also show the usual characters proper to the family. The cheliceral setae \( (cha \) and \( chb) \) have the same morphology, being similarly ciliate and thick.

**Legs.** The first pair of legs is generally more robust than the others. All the legs are monodactylous and the claws bear one or two ventral teeth. The chaetotactic formulae (famulus comprised and solenidia in parentheses) are as follows:

I) 1-4-2(2)-5(1)-17(3)-1 ;
II) 1-3-2(1)-3(1)-12(2)-1 ;
III) 2-2-1(1)-2(1)-10 -1 ;
IV) 2-1-1 -2(1)-10 -1.

The solenidia are generally long, apically coiled (Fig. 27) and coupled with setae according to the *Steganacarus* scheme (Bernini & Avanzati, 1988) (Figs. 22-29). The famulus on tarsus I shows an annulate surface (Fig. 21); the tarsal setae \( (ic) \) and \( (u) \) (and \( p \) on leg IV) are apically coiled but they do not appear so ribbon-like in other congeneric species (Figs. 27, 29).

**Prelarva.** The characters of this stasis have already been illustrated (Bernini, 1971; Lions, 1973) and they are not different from those proper to the family.

**Variations.** As usual many characters show a certain variability between the several populations and also in the same population.

The main variation concerns the thickness and evidence of the aspal and notogastral keels and the heaviness of the body microsculpture, both very massive in some of the older specimens. The sensillus also varies in thickness and apical point in the several examined specimens.

Another variable character is that of the notogastral setae. Sometimes they show slight heterotrichy: the dorsal setae are erect but the lateral ones are procumbent. Nevertheless deviations are so numerous than this cannot be considered the rule. The length and the morphology of the notogastral setae are also rather variable because of the fragility of the apical flagelliform portion, which is often missing (Figs. 5, 6). This is perhaps the reason for the attribute "apically straight" given them by Balogh and Mahunka (1983).

The notogastral lyrifissures and the insertions of the vestigial \( f_1 \) and particularly \( f_2 \) setae also show some slight displacements within the same population.

In the ano-adanal plates, the four setae that in the family are usually arranged in the row \( x_1-x_4 \)
FIGS. 19-26: *Steganacarus* (*Tropacarus*) *carinatus* (Koch).

Figs. 27-30: Steguncarus (Tropacarus) carinatus (Koch).


Corrigenda: Fig 27. — At the level of genual, near d and l'' setae, solenidia may be read σ₁ and σ₂ instead of φ₁ and φ₂.
show slight deviations, especially the second and fourth (Figs. 17, 18).

None of the above-mentioned variations seems to have taxonomic importance.

The anterior notogastral tectum also shows a certain variation in the size of the protuberance containing specimens of Steganacarus (Tropacarus) carinatus even though labelled otherwise:

15/48 — musco, Padovano, Belluno, in potassa (sub Hoplodromca c.) (1); 22/35 — idem (3); 48/22 — piccoli, Vallombrosa (sub Hoplodromca c.) (1); 39/20 — Vallombrosa (sub Phthiricarus c.) (2); 26/1256 — Idem, 1916 (sub Hoplodromca c.) (5); 5/233 — Belluno (sub Hoplophora c.) (1); 5/234 — Montecchia, Padova (sub Hoplophora c.) (15); 45/2236 — Tiarno (sub Phthiricarus c.) (6); 45/2237 Castions di Strada, Udine (sub Phthiracarus c.); 45/2238-39 — Vallombrosa (sub Phthiracarus c.) (all the specimens contained in these two vials are pasted with a white substance and impossible to study).

The study of slides in MICHAELE’S Collection in the British Museum (Natural History) of London revealed that the Algerian specimens labelled Hoplodromca carinatum truly belong to a new entity (BERNINI et al., 1988a).

Geographic distribution

Although this species is recorded in the whole Europe and Siberia (BALOGH & MAHUNKA, 1983), it seems to have a more limited geographic distribution. In fact Steganacarus (T.) carinatus (C. L. Koch) has been reported in Northern Europe: Norway, Finland, Lithuania, Latvia, Byelorussia and Estonia (KARPPINEN & KIIVOLTTISKI, 1982) and in this paper from Sweden. It may be found in some central European countries: Poland (RAJSKI, 1967), Germany (WEIGMANN & KRATZ, 1981), Hungary (BALOGH & MAHUNKA, 1980), Czechoslovakia (KUNTZ, 1971), Rumania (FEIDER et al., 1969), Austria (SCHATZ, 1983), South European Soviet Republics (KARPPINEN et al., 1986; 1987) Bulgaria (CSISzar & JELeva, 1962), Greece (MAHUNKA, 1979), Yugoslavia (TARMAN, 1983) and Italy (ZANGHERI, 1966; BERNINI, 1970; NANNELLI, 1980). This species is also reported in Mediterranean France (LIONS, 1972) and Spain (MIHLEVČIČ, 1957) but these citations belong to a new entity to be described in the following pages.

The extra European countries in which S. (T.) carinatus has been cited are Siberia, both in the western part and the Soviet Far East (GOLOSOVA et al., 1983) and North Africa (Algiers) (MICHAEL, 1890). Nevertheless the latter citations refer to

Material examined

1) Ryygmsøsen Mire (Sweden) : bog and conifer wood, 23.5.1964 (1) (Coll. P. N. LAWRENCE) (Det. J. G. SHEALS).

2) Kelheim, Regensburg (Bavaria, West-Germany) : humus and moss on the ground in Picea excelsa wood; 20.8.1974 (4).


9) Jihlava (Czechoslovakia) : humus under Pinus excelsa wood (Coll. R. DALLAI); 27.9.1973 (20).

10) Pelos di Cadore (BL) : humus near the Piova stream, 800 m (Coll. L. CASTAGNOLI); 22.8.1971 (2).

11) Conighe (BL) : humus under Robinia pseudoacacia (Coll. A. DEL POGGLIA); 27.8.1971 (4).

5) Ibidem : moss near the Piova stream, 800 m (Coll. G. NEAN). The extra European countries in which this species is recorded are Poland (RAJSKI, 1967), Germany (WEIGMANN & KRATZ, 1981), Hungary (BALOGH & MAHUNKA, 1980), Czechoslovakia (KUNTZ, 1971), Rumania (FEIDER et al., 1969), Austria (SCHATZ, 1983), South European Soviet Republics (KARPPINEN et al., 1986; 1987) Bulgaria (CSISzar & JELeva, 1962), Greece (MAHUNKA, 1979), Yugoslavia (TARMAN, 1983) and Italy (ZANGHERI, 1966; BERNINI, 1970; NANNELLI, 1980). This species is also reported in Mediterranean France (LIONS, 1972) and Spain (MIHLEVČIČ, 1957) but these citations belong to a new entity to be described in the following pages.

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11) Conighe (BL) : humus under Robinia pseudoacacia (Coll. A. DEL POGGLIA); 27.8.1971 (4).

12) P. so SanBoldo (TV) : humus under Fagus silvatica, 700 m (Coll. A. M. AVANZATI); 20.3.1986 (452).

13) Fadalto (TV) : humus, 850 m (Coll. A. MNELLI); 12.10.1972 (7).

14) Bosco di Rezzo, Ligurian Alps : mixed humus under Castanea sativa and Fagus silvatica, 600 m (Coll. P. P. FANCILLI); 16.4.1985 (56).

15) Marinì’s Refuge, Madonie (Sicily), 1700 m (Coll. A. VALLE & BIANCHI); 1.6.1963 (1).

With the aim of adding other Italian collection sites we re-examined the following old preparations and vials in Berlise’s Collection at the Istituto Sperimentale per la Zoologia Agraria in Florence

4. Following the collection sites, we have registered in brackets the number of specimens examined. When not otherwise indicated the specimens was collected by F. BERNINI and are preserved in his Collection (Siena).
another unpublished *Tropacarus* species (Bernini et al., 1988a). *S. (T.) carinatus* therefore seems to be absent from the whole of western Europe.

Analysis of the above-mentioned collection sites emphasizes the prevalently central European distribution of this taxon; the sightings in Sweden and Sicily are so scarce and localized as to be biogeographically almost insignificant. In the absence of other specimens in the more suitable neighbouring environments, the latter might be the result of long-distance passive dispersal.

**Ecology and biology**

*Steganacarus (Tropacarus) carinatus* is believed to be a xerophilous form and a typical, particularly pine, forest species (Rajski, 1967). However Nannelli (1980) has experimentally found that *S. (T.) carinatus* has a clear preference for deciduous (*Quercus cerris*) rather than pine (*Pinus nigra*) woods. As for the ecological information given by Lions (1972), we should not neglect the possibility that *Tropacarus carinatus* sensu Lions may be a mixture of the true *carinatus* and the new species which we are about to describe.

In spite of its generally held xeric preference, it must stressed that this species does not seem to be a southern element but rather a mesophile. In fact, besides the considerations expressed in the preceding paragraph, the collection sites in Italy are all above 800-1 000 m.

**Remarks and comparative discussion**

The redescription of *Steganacarus (Tropacarus) carinatus* (C. L. Koch) clarifies some possible diagnostic characters which may be used to further characterize the entities with aspal and notogastral median keels.

The body microsculpture is always very evident and characterized by stellate tubercles (and interposed deep areolae) on the central notogaster and deep areolae on the marginal notogaster, aspis and ventral plates. The ridges are strong and always evident but their pattern on aspis and notogaster is more complex and peculiar than hitherto described.

Aspal morphology is characterized by a high robust sagittal keel flanked on each side by another less massive keel which circumscribes two centro-lateral relatively weakly-sclerotized areas, the internal side of which corresponds to the position of the retracted chelicerae. Behind this system of ridges and in front of the in-le insertions, there is the peculiar presence of a deep furrow.

The notogaster has a median keel, but the two lateral fin-shaped ridges arising from the median anterior protuberance and running laterally alongside it as far as the genital plates, are even more conspicuous and characteristic.

Not only the protuberance and ridges but the whole anterior notogastral border in *Tropacarus* and the steganacarid mites is more complicated and rich in diagnostic characters than in *Phthiracarus*.

Also the notch in the antero-lateral notogastral border is peculiar.

The aspal and notogastral setae are short and slender, the former ciliate, and the latter smooth or rugose.

The ano-adanal setae have the usual pattern and are all equally short and rugose. The variability of the insertion of the second and fourth pairs of setae x₁-x₄ seems to suggest that these organs are not yet well fixed and they are presumably the ad₂ and ad₄ setae respectively settled in a single row together with the an₁ and an₄. In our opinion in this species the notation x₁-x₄ introduced by Grandjean (1933) for *Atropacarus (A.) striculus* (C. L. Koch) can be abandoned in favour of the usual phthiracarid idionymic notation ad₁₃an₁₂.

*Steganacarus (Tropacarus) carinatus* (C. L. Koch) appears to be strictly related to a new species the description of which will be given below. The classical species, *S. (T.) pulcherrimus* (Berlese), is also close to Koch's entity and seems to be differentiated mainly by a very distinct anterior notogastral hump. The analysis of the relationships between the two classical taxa will be the subject of the future paper (Bernini & Avanzati, in preparation).

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5. When this manuscript was in the press, the paper relative to the relationships between the two classical taxa was published. (Bernini (F.) and Avanzati (A. M.), 1988. Notulae Oribatologicae XLVII. Intraspecific variability in *Tropacarus*: the example of *Steganacarus (Tropacarus) pulcherrimus* (Berlese, 1887) junior synonym of *S. (T.) carinatus* (Koch, 1841) (Acarida, Oribatida). — Intern. J. Acarol., 14: 107-114).
STEGANACARUS (TROPACARUS) PSEUDOCARINATUS N. SP.

Diagnosis

Areolate-reticulate body microsculpture; short slender ciliate in setae; very short ciliate spine-like le setae; I.I. evident and complete. Aspal and notogastral keels present but lighter, C3 notogastral setae inserted at a distance from the antero-lateral border. 15 pairs of thin slender procumbent and relatively long notogastral setae.

Other characteristics as in Steganacarus (Tropa-carus) carinatus (C. L. Koch, 1841).

DESCRIPTION OF THE ADULT

Only the diagnostic characters will be illustrated as the new taxon is closely related to S. (T.) carinatus (C. L. Koch).

Measurements. The mean average size (from 10 randomly chosen specimens) is:

Aspis: length 312.5 μm; width 228.01 μm; height 168.1 μm.
Notogaster: length 655.0 μm; width 410.5 μm; height 383.5 μm.

The dimensions of the holotypos are:

Aspis: length 290 μm; width 210 μm; height 150 μm.
Notogaster: length 640 μm; width 400 μm; height 370 μm.

Colour. Pale brown.

Cerotegument and cuticle. As usual the body surface is covered with a continuous waxy laminar layer of cerotegument (Figs. 38, 40, 41). The cuticle is generally areolate and the well delimited areolae join up to form a network (Figs. 31, 33, 38, 40, 42, 44). In some cases the borders of the areolae are confluent in prominent tubercles as in carinatus (Figs. 39, 41) but they are not so elevated and “stellate” as in the preceding species.

Aspis. The pattern of the median and lateral aspal keels as well as the other aspal characters are similar to those of carinatus (Figs. 33, 37, 47, 49). The longer in setae are slender and slightly ciliate whereas the very short le setae are barbed and spine-like (Figs. 32, 34).

Notogaster. The 15 pairs of setae are all relatively long, slender, smooth and procumbent (Figs. 31, 38, 39, 41, 48). The C3 setae are inserted in the same line as the C2 pair, that is, they are displaced posteriorly with respect to the pattern of carinatus (Figs. 38, 48).

Ventral region and gnathosoma. The two species have similar characteristics in these areas (Figs. 42-44, 50).

Legs. The chaetotactic and solenidial formulae are similar in the two species, however SEM analysis reveals some minute differences in the morphology of the coupled setae at tibia II and III (Figs. 35, 36).

Variations. The variations concern the same characters as in the preceding species: in particular, the antero-notogastral protuberance, the notogastral keels and the dorsal stellate tubercles are more prominent in the Greek specimens (Vassilina and Crete). These specimens are also characterized by a slender sensillus and longer le aspal setae. In one we found the symmetrical absence of the g6 genital seta belonging to the series g6-89· Despite these and other differential characters, for the time being we have defined these specimens as pseudocarinatus. Also the ano-adanal setae x3 and x4 are displaced from the row which runs along the inner margin of the ano-adanal plates.

Material examined

1) Colle di Scala, Pollino Massif (Calabria): humus under Quercus ilex, 1 100 m; 14.10.1977 (31).
2) Oltre Civita, Pollino Massif (Calabria): humus under Quercus ilex, 1 000 m; 30.7.1982 (324).
3) Alongside the road Barcelona-Zaragoza (Spain): humus, litter and moss on the ground in a pine wood, 1 000 m (Coll. R. COVARRUBIAS); 27.12.1967, (1). In TRAVE’S Collection, Banyuls-sur-Mer.
4) Mt. Aureliens (Provence, France): humus under Quercus ilex and Q. pubescens, 600 m; 24.5.1975 (38).
5) Le Baron (Aix-en-Provence, France): humus and
FIGS. 31-38: *Steganacarus (Tropacarus) pseudocarinatus* n. sp.

Figs. 39-44: *Steganacarus (Tropacarus) pseudocarinatus* n. sp.

39. — Notogastral microsculpture (× 1 000). 40. — The same, more lateral (× 1 000). 41. — Notogastral seta (× 2 000). 42. — Anterior portion of the genito-agenital plates (× 300). 43. — The same, enlarged (× 2 000). 44. — Pattern of the ano-adanal setae (× 1 500).

Figs. 45-46: *Steganacarus (Tropacarus) balcanicus* n. sp.

45. — Microsculpture of the latero-inferior notogaster (× 1 050). 46. — Lateral notogastral seta (× 1 930).
Figs. 47-50: *Steganacarus (Tropacarus) pseudocarinatus* n. sp.

47. — Detail of the bothridium and sensillus. 48. — Lateral view of the notogaster and ventral plates. 49. — Lateral view of the aspis. 50. — Schematic pattern of the ano-adanal setae.

Figs. 51-54: *Steganacarus (Tropacarus) balcanicus* n. sp.

51. — Aspis, lateral. 52. — Lateral view of the notogaster and ventral plates. 53. — Schematic pattern of the genital setae. 54. — Schematic pattern of the ano-adanal setae.
wood litter; 11.3.1963 (1). In TRAVÈ’s Collection, Banyuls-sur-Mer.

6) Hanbury Garden (Ventimiglia) : humus and litter under Quercus ilex and ivy; 12.5.1980 (6).

7) S. Martino (Corsica) : moss on the ground and humus under Quercus ilex; 8.4.1970 (16).

8) Francardo (Corsica) : humus and litter under Quercus ilex; 24.6.1977 (11).

9) Tertenia (Sardinia) : humus under Quercus ilex; 4.4.1979 (32).

10) Ulassai (Sardinia) : moss on the ground and stones, and meadows; 4.4.1978 (10).

11) Vassilina (Evvoia Island, Greece) : mousses sur rochers humides au bord de la mer; (Coll. J. TRAVÈ); 1.11.1968 (2). In TRAVÈ’s Collection, Banyuls-sur-Mer.


We have chosen as holotypus a specimen from locality n° 1.

Geographic distribution

The new species seems to occur over a large geographic area : a Mediterranean band stretching from Catalonia to Crete through Provence, western Liguria, Corsardina and the southernmost region of the Italian peninsula. On the contrary this taxon has never been collected in North Africa or in the rest of the Italian peninsula or continental France. This disjunct geographic distribution suggests the antiquity of the settlement of S. (T.) pseudocarinatus, according to modern palaeotectonic reconstruction. A connection between Mediterranean Spain and the southernmost balkanic regions such as Crete, is considered to have been possible in the Middle Miocene (late Langhian, 15 Myr ago) (AZZAROLI, 1981), when a festoon of islands (Balearics, Corsardina etc.) and the Alpine arc (then isolated from continental Europe by the perialpine furrow) presumably formed a terrestrial migration route. If this hypothesis is correct, this species could have disappeared from the present-day remains of the alpine arc during the Plio-Pleistocenic climatic deterioration. The absence of this species from North-Africa (Kabylias) however requires explanation. Perhaps it had competition from other Tropacarus species (BERNINI et al., 1988a; NIEDBAŁA, 1986c) or gave origin to one or more north African species.

Alternatively the present disjunct distribution can be explained by Messinian land connections opened during Mediterranean desiccation; however this hypothesis seems more problematical because of the absence of this species from other suitable Mediterranean territories such as Tuscany and the remaining Italian peninsula and so on.

Biology and ecology

Analysis of the available data indicates that like its congenerics the new entity is a forest element and prefers soils rich in organic substance.

Comparative discussion

The new species is closely related to S. (T.) carinatus but is differentiated from the classical species by : c3 notogastral setae displaced from the antero-lateral notogastral margin, the different morphology of the other notogastral setae (slender, procumbent and longer) and a generally lighter cuticular microsculpture (aspal and notogastral keels included).

Other lesser differences concern the laterally roundish aspal outline and the dimensional reduction of the le aspal setae with respect to the in.

STEGANACARUS (TROPACARUS) BALCANICUS N. SP.

Diagnosis

Areolate-stellate body microsculpture; short rugose in and le setae (le half the length of in); lateral line evident in the first portion, then interrupted; 15 thick erect barbed notogastral setae; c₁ inserted at a distance from the antero-median notogastral border; c₃ not inserted on the slope of the antero-lateral notogastral border.

Other characteristic as in S. (T.) carinatus.
DESCRIPTION OF THE ADULT

Only the diagnostic characters will be illustrated as the new taxon is closely related to the previously described species.

Measurements. The mean average size (from the examined specimens) is:

Aspis: length 362.5 μm; width 251.2 μm; height 175.0 μm.
Notogaster: length 718.7 μm; width 476.2 μm; height 421.2 μm.

The dimensions of the holotypus (a male) are:

Aspis: length 237 μm; width 250 μm; height 187 μm.
Notogaster: length 662 μm; width 400 μm; height 412 μm.

The body morphology is peculiar in the elongated outline and the dorsal flattening of the notogaster. The ventral plates are convex (Fig. 52).

Colour. Pale brown.

Cerotegument and cuticle. The whole body surface is covered with a waxy layer of cerotegument (Figs. 45, 46). The cuticle is generally areolate-reticulate (Figs. 45, 52); only in the dorsal and posterior notogastral regions are the confluent margins of the high stellate areolae (Figs. 46, 52).

Aspis. The pattern of the aspal ridges is similar to that proper to carinatus. Only the lateral line (L.I.) is different: it is evident only in the first portion, then its is interrupted and finally re-appears very faintly (Fig. 51). The slender barbed in setae are twice the length of the le setae.

Notogaster. The 15 pairs of setae are generally thick, erect and barbed (Figs. 46, 52). The c1 and c3 setae are inserted more posteriorly with respect to the pattern of carinatus (Fig. 52). The ia lyrifissures are anteriorly placed with respect to the cp setae.

Ventral region and gnathosoma. The characteristics of these regions are similar to those of the two preceding species. The only exception is the greater distance between ad and the anteriormost setae of the ano-adanal row (Figs. 53, 54).

Legs. The morphology and chaetotaxy of the legs are the same as in the congeneric species.

Variation. Despite the different pattern of the ano-adanal setae and the small number of specimens examined, also in this case the x3 and x4 setae show a slight variation in their point of insertion.

Material examined

To date, this new species has been found only in the following locality:

1) Mt. Ossa (Greece): litière au sol et humus, about 1000 m (Coll. J. TRAVÉ); 6.11.1968 (6). In TRAVÉ's Collection, Banyuls-sur-Mer.

Comparative discussion

S. (T.) balcanicus can be included in the Tropacarus species closely related to S. (T.) carinatus (BERNINI et al., 1988a). It is, however, well characterized by: the thick erect barbed notogastral setae, the different insertion of the c1 and c3 notogastral setae, the pattern of the ano-adanal setae and other minor elements (the relative length of the le setae, the short interrupted aspal lateral line, the ia lyrifissure placed anteriorly to the cp setae etc.).

GENERAL REMARKS

The study performed on the several European populations produced two results. The first is the clarification of the diagnostic characters of the classic entity, Steganacarus (Tropacarus) carinatus (C. L. Koch, 1841). The second is immediately consequent and consists of the determination of two other closely related new species, S. (T.) pseudocarinatus and S. (T.) balcanicus. These new species increase the number of taxa to be included in the carinatus group (BERNINI et al., 1988a) which are characterized by relatively short aspal, notogastral and ano-adanal setae, and by the presence of massive fin-shaped antero-lateral notogastral keels. Another constant element of this species-group is the slight displacement exhibited by the x3 and x4 ano-adanal setae. This variability in our opinion justifies the utilization of the usual idionymic notation proper to Phthiracarus and suggest the early derivative position of this species-group with respect to the more evolved Steganacarus (s. str.) and Atropacarus where the alignment of the two posterior adanal setae and the two anal setae has become perfect.
The pattern of the genital setae also requires comment; in all the three examined species it is 5 + 4 where $g_3$ is anteriorly inserted with respect to $g_5$. The *Tropacarus* species are therefore similar to *Steganacarus* (s. str.) with regard to this character, in spite of the indication of characters for the *Tropacarus* species groups, such as the system of aspal and notogastral ridges and the length of the body setae (Bernini et al., 1988a).

On the contrary, other characters such as cuticular microsculpture and the size of the antero-notogastral tectum require further research before their effective taxonomic value can be determined. This analysis will be the subject of a future paper.

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