Rediscovery of the genus *Pseudotydeus* (Acari: Tydeoidea), with description of the adult using digital imaging

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This paper describes the adult female of the genus *Pseudotydeus* Baker & Delfinado 1974 and confirms that the genus belongs to the Ereynetidae. The description is based on a new species collected from a Belgian cave ("Nou-Maulin", Rochefort). For the first time, a mite is described with microscope photographs instead of traditional line drawings. The two methods are compared. A new typology is proposed for sensilli clusters and a key to the genera of the Ereynetinae is provided.

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Introduction

In 1974, Baker and Delfinado published the description of a strange tydeid mite they aptly named *Pseudotydeus perplexus*. The new species was "somewhat atypical of the Tydeidae" and the two authors proposed a new subfamily to accommodate it. The major features of the new subfamily, the Pseudotydeinae, were the coalesced genital and anal areas that were protruding posteriorly, and the clawlike and rayed empodium of apotele I. The type-material consisted of three females from old lawn clippings collected from Columbus (Ohio, USA).

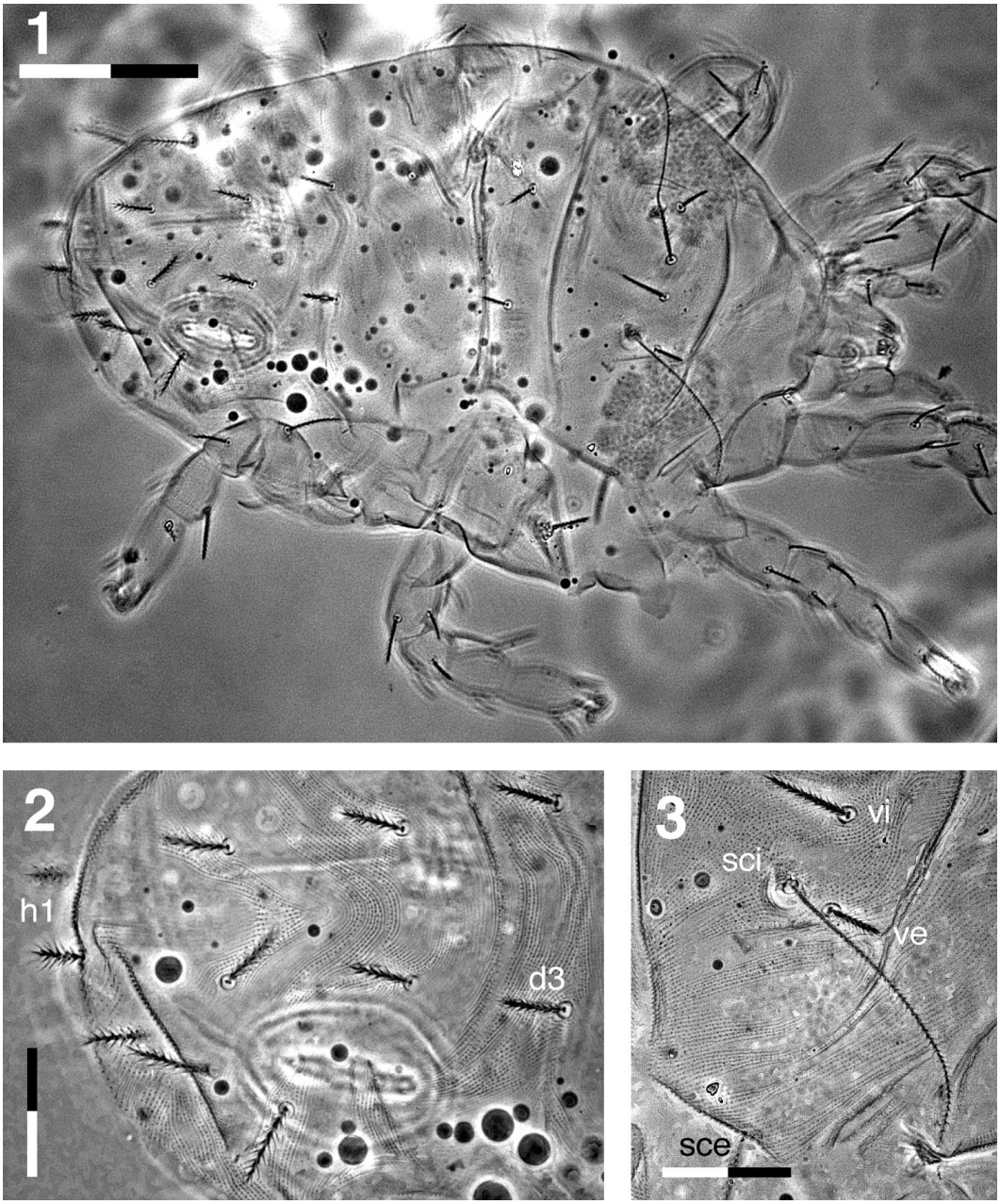
A paratype was examined by André (1980) who concluded that it was not a female but a tritonymph. The specimen had no genital aperture and the genital chaetotaxy (4-4) well illustrated on Baker and Delfinado's figure 4, was typical of the tritonymph. André (1980) completed the description and pointed out the presence of two sensilli clusters, (ωI-*ft*') on tarsus I and (*k*"-*l*"ζ) on tibia I, that were typical of a member of the family Ereynetidae described by Grandjean (1939, Fig. 1).

Subsequent to cladistic analyses of the superfamily Tydeoidea, the genus *Pseudotydeus* was transferred to the family Ereynetidae by André and Fain (2000). As *Pseudotydeus* was found to be close to the genus *Ereynetes*, Pseudotydeinae was thus considered a junior synonym of Ereynetinae. However, the proper position of the genus *Pseudotydeus* within the subfamily remained unclear due to the lack of adult characters.

The discovery of a *Pseudotydeus* female from a Belgian cave now allows us to give a complete description of the genus and present a new description approach of mites.

Material and methods

It is customary to use line drawings in the description of new mite species. Occasionally, SEM views are provided. Instead of the traditional drawings, we used photographs taken with a Leica TC200 2.6 megapixel digital camera mounted on a Leica DM LB microscope equipped with phase contrast, to describe our new species. Digital manipulations of the images were confined to routine operations to reduce field size, transform 30-bit color into 256 gray images, and improve the contrast. No digital cleanup was used to remove disturbing objects from the background. The AUTO-MONTAGE program (version 3.03.0103 by



Figures 1-3. *Pseudotydeus lebruni* sp. n.: (1) Habitus; (2-3) Detail of the opisthosoma (2) and prodorsum (3). Scale bar = 50 µm (1), 20 µm (2-3).

Synoptics Ltd) was used to automatically combine the in-focus regions from a series of source images each at a different point of focus, to generate a single montaged image, which tends to be completely in focus.

Photographs, sensilli and cluster types

The main characters used in tydeid mite descriptions comprise the striation pattern and organotaxy (chaetotaxy and solenidiotaxy). The striation pattern and density are clearly visible in photographs (Figs 2-3). Distinct types of sensilli (setiform organs or phaneres) are also easy to recognize. The difference between a normal seta (with a plugged root), an eupathidium (hollow root) and a famulus (no root) is clearly illustrated in Fig. 8 (*d*, *l"* ζ and *k"*, respectively). Similarly, the difference of opacity between a seta and a solenidion is clearly exhibited in Figs 10 and 12.

Associations between sensilli are also well presented with photographs. Such associations, especially a solenidion with a seta, were first defined by Grandjean (1935) as clusters ("groupes" in French). Subsequent authors designated them as "duplex setae" (Pritchard & Baker 1955: 6; Krantz 1978: 343; Evans 1992: 84) or as "coupled setae" (Evans 1992: 84). These designations are usually incorrect, as the solenidion is not a seta by definition. These designations are also unclear as they refer to different associations observed in various taxa. Depending on the relative lengths of the two sensilli and their insertion, Fain & Camerik (1994) made a distinction between two types of ereynetal organs (types A and B).

We wish to refine Fain & Camerik's (1994) terminology. When the two elements of a cluster are close together but do not share the same base, we refer to it as a "duplex cluster". This is the situation observed in Tetranychidae (Pritchard & Baker 1955: 6; Krantz 1978: 343). When the two elements share a combined base (Fig. 8), we name it a "twin cluster" in the same way one speaks of a twin room or twin set. Lastly, when sensilli share a combined base and are coupled over their whole length (Fig. 10), we refer to it as an intertwined cluster. The seta with barbules enveloping the solenidion (Fig. 10) is sometimes called a "guard seta" (Fain & Camerik, 1994).

Description of *Pseudotydeus* female

(Figs 1-15)

The description follows André's (1980) format and notation.

Prodorsum: procurved; no eyes (Fig. 3). Opisthosoma: dorsal chaetotaxy: 11 (*l*2 missing); poroidotaxy: 4; genital organotaxy: Ad(0-6-4) with two pairs of perigenital discs and cis-acetabulal area enlarged (Fig. 4); epimeral formula: (3-1-4-3) with double Claparède organs (Fig. 5). Legs: chaetotaxy: I(12-5-4-6-1) II(8-2-4-4-1) III(7-2-3-3-1) IV(7-2-1-2-0); eupathidia on tarsus I: *ft"*, (*t*) and (*p*) with an intertwined cluster (ωI-*ft'*) (Fig. 10); twin cluster (*k"*-*l"*ζ) on tibia I (Figs 8-9); solenidiotaxy: 3 (φI recessed, Figs 8-9); femur IV entire. Palp: (5-1-1-0) plus the tarsal solenidion (Fig. 14), short and thin chelicerae (Fig. 13).

The structure of the palp was not commented upon by André (1980). The palp of the female closely resembles that of the genus *Ereynetes*: the palptarsus is also gibbous, has the same organotaxy but is not divided. In the evolutionary series proposed for Tydeoidea, it occupies an intermediate position between the palp of *Tydeus* and that of *Ereynetes* (thus between A and B in fig. 6 by André & Fain 2000). The palp segmentation is a key character to discriminate the three genera of Ereynetinae.

Key to the genera of Ereynetinae

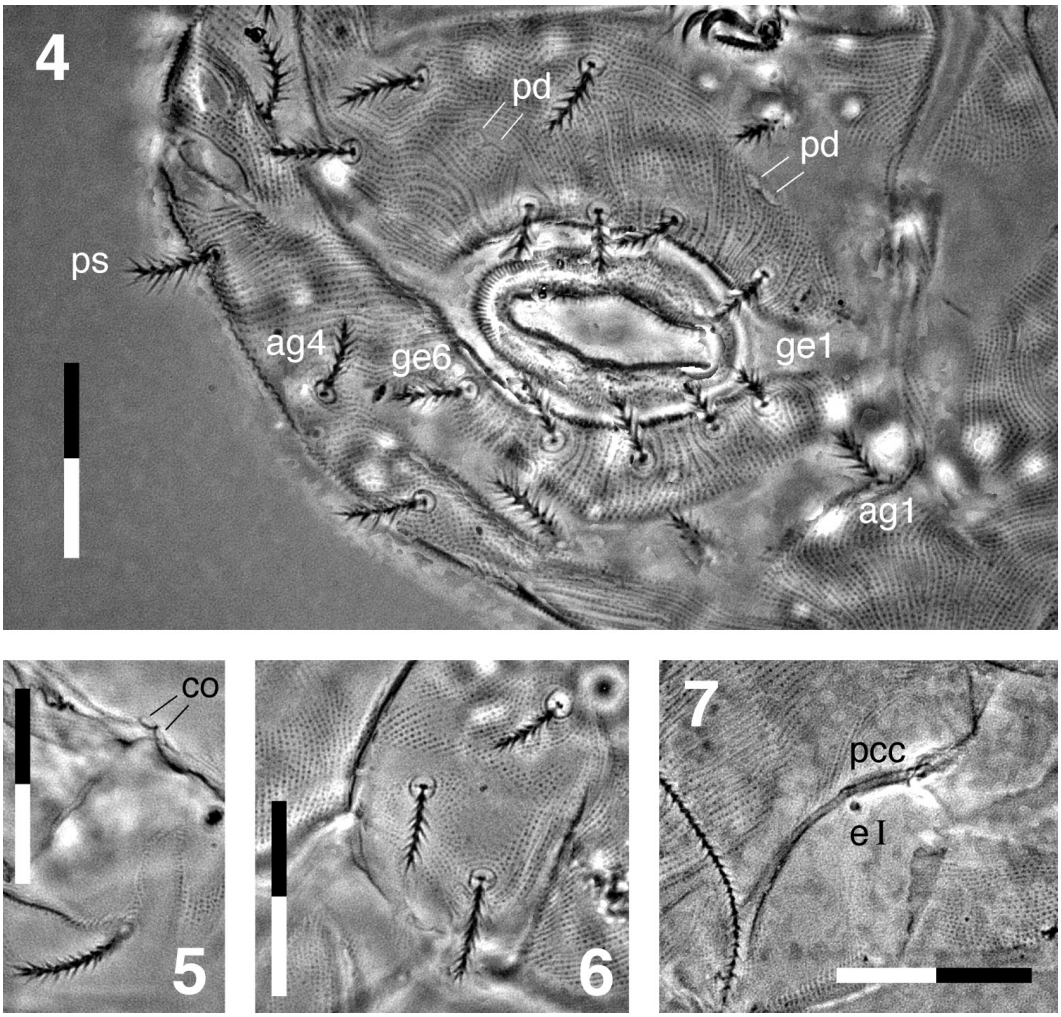
1. Palp seemingly 5-segmented with a strong distal seta, opisthosoma with one pair of trichobothria, femur I with 7 setae ..... *Ereynetes*
– Palp with less than 5 segments, femur I with 6 setae or less 2
2. 3-podomere palp, opisthosoma with 1 pair of trichobothria, tibia I with 6 setae ..... *Riccardoella*
– 4-podomere palp, opisthosoma without trichobothria, tibia I with 5 setae ..... *Pseudotydeus*

Pseudotydeus lebruni sp. n.

(Figs 1-15)

The description is based on a single specimen collected from the "Nou Maulin" cave, Rochefort, Belgium on 25 May 2000. The holotype has been deposited at the Institut royal des Sciences naturelles, Brussels, Belgium.

Except for the posterior "tubular structure", the new species closely resembles *P. perplexus*: the habitus, striation pattern and shape of setae are similar. The two species are small (body length, gnathosoma and posterior protrusion excluded, L=165µm in *perplexus* vs 216 in *lebruni*) with a tydeine compact figure (body length/maximum width, L/W=1.55 in *perplexus* vs 1.68 in *lebruni*). The dorsal striation pattern of opisthosoma (Fig. 2) is regular and transverse in both species. However, the new species does not exhibit any reticulation on the prodorsum as in *perplexus*. In



Figures 4-7. Ano-genital and coxal areas of *Pseudotydeus lebruni* sp. n.: Ventral views of the ano-genital area (4), coxae I and II (5), coxa III (6), and dorsal view of coxa I (7). Scale bar = 20 µm. pd = perigenital disc; co = Claparède organ; pcc = podocephalic canal.

both species, most dorsal and ventral setae of the idiosoma are markedly serrate (Figs 1-6); bothridial setae (*sci*) are long, hairlike and pilose (Fig. 3).

Apoteles of the new species are all similar with a padlike empodium between the two lateral claws, opposed to empodium I different from the others in *perplexus*. The shape of tarsus II also characterizes the new species, with a dorsal cavity sheltering solenidion ωII; the latter is flanked by the two fastigials (Figs 11-12). A last difference concerns the structure of the cluster on tibia I. André's (1980) figure 16b shows a cluster (*k"-l"* ζ-*d*) in *perplexus,* seemingly absent in *lebruni*.

The vertition of seta *d*2 was observed in the Belgian specimen while that of *d*1 was already observed in a paratype of *P. perplexus* (André unpublished data).

Etymology. – The authors are pleased to celebrate Prof. Ph. Lebrun 65th birthday and name the new species after him.

Discussion and conclusions

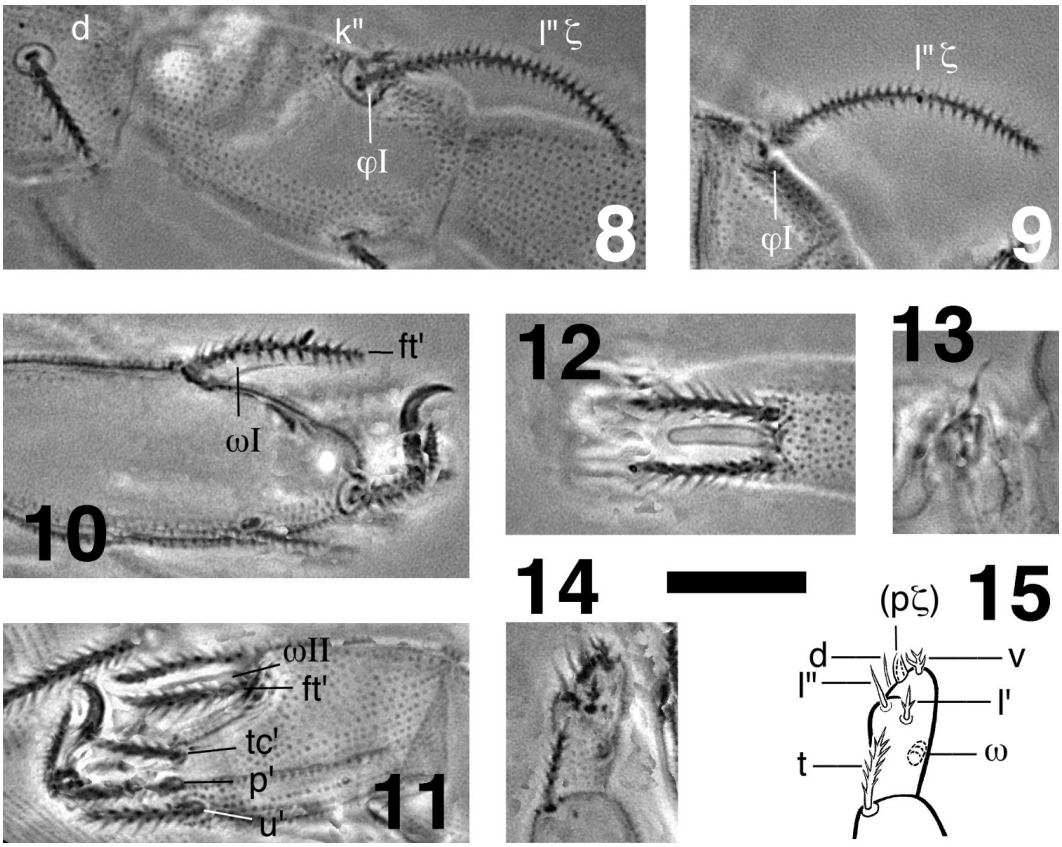
Mite description through photographs, pros and cons. – Photographs have already been used to supplement mite descriptions based on line drawings (e.g. Camerik & Coetzee 1997, 1998). This is the first attempt to describe a mite based on microscope pictures only. In the past, drawings have probably been preferred to photographs because the depth of field prevents the observer from having a complete view of an organ. However, recent progress in computer assisted imagery, has considerably improved the quality of microscope photographs.

This does not mean the end of line drawings. Drawings will probably remain a major technique in interpreting the mite morphology through suggestive symbolism and adequate conventions (compare Figs 14 and 15). Morphological illustrations are not only imitative reproductions but, above all, demonstrative syntheses (Coineau 1974: 19). Thus photographs cannot, any more than words, substitute for good drawings (Coineau 1978: 1) and "many biologists, including Harvard's Wilson – an accomplished biological illustrator as well as a noted sociobiologist – consider drawing to be one of the most valuable and irreplaceable analytic tools available to them" (King 1989).

However, computer based photography can produce better images of some morphological characters. For instance, the distinction of opacity between a solenidion and a seta (Figs 10-12) and the root structure of normal and eupathidial setae (Fig. 8) are almost impossible to render with line drawings. This is why sensilli are conventionally drawn with distinct symbols (e.g. solenidia are indicated with a transverse line pattern, see Fig. 15). Even minute sensilli, such as supracoxal setae, are accurately reproduced (Fig. 7). Photographs also display the shape of the setae better than most sketches published. The striation pattern and density, and integument granulation are also of uttermost importance in species descriptions. Again, such details are virtually impossible to depict with line drawings (compare Figs 2-3 to drawings by Baker & Delfinado 1974). Lastly, some morphological details usually neglected by systematists are nevertheless captured by photographs. This is the case of coxal glands well visible in Fig. 1. These glands have never been reproduced in taxonomic drawings although they have probably been confused with eyespots (André & Fain 2000). Comparison of our Fig. 1 with figs 1A and B published by André & Fain (2000) clearly illustrates the difference of structure between glands and eyespots, a difference difficult to depict with line drawings. Contrary to SEM micrographs, photographs provide the reader with a picture similar to what is observed under a compound microscope. Identifications should thus be made easier and more precise. Provided that specimens are correctly oriented, measurements with the computer-based technology are also easier and more accurate than with the conventional methods.

However, the new technology has some drawbacks. First, hard- and software are costly. It requires time to process pictures and a high storage capacity: 136 digital images (358 Mb) were taken during this study; no less than five original pictures were needed to get the montage of figure 12. Next, some montages are locally dazzled because of optic turbulence (see borderlines on the right of Fig. 14). Some 3-dimensional structures (eg. the apotele) are difficult to reconstitute using the montage program and resulting montaged images are blurred and not publishable. Lastly, the photograph quality also depends on the optical features (light source, magnification, numerical aperture of lens, etc) of the compound microscope, digitalization operations and printing process. It is affected as well by the diffraction limit of the light microscopy (ca 1µm). Fig. 14 representing tiny setae at the tip of the palptarsus dramatically illustrates this limitation.

Systematics. – According to Baker & Delinado (1974), the genus *Pseudotydeus* was "somewhat atypical of the Tydeidae" and they aptly named the new species "*perplexus*". Three specimens, all tritonymphs, were collected but all are lost. The paratype that, according to the publication, is housed at the New York State Museum has never been deposited in this institution (Timothy McCabe pers. comm.). The second paratype and the holotype housed at the U.S. National Museum have been lost (Ronald Ochoa pers. comm.). Since the original description in 1974, the genus has never been encountered again. The adult characters being unknown, it was not possible to determine the proper position of the genus *Pseudotydeus* within the Ereneytinae through cladistic analysis (André and Fain 2000). The discovery of a single female allowed us to describe the adult



Figures 8-15. Appendices of *Pseudotydeus lebruni* sp. n.: Detail of tibia I, right (8) and left (9), cluster (w-*ft'*) on tarsus I (10), dorso-lateral view of tarsus II (11), dorsal view of wII flanked by fastigials (12), dorsal views of the right chelicera (13) and right palp (14, 15). Scale bar = 10 µm. Note the difference between the root of a normal (*d*) and eupathidial (*l"*) seta and the absence of root in the famulus in Fig. 8.

characters and confirm that *Pseudotydeus* does not belong to Tydeidae but belongs to the subfamily Ereynetinae (procurved prodorsum, double genital discs, ereynetal organs, sensilli clusters on tarsus and tibia I, holotrichy but no orthotrichy of tarsus I, tarsal cavity on leg II).

Habitat. – The single specimen was collected from the "Nou Maulin" cave, one of the 360 "Natura 2000" sites recently protected in Wallonia (code BE35NR019). The genus is supposedly rare, as it has never been rediscovered since its description in 1974. This could of course be explained by the lack of specialists able to identify these mites or the disregard of soil zoologists for Prostigmata (André et al. 2002).

Nevertheless, only one specimen was found in the cave, although a total of 160 samples (48 cm^3) were collected from this site at different times of the year. This probably means that the collecting site is not the original habitat of the new species. The specimen may have come in either from outside with annual floods or from another part of the cave. It probably did not migrate through crevices in the roof of the cave, as the species was not found in any of the samples collected from the forest soil above the cave.

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