The first record of *Acherontacarus* (Acari, Hydrachnidia) in continental France, with a key to the described species of the genus

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Abstract

A new species of *Acherontacarus* (Acari, Hydrachnidia) is described from a well in the south of France. The description is made with the help of images taken with the Environmental Scanning Electronic Microscope. A key to all described species is included. The chaetotaxy of terminal segments of IV-Leg in male, general morphology of genital field and related platelets of male and female are diagnostic in this species. This is the first time that the genus is found in continental France, and the distributional data of known species is discussed.

Keywords: ESEM, Acherontacarus, new species, subterranean, water mite, well

Introduction

The superfamily Hydrovolzioidea has been recently revised by Tuzovskij et al. (2001) and the subfamily Acherontacarinae Cook, 1967 raised by them to family rank. In total there are nine species of the genus *Acherontacarus* Viets, 1932 known from interstitial and superficial waters of southern Europe and northern Africa that are typically sexually dimorphic.

A new species has been found in a well from southern France. This is the first time that an *Acherontacarus* species has been found in continental France.

Material and methods

The new species was collected in a well, using a Cvetkov phreatobiological net, in the Perpignan region, south-western France (Figure 10). All previous findings of *Acherontacarus* have been in the interstitial environment or near to it. This region is characterized by a Mediterranean climate with dry periods and periods with strong rainfall. The mean annual precipitation is between 550 and 2200 mm per year.
For the description of the species we have used the Environmental Scanning Electron Microscope (ESEM) (Valdecasas and Camacho 2005) that allows the acquisition of high-resolution images (up to $3598 \times 3301$ pixels) without the need for coating the specimens, allowing them to be further studied by transmission light microscopy or molecular analysis, if necessary. However, in some cases the details in the high resolution images are lost when sizing for journal publication. Only those images that retain enough detail for taxonomic purposes at journal image resolution (around $600 \times 553$ pixels) are presented, in all other cases images have been substituted by drawings delineated with the help of ESEM images.

We follow Cook’s (1974) terminology for the description of the morphology. It is simple and intuitive, and is more accessible to the interested reader who it is not a specialist. More precise terminology such as that of Tuzovskij et al. (2001) is best left for comparative and phylogenetic studies. All measurements are in micrometres and the abbreviation MNCN is the Museo Nacional de Ciencias Naturales, Madrid.

*Acherontacarus nicoleiana* nov. sp.
(Figures 1–9)

Characters of *Acherontacarus* Viets, 1932, subgenus *Acherontacarus* Cook, 1974 (Cook 1974)
Female (Figures 1–3)

Typical of genus, morphologically similar to male but differing in structure of genital field and IV-Leg structure. Glands of glandularia and eye capsules absent. Body length 1352, width 843. Dorsum with large posterior plate 965 long, 525 wide, surrounded by 10 pairs of small platelets, five pairs with setae, alternating, beginning with the anterior platelet and a larger anterior plate 180 long, 380 wide; posterior margin of anterior plate concave and paired with a slight convexity of the anterior margin of the posterior plate; four pairs of setae located on anterior plate and four pairs of setae on posterior plate.

Venter with fused coxal plates of I-Leg and II-Leg separate medially; two pairs of similarly sized genital platelets flank the genital pore between two larger trapezoidal anteromedial platelets, a small pair of anterolateral platelets and coxal plates of III-Leg; a large posteromedial excretory plate 375 long, 265 wide, is flanked by a pair of large triangular posterolateral platelets between the coxal plates of IV-Legs behind the genital field. Length genital field 205 long, 115 wide (across genital platelets). The anteromedial platelets are considerably smaller than the posterolateral platelets. Capitulum 335 long with a pair of fine setae located at the distal tip. Palps typical, dorsal lengths: P-I 25, P-II 225 (two setae), P-III 112 (one seta), P-IV 125 (one ventral seta), P-V 58. Legs without Figure 2. Ventral view female.
swimming setae; dorsal length of first leg segments: I-Leg-2 300, I-Leg-3 145, I-Leg-4 180, I-Leg-5 175, I-Leg-6 210; IV-Leg-2 325, IV-Leg-3 110, IV-Leg-4 225, IV-Leg-5 230, IV-Leg-6 190.

**Male (Figures 4–8)**

Similar to female differing in genital field and IV-Leg morphology. Length 1294, width 900. Dorsum: anterior plate length 175, width 365; posterior plate 890 long, 480 wide. Venter: genital pore between one pair of genital plates flanked by posterolateral platelets and located posterior to the anteromedial and anterolateral platelets and III-Leg coxal plates, length genital field 105, width 140; posterior part of excretory pore plate broader than female, length 395, width 350; posterolateral platelets curved anteriorly around genital plates, not reaching posterior margin of excretory pore plate. Capitulum length 315. Palp dorsal lengths: P-I 40, P-II 230 (three setae), P-III 110, P-IV 120 (one ventral seta), P-V 55. Legs without swimming setae; dorsal lengths: I-Leg-2 330, I-Leg-3 150, I-Leg-4 210, I-Leg-5 200, I-Leg-6 150; IV-Leg-1 120, IV-Leg-2 410, IV-Leg-3 140, IV-Leg-4 350.
(five long setae in ventral side), IV-Leg-5 250 (six short ventral), IV-Leg-6 130 (11 ventral setae, the first six decreasing in thickness plus 10 dorsal setae, plus distal setae).

**Nymph (Figure 9)**

Similar to the adult, but the dorsal and ventral plates smaller and separated more widely. Body length 800, width 600.

**Type specimens**

Holotype: adult female, well in the Têt river basin, France (X: 2,70324; Y: 42,6756; Z: 114), 13 March 2002, leg. Coineau and Giani (MNCN 20.02/12640). Paratypes: two males (MNCN 20.02/12641), five females and one nymph (MNCN 20.02/12642), same place and date as holotype.

**Etymology**

The species is named to honour Dr Nicole Coineau, for her dedication to the study of interstitial crustacean species, especially of microcrustaceans, all her life and even after her retirement, in the Laboratoire Arago, Banyuls-sur-Mer, France.
Discussion

Acherontacarus nicoleiana seems closely related to those Acherontacarus species with stout setae on IV-L-6 segment of male: A. dividuus, A. vietsi, A. bicornis, and A. tuberculatus. Acherontacarus vietsi is easily distinguished because it has only two thick setae on IV-L-6 ("2 dents chitineuses"; Angelier 1954) and A. bicornis has the thick setae on the expanded distal half of IV-L-6. Acherontacarus nicoleiana has six to seven stout setae and IV-L-6 is not distally expanded. IV-L-5 is approximately the same size as IV-L-6 in A. dividuus but longer in A. nicoleiana. IV-L-6 of A. tuberculatus has more a ventral line of fine setae and more thickened setae than A. nicoleiana.

On the habitat

So far, this new species of Hydrachnidia is known only from the type locality, though many wells were prospected in the same region. The site is located within the hydrological basin of the Têt River (Figure 10) in the Roussillon Quaternary alluvial flood plain. The area is largely used for agriculture, mainly of vines and orchards. The well is dug in alluvial unconsolidated sediments, in the border of an orchard, a few metres away from the bed of
the Comelade River. The Comelade River is a small right-side tributary of the Têt River, and flows through some exposed limestone area in the vicinity of the village of Corbère, some kilometres in the south-west of ROU089/T4 (Figure 10). The well is 8.5 m deep and 1.0 m in diameter. It is made of concrete pipes, well protected by a half metre high curb and covered by a strong steel sheet.

Two sampling operations were carried out: the first one in March 2002 (sampling operation no. 89) with a water level located 4.2 m below the soil surface and the second one in April 2003 (sampling operation no. 38) with water level 3.5 m below the soil surface.

The water of the well was well oxygenated on both occasions (8.1 mg l$^{-1}$ in 2002 and 8.6 mg l$^{-1}$ in 2003) with a temperature of 14.0 and 13.5°C, a low electric conductivity (195 and 186 μS cm$^{-1}$) and pH very close to neutrality (6.63 and 6.96) in 2002 and 2003, respectively.

In April 2003 the orthophosphate concentration in the water was rather low ([PO$_4^{3-}$] = 0.07 mg l$^{-1}$), as well as the nitrate concentration ([N-NO$_3^-$] = 2.6 mg l$^{-1}$ or less than 11.5 mg l$^{-1}$ of NO$_3^-$). In spite of what could be expected from the water’s origin, the hardness was moderate: [Mg$^{2+}$] = 16 mg l$^{-1}$ and [Ca$^{2+}$] = 52 mg l$^{-1}$.

The mite specimens collected represent 19% of all aquatic organisms collected in the well in 2002, the other 81% being mainly Oligochaeta and Amphipoda (mainly

Figure 6. Last segments of IV-Leg male.
niphargids). The exact composition of the aquatic fauna collected in the well during the March 2002 sampling is represented in Table I.

The two sampling operations gave rather similar results for the overall fauna of the well, except for two crustaceans, an isopod *Microcharon* sp. (four specimens) of the family Microparasellidae and the amphipod *Salentinella petiti* Coineau, 1968 (three specimens) which were collected during the second operation only. Several terrestrial taxa were also accidentally present in the well water (pseudoscorpionids, opilionids, Homoptera and Diptera larvae). *Niphargus* amphipods appeared to be more numerous (83) the second time.

**Distribution**

There are nine species of *Acherontacarus* described, with a distribution in southern Europe, northern Africa and the Canary Islands: *A. halacaroides* Viets, 1932 and *A. fonticola* Viets, 1934 (former Yugoslavia); *A. rutilans* Angelier, 1951 and *A. vietsi* Angelier, 1951 (Corsica); *A. cedro* Lundblad, 1962 (Canary Islands); *A. bicorne* Cook, 1974 (Iberian Peninsula); *A. cicolanii* Bader, 1983 (Sardinia); *A. tuberculatus* Bader, 1989 and *A. dividuus* (Bader, 1989)
Benfatti and Gerecke (1999) provide a map of the distribution of the known taxa and three species still undescribed. To this distribution we should add the new species and another record (Valdecasas 1981) of an *Acherontacarus* nymph (probably *A. bicornis* Cook, 1974) in central Spain, the most inland record of an *Acherontacarus*, a taxon that seems primarily to have close littoral affinities. Except for the species found in the Canary Islands, *A. cedro*, which was collected in the surface waters of a stream, all the other records came from typical subterranean (s.l.) environments: interstitial water or wells. It is known that many “interstitial” water mites appear with regularity in samples of surface waters of streams (Valdecasas 1984) and it is tempting to hypothesize that *A. cedro* (represented only by a female and a nymph in Lundblad’s records and not found again) could be more abundant in the interstitial waters of the stream where it was found. In this sense, a study by Santucci (1975) in Corsica shows that extensive study of interstitial waters may result in numerous records and in this case, two different *Acherontacarus* species: *A. vietsi* and *A. rutilans*. At the same time, he pointed out the simultaneous occurrence of *A. vietsi* in superficial and interstitial waters.

The predominant marine littoral distribution of *Acherontacarus* species makes it tempting to hypothesize that this genus is a Tethyan relict and that the family Acherontacaridae is of

![Figure 8. Palp male.](image)
Figure 9. (A) Dorsal view nymph; (B) ventral view nymph. Scale bar: 0.2 mm.

Figure 10. Sampling area and localization of site ROU089/T4.
thalassoid origin. The occurrence of *A. cedro* in the Canary Islands, now considered as fully oceanic islands (permanently without any land connection with the continent), points strongly toward this origin. However, it is now known that the larvae of *Acherontacarus* are phoretic on species of the beetle genus *Deronectes*. At least three species previously assigned to *Deronectes* are found in the Canary Islands: *Potamonectes cerisyi* (Aubé, 1836), *Potamonectes clarkii* (Wollaston, 1862), and *Nebrioporus canariensis* (Bedel, 1881) (Machado and Oromi 2000). The last species is found in Gomera, from where *A. cedro* was described. An ancestral oceanic invasion from northern Africa cannot be excluded. It is clear that an analysis of phylogenetic relationships is urgently needed in this intriguing subterranean taxon.

**Key to the species of Acherontacarus**

This is a preliminary key for the males and females of all described species of *Acherontacarus*, based on published descriptions.

1. First coxal group fused medially ................................................. 2
   – First coxal groups separate medially ........................................... 3

2. Posterior margin of anterior dorsal plate straight ............................ *A. halacaroides*
   – Posterior margin of anterior dorsal plate concave (known from nymph only) ................................................................. 4

3. Genital field with one pair of genital plates, located between posterolateral platelets and excretory pore plate, and posterior to coxal plates of III-Leg ................................. males 4

   – Genital field with two pairs of genital plates ................................ 5


| Taxa                          | Number of individuals collected |
|-------------------------------|---------------------------------|
| Crustacea Amphipoda           |                                 |
| *Niphargus angeliieri*        | 20                              |
| *Niphargus delamarei*         | 3                               |
| *Gammaridae*                  | 4                               |
| Crustacea Isopoda             |                                 |
| *Stenocellus*                 | 7                               |
| Crustacea Copepoda Harpacticoida |                                |
| Unidentifiable Harpacticoida copepodes | 2 |
| Crustacea Copepoda Cyclopoida |                                 |
| *Diacyclops bisetosus*        | 1                               |
| *Diacyclops cf. paolae*       | 1                               |
| *Eucyclops serrulatus*        | 1                               |
| Unidentifiable Cyclopoida copepodes | 9 |
| Crustacea Ostracoda           |                                 |
| *Pseudocandona albicans*      | 8                               |
| *Mixtacandona* sp.            | 11                              |
| Oligochaeta                   |                                 |
| *Cernosvitoviellia* sp.       | 2                               |
| *Trichodrilus* sp. A mature   | 2                               |
| *Trichodrilus* sp. A immature | 10                              |
| *Pristina acquiseta f. foreli*| 15                              |
| Myriapoda                     |                                 |
| Diplopoda (larvae)            | 7                               |
| Mollusca                      |                                 |
| Gastropoda                    | 2                               |
| Nematoda                      | 2                               |
| Chelicerata                   |                                 |
| *Acarina*                     | 25                              |

Table I. Number of individuals of each aquatic taxa collected in the well ROU089/T4 during the sampling operation of March 2002.
Genital field with two pairs of genital plates, located between anteromedial platelets anterior to the posterolateral platelets, and between coxal plates of III-Leg females 10

4. Two pairs of platelets anterior to the genital field of approximately the same size A. bicornis
   – Two pairs of platelets anterior to the genital field of different size 5

5. IV-leg-6 with several rows of similar-sized setae A. rutilans
   – IV-leg-6 with setae of different size 6

6. More than five setae on P-II A. halacaroides
   – Fewer than five setae on P-II 7

7. Anterior plate of the dorsum almost twice as long as wide. Genital field longer than wide A. nicoleiana n. sp.
   – Anterior plate of the dorsum more than twice as long as wide. Genital field approximately as wide as long 8

8. IV-Leg-6 with two enlarged setae A. vietsi
   – IV-Leg-6 with several enlarged setae 9

9. Posterior border of the first two pairs of coxa almost straight A. tuberculatus
   – Posterior border of the first two pairs of coxa angled A. dividuus

10. (Females). P-II with five or more setae A. halacaroides
    – P-II with less than five setae 11

11. Two pairs of platelets lateral to genital field similar in size A. bicornis
    – Two pairs of platelets lateral to genital field different in size 12

12. Posterior margin of first coxae concave A. cicolanii
    – Posterior margin of first coxae straight or convex 13

13. P-II much longer than P-III A. cicolanii
    – P-II similar in length to P-III 14

14. P-II with several setae A. rutilans
    – P-II without ventral setae A. cedro

15. Paired ventral posterior plates not reaching the oval posterior plate A. vietsi
    – Paired ventral posterior plates reaching the oval posterior plate 16

16. P-II with no setae A. tuberculatus
    – P-II with two setae A. nicoleiana

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References

Angelier E. 1951. Diagnoses sommairies d’Hydracariens psammiques nouveaux de Corse. Bulletin du Muséum National d’Histoire Naturelle, Paris (Série 2) 23(5):508–510.

Angelier E. 1954. Contribution à l’étude de la faune d’eau douce de Corse. Acariens psammiques (Hydrachnellae et Porohalacaridae). Vie Milieu 4(3):505–539.

Bader C. 1983. Zwei neue Wassermilben-arten aus dem Interstitial des Mittelmeergebietes. Rivista di Idrobiologia 22(2/3):169–177.

Bader C. 1989. Wassermilben (Acari: Hydrovolziidae et Hydrachnellae) aus Algerien. Bijdragen tot de Dierkunde 59(1):33–42.

Benfatti D, Gerecke R. 1999. Remarks on the morphology, life cycle, distribution and taxonomy of water mites of the subfamily Acherontacarinae in the Western Palaearctic. In: Bruin J, van der Geest LPS, Sabelis MW, editors. Ecology and evolution of the Acari. Dordrecht: Kluwer Academic Publishers. p 473–482.

Cook D. 1967. Water mites from India. Memoirs of the American Entomological Institute 9:1–411.

Cook D. 1974. Water mites genera and subgenera. Memoirs of the American Entomological Institute 21:1–860.

Lundblad O. 1962. Wassermilben von den Kanarischen Inseln. Arkiv för Zoologi (Ser 2) 15(16):285–300.

Machado A, Oromi P. 2000. Elenco de los Coleópteros de las Islas Canarias [Catalogue of the Coleoptera of the Canary Islands]. La Laguna: Instituto de Estudios Canarios. 306 p.

Santucci J. 1975. Contribution à l’étude de deux espèces du genre Acherontacus (Hydrachnellae) de Corse. Revue de Biologie et d’Ecologie Méditerranéenne 2(3):15–18.

Tuzovsky P, Benfatti D, Gerecke R. 2001. The water mite family Acherontacaridae Cook, (1967) nov. stat. and diagnosis of the superfamily Hydrovolzioidea Thor (1905) (Acariformes, Hydrachnidiida). Acarologia 41(4):451–473.

Valdecasas AG. 1981. Las hidracnelas de la sierra del Guadarrama: taxonomia, distribución y ecologia [doctoral thesis]. Madrid: Universidad Complutense. 532 p.

Valdecasas AG. 1984. A review of the water mite Hungarohydracarus subterraneus and its subspecies (Hydrachnellae, Acari). Acarology 6(2):971–979.

Valdecasas AG, Camacho A. 2005. On the environmental scanning electron microscope for taxonomic purposes. Invertebrate Biology 124:66–73.

Viets K. 1932. Dritte Mitteilung über Wassermilben aus unterirdischen Gewässern. Zoologischer Anzeiger 100(11/12):292–299.

Viets K. 1934. Sechste Mitteilung über Wassermilben aus unterirdischen Gewässern. Zoologischer Anzeiger 105(11/12):273–281.