NEW DATA ON PROTURA (ARTHROPODA: HEXAPODA) FROM SOUTHERN FRANCE

LORIS GALLI[1*], PHILIPPE LECLERC[2], ANTONIO SARÀ[3]

[1] Department of Earth, Environment and Life Sciences, University of Genoa, Corso Europa 26, 16132 Genoa, Italy.
[2]62, rue des arcades 07150 Vallon Pont D'Arc, France.
[3]Studio Associato Gaia, Genoa, Italy.

Correspondence: loris.galli@unige.it

ABSTRACT

Protura is a class of euedaphic microarthropods represented in France by 47 species belonging to 10 genera. In this paper data on 361 proturans collected in 40 localities of Southern France (Ardèche, Gard, Hérault, Alpes Maritimes, Var, Pyrénées areas and Corsica) are shown. Thanks to this data, three species have been added to the 47 already known in this country: *Acerentulus gisini* Condé, 1952, *Podolinella ruseki* (Nosek, 1967) and *Eosentomon noseki* Tuxen, 1982.

Key Words: Acerentomidae, Eosentomidae, *Podolinella ruseki*.

INTRODUCTION

Protura is a taxon of euedaphic Arthropods (Rusek 2007) represented by 836 species known worldwide (Galli et al., 2025), of which 47 species in 10 genera (Table 1) are known in France (Nosek, 1973; Szeptycki, 2007; Galli, 2022). For a complete bibliographical review and the list of localities where the individual species are recorded, please refer to the works indicated above.

Table 1. List of Protura species known in France.

Acerentomata Protentomidae
Protentomon barandiarani Condé, 1947
Proturentomon discretum Condé, 1961
Proturentomon pectinatum (Condé, 1948)
Proturentomon picardi Condé, 1960
Acerentomata Acerentomidae
Acerentulus cassagnaui Nosek, 1969 End
Acerentulus catalanus Condé, 1951
Acerentulus charrieri Shrubovych, Schneider & D'Haese, 2012
Acerentulus condei Nosek, 1983
Acerentulus confinis (Berlese, 1908)
Acerentulus correzeanus Szeptycki, 1997 End
Acerentulus exiguus Condé, 1944
Acerentulus gigas Szeptycki, 1997 End
Acerentulus insignis Condé, 1945

Acerentulus noeli Shrubovych, Schneider & D'Haese, 2014 End
Acerentulus proximus Szeptycki, 1997 End
Acerentulus pyreneicus Shrubovych, Schneider & D'Haese, 2014 End
Acerentulus tolosanus Nosek, 1969
Acerentulus traegardhi Ionesco, 1937
Acerentulus aubertoti Condé, 1944
Berberentulus berberus (Condé, 1948)
Berberentulus capensis (Womersley, 1931)
Gracilentulus corsicanus Szeptycki, 1993
Gracilentulus gracilis (Berlese, 1908)
Gracilentulus hyleus Szeptycki, 1993
Gracilentulus meridianus (Condé, 1945)
Gracilentulus orousseti Szeptycki, 1993
Najtentulus silvestris Szeptycki &Weiner, 1997
Acerentomon affine Bagnall, 1912
Acerentomon brevisetosum Condé, 1945
Acerentomon gallicum Ionesco, 1933
Acerentomon italicum Nosek, 1969
Acerentomon meridionale Nosek, 1960
Acerentomon microrhinus Berlese, 1909
Acerentomon nemorale Womersley, 1927
[*Acerentomon quercinum* Ionesco, 1932]*
Acerella muscorum (Ionesco, 1930)
Acerella remyi (Condé, 1944)
Acerella tiarnea (Berlese, 1908)
Eosentomata Eosentomidae
Isoentomon atlanticum (Condé, 1947)
Eosentomon armatum Stach, 1926
Eosentomon carolae Condé, 1947
Eosentomon delicatum Gisin 1945
Eosentomon denisi Condé, 1947
Eosentomon germanicum Prell, 1912
Eosentomon mirabile Szeptycki, 1984
Eosentomon mixtum Condé, 1945
Eosentomon semiarmatum Denis, 1927
Eosentomon transitorium Berlese, 1908

*According to Szeptycki (2007) data from France should be confirmed.

This paper reports several unpublished records related to collections carried out in the Southern part of France (mainly from Ardèche, Gard, Hérault, Alpes Maritimes, Var, Pyrénées areas and Corsica) with the aim of integrating the knowledge framework about Protura in this country.

MATERIAL AND METHODS

Specimens preserved in 70% ethanol, were cleared overnight in lactic acid and mounted on slides in Marc André 2 medium. An interference contrast microscope (Leica DM LB2 –

Wetzlar, Germany), a Leica DFC 295 camera (Heerbrugg, Switzerland) and Leica Application Suite Vers. 3.8 (Heerbrugg, Switzerland) were used to examine proturans and obtain diagnostic measurements of each specimen.

The following abbreviations have been used to distinguish the sex and age classes of the specimens: F/FF = female/females, LI = larva I, LII = larva II, M/MM = male/males, MJ = maturus junior, PI = Praeimago, PL = Praelarva.

RESULTS AND DISCUSSION

A total of 361 proturans from 40 localities were examined (Figure 1). Of these, only 250 specimens have been identified to species level, while 84 and 27 have been classified only to genus and family level, respectively.

Below is a detailed list of fauna by location. In brackets, before the name of each sampling site, a numeric code corresponding to the number assigned to it on the map in Figure 1. Sites close to each other share the same numeric code.

Ardèche/Gard:

(1) Col de Malons et Elze, 870 m elev., 3/IX/1979, P. Leclerc coll. *Eosentomon transitorium* 3 MM, 5 FF, 1LII, 1 MJ – (1) Eboulis de Pente, Malons, 980 m elev., 25/V/1985, P. Leclerc coll. *Acerentulus confinis* 2 MM, 1 F, 1 MJ; *Eosentomon transitorium* 1 M, 1 F. – (2) Baume Saint Arnaud, Les Assions, 210 m elev., 17/XI/2022, P. Leclerc coll. *Eosentomon transitorium* 1 M. – (3) Font Garou, Lagorce, 158 m elev., 22/III/2024, P. Leclerc coll. *Eosentomon armatum* 1 F; *Eosentomon* sp. 2 MM, 2 FF, 1 LI, 2 MJ. – (3) Source de l'Aiguille, Vallon Pont d'Arc, 57 m elev., 10/III/2024, P. Leclerc coll. *Eosentomon* sp. 1 LI. – (3) Source du Toul, Casteljau, 190 m elev., 29/X/2023, P. Leclerc coll. *Acerentulus* sp. 1 LI; *Eosentomon* sp. 1 LII. – (4) River Ardèche (left bank), Saint Just-d'Ardèche, 8/VI/2023, P. Leclerc coll. *Acerentulus confinis* 1 M, *Eosentomon* sp. 1 LI. – (5) Source de Bourgène, Saint Alban, 114 m elev., 19/X/2023, P. Leclerc coll. *Eosentomon transitorium* 1 F. – (5) Dérive Exsurgence de la Font Vive, Grospierres, 160 m elev., 1/XI/2022, P. Leclerc coll. *Eosentomon* sp. 1 LI. – (5) Source de Ranc d'Aven, Grospierres, 108 m elev., 15/IX/2022, P. Leclerc coll. *Eosentomon* sp. (*delicatum* group) 1 F, 1 MJ. – (5) Dérive Source Regourdet, Beaulieu, 160 m elev., 1/XI/2021, P. Leclerc coll. *Acerentulus* sp. 1MJ; *Acerentomon* sp. (cf. *microrhinus*) 1 LII; *Eosentomon* sp. 3 MM. – (6) Exsurgence de Marnade, Montclus, 88 m elev., 23/V/1985, P. Leclerc coll. *Proturentomon* sp. 1 F; *Acerentulus traegardhi* 6 MM, 6FF, 2 LI, 8 MJ, 1 PI; *Acerentulus* sp. 1 M, 1 F, 3 LI, 2 LII, 1 MJ, 1 PI; *Podolinella ruseki* 6 MM, 10 FF, 1 LII, 3 MJ; *Acerentomon* sp. (cf. *microrhinus*) 1 LI; *Acerella* sp. 1 F; Acerentomidae undet. 25; *Eosentomon armatum* 1 F; *Eosentomon* sp. 8 MM, 1 F, 1 LI, 1 LII, 5 MJ, 1 undet.

Alpes Maritimes/Var

(7) L'Imberguet, Saint Jean de la Riviere, 500 m elev., mixed *Ostria* and *Quercus* forest, 9/X/1984, R. Rizzerio & S. Zoia coll. *Acerentomon gallicum* 1 M, 6 FF, 1 undet. – (8) Lantosque, 9/X/198, R. Rizzerio & S. Zoia coll. *Acerentomon gallicum* 1 M, 1 F. – (8) Peira Cava, 20/IX/1981, S. Zoia coll. *Acerentomon gallicum* 1 LII; *Acerella muscorum* 1 F, 1 undet; *Acerella* sp. 2 MM, 7 FF; *Eosentomon germanicum* 1 M – (9) Arpetta, Testa d'Alpe, 1300 m elev., mixed conifer forest, 27/VI/2008, M. Capurro coll. *Acerentulus* sp. 1 LII; *Eosentomon noseki* 1 M; *E.*

transitorium 1 M, 1 F. – (10) Levens, 143 m elev., *Ostria* forest, 9/X/1984, R. Rizzerio coll. *Acerentomon gallicum* 1 M, 1 F, 1 undet.; *Eosentomon transitorium* 2 FF. – (11) Castellane, La Baite, 1000 m elev., mixed *Ostria* and *Quercus* forest, 9/VII/1984, S. Zoia coll. *Acerentomon gallicum* 3 MM, 13 FF, 3 MJ, 5 PI; *Acerella tiarnea* 2 FF; *Acerella* sp. 3 FF; *Eosentomon transitorium* 1 MJ. – (11) Vergons, Rovaines, 810 m elev. 9/VII/1984, S. Zoia coll. *Gracilentulus* sp. 1F; *Acerella* sp. 1F. – (12) V.lé Rio Albarera, Sospel, 800 m elev., 26/IV/1980, S. Zoia & A. Torchia coll. *Acerentomon gallicum* 1 M. – (13) Faille du Chéne, Andon, str. D5 km 24, 18/VIII/1981, S. Zoia coll. *Acerella muscorum* 1 F. – (14) Contes, Nice, 250 m elev., *Quercus ilex* forest, 7/II/1984, C. Torti & S. Zoia coll. *Acerentomon gallicum* 6 FF. – (15) Pas de la Faye, 1000 m elev. *Fagus sylvatica* forest, 20/VIII/1983, C. Torti & S. Zoia coll. *Acerentulus gisini* 4 MM, 7 FF; *Acerella tiarnea* 7 MM, 21 FF; *Acerella* sp. 4 FF, 1 PI; *Eosentomon transitorium* 2 MM, 1 undet. – (16) Vence, Nice, 13/XI/1983, S. Zoia coll. *Acerentomon gallicum* 1 M, 1 F. – (16) Cagnes, *Quercus ilex* forest, 20/VIII/1983, C. Torti & S. Zoia coll. *Acerentomon gallicum* 7 MM, 6 FF, 1 LII, 6 MJ, 4 PI; *Acerella tiarnea* 2 FF, 1 M; *Acerella* sp. 1 F; *Eosentomon transitorium* 3 MM, 2 FF. – (16) Nice (surroundings), *Quercus ilex* forest, 13/XI/1983, S. Zoia coll. *Eosentomon transitorium* 1 F. – (17) Chapelle Saint Cassien des Bois, Siagne river, 63 m elev., 13/V/2022, R. Poggi coll. *Acerentomon microrhinus* 1 F. – (18) Saut du Loup, Grasse, 20/VIII/1983, C. Torti & S. Zoia coll. *Acerentomon gallicum* 5 MM, 10 FF, 1 PI; *Acerella* sp. 1 F; *Eosentomon* sp. (*delicatum* group) 1 F. – (18) Grasse (surroundings), *Quercus ilex* forest, 20/VIII/1983, C. Torti & S. Zoia coll. *Acerentomon gallicum* 2 FF, 2 MM; *Acerella tiarnea* 2 MM, 2 FF.

Hérault

(19) Clapiers, ruisseau de la Pissieirasse, 14/XII/1982, H.-P. Aberlenc coll. Protentomidae undet. 2; Eosentomon sp. 1 M, 1 F, 1 LI.

Pyrenees

(20) Saint Pé de Bigorre, mixed forest (*Fagus sylvatica* dominant), 2/VIII/1985, S. Zoia coll. *Acerentomon affine* 2 MM, 2 FF. – (21) Angave, Campan, 700 m elev., *Fagus sylvatica* forest, 4/VIII/1985, S. Zoia coll. *Acerentomon affine* 2 MM, 2 FF, 1 MJ. – (22) Moulin Lauga, Seix, mixed forest (*Fagus sylvatica* dominant), 9/VIII/1985, S. Zoia coll. *Acerentulus* sp. (*confinis* group) 1 M, 7 FF, 1 MJ; *Acerentomon* sp. 1 MJ. – (23) Mines d'Anglad (surroundings), Salau, 1250 m elev., 9/VIII/1985, S. Zoia coll. *Acerentomon affine* 2 MM, 2 FF, 1 MJ. – (24) Roquefeuil (surroundings), Belcaire, 1000 m elev., 11/VIII/1985, S. Zoia coll. *Acerella tiarnea* 1 F.

Corsica

(25) Rogliano (surroundings), Capo Corso, 23/V/1982, S. Zoia & A. Torchia coll. *Acerentomon meridionale* 3 FF. – (26) Erbalunga, Bastia, *Quercus ilex* forest on limestone, 22/V/1982, A. Torchia & S. Zoia. *Acerentomon italicum* 2 MM, 3 FF. Santa Maria di Lota, Bastia, *Quercus ilex* forest, 22/V/1982, A. Torchia & S. Zoia. *Acerentomon italicum* 2 MM, 1 F. – (27) SW slope Mt Petrone, Lano (surroundings), *Quercus ilex* forest on limestone, 26/V/1982, S. Zoia & A. Torchia. *Acerentomon affine* 1 F.

In summary, a total of 15 Protura species were identified in the samples examined: *Acerentulus confinis*, *A. gisini*, *A. traegardhi*, *Podolinella ruseki*, *Acerentomon affine*, *A. gallicum*, *A. italicum*, *A. meridionale*, *A. microrhinus*, *Acerella muscorum*, *A. tiarnea*,

Eosentomon armatum, *E. germanicum*, *E. noseki* and *E. transitorium*. In addition, we can mention the genera *Proturentomon* and *Gracilentulus*.

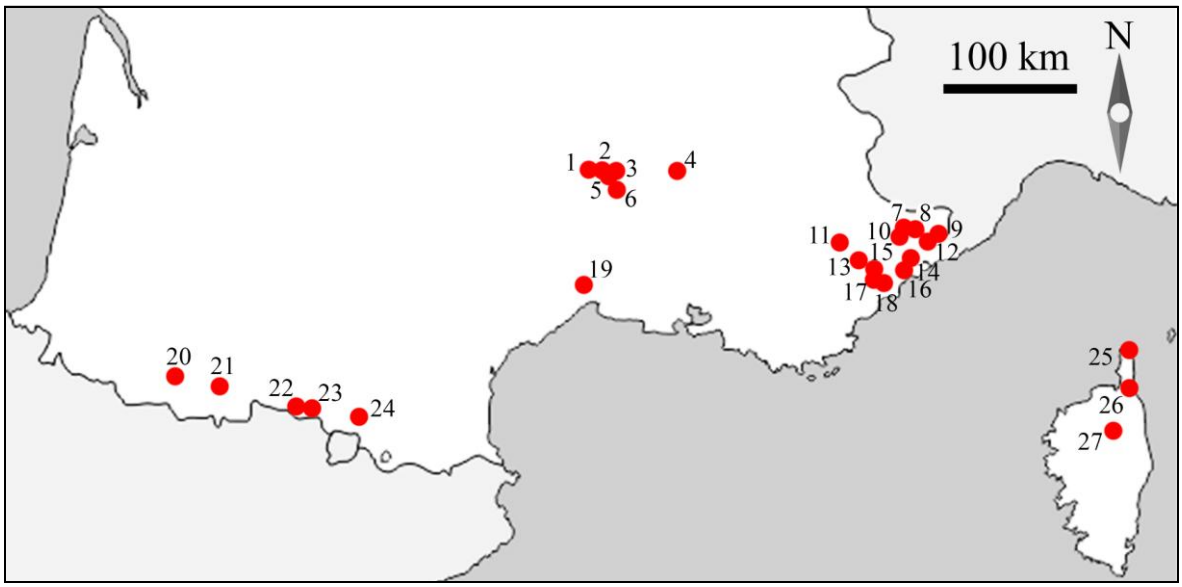

Figure 1. Protura sampling localities in Southern France. For the numeric codes of the collection sites see the text (each number can correspond to multiple sites close to each other).

As already highlighted in the literature for some Protura (e.g. Galli et al., 2019a,b), probably due to their reproductive strategies, for two acerentomid species an imbalance towards females was detected: *Acerella tiarnea* (26 females vs 9 males – $\chi^2 = 8.2571$, d.f. 1, $p < 0.01$, Monte Carlo $p < 0.01$) and *Acerentomon gallicum* (44 females vs 22 males – $\chi^2 = 7.3333$, d.f. 1, $p < 0.01$, Monte Carlo $p < 0.05$). For both species the same disproportion was also found in Italy (Galli et al., 2019 b).

Based on the data, three new records have been added to the French fauna. *Acerentulus gisini* Condé, 1952 known from Germany, Switzerland, Austria, Italy and Ukraine; *Podolinella ruseki* (Nosek, 1967), which also represents a new record at the genus level, previously found in Austria and Italy; *Eosentomon noseki* Tuxen, 1982 from Macaronesia, Spain and Italy (Szeptycki, 2007; Galli, 2022).

CONCLUSIONS

Protura are understudied hexapods due to the small number of specialists (Bernard & Whittington, 2021; Szeptycki, 2007). The French fauna is quite well known above all thanks to Bruno Condé's research, without neglecting Jean J. François' invaluable contribution to the general knowledge of proturans (Thibaud et al. 2022). Nevertheless, the few dozen specimens examined in this research made it possible to enrich the national list with three species and one genus.

This result confirms the importance of in-depth research on the so-called minor taxa for a better estimate of biodiversity.

ACKNOWLEDGEMENTS - The authors wish to thank Henri-Pierre Aberlenc, Sara Ferrando and Lorenzo Gallus for the critical review of the manuscript.

REFERENCES

Bernard E.C. & Whittington A.E., 2021. Papers and new species of minor insect orders published in Zootaxa, 2001-2020. Zootaxa 4979(1): 232–235.

Galli L., 2022. Updates to Szeptycki's check-list of the Protura of the World. Biogeographia – The Journal of Integrative Biogeography 37(2): a020.

Galli L., Capurro M., Colasanto E., Molyneux T., Murray A., Torti C. & Zinni M., 2019a. A synopsis of the ecology of Protura (Arthropoda: Hexapoda). Revue suisse de Zoologie 126(2): 155–164.

Galli L., Capurro M., Molyneux T., Torti C. & Zinni M., 2019b. Ecology of Italian Protura. Pedobiologia 73: 20–28.

Galli L., Remelli S. & Menta C., 2025. *Tuxenidia lorenzoi* (Protura: Acerentomidae), a new species from Italy and updates on the distribution of genus *Tuxenidia*. The European Zoological Journal 92(1): 361–370.

Nosek J., 1973. The European Protura, their taxonomy, ecology and distribution with keys for determination. Muséum d'Histoire Naturelle, Genève, 345 pp.

Rusek J., 2007. A new classification of Collembola and Protura life forms. In: Tajovsky K, Schlaghamersky J, Pižl V (Eds.), Contributions to soil zoology in Central Europe. II. Proceedings of the 8th Central European Workshop on Soil Zoology, Česke Budějovice, Czech Republic, pp. 109–115.

Szeptycki A., 2007. Catalogue of the world Protura. Acta Zoologica Cracoviensia 50B(1): 1–210.

Thibaud J.-M., Sendra A. & Shrubovych J., 2022. Historical and global scale catalogue of diplurologists (1842-2019) and proturologists (1907-2020). Bulletin de la Société entomologique de France 127(1): 19–36.

DOI: 10.15167/2612-2960/BELS2025.7.1.2548