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CONTRIBUTION TO THE KNOWLEDGE OF THE *PROTONEMURA CORSICANA* SPECIES GROUP, WITH A REVISION OF THE NORTH AFRICAN SPECIES OF THE *P. TALBOTI* SUBGROUP (PLECOPTERA: NEMOURIDAE)

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ABSTRACT

Protonemura dakkii sp. n. (Morocco) and *P. algirica bejaiana* ssp. n. (Tunisia) are described from both sexes and larvae. For comparison, three other North African members of the *Protonemura corsicana* group are redescribed: *P. talboti* (Navás, 1929), *P. algirica* (Aubert, 1956) and *P. berberica* Vinçon & Sánchez-Ortega, 1999, and the larva of *P. berberica* is described for the first time. A morphological and biogeographical study of the *P. corsicana* group is presented. This group now comprises 31 species and 3 subspecies split in four subgroups (*corsicana, talboti, consiglioi* and *spinulata*) mainly according to the shape of the epiproct. The utility of the *Protonemura tuberculata* group is questioned, and a new group, *Protonemura bacurianica* group, is distinguished.

Keywords: *Protonemura corsicana* group, new taxa, redescription, larval description, systematics, taxonomy, zoogeography, North Africa

INTRODUCTION

In 1956, five species of the *Protonemura corsicana* group were already gathered by Aubert (1956), but in this work he didn't give a name to this group. It is only in 1964 that he created the *P. corsicana* group, adding *P. libanica* Aubert, 1964b and *P. zernyi* Aubert, 1964b, to the five previously gathered species: *P. corsicana* (Morton, 1930), *P. navacerrada* (Aubert, 1954), *P. talboti*, (Navás, 1929), *P. algirica* (Aubert, 1956) and *P. ichnusae* (Consiglio, 1957a).

The knowledge of this group has progressively improved with the contributions brought by Consiglio (1957a, 1957b), Raušer (1962, 1963), Zwick (1978) and Berthélemy & Dia (1982).

Then a major biogeographic and bibliographic synthesis was made by Nicolai (1985), including 18 species: *P. bifida* Martynov, 1928, *P. triangulata* Martynov, 1928, *P. talboti*, *P. corsicana*, *P. viridis* Balinsky, 1950, *P. navacerrada*, *P. algirica*, *P. ichnusae*, *P. bucolica* (Consiglio, 1957b), *P. teberdensis* Zhiltzova, 1958, *P. albanica* Raušer, 1963, *P. waliabadi* Aubert, 1964a, *P. hassankifi* Aubert, 1964a, *P. zernyi*, *P. libanica*, *P. malickyi* Zwick, 1978, *P. pectinata* Berthélemy & Dia, 1982 and *P. helenae* Nicolai, 1985. Nicolai also mentioned 3 other species, *P. tyrrhena* (Festa, 1938), *P. macrura* (Aubert, 1953) and *P. ruffoi* Consiglio, 1961, but he preferred not to include them in the *P. corsicana* group since their filament is short and rising

upwards at the tip of the epiproct. Nevertheless, as proposed by Fochetti (1991), we consider that they belong to the *P. corsicana* group.

Biogeographical studies subsequently carried out by Fochetti (1991) separated several sets of species in the *P. corsicana* group: a first one composed of strictly insular elements (*P. corsicana, P. bucolica, P. ichnusae, P. helenae*), a second one occurring in the Apennines, Sicily and/or Algeria (*P. tyrrhena*, *P. macrura*, *P. ruffoi*), while the two remaining species *P. navacerrada* (NW. Spain) and *P. consiglioi* (Aubert, 1953) (S. Apennines) appeared rather isolated. Few years after, biochemical studies were applied on some of these species (Fochetti 1994) showing few contradictions in the results. Indeed, the cladistic analysis agreed with the theory of a Miocenic colonization of the Mediterranean basin, but the phenetic analysis did not clearly support this theory since the greatest similarities appeared between the species from Sardinia and Sicily instead of Corsica.

During the last two decades, seven further species belonging to the *P. corsicana* group have been described: *P. cressa* Zwick, 1978 (male described by Zwick (1996)), *P. canigolensis* Zwick & Vinçon, 1993, *P. berberica* Vinçon & Sánchez-Ortgea, 1999, *P. phoenicia* Sivec & Dia, 2001, *P. androsiana* Pardo & Zwick, 2004, *P. ausonia padana* Vinçon & Ravizza, 2005 and *P. drahamensis* Vinçon & Pardo, 2006. In the mean time, three other taxa were added to the *corsicana* group by Vinçon & Zhiltzova (2004): *P. spinulata* Martynov, 1928 and *P. oreas* Martynov, 1928, that were previously placed in the *P. spinulata* group (Zhiltzova 2003), and *P. bifida madani* Aubert, 1964a, that was assigned to the *P. nimborum* group (Aubert 1964a). Recently, Murányi (2007) has given the description of the larva of *P. albanica* and a distribution map for 28 members of the *P. corsicana* group (Murányi 2007: Fig. 104).

In this work, four species are added to the *P. corsicana* group since they have a bifid terminal filament on the epiproct, though it is hardly prominent and difficult to see. It is the case for one Macedonian species, *P. miatchense* Ikonomov, 1983, initially assigned to the *P. risi* group and that is close to *P. albanica*, and for 3 Italian species that are taken out of the *P. tuberculata* group: *P. consiglioi* as proposed by Fochetti (1991), *P. ausonia* (Consiglio, 1955) as proposed by Vinçon & Ravizza (2005) and *P. hirpina* (Consiglio, 1958) as verified by Fochetti (in lit.). On the other hand, we remove four species from the *P. corsicana* group: - *P. viridis* and *P. hassankifi*, since they have no terminal filament at the tip of the epiproct and should be considered as isolated species that couldn't be included in pre-existant groups, - *P. navacerrada,* its terminal filament is not typical of the *P. corsicana* group (see hereafter), and we placed it in the *P. nitida* group (*meyeri-nitida-nimborum* group sensu Vinçon & Ravizza (2005)) where it shares strong affinities with *P. zhiltzovae* Vinçon & Ravizza, 2005 and *P. brevistyla* (Ris, 1902), - *P. dilatata* Martynov, 1928, previously assigned to the *P. corsicana* group (Vinçon & Zhiltzova 2004), is now placed in the *P. risi* group, as suggested by Zhiltzova (2003) (sensu *P. auberti* group).

Lastly, in February and June 2006, two collecting trips were undertaken in the Moroccan Rif and Atlas mountains. The study of this material has resulted in the identification of a new Moroccan species, *Protonemura dakkii* sp. n., previously confused with *P. algirica* and *P. talboti* in Aubert's and Berthélemy's collections. We also describe a new Tunisian subspecies *P. algirica bejaiana* ssp. n. that corresponds to *P. algirica* ssp. nov. sensu Berthélemy (1973). Including these two last taxa here described, the list of the *P. corsicana* group now comprises 31 species and 3 subspecies (Table 1). These new Maghrebin species are compared to the other members of the *Protonemura corsicana* group, inducing several modifications in the composition of this group.

Hereafter, we present the morphological criteria that we use to divide the *P. corsicana* group into four subgroups (Table 1), and then we present the zoogeographical aspects.

MATERIAL AND METHODS

The material is preserved in alcohol. Type specimens are deposited in the Zoological Museum of Lausanne, Switzerland (ZML). Further specimens, including those of Berthélemy's collection, are held by G. Vinçon, Grenoble, France (CGV), and other specimens are stored in the Hungarian Natural History Museum, Budapest, Hungary (HNHM) or in the Granada University collection, Spain (GUC) (Sánchez-Ortega and Tierno de Figueroa coll.).

When necessary, terminalia were cleared by boiling in 10% KOH. SEM photos were made using

golden-palladium coating after critical point drying.

Terminology of the terminalia follows Baumann (1975). Distribution maps were compiled from data extracted from the following papers: Aubert 1953, 1954, 1964a, 1964b, Balinsky 1950, Berthélemy & Dia 1982, Consiglio 1955, 1957a, 1957b, 1958, 1961, Festa 1938, Ikonomov 1983, Lounaci & Vinçon 2005, Martynov 1928, Morton 1930, Murányi 2007, Nicolai 1985, Pardo & Zwick 2004, Raušer 1963, Sivec & Dia 2001, Tierno de Figueroa et al. 2003, Vinçon & Pardo 2006, Vinçon & Ravizza 1998, 2005, Vinçon & Zhiltzova 2004, Zhiltzova 1958, 2003, Zwick 1978, Zwick & Vinçon 1993.

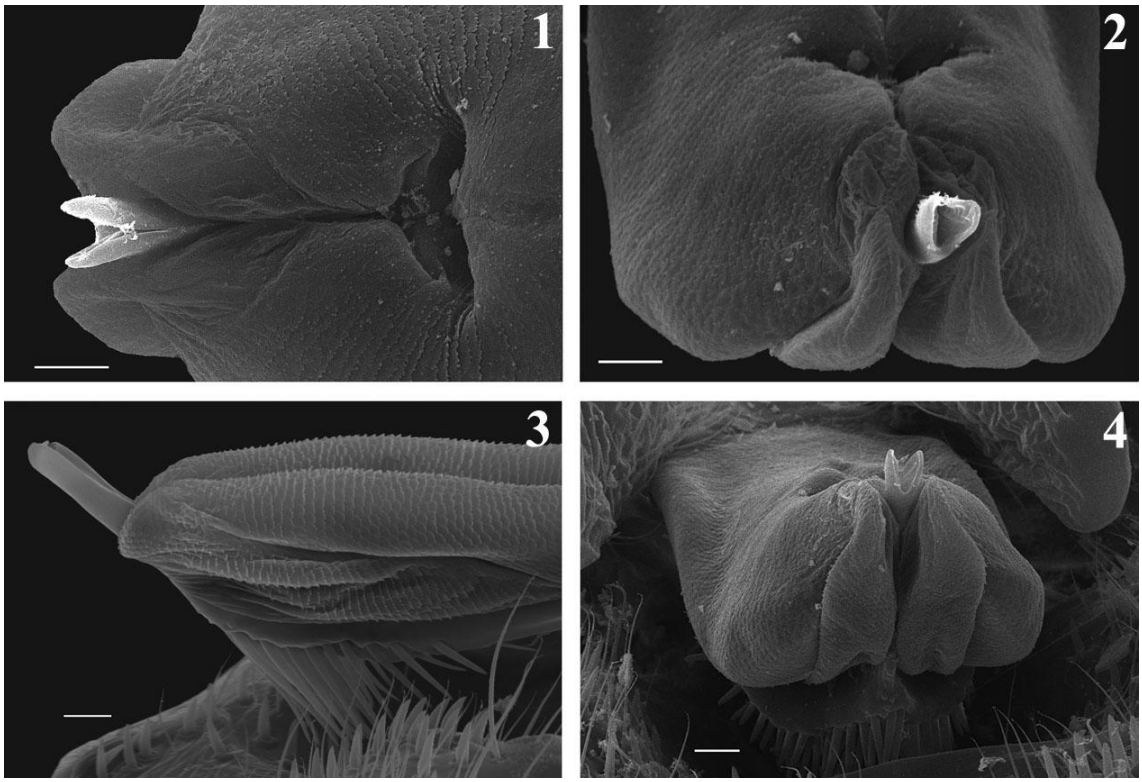
RESULTS AND DISCUSSION

Morphological characterisation of the *Protonemura corsicana* group

The main characters useful to separate different subgroups within the *P. corsicana* group mainly concern the male genitalia. Indeed the females have no distinctive criteria. The larvae have very short, not constricted gills, but this criteria is also present in other species or species group (*P. risi* complex, for example).

Shape of the terminal filament of the epiproct
(Figs. 1-4)

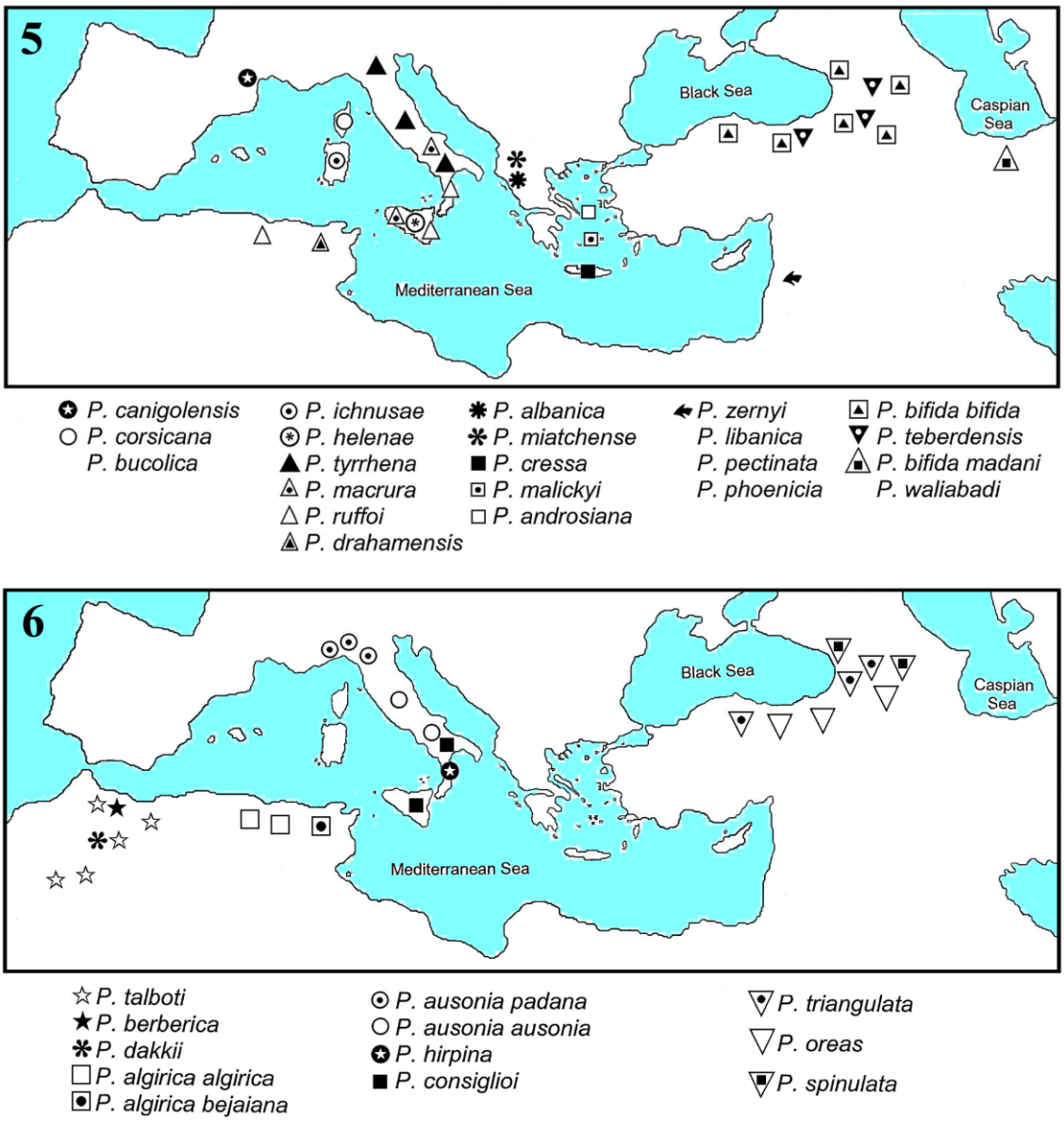
All authors agree to characterize the *P. corsicana* group by the presence of a more or less long expansion also named 'terminal filament' at the apex of the epiproct (Figs. 1-4), but this feature is poorly reliable since it is not exclusive of the *P. corsicana* group. On the other hand, the bifid opening of the terminal filament is a more important feature since it is exceptional in the genus *Protonemura* Kempny, 1898. Zwick (1978) and Nicolai (1985) consider that this filament, looking like an open tube, is a hollow lengthening of the ventral sclerite through which the sperm passes.



Figs. 1-4. Apex of the male's epiproct of the *Protonemura corsicana* group. 1: the terminal filament and the apical part of the dorsal sclerite, dorsal view; 2: the terminal filament and the apical part of the dorsal sclerite, dorso-apical view; 3: the terminal filament, the apical part of the dorsal sclerite and the spiny bulge of the ventral sclerite, lateral view; 4: the terminal filament, the dorsal sclerite and the spiny bulge of the ventral sclerite, apical view (1-2, 4: *Protonemura berberica* Vinçon & Sánchez-Ortega, 1999; 3: *P. talboti* (Navás, 1929); scale 0.02 mm).

Table 1. Morphology and biogeography of the *Protonemura corsicana* group (L = long, M = medium, S = short).

	Outer lobe's apex	**Terminal filament of epiproct**			**Epiproct**		**Distribution**
		size	bifid apex	rising upwards	ventral bulge	abrupt shrinking	
***P. corsicana* subgroup**							
P. canigolensis Zwick & Vinçon, 1993	medium	M	•		slight		E. Pyrenees
P. bucolica (Consiglio, 1957b)	narrow	M	•		slight		Corsica
P. corsicana (Morton, 1930)	medium	L	•		slight		Corsica
P. ichnusae (Consiglio, 1957a)	narrow	M	•		slight		Sardinia
P. helenae Nicolai, 1985	narrow	L	•		slight		Sicily
P. tyrrhena (Festa, 1938)	narrow	S	•	•	slight		Apennines
P. macrura (Aubert, 1953)	narrow	S	•	•	slight		S. Apennines, Sicily
P. ruffoi Consiglio, 1961	narrow	S	•	•	slight		S. Apennines, Sicily, Algeria
P. drahamensis Vinçon & Pardo, 2006	narrow	R	•		slight		Tunisia
P. albanica Raušer, 1963	wide	M	•		slight		Albania
P. miatchense Ikonomov, 1983	wide	S	•		slight		Macedonia
P. cressa Zwick, 1978	narrow	M	•		slight		Creta
P. malickyi Zwick, 1978	narrow	L	•		slight		Naxos (Greek island)
P. androsiana Pardo & Zwick, 2004	wide	L	•		slight		Andros (Greek island)
P. zernyi Aubert, 1964b	medium	L	•		slight		Israel, Lebanon
P. libanica Aubert, 1964b	medium	S	•		slight		Lebanon
P. pectinata Berthélemy & Dia, 1982	medium	L	•		slight		Lebanon
P. phoenicia Sivec & Dia, 2001	narrow	S	•		slight		Lebanon
P. teberdensis Zhiltzova, 1958	wide	M	•		slight		Causasus, E Pontic chain
P. bifida bifida Martynov, 1928	wide	M	•		slight		Causasus, E Pontic chain
P. bifida madani Aubert, 1964a	wide	M	•		slight		Iran (Khorassan)
P. waliabadi Aubert, 1964a	narrow	L	?		slight		Iran (Khorassan)
***P. consiglioi* subgroup**							
P. ausonia padana Vinçon & Ravizza, 2005	wide	S	•		strong		W. Alps, N. Apennines
P. ausonia ausonia (Consiglio, 1955)	wide	R	•		strong		C. S. Apennines
P. hirpina (Consiglio, 1958)	wide	S	•		strong		S. Apennines
P. consiglioi (Aubert, 1953)	wide	S	•		strong		S. Apennines, Sicily
***P. talboti* subgroup**							
P. berberica Vinçon & Sánchez-Ortega, 1999	wide	S	•	•	medium		Moroccan Rif
P. dakkii sp. n.	wide	M	•	•	medium		Moroccan Middle-Atlas
P. talboti (Navás, 1929)	wide	M	•		medium		Morocco, W. Algeria
P. algirica algirica (Aubert, 1956)	wide	S	•		medium		Algeria
P. algirica bejaiana ssp. n.	wide	S	•		medium		Tunisia
***P. spinulata* subgroup**							
P. triangulata Martynov, 1928	wide	S	•		medium	•	Causasus, Pontic chain
P. oreas Martynov, 1928	narrow	M	•		medium	•	Causasus, E Pontic chain
P. spinulata Martynov, 1928	medium	S	•		medium	•	Caucasus



Figs. 5-6. Distribution of the species of the *Protonemoura corsicana* group. 5: *Protonemura corsicana* subgroup; 6: *P. talboti* subgroup, *P. consiglioi* subgroup and *P. spinulata* subgroup.

Consequently, several European species, though they have a terminal filament on the epiproct, don't belong to the *P. corsicana* group; indeed their filament is not a tube with bifid opening, and it better looks like the rounded tip of an internal sclerite: *P. navacerrada*, *P. algovia* Mendl, 1968, *P. culmenis* Zwick & Vinçon, 1993, *P. brittaini* Vinçon & Ravizza, 1998, *P. fusunae* Vinçon & Ravizza, 1998, *P. zhiltzovae* Vinçon & Ravizza, 2005. It is also the case for three Japanese or East Asiatic groups: the *P. hotakana* and *P. towadensis* groups having a short filament and the *P. orbiculata* group having a bifurcate flagellum rising from the epiproct's apex like a snake tong (Shimizu 1998).

The filament's length is rather variable, from hardly prominent in few species (*P. consiglioi*, *P. hirpina*, *P. drahamensis* or *P. phoenicia*), up to about one third of the epiproct's length in *P. helenae*.

Moreover it may be different between two subspecies of the same species, indeed the filament is hardly visible in *P. ausonia ausonia* and conspicuous in *P. ausonia padana*.

Most frequently, the filament is rectilinear and projects at the tip of the epiproct, but in eight species it clearly rises upwards from the tip (Table 1). Nevertheless, this feature can be affected by the conservation conditions of some specimen (SEM preparation for example, see Fig. 3). In two other species, the terminal filament is not rectilinear but curved upwards in *P. waliabadi* or bent right and downwards in *P. canigolensis*.

Shape of the epiproct (Figs. 3-4)

Most (22) species or subspecies of the *P. corsicana* group have a slim epiproct with an almost flat or hardly pronounced spiny bulge on the inferior face of the epiproct, a feature that characterizes a first subgroup in the *corsicana* group (*P. corsicana* subgroup).

The 12 remaining species distinguish themselves by the shape of their epiproct (size of the spiny bulge, presence or absence of an abrupt shrinking near the epiproct's tip). Among them, we distinguish 3 subgroups (*P. talboti, P. consiglioi* and *P. spinulata* subgroups) (see hereafter).

Shape of the paraprocts

Raušer (1962) established several groups in the *Protonemura* genus mainly according to the shape of the paraprocts. However these features are not reliable since they are highly variable within each group. For example, in the *P. corsicana* group, the paraprocts of *P. corsicana* (Corsica), *P. bucolica* (Corsica), *P. ichnusae* (Sardinia) and *P. helenae* (Sicily) are clearly different, even though these species are closely related (Nicolai 1985, Fochetti 1991, 1994). Even within one species, the blade-shaped expansion of the median lobe (style) can be variable in length (see *P. talboti* in Aubert 1956: Figs. 9-10). For these reasons, the shape of the epiproct appears much more reliable to distinguish different groups in the *Protonemura* genus, and it has already been used to define the *P. praecox, P. risi, P. intricata, P. corsicana, P. curvata, P. hotakana, P. orbiculata* and *P. towadensis* groups (Zhiltzova 2003, Vinçon & Zhiltzova 2004, Vinçon & Ravizza 2005, Shimizu 1998).

Evolution and biogeography of the *Protonemura corsicana* group and its subgroups

The *P. corsicana* group is characterized by the filament extending at the tip of the epiproct, a feature that is probably plesiomorphic since it also occurs in some Japanese *Protonemura*, some *Amphinemura* Ris, 1902 and other Asiatic genera (*Indonemoura* Baumann, 1975, *Mesonemoura* Baumann, 1975 and *Sphaeronemoura* Shimizu & Sivec, 2001); in fact this could hardly be explained by convergent evolutions (Nicolai 1985). On the other hand, the bifid opening of the epiproct that better characterizes the *P. corsicana* group is probably an apomorphic feature since it is exceptional in the Nemouridae except the *P. corsicana* group (Zwick 1978).

On a biogeographical point of view, the *P. corsicana* group mainly covers the Mediterranean region where it has probably originated (27 taxa). It also extends eastwards in the Pontique chain and Caucasus (5 taxa), even up to the Iranian Elbourz Massif (2 taxa). All its members have a limited distributional area, most of them being relict micro-endemic species, occuring in islands or in widely scattered mountainous ranges in dry areas of the western Palearctic region (southern Europe, northern Africa and Middle East as far as the Caspian Sea).

All authors agree to consider that the actual distribution of this group is probably a consequence of its ancient origin, during the Tertiary period or even earlier. According to Nicolai (1985), it could be the result of the Miocenic rifting of the Mediterranean microplates later modified by Quaternary glaciations, but biochemical studies performed by Fochetti (1994) also seem to indicate the influence of more recent colonization, and therefore, further studies are needed to better understand its origin and wide dispersal.

In what follows, we characterize the biogeography of the four defined subgroups in the *P. corsicana* group.

The *Protonemura corsicana* subgroup (21 species and 1 subspecies)

The members of this subgroup have a very shallow bulge, covered with scattered short spines, on the inferior face of the epiproct. This bulge is even sometimes hardly visible since it is nearly flat. The epiproct's terminal filament is of various lengths, always ending in a bifid opening.

The *Protonemura corsicana* subgroup has a Circum-

Mediterranean distribution extending up to the Black and Caspian Seas (Fig. 5) and covering numerous Mediterranean Islands: Corsica (*P. bucolica, P. corsicana*), Sardinia (*P. ichnusae*), Sicily (*P. helenae, P. macrura*, *P. ruffoi*), Crete (*P. cressa*), Naxos (*P. malickyi, P. androsiana*) and Andros (*P. androsiana*). It is also widely spread on both northern and southern sides of the Mediterranean Sea (Fig. 5).

According to Nicolai (1985), it has probably originated somewhere in the Mediterranean Sea region and widely spread in the Tertiary period, probably between the late Mesozoic and the early Oligocene, when the Mediterranean Sea was narrower and easier to cross for aquatic insects with poor flying activity.

It is mainly composed of eurythermous species, a character that could have favored its wide dispersal between the Mediterranean Islands and both sides of the Mediterranean Sea during the Tertiary period.

The *Protonemura talboti* subgroup (4 species and 1 subspecies)

This subgroup is characterized by a well developed bulge, but not strongly prominent, covered with long spines on the inferior face of the epiproct (Figs. 3-4). The terminal filament always ends in a bifid tip and is rather short. The outer lobes of the paraprocts have a very wide apex. The female subgenital plate is wide, slightly bilobed, with two small lateral lobes. Larvae of this subgroup can be characterized with short and simple cervical gills and short pilosity. Short cervical gills possibly characterize the whole group, but many of the larvae hitherto remain undescribed (Murányi 2007).

This subgroup covers the whole North African cordillera from the Moroccan Atlas and Rif, throughout the Algerian cordillera, and up to the Khroumirian mountains (western Tunisia) (Fig. 6).

The *Protonemura consiglioi* subgroup (3 species and 1 subspecies)

This subgroup is characterized by a very strong bulge covered with a small group of long spines on the inferior face of the epiproct. The terminal filament ends in a bifid opening and is hardly prominent at the tip of the epiproct. The female subgenital plate is tong shaped, slightly bilobed, with two strongly developed lateral lobes.

This set of species mainly extends from Sicily, throughout the Apennines, and up to the French Maritime Alps (Fig. 6).

The *Protonemura spinulata* subgroup (3 species)

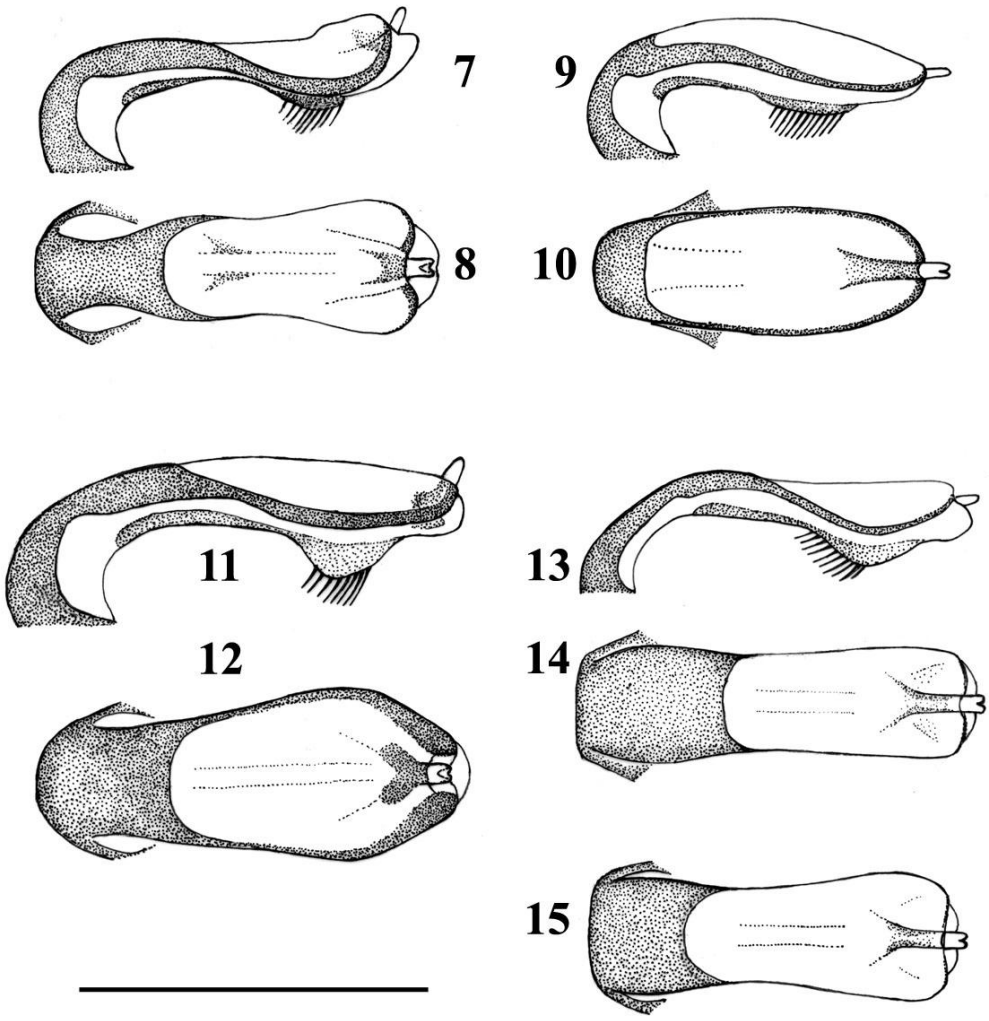
This group, previously defined as a distinct group (*P. spinulata* group) by Zhiltzova (2003), is characterized in the male by the epiproct having an abrupt, almost right angled shrinking near the apex of the epiproct (Zhiltzova 2003: Figs. 337, 341 and Vinçon & Zhiltzova 2004: Fig. 3c). The median bulge is clearly prominent, covered with long spines, as it is in the *P. talboti* subgroup (convergence ?). The terminal filament of the epiproct is bifid at the tip and of various length. The female is also well characterized by a very wide subgenital plate, covering almost all the lateral lobes that are therefore hardly visible on each side of the plate.

This subgoup is a Caucasian element slightly extending along the Black Sea, in the eastern part of the Turkish Pontic chain, up to the Bolu region (*P. triangulata*) (Fig. 6).

The validity of the *Protonemura tuberculata* group

The utility of the *Protonemura tuberculata* group appears questionable since the only criterion that defines it, the presence of a strong spiny bulge on the inferior face of the epiproct, is very variable. Using this character, a few species of the *P. corsicana* group were wrongly assigned to the *P. tuberculata* group (*P. ausonia, P. consiglioi, P. hirpina*). Even within the remaining species of the *P. tuberculata* group the size of the bulge remains highly variable, from moderate in *P. globosa* Berthélemy & Whytton da Terra, 1980 to very strong in *P. tuberculata* (Despax, 1929) and *P. alticola* Zhiltzova, 1958, three species having little in common except this bulge. Moreover, according to Berthélemy & Whytton da Terra (1980), *P. globosa* is close to *P. alcazaba* (Aubert, 1954), but both are far from *P. tuberculata*.

Therefore, we propose to delete the *P. tuberculata* group, leading to the following modifications. *P. alcazaba* and *P. globosa* are placed in the *meyeri-nitida-nimborum* group considered as a unique group by Vinçon & Ravizza (2005). *P. bacurianica bacurianica* Zhiltzova, 1957, *P. bacurianica bythinica* Aubert, 1964a, *P. bacurianica adana* Vinçon & Zhiltzova, 2004, *P. elbourzi* Aubert, 1964a and *P. strandschaensis* Braasch & Joost, 1972 are moved into a separate group called the *P. bacurianica* group that corresponds to the *P. bacurianica* subgroup of the *P. tuberculata* group sensu



Figs. 7-15. Epiprocts of the North African species of the *Protonemura talboti* subgroup. 7-8: *Protonemura dakkii* sp. n.; 9-10: *P. talboti* (Navás, 1929); 11-12: *P. berberica* Vinçon & Sánchez-Ortega, 1999; 13-14: *P. algirica algirica* Aubert, 1956; 15: *P. algirica bejaiana* ssp. n. (7, 9, 11, 13: lateral view; 8, 10, 12, 14-15: dorsal view; scale 0.5 mm).

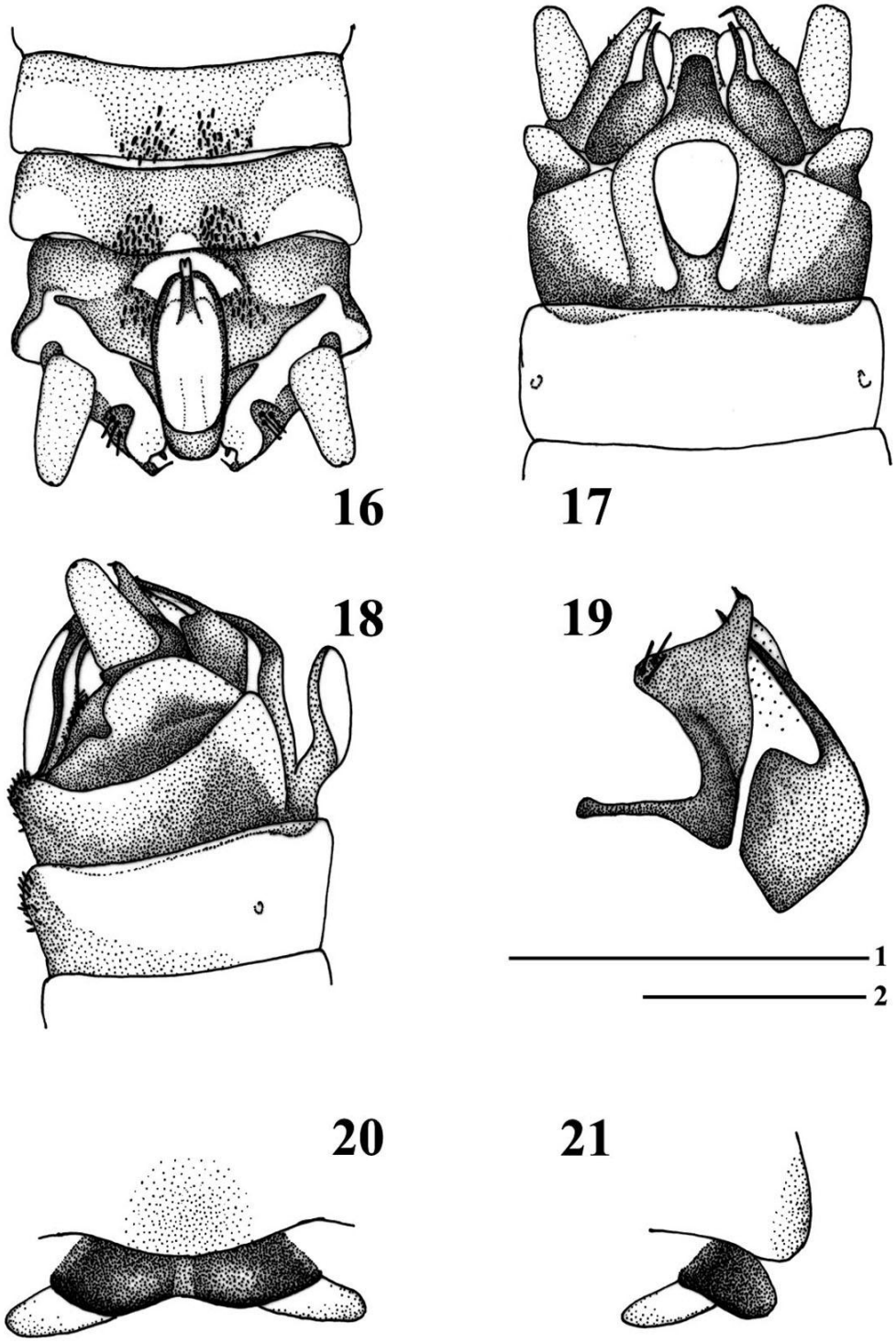
Vinçon & Zhiltzova (2004), also named *P. bithynica* group by Zhiltzova (2003). The three remaining elements are isolated endemic species occurring in the Pyrenees (*P. tuberculata* and *P. culmenis*) or the Caucasus (*P. alticola*), that couldn't be included in pre-existant groups.

Taxonomy of the Maghrebin species of the *Protonemura talboti* subgroup

The five members of the *Protonemura talboti* subgroup occur in the Maghreb in North Africa: *P. talboti*, *P. berberica*, *P. dakkii* sp. n., *P. algirica algirica*, *P. algirica bejaiana* ssp. n. Since they were often confused in collections, complementary descriptions are given for *P. talboti*, *P. algirica* and *P. berberica*.

***Protonemura talboti* (Navás, 1929)**
(Figs. 3, 6, 9-10, 16-27, 75)

Nemoura talboti Navás, 1929:230. (original description



Figs. 16-21. Terminalias of the imago of *Protonemura talboti* (Navás, 1929). 16: male terminalia, dorsal view; 17: male terminalia, ventral view; 18: male terminalia, lateral view; 19: male paraproct, ventrolateral view; 20: female pregenital and subgenital plates, and vaginal lobes, ventral view; 21: female pregenital and subgenital plates, and vaginal lobes, lateral view (scales 0.5 mm; scale 1: Fig. 19, scale 2: Figs. 16-18, 20-21).

from Algeria); Claassen, 1940:64. (catalog).

Nemoura (Protonemura) talboti Aubert, 1952:239. (redescription of the types); Aubert, 1956:422. (complementary description of the imago, description of the larva, first records from Morocco); Aubert, 1961 (partim):219. (new records from Morocco).

Protonemura talboti: Raušer, 1963:804. (comparative drawings, distribution map); Aubert, 1964a:72. (comparison); Aubert, 1964b:291. (initiation of the *P. corsicana* species group); Illies, 1966:243. (catalog); Meinander, 1967:45. (new records from Morocco); Berthélemy, 1973:1544. (distribution); Zwick, 1978:33. (composition of the *P. corsicana* group); Giudicelli & Dakki, 1984:54 (distribution); Nicolai, 1985:249. (biogeography and composition of the *P. corsicana* group); Gagneur & Aliane, 1991:312. (ecology, distribution); Zhiltzova, 2003:227. (composition of the *P. corsicana* group); Vinçon & Zhiltzova, 2004:193. (composition of the *P. corsicana* group); Lounaci & Vinçon, 2005:117. (new records from Algeria and Morocco, distribution); Murányi, 2007:28. (comparison, distribution).

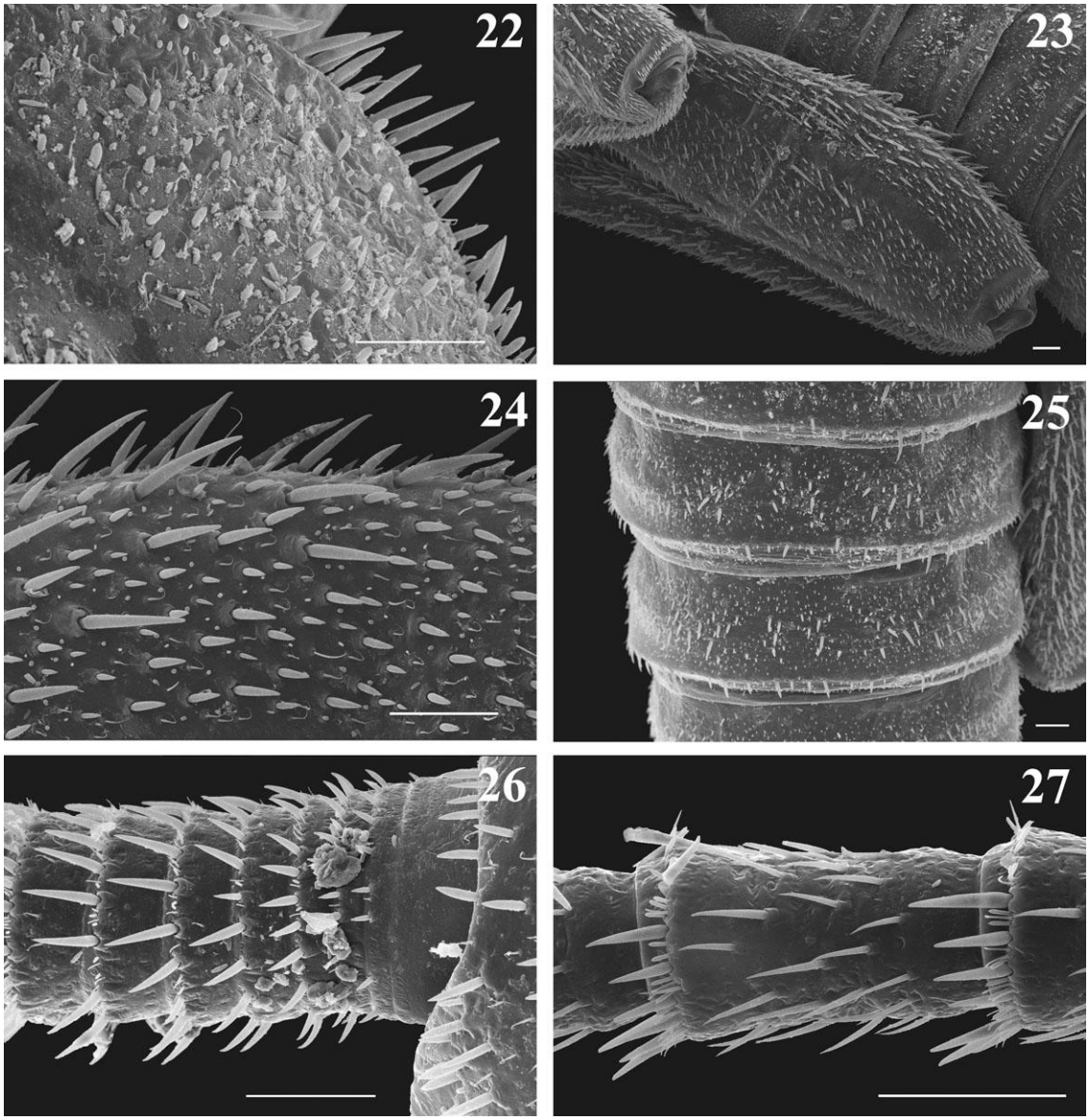
Nemoura (Protonemura) algirica auctt., nec Aubert, 1956; Aubert, 1961 (partim):218. (new records from Morocco).

Material examined. Morocco, High Atlas: M'Goun Massif, spring of Asif M'Goun, 2500 m, 17-VI-1954, 1♂ 1♀; Siroua Massif, Asif Siroua, above 2900 m, 29-VI-1954, 1♂ 4♀ (Vaillant leg, Aubert coll. ZML, published in Aubert 1956); Toufliht, 50 Km from Marrakech → Ouarzazate, 30-III-1988, 2♂; 68 Km from Marrakech → Ouarzazate, 1500 m, 30-III-1988, 1♂ (Sánchez-Ortega leg, GUC); tributary of Oued Ouarzazate, 116 Km from Marrakech → Ouarzazate, 2600 m, 9-III-1989, 4♂ 3♀ (Ropero & Peña leg, GUC); Tizi n'Test pass, above Tjoukak, 24-II-1996, 3♂ (Vinçon leg, CGV); Tizi n'Tichka pass, 10-IV-1997, 7♂ 6♀ (Luzón leg, GUC); southern slope of Tizi n'Test pass, big spring and brook, 1900 m, 22-I-2006, 9♂ 5♀ - 4♂ 4♀, 1♀ larva (Vinçon leg, HNHM; 1♂ and 1♀ terminalia prepared for SEM); 21-I-2006, 1♂ 2♀ larvae, 1♀ exuviae (Vinçon leg, HNHM; 1♀ larva prepared for SEM); same brook, 1600 m, 22-I-2006, 2♂ 2♀ (Vinçon leg, CGV); above Oukaimeden ski station, 2800 m, 3-VI-2006, 5♂ 4♀; below Oukaimeden, Ait El Kake village, 2150 m, 3-VI-2006, 5♂ 10♀; below Oukaimeden, small torrent on the left side of the road, 2000 m, 3-VI-2006, 5♂ 9♀ (Vinçon leg, CGV). **Morocco, Middle Atlas:** Azrou, 3-V-1960, 4♀ macropterous (labeled *P. algirica* Aubert 1960 and *Prot. spec* Zwick 1982, published as *N. (P.) algirica* in Aubert 1961); Ifrane, Oued Ifrane, 1700 m, 3-V-1960, 26♂ 13♀ 3 larvae (Besuchet leg, Aubert coll. ZML). **Morocco, Rif:** R. Achraf, 4 Km from Ketama, 1400 m, 7-VI-1992, 1♀ (Azzouz leg, GUC); above Tétouan, above Sefliane, brook, 22-II-1996, 1♂ (Vinçon leg, CGV). **Spain, Rif:** Ceuta, Embalse del Renegado, 85 m, 14-III-1997, 1♂; 20-IV-1997, 1♀ (Moro & Tierno de Figueroa leg, GUC). **Algeria, Tlemcen Region:** Oued Tlemcen, 31-V-1954, 5♂ 4♀ (Vaillant leg, Aubert coll. ZML, published in Aubert 1956).

Male genitalia (Figs. 3, 9-10, 16-19)**.** Paraprocts: Median lobe with a rounded base and a blade-shaped expansion with variable length (Aubert 1956: Figs. 9-10); outer lobe sclerite widely enlarged at the tip, with a rounded dorsal expansion carrying few strong spines (1–7) and a rather long and thin ventral expansion, curved inwards, and ending in one or two spines (Fig. 19 and Aubert 1956: Fig. 9, Raušer 1963: Fig. 3a). Epiproct: Thin, with its sides slightly convex, ending progressively in an oval tip; terminal filament of moderate size and bifid at the tip (Figs. 10, 16). In side view the terminal filament is about parallel to the epiproct but it can be slightly rising due to the condition of the specimen (Figs. 3, 9). Lateral sclerites thin, visible by transparency, and slightly curved upwards on each side of the epiproct's tip. Ventral sclerite with a prominent bulge partly covered with two rows of long spines forming a 'V' shape in ventral view (Fig. 3 and cf. *P. pectinata* Berthélemy & Dia 1982: Fig. 23). Sternite IX: Vesicle racket-shaped and widening at the tip (Fig. 17 and Aubert 1956: Fig. 7), but this character is rather variable.

Female genitalia (Figs. 20-21)**.** Subgenital plate slightly concave, with rounded vaginal lobes. Sternite VII with a postero-median pigmented pregenital plate.

Mature larva (Figs. 22-27, 75)**.** Body relatively slender, body length 6.5–9.0 mm. General colour brown. Pilosity distinct. Scales present only in the dorsal midline of the femora and on the tarsi. Legs typical of the genus, tibiae slightly longer than femora; width of hind femora less than one third of its length. Head stout, brown with dark patches. The pronotum is subtrapezoidal, with distinct granules and rounded corners; it is slightly narrowing towards the posterior margin and its length is more



Figs 22-27. Larva of *Protonemura talboti* (Navás, 1929). 22: front angle of the pronotum; 23: hind femur; 24: outer apical part of the femur; 25: 5–6th tergal segments; 26: basal segments of the cercus; 27: 15th segment of the cercus (scale 0.1 mm).

than two thirds of its maximum width. Cervical gills simple, the longest one equivalent to the width of the fore coxa. Wing pads shortened or of typical length for the genus. Abdomen relatively slender, integument light and matt, first 6 abdominal segments divided by pleura. Posterior margin of sternite IX of the mature male larva triangular, tip rounded; paraprocts slightly elongated but not pointed (Fig. 75 and Aubert 1956: Figs. 13-14). Genital opening well visible on the mature female larva, and placed under the anterior half of sternite VIII; paraprocts not pointed (Aubert 1956: Fig. 15). Cerci long, with more than 30 segments; segment sides nearly parallel, the width of segments 13–17 is

three fifths of their length.

Pilosity: Head with dense, stout bristles, and a few sensilla; the eyes bear small setae between the ocelli. Antennal segments with short pilosity. Pronotum with dense, stout and blunt bristles, and a few sensilla. Margin of the pronotum bearing acute bristles, the length of the longest ones is less than 1/15 of the pronotum's width (Fig. 22). The bristles on the anterior corners of the meso and metanotum are as long as the marginal bristles of the pronotum. The setae placed in lines on the wing pads are short and blunt. Legs with dense setation. All femora bear both short and long, acute bristles and a few thin hairs. Long bristles occur mostly on the outer surface; on hind femora they are placed on the apical half. Bristles not in a regular arrangement; the longest ones reach one fourth of the femur's width on the first pair, one fifth on the hind legs (Figs. 23-24). A bald median line is conspicuous on the dorsal surface of all femora and it is covered with rounded scales. Tarsi relatively slender, covered with thin hairs and bristles, metatarsi with triangular scales on the dorsal surface; apical spike of tibiae short. Tergal segments with acute bristles and thin hairs. Paired spines on the posterior margin acute, not much longer than the other spines of the row; on tergite V they reach more than one fourth of the segment's length (Fig. 25). Distal margin with tiny triangular spikes around the row of bristles. Cercal segments with acute bristles, blunt or thin ones occur only in the apical whorl (Figs. 26-27). The apical whorl on segments 13-15 is a set of 13–16 strong, acute spikes mixed with short, blunt and short, thin setae. Longest bristles reach one third of the segment's length on segments 13–15.

Affinities. In the male, the outer lobe of the paraprocts has a characteristic ventral finger-shaped expansion, and the epiproct is slender at the tip. In *Protonemura algirica*, *P. berberica* and *P. dakkii* sp. n., it is stronger at the tip, with wide rounded apex. The female is very close to that of *P. dakkii* sp. n. The larva is very similar to those of *P. dakkii* sp. n. and *P. berberica*, and only the pharate males can be identified with sure, on the basis of the male imago terminalia under the larval skin. However, it differs by its darker habitus and the frequency of stout, blunt bristles on the pronotum, tergites and femurs.

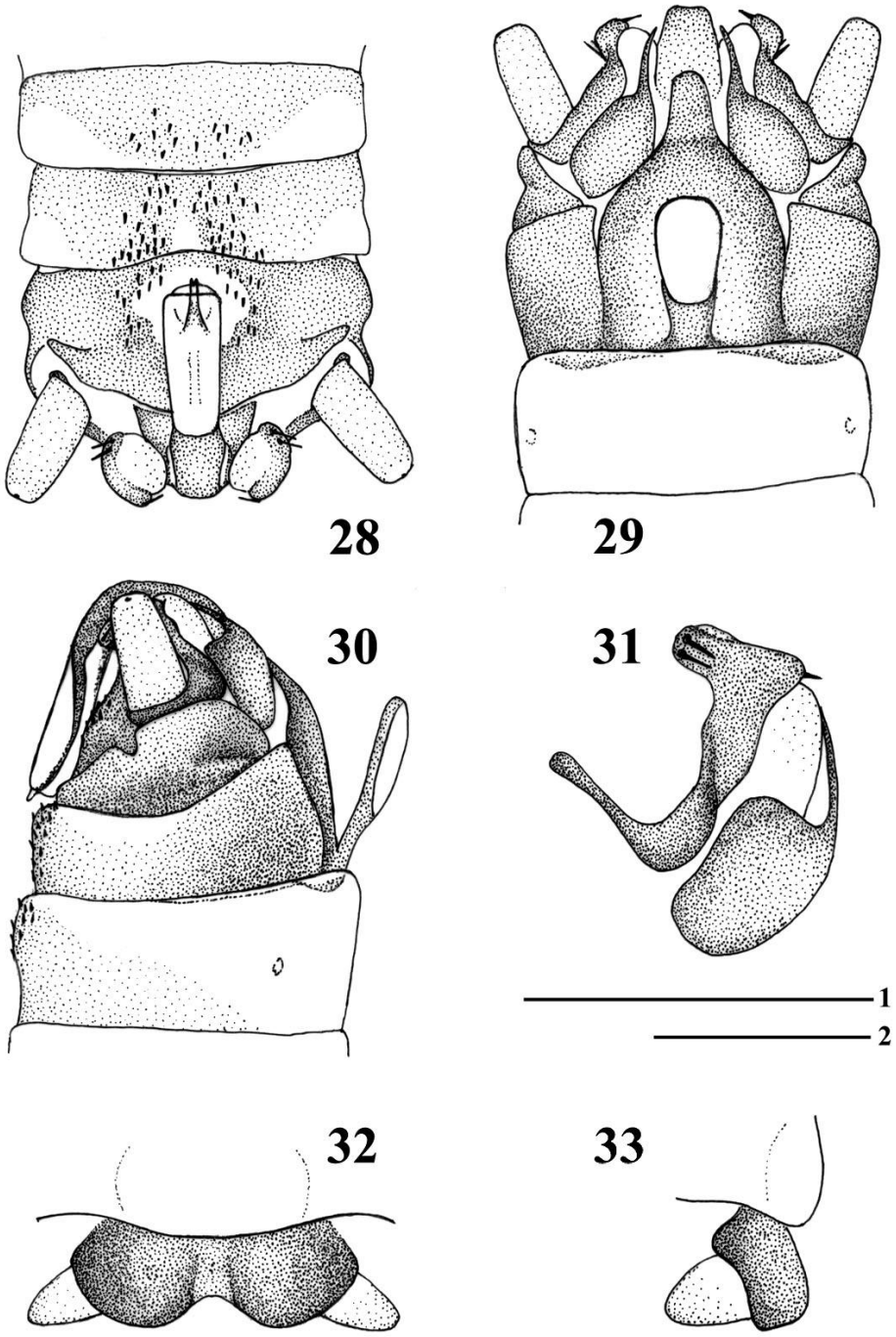
Geographical distribution and ecology. *P. talboti* is a west Maghrebin species inhabiting the Rif, the Middle and High Atlas, and the Tlemcen Mountains in western Algeria (Fig. 6). It occurs in mountain springs and brooks at various altitudes (85–2900 m). The specimens collected in the highest localities of the High Atlas are brachypterous.

***Protonemura algirica algirica* Aubert, 1956**
(Figs. 6, 13-14, 28-33)

Nemoura (Protonemura) algirica Aubert, 1956:424. (original description from Algeria and Morocco); Aubert 1961 (partim):218. (new records from Morocco). *Protonemura algirica*: Raušer, 1963:804. (comparative drawings, distribution map); Aubert, 1964a:72. (comparison); Aubert, 1964b:291. (initiation of the *P. corsicana* species group); Illies, 1966:223. (catalog); Berthélemy, 1973:1544. (distribution); Zwick, 1978:33. (composition of the *P. corsicana* group); Nicolai, 1985:249. (biogeography and composition of the *P. corsicana* group); Gagneur & Aliane, 1991:323. (distribution); Sánchez-Ortega & Azzouz, 1998:452. (new records from Morocco, but probably belonging to *P. berberica* or *P. dakkii* sp. n.); Vinçon & Sánchez-Ortega, 1999:233. (comparison); Zhiltzova, 2003:227. (composition of the *P. corsicana* group); Vinçon & Zhiltzova, 2004:193. (composition of the *P. corsicana* group); Lounaci & Vinçon, 2005:(new records from Algeria, ecology, distribution); Murányi, 2007:28. (comparison, distribution).

Material examined. Algeria, Atlas de Blida: Oued Chiffa, "Ruisseau des Singes" brook, "Rocher des Singes", 23-VI-1953, 2♂ 1♀ (written Paralectotypes on the label, Vaillant leg, Aubert coll. ZML). **Algeria, Kabylie:** Tala Guilef, 16-IV-1953, 1♀ (written Paralectotypes on the label, Vaillant leg, Aubert coll. ZML); Djurdjura Massif, Oued Aïssi, 480 m, 30-IV-1985, 2♂ 1♀; 14-V-1985, 2♂ 1♀ - 1♂ (HNHM); 23-IV-1986, 2♂ 1♀; 25-VI-1986, 3♂ 6♀; 20-IV-1993, 2♂ 2♀, 1♂ larva (larva pharate, but terminalia of the larval skin missing); Oued Aïssi, 140 m, 21-VIII-1985, 7♂ 8♀ (Lounaci leg, CGV); Central Djurdjura Massif, Tikjda, small torrent, 1470 m, 20-IV-1993, 4♂ 4♀, 2♂ nymph; Eastern Djurdjura Massif, Assif Sahel, 1000 m, 17-V-1994, 1♂ nymph (Lounaci leg, CGV).

Male genitalia (Figs. 13-14, 28-31)**.** Paraprocts: Median lobe with a rather long sub-triangular base and a long blade-shaped expansion. Outer lobes sclerite widely enlarged at the tip; with about two spines on the dorsal expansion and one or two spines



Figs. 28-33. Terminalias of the imago of *Protonemura algirica algirica* (Aubert, 1956). 28: male terminalia, dorsal view; 29: male terminalia, ventral view; 30: male terminalia, lateral view; 31: male paraproct, ventrolateral view; 32: female pregenital and subgenital plates, and vaginal lobes, ventral view; 33: female pregenital and subgenital plates, and vaginal lobes, lateral view (scales 0.5 mm; scale 1: Fig. 31, scale 2: Figs. 28-30, 32-33).

on the ventral expansion (Fig. 31 and Aubert 1956: Fig. 18, Raušer 1963: Fig. 3b); few scattered spines (1-3) are sometimes located between the dorsal and ventral expansions. Epiproct: Strong, with its sides about parallel, ending abruptly in a rounded tip; well visible terminal filament rather short, bifid at the tip (Figs. 13, 28). In side view the terminal filament is about parallel to the epiproct (Fig. 14). Ventral sclerite with a prominent bulge partly covered with two rows of long spines forming a 'V' shape in ventral view. Sternite IX: Vesicle long and narrow (Fig. 29 and Aubert 1956: Fig. 16).

Female genitalia (Figs. 32-33)**.** Subgenital plate wide, bilobed. Vaginal lobes mostly hidden by the subgenital plate and partly visible on each side of the plate. Sternite VII without postero-median pigmented pregenital plate.

Mature larva. Body shape, coloration and proportions similar to the larva of *Protonemura algirica bejaiana* ssp. n., as described below, and agreeing with the original description (Aubert 1956). Distribution and type of pilosity also similar, though the overall bluntness of the bristles appears not so pronounced.

Affinities. In the males, *Protonemura algirica algirica* is mainly distinguished from *P. talboti* by the shape of the epiproct, ending abruptly in *P. algirica* and progressively in *P. talboti*. The apex of the outer lobe of the paraprocts is also a good distinctive character. *P. dakkii* sp. n. is distinguished from *P. algirica* by the terminal filament of the epiproct rising upwards and by the apex of the outer lobe of the paraprocts carrying a group of spines only on its posterior edge. In the females, the subgenital plate of *P. algirica* is thicker than that of *P. talboti* or *P. dakkii* sp. n. On sternite VII, the postero-median pigmented plate is lacking in *P. algirica* and present in *P. talboti*, *P. dakkii* sp. n. and *P. berberica*. Affinities of the larva are given below, for *P. algirica bejaiana* ssp. n.

Geographical distribution and ecology. *Protonemura algirica algirica* is known with certainty only from the central part of Algeria (Atlas of Blida and Djurdjura) (Fig. 6). Its presence in eastern Algeria (Aubert 1956: Aurès Massif) should be confirmed by the capture of males. The Tunisian specimens belong to *P. algirica bejaiana* ssp. n. The Moroccan specimens from the Rif belong to *P. berberica* or *P. talboti* (Aubert, Sánchez-Ortega and Berthélemy collections), those from the Middle Atlas belong to *P. dakkii* sp. n. or *P. talboti* (Aubert, Berthélemy and Dakki collections) and those from the High Atlas remain problematic since the Moroccan paralectotypes (ZML) are presently lost and since all our specimens from the High Atlas belong to *P. talboti*. Therefore, the occurrence of *P. algirica* in Morocco is uncertain and needs to be confirmed. In the Djurdjura Massif (Kabylia), *P. algirica algirica* occurs in different kinds of mountain water courses (480–1300 m). The emergence period is from spring to summer (IV–VIII) (Lounaci & Vinçon 2005).

Protonemura algirica bejaiana **Vinçon & Murányi ssp. n.**

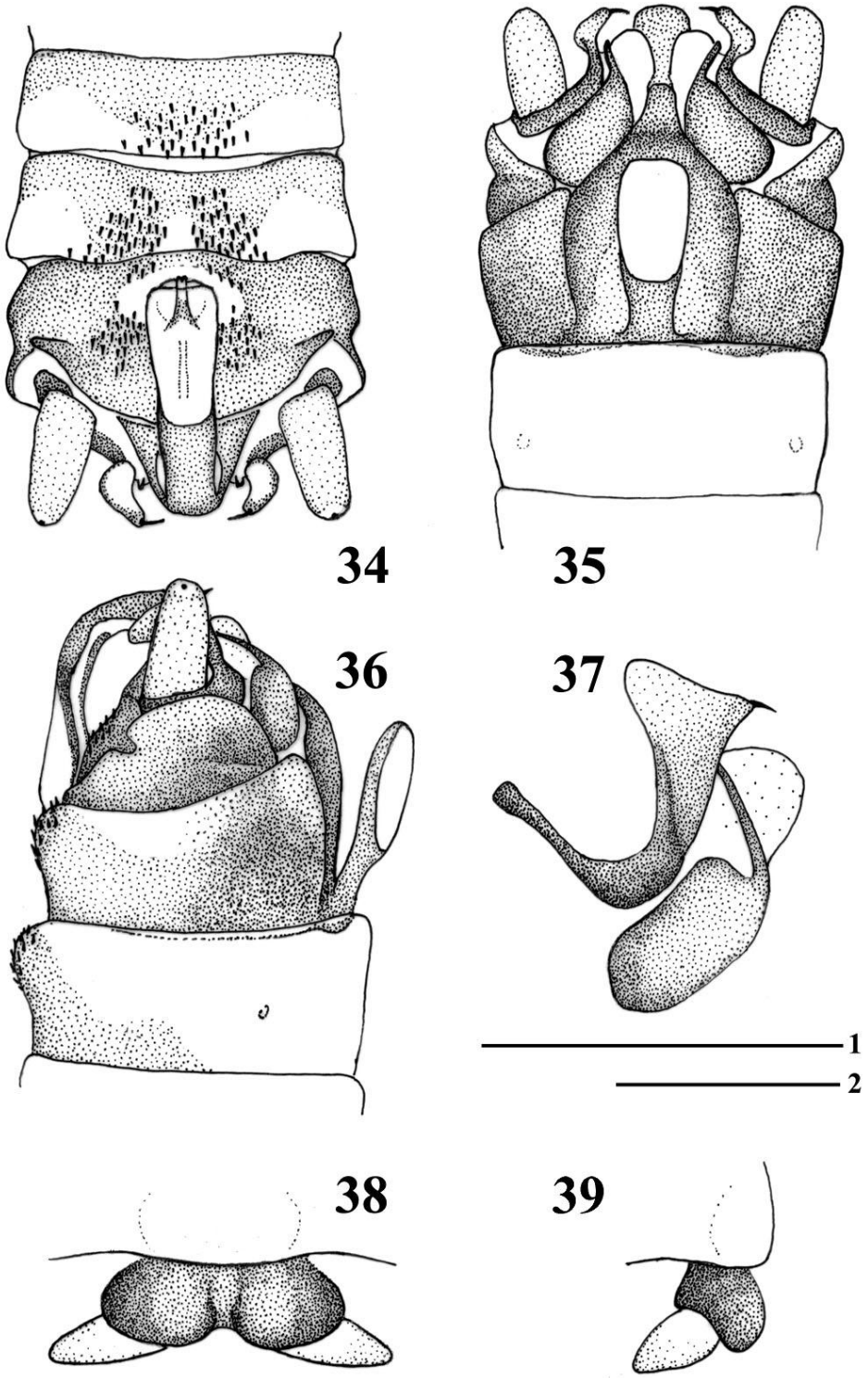
(Figs. 6, 15, 34-45, 76)

Protonemura algirica ssp. nov.: Berthélemy, 1973:1544. (distribution and ecology).

Material examined. Holotype male: **Tunisia, Aïn Draham:** Chabet El Khantra, Oued el Lil tributary, above Ben Metir dam, 540 m, 9-V-1969; Paratypes, same locality: 2-V-1969, 3♂ 2♀, 1♂ larva, 1 exuviae (larva pharate, terminalia of the larval skin missing; exuviae having thoracic parts only); 9-V-1969, 1♀; 10-V-1969, 1♂ 1♀; 16-XI-1969, 2♀; 10-I-1970, 2♂ 3♀ - 1♂ 1♀ larvae, 1♂ 1♀ exuviae (HNHM; ♀ larva prepared for SEM, ♂ larva pharate, terminalia of the larval skin missing); 12-II-1970, 2♂ 2♀; 18-IV-1970, 2♀; 7-VI-1970, 1♂; 13-XI-1970, 1♀ nymph; 30-XII-1970, 1♂. Holotype and 2♂ 2♀ paratypes are deposited in the ZML, other paratypes held in the CGV.

Other material: Tunisia, Aïn Draham: Oued ed Demène, near Ben Metir dam, 450 m, 19-IV-1970, 1♂ - 1♂ (HNHM); 9-V-1970, 4♀; 7-VI-1970, 1♀; Oued ed Demène at 630 m, 17-IV-1970, 1♀; Oued el Lebga, Oued el Lil tributary, above Ben Metir dam, 450 m, 19-IV-1970, 1♀ nymphae (Berthélemy coll. CGV).

Description. Medium-sized *Protonemura* of the *corsicana* group. Body length, male: 6.9–7.5 mm; female: 7.1–8.3 mm; forewing length, male: 8.7–9.2 mm; female: 8.7–9.6 mm. Head brownish with two yellow triangular areas between eyes and ocelli; antennae brown. Pronotum brown with dark pattern, its lateral sides light brown. Legs yellowish with brown longitudinal marks. Abdomen light brown. Gills short, without subterminal constriction.



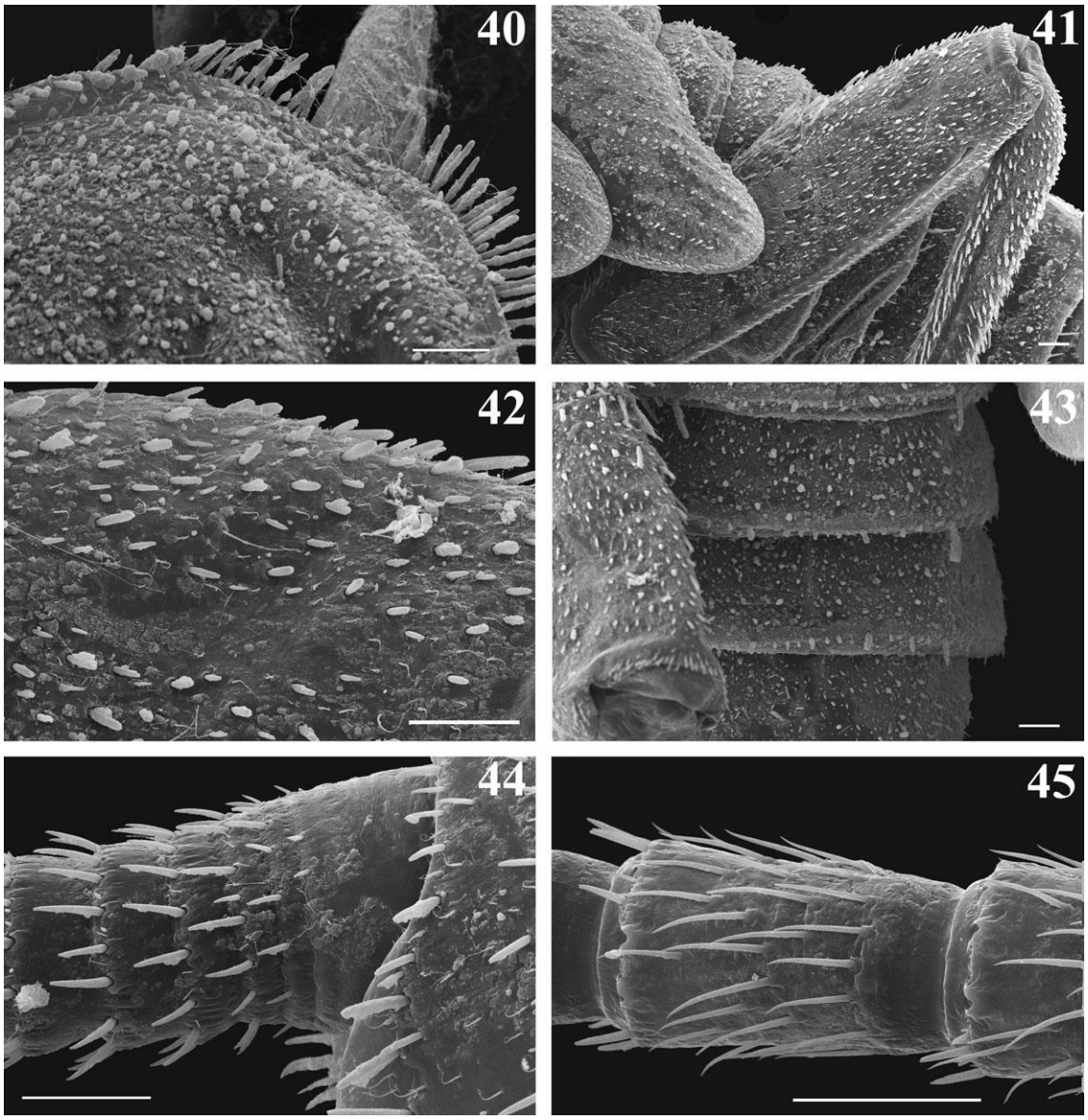
Figs. 34-39. Terminalias of the imago of *Protonemura algirica bejaiana* ssp. n. 34: male terminalia, dorsal view; 35: male terminalia, ventral view; 36: male terminalia, lateral view; 37: male paraproct, ventrolateral view; 38: female pregenital and subgenital plates, and vaginal lobes, ventral view; 39: female pregenital and subgenital plates, and vaginal lobes, lateral view (scales 0.5 mm; scale 1: Fig. 37, scale 2: Figs. 34-36, 38-39).

Male (Figs. 15, 34-37)**.** Tergites I-VI simple; tergite VII with few spines scattered medially on its posterior edge; tergite VIII similar but the spiny area deeply extends near the middle of the segment, in several specimens this group of spines is about separated in two spiny contiguous fields; tergite IX with two strong triangular groups of spines separated by a median smooth strip (Fig. 34); tergite X with several spines surrounding the tip of the epiproct. Paraprocts (Fig. 37): Inner lobe blade-shaped, partly hidden under the expansion of the hypoproct. Median lobe wide, with well developed globular membranous apex covered with thin setae; sclerotized base slightly longer than wide and ending in a gently curved, blade-shaped expansion which is more or less long, about reaching the tip of the outer lobe. Outer lobe sclerite enlarged at the tip, with a rounded, smooth and light posterior expansion without any spine; the anterior part of the lobe ends in a unique sharp spine, curved inwards. Epiproct: Rather strong and pale, slightly enlarging towards the tip in dorsal view and ending abruptly in a rounded tip (Fig. 15). A smooth bilobed expansion is visible at the tip. The epiproct terminal filament is rather short, bifid at the apex; in side view the filament is about parallel to the epiproct. Dorsal sclerite of the epiproct forked, well visible in dorsal view. The two lateral branches are getting nearer and narrowing toward the epiproct's tip, where they are curving upwards and meeting close to the projection of the terminal filament (Fig. 15). Ventral sclerite with a prominent bulge partly covered with two rows of long spines. In ventral view, the rows of spines are getting nearer towards the apex, forming a 'V'. Sternite IX: Hypoproct rounded distally, ending into a long tapering extension. Vesicle long, with its sides about parallel (Fig. 35).

Female. (Figs. 38-39). Abdomen typical of the genus. Sternite VII: Pregenital plate not sclerotized and therefore hardly visible. Sternite VIII: Subgenital plate well sclerotized and clearly bilobed; vaginal lobes strong, extending on each side of the subgenital plate.

Mature larva (Figs. 40-45, 76)**.** Body relatively slender, body length 9.0–10.5 mm. General color brown. Pilosity distinct. Scales present only in the dorsal midline of the femora and on the tarsi. Legs typical of the genus, tibiae slightly longer than femora; width of hind femora less than one third of its length. Head stout, brown with dark patches. The pronotum is subtrapezoidal, with distinct granules and rounded corners; it is slightly narrowing towards the posterior margin and its length is two thirds of its maximum width. Cervical gills simple, the longest one equivalent to the width of the fore coxa. Wing pads of typical length for the genus. Abdomen relatively slender, integument light and matt, first 6 abdominal segments divided by pleura. Posterior margin of sternite IX of the mature male larva triangular, sharply pointed; paraprocts not pointed (Fig. 76). Genital opening well visible on the mature female larva, and placed under the anterior half of sternite VIII; paraprocts not pointed. Cerci long, with more than 35 segments; segment sides nearly parallel, the width of segments 13–17 is three fifths of their length.

Pilosity: Head with dense, stout bristles and a few sensilla. Antennal segments with short pilosity. Pronotum with dense, stout bristles, a few sensilla and thin hairs. Margin of the pronotum bearing blunt bristles, the length of the longest ones is less than 1/15 of the pronotum's width (Fig. 40). The bristles on the anterior corners of the meso and metanotum are as long as the marginal bristles of the pronotum. The setae placed in lines on the wing pads are short and blunt. Legs with dense setation. All femora bear both short and long, blunt bristles and thin hairs. Long bristles occur mostly on the outer surface; on hind femora they are placed on the apical half. Bristles not in a regular arrangement; the longest ones reach one fifth of the femur's width on all legs (Figs. 41-42). A bald median line is conspicuous on the dorsal surface of all femora and it is covered with rounded scales. Tarsi relatively stout, covered with thin hairs and bristles, metatarsi with triangular scales on the dorsal surface; apical spike of tibiae short. Tergal segments with short, blunt bristles and a few thin hairs. Paired spines on the posterior margin blunt or hardly acute, two times longer than the other spines of the row; on tergite V they reach one fourth of the segment's length (Fig. 43). Distal margin lacks tiny triangular spikes around the row of bristles. Cercal segments with acute bristles, blunt or thin ones occur only in the apical whorl (Figs. 44-45; apical row scanty on Fig. 45). The apical whorl on segments 13-15 is a set of 10–12 strong, acute spikes mixed with short, blunt and short, thin setae. Longest bristles reach one fifth of the segment's length on segments 13–15.



Figs. 40-45. Larva of *Protonemura algirica bejaiana* ssp. n. 40: front angle of the pronotum; 41: hind femur; 42: outer apical part of the femur; 43: 5–6th tergal segments; 44: basal segments of the cercus; 45: 15th segment of the cercus (scale 0.1 mm).

Etymology. *Protonemura algirica bejaiana* ssp. n. is named after Beja, main town of the Khroumiry region, in Western Tunisia.

Affinities. *Protonemura algirica bejaiana* ssp. n. mainly differs from *P. algirica algirica* by the shape of the outer lobe of the paraproct, without any spine on its dorsal expansion instead of carrying two spines or more in *P. algirica algirica.* The ventral part of the paraproct's outer lobe always ends in a unique spine instead of one or two spines in *P. algirica algirica*. In the female, the vaginal lobes are more exposed on each side of the subgenital plate than in *P. algirica algirica* where they are often more hidden under the plate. *P. algirica algirica* and *P. algirica bejaiana* ssp. n. are also closely related to *P. albanica* from which they differ by the following features: in the male, the epiproct is not prolonged by a membranous expansion and its filament is much longer; in the

female, the vaginal lobes are strongly extending in front of the plate. The overall shape and the terminalia of the larva are very similar to those of the other North African species, but the *P. algirica* larva can be separated by the blunt bristles on the margin of pronotum, tergites and femurs. In addition, it differs from *P. dakkii* sp. n. and *P. berberica* by its darker habitus. The nominal subspecies seems to have not so pronounced blunt bristles, but this feature should be confirmed with the study of additional material.

Geographical distribution and ecology. *Protonemura algirica bejaiana* ssp. n. inhabits the north-western part of Tunisia (Khroumiry Mountains) (Fig. 6), where it occurs in brooks and brooklets at moderate altitudes (450–600 m). The adults emerge in winter and spring (XI–V).

Protonemura berberica Vinçon & Sánchez-Ortega, 1999

(Figs. 1-2, 4, 6, 11-12, 46-58)

Protonemura berberica Vinçon & Sánchez-Ortega, 1999:231. (original description from Morocco); Vinçon & Zhiltzova, 2004:193. (composition of the *P. corsicana* group); Lounaci & Vinçon, 2005:(distribution); Murányi, 2007:28. (distribution)

Nemoura (Protonemura) algirica auctt., nec Aubert, 1956: Aubert, 1961 (partim):218. (records from the Moroccan Rif).

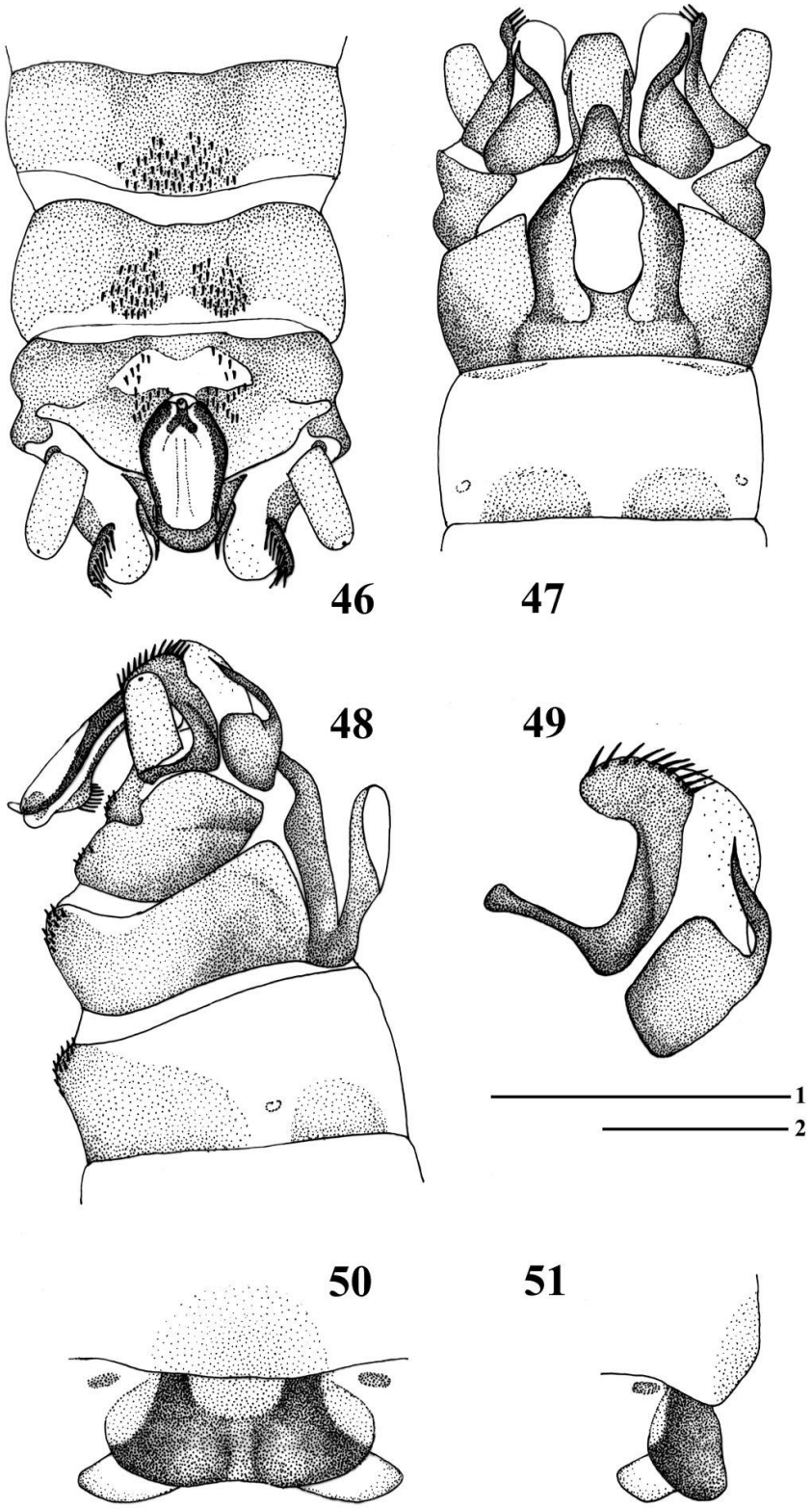
Protonemura sp.: Sánchez-Ortega & Azzouz, 1998:452. (records from the Moroccan Rif).

Material examined. Morocco, Rif: Ketama, Djebel Tidirehine, 1800 m, 24-IV-1960, 1♂ nymph and 7 larvae - 2♀ 1♂ larvae (1♀ larva prepared for SEM, ♂ larva pharate, terminalia of the larval skin missing) (Besuchet leg, labeled *P. algirica* det. Aubert, Aubert coll. ZML, published as *N. (P.) algirica* in Aubert 1961); spring 14 Km South West Ketama, 1500 m, 21-VII-1980, 2♂ 1♀ (Berthélemy coll. CGV); 14 km from Boohivid, 3-VI-1992, 2♂ 1♀; Loukous brook, 300 m, 5-VI-1992, 1♂ 2♀ (dried specimens, labeled *P. algirica* Azzouz 1992 det and leg, GUC); Spring between Bab-Besen and Ketama, 1600 m, 22-II-1996, 2♂ 5♀; above Azila Ketama, Djebel Tidirehine, 1600-1800 m, 4-VI-2006, 3♂ 9♀; Djebel Tidirehine, 2000-2100 m, 4-VI-2006, 6♂ 16♀ 1 larva (Vinçon leg, CGV) - 3♂ 3♀ (HNHM; 1♂ and 1♀ terminalia prepared for SEM).

Imago (Figs. 1-2, 4, 11-12, 46-51)**.** A detailed description is already given in Vinçon & Sánchez-Ortega (1999). The male is well characterized by the apex of the paraproct's outer lobe, bordered by a regular comb-shaped fringe of spines (Fig. 49), and by the terminal filament of the epiproct risen upwards (Figs. 4, 11, 48). This filament is short and bifid at the tip (Figs. 1-2, 4).

Mature larva (Figs. 52-58)**.** Body relatively slender, body length 9.0–10.5 mm (Fig. 52). General color pale, yellowish brown. Pilosity pronounced but not distinct. Scales present only in the dorsal midline of the femora and on the tarsi. Legs typical of the genus, tibiae slightly longer than femora; width of hind femora more than one third of its length. Head stout, pale with indistinct, slightly darker patches. The pronotum is subtrapezoidal, with hardly visible granules and rounded corners; it is slightly narrowing towards the posterior margin and its length is two thirds of its maximum width. Cervical gills simple, the longest one equivalent to the width of the fore coxa. Wing pads of typical length for the genus. Abdomen relatively slender, integument light and matt, first 6 abdominal segments divided by pleura. Terminalia of the larval skin is missing on the single examined pharate male. Genital opening well visible on the mature female larva and placed under the anterior half of sternite VIII; paraprocts not pointed. Cerci long, with more than 30 segments; segment sides nearly parallel, the width of segments 13–17 is three fourths of their length.

Pilosity: Head with dense, stout but acute bristles, and a few sensilla; eyes bearing small setae between the ocelli. Antennal segments with short pilosity. Pronotum with dense, stout but acute bristles, and a few sensilla. Margin of the pronotum bearing acute bristles, the length of the longest ones is less than 1/15 of the pronotum's width (Fig. 53). The bristles on the anterior corners of the meso and metanotum are as long as the marginal bristles of the pronotum. The setae placed in lines on the wing pads are short but acute. Legs with dense setation. All femora bear both short and long, acute bristles and a few thin hairs. Long bristles occur mostly on the outer surface; on hind femora they are placed all along its length. Bristles not in a regular arrangement; the longest ones reach one fourth of the femur's width on all legs (Figs. 54-55). A bald median line is conspicuous on



Figs. 46-51. Terminalias of the imago of *Protonemura berberica* Vinçon & Sánchez-Ortega, 1999. 46: male terminalia, dorsal view; 47: male terminalia, ventral view; 48: male terminalia, lateral view; 49: male paraproct, ventrolateral view; 50: female pregenital and subgenital plates, and vaginal lobes, ventral view; 51: female pregenital and subgenital plates, and vaginal lobes, lateral view (scales 0.5 mm; scale 1: Fig. 49, scale 2: Figs. 46-48, 50-51).

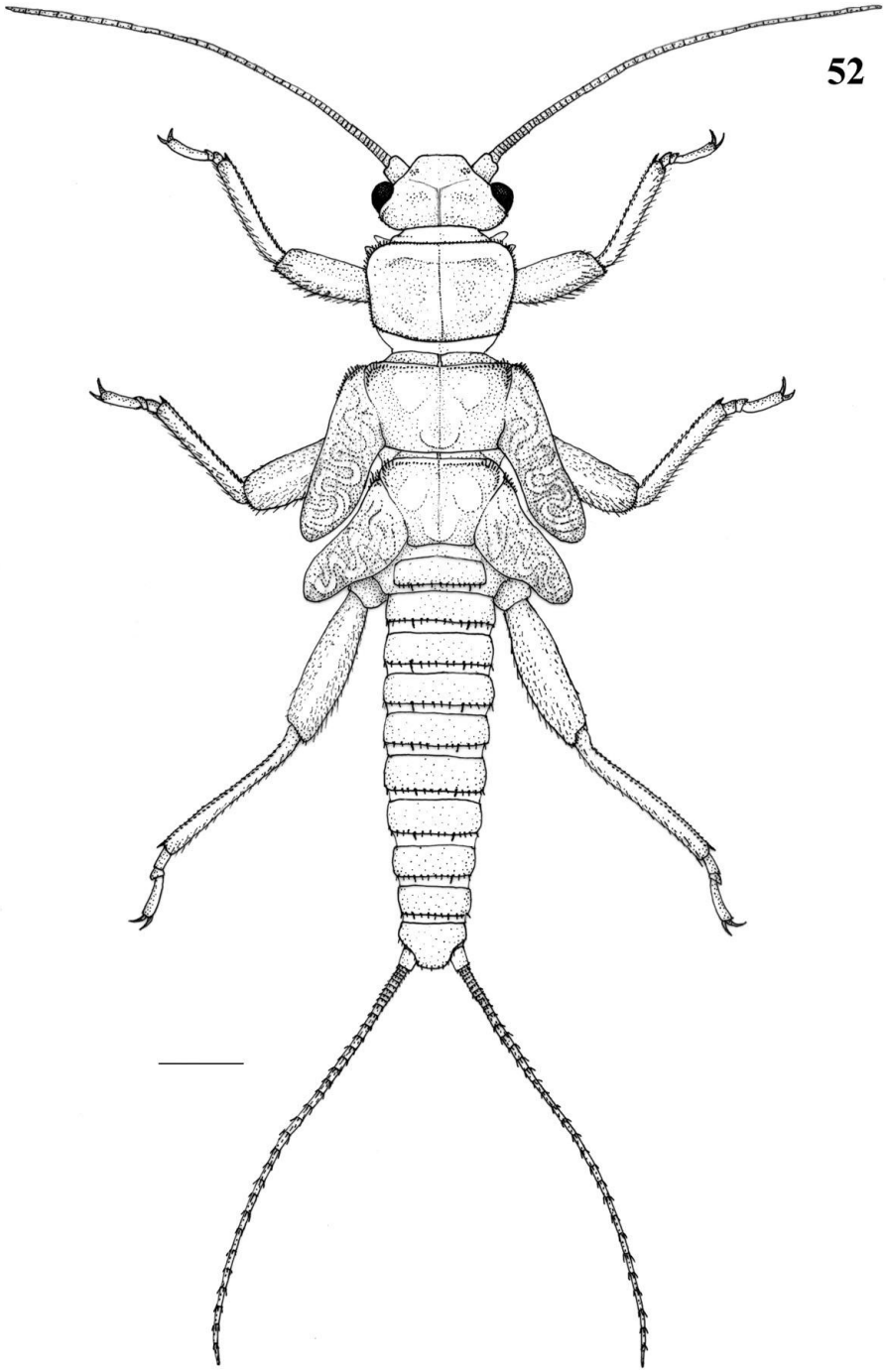
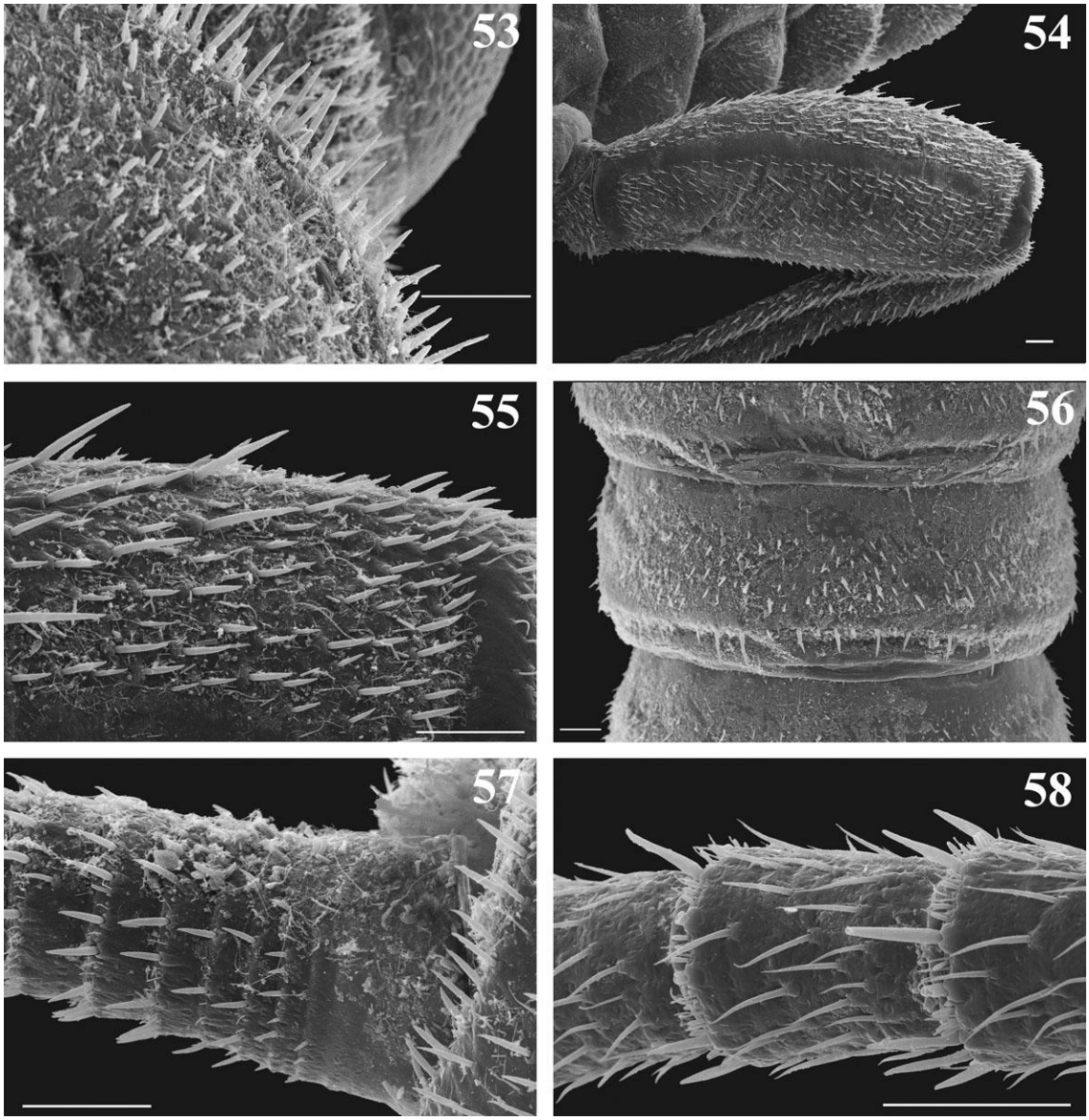


Fig. 52. Habitus of the matured larva of *Protonemura berberica* Vinçon & Sánchez-Ortega, 1999. (scale 1 mm).

the dorsal surface of all femora and it is covered with rounded scales. Tarsi relatively slender, covered with thin hairs and bristles, metatarsi with triangular scales on the dorsal surface; apical spike of tibiae short. Tergal segments with short bristles and a few thin hairs. Paired spines on the posterior margin acute, not much longer than the other spines of the row; on tergite V they reach one fourth of the

segment's length (Fig. 56). Distal margin lacking tiny triangular spikes around the row of bristles. Cercal segments with acute bristles, blunt or thin ones occur only in the apical whorl (Figs. 57-58). The apical whorl on segments 13-15 is a set of 9–11 strong, acute spikes mixed with short, blunt and short, thin setae. Longest bristles reach two fifths of the segment's length on segments 13–15.



Figs. 53-58. Larva of *Protonemura berberica* Vinçon & Sánchez-Ortega, 1999. 53: front angle of the pronotum; 54: hind femur; 55: outer apical part of the femur; 56: 6th tergal segment; 57: basal segments of the cercus; 58: 15th segment of the cercus (scale 0.1 mm).

Affinities. *Protonemura berberica* is closely related to *P. dakkii* sp. n. by the shape of the epiproct, with its terminal filament rising upwards in lateral view; this character is not observed in the other species of the *P. talboti* subgroup. The male clearly distinguishes by the shape of the paraproct's outer lobe with its regular fringe of spines, and the female by its strongly developed vaginal lobes and the presence of

a strongly pigmented pregenital plate on sternite VII. This plate is also present in *P. talboti*, but absent or hardly visible in the other mentioned species. The larva is very similar to those of *P. dakkii* sp. n. and *P. talboti*, and only the pharate males can be identified with sure, on the basis of the male imago terminalia under the larval skin. However, it differs from *P. talboti* by its pale habitus and the scarcity of stout, blunt bristles on the pronotum, tergites and femurs, from *P. dakkii* sp. n. by the longer bristles on the margin of the pronotum.

Geographical distribution. This species is probably endemic of the Moroccan Rif (Fig. 6). The previous citations of *P. algirica* from the Rif all concern *P. berberica*, as it was verified by the study of adults and male nymphs from the collections of Aubert, Berthélemy, Sánchez-Ortega and Tierno de Figueroa.

Protonemura dakkii Vinçon & Murányi sp. n.
(Figs. 6-8, 59-74, 77-79)

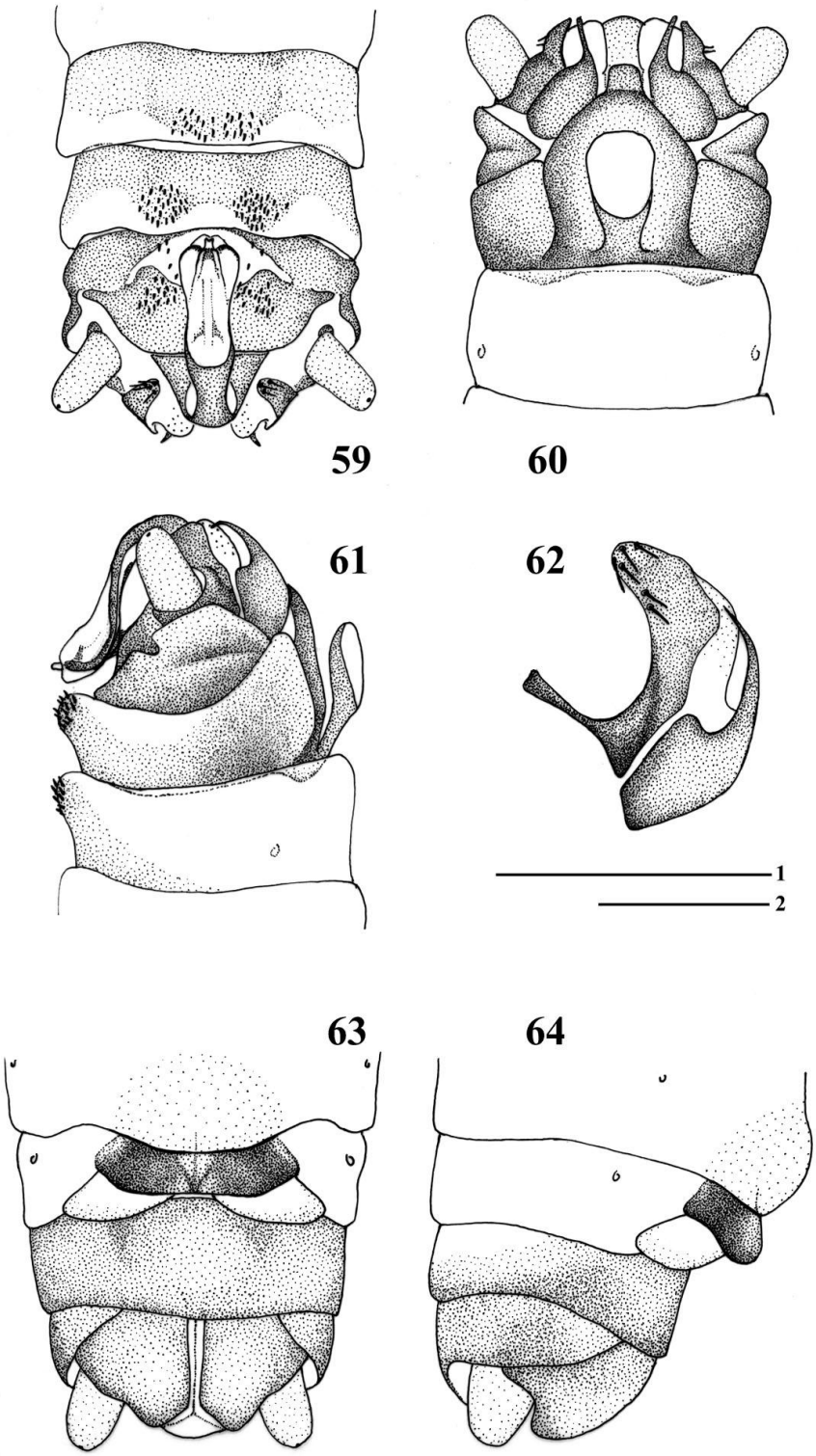
Nemoura (Protonemura) algirica auctt., nec Aubert, 1956: Aubert 1961 (partim):218. (records from Morocco).
Nemoura (Protonemura) talboti auctt., nec Navás, 1929: Aubert 1961 (partim):219. (records from Morocco).

Material examined: Holotype male: **Morocco, Middle Atlas:** Ifrane, Ifrane Oued, 1700 m, 3-V-1960, micropterous (Besuchet leg, labeled *P. algirica* by Aubert, Aubert coll. ZML, published as *N. (P.) algirica* in Aubert 1961); Paratypes: same date and locality, 5♂ 5♀ micropterous, 2 larvae - 2♂ 2♀, 1 non matured larva. Holotype and 2♂ 2♀ paratypes are deposited in the ZML, other paratypes held in the CGV.

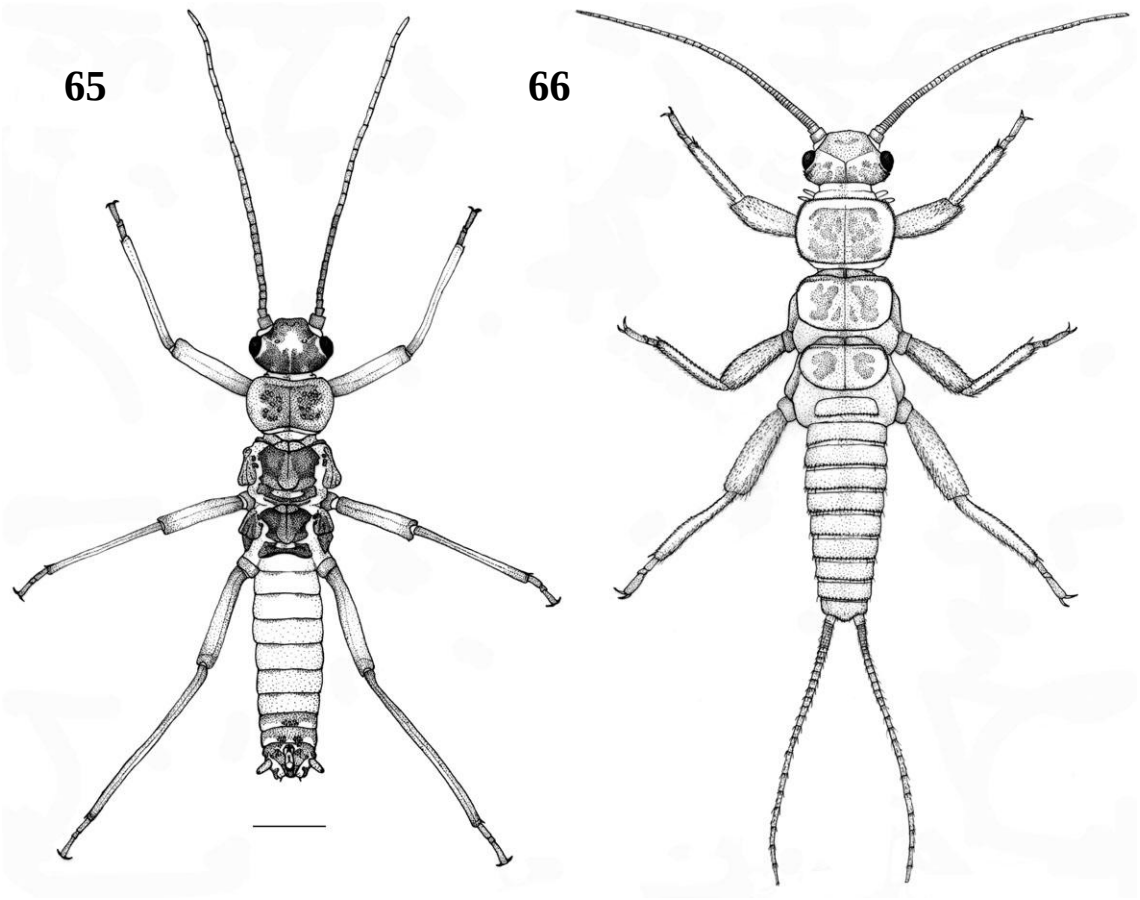
Other material: Morocco, Middle Atlas: Ain Leuh, 4-V-1960, 1♀ macropterous (Besuchet leg, labeled *P. talboti* Aubert 1960, Aubert coll. ZML, published as *N. (P.) talboti* in Aubert 1961); Azrou, 3-V-1960, 2♀ macropterous (leg. Besuchet, labeled *P. talboti* Aubert 1960 and *Protonemura* spec. Zwick 1982, Aubert coll. ZML, published as *N. (P.) algirica* in Aubert 1961); Oriental Middle Atlas, Imouzzer des Marmoucha, high Oued Al Mahçar, karstic permanent spring, labeled *P. algirica*, SM (JI), 20-VII-1981, 3♂ 5♀ macropterous, 5 larvae (Dakki leg, Berthélemy coll., CGV); from them: 1♂ 1♀, 1♂ 1♀ larvae (HNHM; female larva prepared for SEM); karstic temporary spring of the same hydrographic basin, "Aghbalou Abekhbakh", labeled *P. algirica*, AA (JN 83), 2♂ macropterous, 20-VI-1983 (Dakki leg, Berthélemy coll., CGV).

Description (Fig. 65)**.** Medium-sized *Protonemura* of the *corsicana* group. Body length, male: 5.6–6.1 mm; female: 7.5–8.4 mm; forewing length, male: 0.2 (micropterous specimens) – 6.2 mm; female: 0.2 (micropterous specimens) – 9.0 mm. Head dark brown with a median rounded yellow spot between the ocelli; antennae brown. Pronotum brown with dark pattern, its anterior corners light brown. Legs and abdomen light brown. Gills short, without subterminal constriction.

Male (Figs. 7-8, 59-62)**.** Tergites I-VII simple; tergite VIII with a median rounded group of spines on its posterior edge; tergite IX with two oval groups of spines widely separated by a space about as wide as the width of each group of spines (Fig. 59); tergite X with two groups of spines placed on each side of the epiproct's tip. Paraprocts (Fig. 62): Inner lobe blade-shaped, partly hidden under the expansion of the hypoproct. Median lobe wide, with well developed globular membranous apex covered with thin setae; sclerotized base slightly longer than wide and ending in a gently curved, blade-shaped expansion which is more or less long, about reaching the tip of the outer lobe. Outer lobe sclerite enlarged at the tip, with a rounded posterior expansion with many (more than 5) spines; the anterior part of the lobe weakly produced and bearing no spine. Epiproct: Rather strong and pale, slightly enlarging towards the tip in dorsal view and ending abruptly in a rounded tip (Figs. 8, 59). A smooth bilobed expansion is visible at the tip. The epiproct terminal filament is of moderate size, bifid at the apex; in side view the filament is risen upwards (Figs. 7, 61). Dorsal sclerite of the epiproct forked, well visible in dorsal view. The two lateral branches are getting nearer and narrowing toward the epiproct's apex; they are curving upwards on each side of the epiproct's tip where they meet close to the terminal filament (Fig. 8). Ventral sclerite with a prominent bulge partly covered with two rows of long spines (Fig. 7). In ventral view, the rows of spines are getting nearer towards the apex, forming a 'V'. Sternite IX: Hypoproct rounded distally ending in a short, slightly tapering extension. Vesicle short, slightly widening at the tip (Fig. 60).



Figs. 59-64. Terminalias of the imago of *Protonemura dakkii* sp. n. 59: male terminalia, dorsal view; 60: male terminalia, ventral view; 61: male terminalia, lateral view; 62: male paraproct, ventrolateral view; 63: female terminalia, ventral view; 64: female terminalia, lateral view (scales 0.5 mm; scale 1: Fig. 62, scale 2: Figs. 59-61, 63-64).



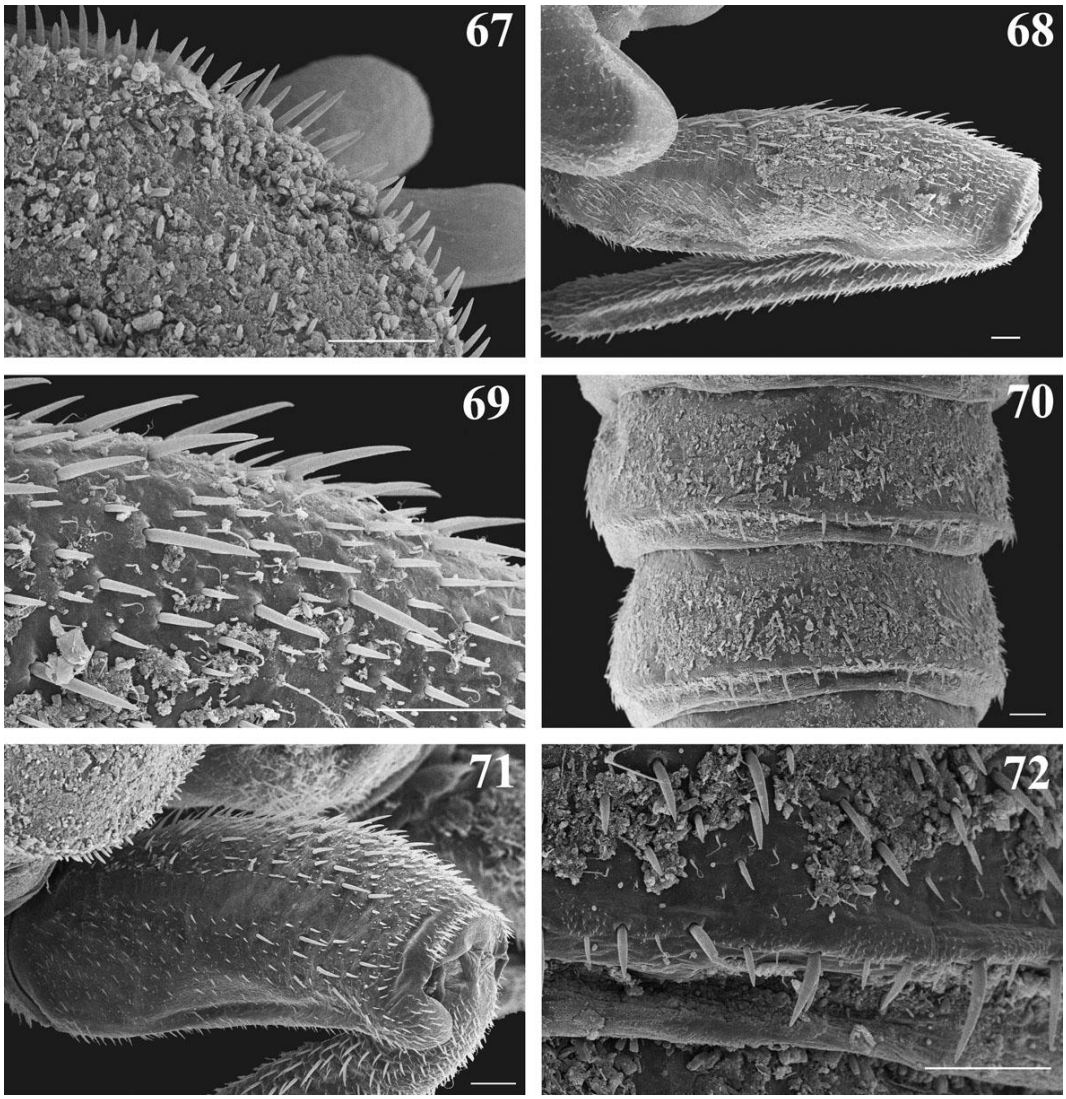
Figs. 65-66. Habitus of the micropterous form of *Protonemura dakkii* sp. n. 65: male imago; 66: not matured larva (scale 1 mm).

Female (Figs. 63-64)**.** Abdomen typical of the genus. Sternite VII: Pregenital plate very slightly sclerotized and therefore hardly visible. Sternite VIII: Subgenital plate well sclerotized, posterior margin rectilinear, very slightly indented; vaginal lobes strong, extending on each side of the subgenital plate. Sternite IX simple.

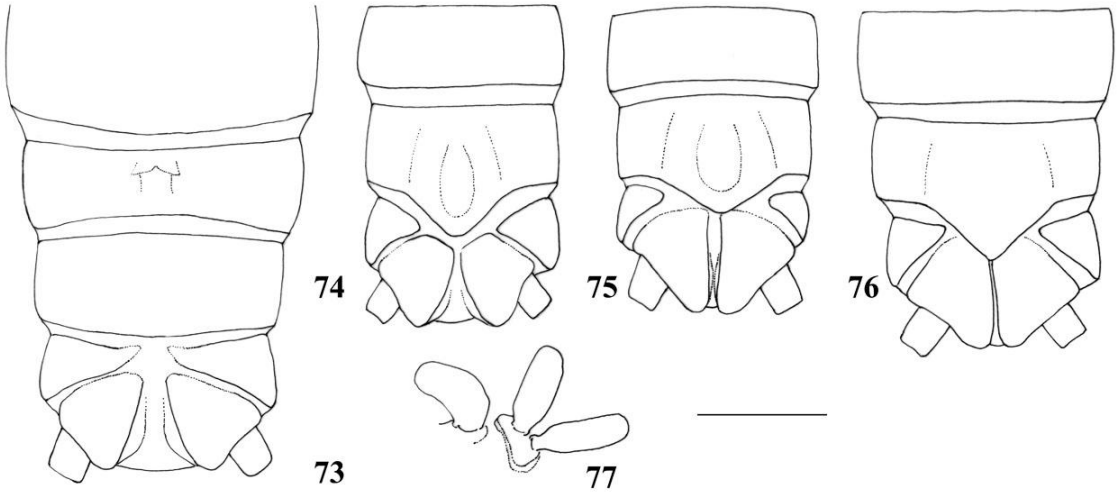
Mature larva (Figs. 66-74, 77)**.** Body relatively stout, body length 7.0–9.0 mm (Fig. 66). General color pale, yellowish brown. Pilosity not distinct. Scales present only in the dorsal midline of the femora and on the tarsi. Legs typical of the genus, tibiae slightly longer than femora; width of hind femora equivalent to one third of its length. Head stout, brown with dark patches. The pronotum is subtrapezoidal, with distinct granules and rounded corners; it is slightly narrowing towards the posterior margin and its length is two thirds of its maximum width. Cervical gills simple, the longest one is equivalent to the width of the fore coxa (Fig. 77). Wing pads shortened or completely absent. Abdomen relatively stout, integument light and matt, first 6 abdominal segments divided by pleura. Posterior margin of sternite IX of the mature male larva triangular, weakly pointed; paraprocts not pointed (Fig. 74). Genital opening well visible on the mature female larva and placed under the anterior half of sternite VIII; paraprocts not pointed (Fig. 73). Cerci of the matured larva with about 20 segments; they are longer, with more than 30 segments, in the not matured larva.

Pilosity: Head with dense, stout but acute bristles and a few hairs and sensilla; the eyes bear small setae between the ocelli (Fig. 72). Antennal segments with

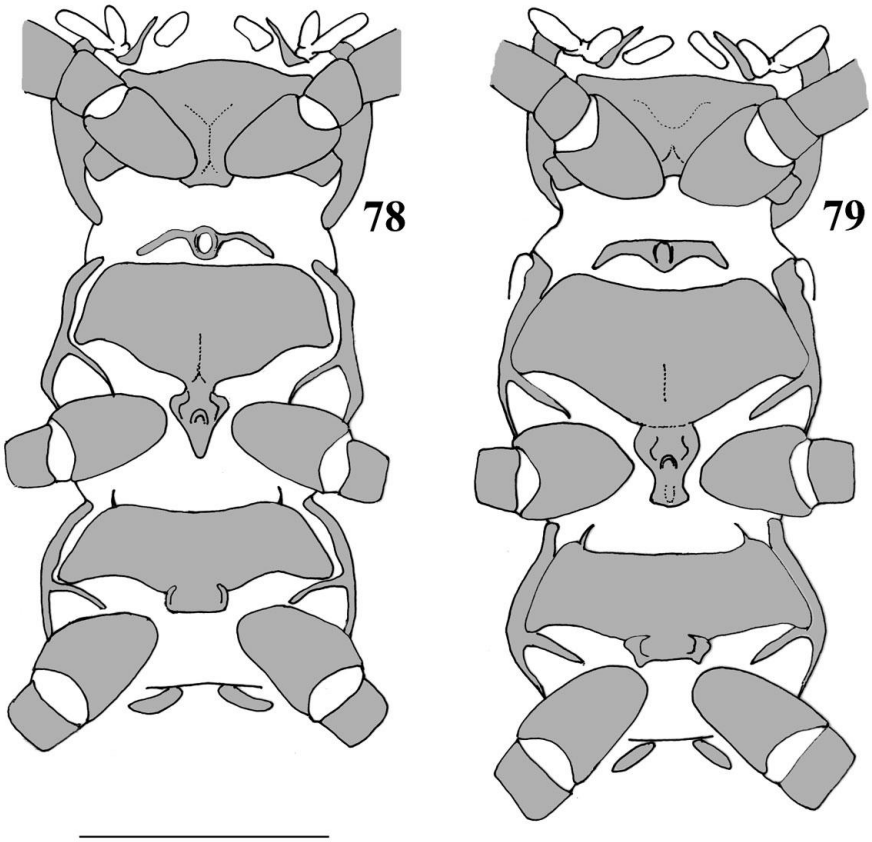
short pilosity. Pronotum with stout bristles, a few sensilla and thin hairs. Margin of the pronotum bearing acute bristles, the length of the longest ones is less than 1/20 of the pronotum's width (Fig. 67). The bristles on the anterior corners of the meso and metanotum are as long as the marginal bristles of the pronotum. The setae placed in lines on the wing pads are short and blunt. Legs with dense setation. All femora bear both short and long, blunt bristles and thin hairs. Long bristles occur mostly on the outer surface; on hind femora they are placed all along its length. Bristles not in a regular arrangement; the longest ones reach one fifth of the femur's width on all legs (Figs. 68-69, 71). A bald median line is conspicuous on the dorsal surface of all femora and it is covered with rounded scales. Tarsi relatively stout, covered with thin hairs and bristles, metatarsi with triangular scales on the dorsal surface; apical spike of tibiae short. Tergal segments with acute bristles and thin hairs. Paired spines on the posterior margin acute, hardly longer than the other spines of the row; on tergite V they reach one fourth of the segment's length (Fig. 70). Distal margin with scarce tiny triangular spikes around the row of bristles. Cercal pilosity of the larva similar to that of the closely related species.



Figs. 67-72. Larva of *Protonemura dakkii* sp. n. 67: front angle of the pronotum; 68: hind femur; 69: outer apical part of the femur; 70: 5–6th tergal segments; 71: fore femur; 72: eye (scale 0.1 mm).



Figs. 73-77. Larval terminalias and gills of the North African species of the *Protonemura talboti* subgroup. 73: *Protonemura dakkii* sp. n., matured female terminalia; 74: *P. dakkii* sp. n., matured male terminalia; 75: *P. talboti* (Navás, 1929), matured male terminalia; 76: *P. algirica bejaiana* ssp. n., male exuviae terminalia; 77: *Protonemura dakkii* sp. n. gills (ventral views; scale 0.5 mm).



Figs. 78-79. Ventral view of the thorax of *Protonemura dakkii* sp. n. 78: micropterous form; 79: macropterous form (scale 1 mm).

Etymology. This species is named in honor of Mohamed Dakki (Rabat Scientific Institute), who has collected this species in several places of the Middle Atlas.

Affinities. *Protonemura dakkii* sp. n. is distinguished from *P. algirica* and *P. berberica* by the shape of the epiproct in lateral view and by the shape of the exterior lobe of the paraprocts. The females resemble those of *P. algirica* and *P. talboti* and therefore the presence of *P. dakkii* sp. n. in new localities should be confirmed by the capture of males. The larva is very similar to *P. berberica* and *P. talboti*, and only the pharate males can be identified with sure, on the basis of the male imago terminalia under the larval skin. However, it differs from *P. talboti* by its pale habitus and the scarcity of stout, blunt bristles on the pronotum, tergites and femurs, from *P. berberica* by the shorter bristles on the margin of the pronotum. Larvae of the micropterous form can be separated by the absence of wing pads, as micropterous form are hitherto not known in the other North African species. The diminution of the imaginal ventral sclerites from the normal winged form towards the micropterous form (Figs. 78-79) shows a similar, but lesser degree than it was shown by Berthélemy (1969) in the case of the genus *Capnioneura* Ris, 1905, and by Vinçon & Pardo (1994) in the case of the genus *Leuctra* Stephens, 1835.

Geographical distribution. This species is probably endemic of the Moroccan Middle Atlas (Fig. 6).

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