

The Nemouridae from Algeria (Insecta: Plecoptera)

Nabila YASRI-CHEBOUBI

Département de Biologie, Faculté des Sciences biologiques et Sciences agronomiques,
Université Mouloud Mammeri, Tizi-Ouzou (Algeria)
bily3005@yahoo.fr

Gilles VINÇON

55 boulevard J. Vallier, F-38100 Grenoble (France)
vincon@kls-logic.fr

Abdelkader LOUNACI

Département de Biologie, Faculté des Sciences biologiques et Sciences agronomiques,
Université Mouloud Mammeri, Tizi-Ouzou (Algeria)
lounaci@yahoo.fr

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ABSTRACT

Intensive research on the stoneflies of Central and Eastern Algeria has uncovered three *Protonemura* Kempny, 1898 taxa new for Algeria: *P. drahamensis* Vinçon & Pardo, 2006 and *P. algirica bejaiana* Vinçon & Muranyi, 2009, and *Amphinemura berthelemyi* Vinçon, Yasri & Lounaci, 2013. The three Nemouridae Newman, 1853 are endemic of Central Maghreb (Western Tunisia and Eastern Algeria), increasing the list of Algerian Nemouridae to seven species. Two other species, collected only as larvae, could not be identified to species: *Amphinemura* sp. and *Nemoura* sp. *Protonemura talboti* (Navás, 1929) is reported for the first time from Central Algeria (Blida). The distribution and the ecology of the Algerian Nemouridae are discussed. Distribution maps, habitat photos and drawings of the species are presented.

KEY WORDS

Nemouridae,
zoogeography,
Algeria,
new records.

RÉSUMÉ

Nouvelles données sur les Nemouridae d'Algérie (Insecta: Plecoptera).

Des recherches intensives dans le centre et l'Est algérien ont permis de découvrir trois taxons de *Protonemura* Kempny, 1898 nouveaux pour l'Algérie: *P. drahamensis* Vinçon & Pardo, 2006; *P. algirica bejaiana* Vinçon & Muranyi, 2009 et *Amphinemura berthelemyi* Vinçon, Yasri & Lounaci, 2013. Les trois Nemouridae Newman, 1853 sont endémiques du Maghreb central (Tunisie occidentale et Algérie orientale), augmentant la liste des Nemouridae d'Algérie à sept espèces. Deux autres espèces, collectées à l'état larvaire, n'ont pu être identifiées au niveau spécifique: *Amphinemura* sp. et *Nemoura* sp. *Protonemura talboti* (Navás, 1929) est signalée pour la première fois d'Algérie centrale (Blida). La distribution et l'écologie des Nemouridae d'Algérie sont discutées. Des cartes de distribution, des photos des biotopes et des dessins des espèces sont présentés.

MOTS CLÉS

Nemouridae,
zoogéographie,
Algérie,
signalisations nouvelles.

INTRODUCTION

The first works concerning Algerian stoneflies were from Lestage (1925), Aubert (1956) and Berthélemy (1973). After 1980, systematics, ecology, biogeography and distribution of the stoneflies in Algeria have been studied in several works: Lounaci 1987, Ait Mouloud 1988, Gagneur & Aliane 1991, Lounaci-Daoudi 1996, Lounaci *et al.* 2000, Mebarki 2001, Lounaci 2005, Lounaci & Vinçon 2005, Yasri 2009, Haouchine 2011, Yasri *et al.* 2013 and Yasri-Cheboubi *et al.* 2013.

Between 2010 and 2013, intensive research in Northern and Eastern Algeria has reported *Protonemura drabamensis* Vinçon & Pardo, 2006 and *P. algirica bejaiana* Vinçon & Muranyi, 2009 for the first time from Algeria, in addition to *Amphinemura berthelemyi* Vinçon, Yasri & Lounaci, 2013 described in the work of Yasri *et al.* (2013).

The Nemouridae populations are compared in geographical and ecological context.

MATERIAL AND METHODS

Stoneflies were collected using a Surber net, a kick net, a Japanese umbrella and hand collecting, enabling us to collect rare species and to have a relatively complete picture of the stonefly diversity at each locality. The specimens were preserved in 70% ethanol. Some of the studied specimens are deposited in the Muséum national d'Histoire naturelle and in the Zoological Museum of Lausanne, Switzerland. Other specimens are stored in the following collections: N. Yasri, Boumerdes, Algeria; Haouchine & Lounaci, Tizi Ouzou, Algeria and G. Vinçon, Grenoble, France.

ABBREVIATIONS

Repositories

coll. H&L	Haouchine & Lounaci collection (Tizi Ouzou, Algeria);
coll. NY	Nabila Yasri collection (Boumerdes, Algeria);
coll. VIN	Vinçon collection (Grenoble, France);
MNHN	Muséum national d'Histoire naturelle (Paris);
ZML	Zoological Museum of Lausanne (Switzerland).

RESULTS

Family NEMOURIDAE Newman, 1853
Genus *Amphinemura* Ris, 1902

Amphinemura berthelemyi
Vinçon, Yasri & Lounaci, 2013
(Figs 1; 2; 3)

Amphinemura berthelemyi Vinçon, Yasri & Lounaci, in Yasri *et al.* 2013: 29.

MATERIAL EXAMINED. — **Eastern Algeria.** El Kala, Algerian slope of Khroumir mountains: Oued Haddada (Fig. 3A), brook below Djebel Haddada (Haddada village), 180 m, 7.V.2010, 12 larvae; 25.III.2011,

82 larvae; 23.IV.2011, 72 larvae; 12.V.2011, 8 larvae (coll. NY); 3.III.2012, 1 ♂ (coll. VIN), 3 ♂, 2 ♀ (ZML); 24.III.2012, 3 ♂, 2 ♀ (MNHN). Oued Dar Essalem (Fig. 3B), other brook below Djebel Haddada, 190 m, 7.V.2010, 20 larvae; 25.III.2011, 130 larvae (coll. NY); 23.IV.2011, 120 larvae (coll. NY), 3 ♂, 1 ♀ (coll. VIN); 12.V.2011, 26 larvae; 3.III.2012, 2 ♂, 1 ♀; 24.III.2012, 7 ♂, 9 ♀; 2.V.2012, 5 ♂, 17 ♀ (coll. NY).

Small Kabylia. Above Aokas, above Pass, second brook left side of road W16, 900 m, 18.IV.2012, 1 ♂, 2 ♀ (coll. VIN).

Great Kabylia. Between Tagma Pass and Kebouche Adekar, below Djebel Toukra, 1000 m, 17.IV.2012, 1 ♂ (coll. VIN).

Central Algeria, Djurdjura. NE Tizi Ouzou, Illilthen, 1010 m, 11.V.2009, 1 ♂ nymph; Ath Zikki, 1050 m, 15.V.2009, 1 ♂ nymph (coll. H&L).

Central Algeria, Tell Atlas. near Blida, Chiffa Valley, oued Chiffa above junction with “Ruisseau des Singes” brook, 270 m, 28.III.2012, 1 ♂ (coll. NY).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY. — *A. berthelemyi* is an endemic species of the Central Maghreb (W Tunisia and E Algeria). It has a wide distribution extending from the Tunisian Khroumiry up to the Algerian Tell Atlas near Blida (Fig. 11). In Algeria, it extends from the El Kala area to the Blidean Atlas (Fig. 12). It is very abundant in streams in the area of El Kala. In Kabylia and Blidean Atlas, it is scarcer. In Morocco, the species is absent and replaced by the closely related *A. chiffensis* Aubert, 1956. It is a crenophilic species which occurs in brooks and torrents between 200 and 1000 m a.s.l. The adults emerge in spring (III-V).

DIAGNOSIS. — *A. berthelemyi* is related to *A. chiffensis* from which it differs, in the male imago, by the median lobe of the paraprocts enlarging in its distal part and carrying a set of strong apical setae (Fig. 1A, B); in *A. chiffensis* the median lobe is not enlarged and bald at the tip (Yasri *et al.* 2013: figs 4, 5). The spiny bulge of the epiproct is clearly prominent in *A. Berthelemyi* (Fig. 1G) instead of being hardly pronounced as in *A. chiffensis* (Yasri *et al.* 2013: figs 6, 7). Female subgenital plate with vaginal lobes clearly separated by a shallow notch in *A. berthelemyi* (Fig. 1C), while closely connected in *A. chiffensis* (Yasri *et al.* 2013: fig. 3). Nymphal pilosity much stronger in *A. berthelemyi* (Fig. 2A-D) than in *A. chiffensis* (Yasri *et al.* 2013: figs 8-11).

Amphinemura sp.

REMARK

The larvae could not be specifically identified to confirm the species, therefore adult catches should be performed to confirm this species.

MATERIAL EXAMINED. — **Central Algeria.** Djurdjura, NE Tizi Ouzou: 6 km S Ain El Hammam village, Djemaa brook, Aissi tributary, 900 m, III.2010, 31 larvae; V.2010, 12 larvae; VI.2010, 17 larvae; VII.2010, 55 larvae (coll. H&L); 3 km above Illilthen village, Illilthen brook Boubhir tributary, 1010 m, III.2010, 15 larvae; V.2010, 9 larvae; VII.2010, 43 larvae (coll. H&L), 500 m above Ath Atsou village, Ath Atsou brook Boubhir tributary, 1080 m, III.2010, 2 larvae; V.2010, 1 larva; VII.2010, 20 larvae (coll. H&L); 1 km below Tirourda Pass, Tirourda brook Halil tributary Boubhir tributary, 1115 m, III.2010, 20 larvae; V.2010, 31 larvae; VII.2010, 28 larvae (coll. H&L).

GEOGRAPHICAL DISTRIBUTION. — *Amphinemura* sp. is limited to the Djurdjura Massif in Great Kabylia. It occurs in brooks between 900 and 1110 m.

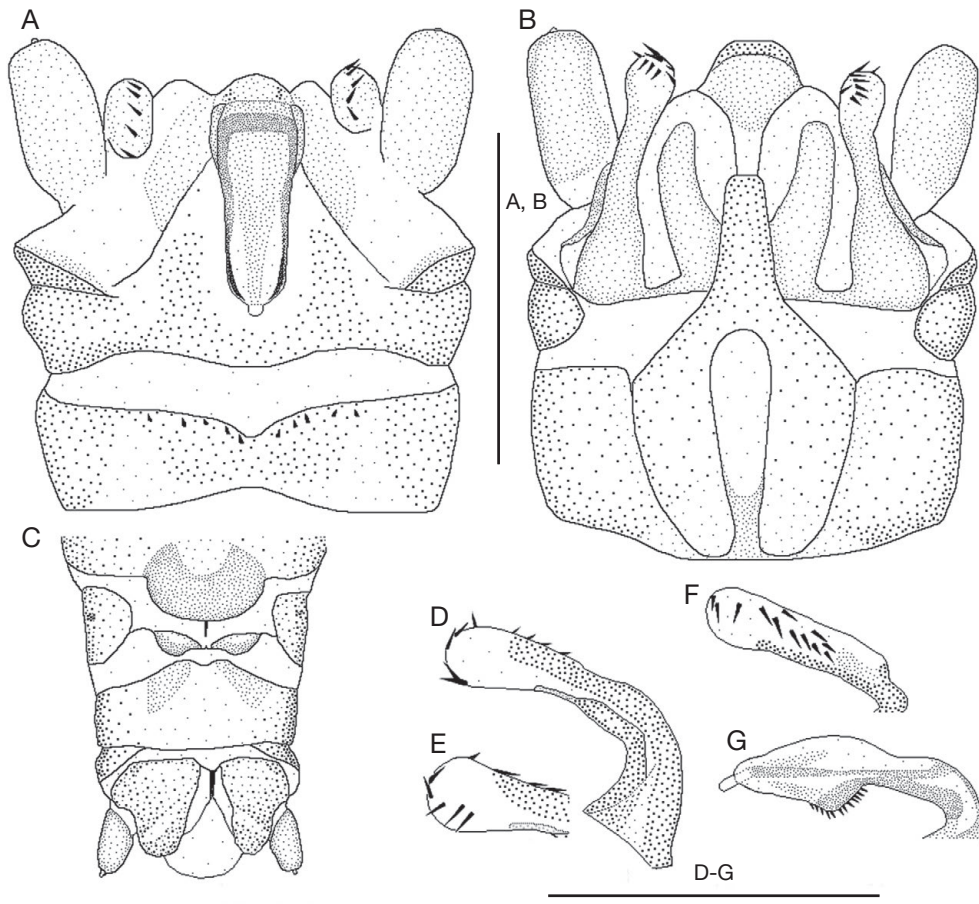


FIG. 1. — *Amphinemura berthelemyi* Vinçon, Yasri & Lounaci, 2013: **A**, ♂ abdomen dorsal view; **B**, ventral view; **C**, ♀ abdomen ventral view; **D**, paraproct lateral view; **E**, idem specimen from Aokas; **F**, dorsal view; **G**, epiproct lateral view (Yasri et al. 2013). Scale bars: A, B, D-G, 0.5 mm; C, 1 mm.

Genus *Protonemura* Kempny, 1898

Protonemura ruffoi Consiglio, 1961

Protonemura ruffoi Consiglio, 1961: 179.

MATERIAL EXAMINED. — **Central Algeria.** Kabylia Djourdjura, NE Tizi Ouzou, Ath Agad village, Thaânsrine district, Ighzer Ath Agad brook Ouacif tributary Aissi tributary, 920 m, III.2010, 8 larvae; VII.2010, 90 larvae (coll. H&L); 16.IV.2012, 1 ♂, 2 ♀ (YN); 500 m above Ouacif village, Ouacif river Aissi tributary, 380 m, V.2010, 11 larvae; VII.2010, 33 larvae (coll. H&L). Tizi n’Kouilal Pass below Main-du-Juif Mount, brook, 1300 m, 16.IV.2012, 1 ♂, 2 ♀ (MNHN); 3.V.2013, 1 ♂, 1 ♀ (coll. NY).

Great Kabylia. Addekar village, between Tagma Pass and Kebouche Adekar, below Djebel Toukra (1450 m), second brook right side of road, 1100 m, 17.IV.2012, 23 ♂, 12 ♀ (coll. NY), third brook right side of road, 1000 m, 17.IV.2012, 1 ♀ (coll. NY).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY. — *Protonemura ruffoi* is a west Mediterranean species not known from the Iberian Peninsula (Lounaci & Vinçon 2005). It extends to Sicily and the southern part of the Italian Peninsula. In Sicily, it occurs between 970 and 1600 m a.s.l. (Consiglio 1961). It was reported by Aubert (1956) as *Protonemura tyrrhena* in the Kabylia Djourdjura (1400 m) and the Bliedean Atlas (Fig. 11). Lounaci & Vinçon (2005) reported it from the Kabylia Djourdjura between 480 and 1680 m. We collected it in the Kabylia Djourdjura (Fig. 12), between 380 and 1300 m. It is a crenophilic species. The adults emerge in spring.

Protonemura drahamensis Vinçon & Pardo, 2006

(Figs 4; 5)

Protonemura drahamensis Vinçon & Pardo, 2006: 2.

MATERIAL EXAMINED. — **Eastern Algeria.** El Kala, Algerian slope of Khroumir mountains: Ech chaba El Waara, brook below Djebel Haddada, Haddada village (Fig. 5), 180 m, 7.V.2010, 40 larvae; 25.III.2011, 132 larvae; 23.IV.2011, 20 larvae; 3.III.2012, 1 ♂; 24.III.2012, 3 ♂, 2 ♀ (MNHN); 2.V.2012, 1 ♂, 2 ♀ (coll. NY). Bougousse district, below Djebel Ghorra (1200 m), forest house of El Ghorra, 5 tributaries of Bougousse r. flowing in Mexna dam: Ghorra brook 1, 900 m, 3.V.2012, 1 ♂, 3 ♀ (coll. NY), Ghorra brook 2, 900 m, 3.V.2012, 1 ♂, 1 ♀ (coll. NY), Ghorra brook 3, 900 m, 3.V.2012, 2 ♀ (coll. NY), Ghorra brook 4, 950 m, 3.V.2012, 1 ♂, 9 ♀ (coll. NY), Ghorra brook 5, 950 m, 3.V.2012, 5 ♂, 2 ♀ (coll. NY).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY. — *P. drahamensis* is an endemic species occurring in Central Maghreb (W Tunisia and E Algeria) (Fig. 11). In Algeria, it is restricted to the El Kala region (Fig. 12). In the Kabylia Djourdjura, it is replaced by *P. ruffoi*. In Tunisia, it occurs in brooks and brooklets at moderate altitudes 350-600 m of the Khroumirian mountainous massif (Vinçon & Pardo 2006). We collected it up to 950 m a.s.l. The adults emerge in spring.

DIAGNOSIS. — *Protonemura drahamensis* is assigned to the *corsicana* group, characterized by a terminal filament at the apex of the epiproct. Nevertheless, this filament is hardly visible in this

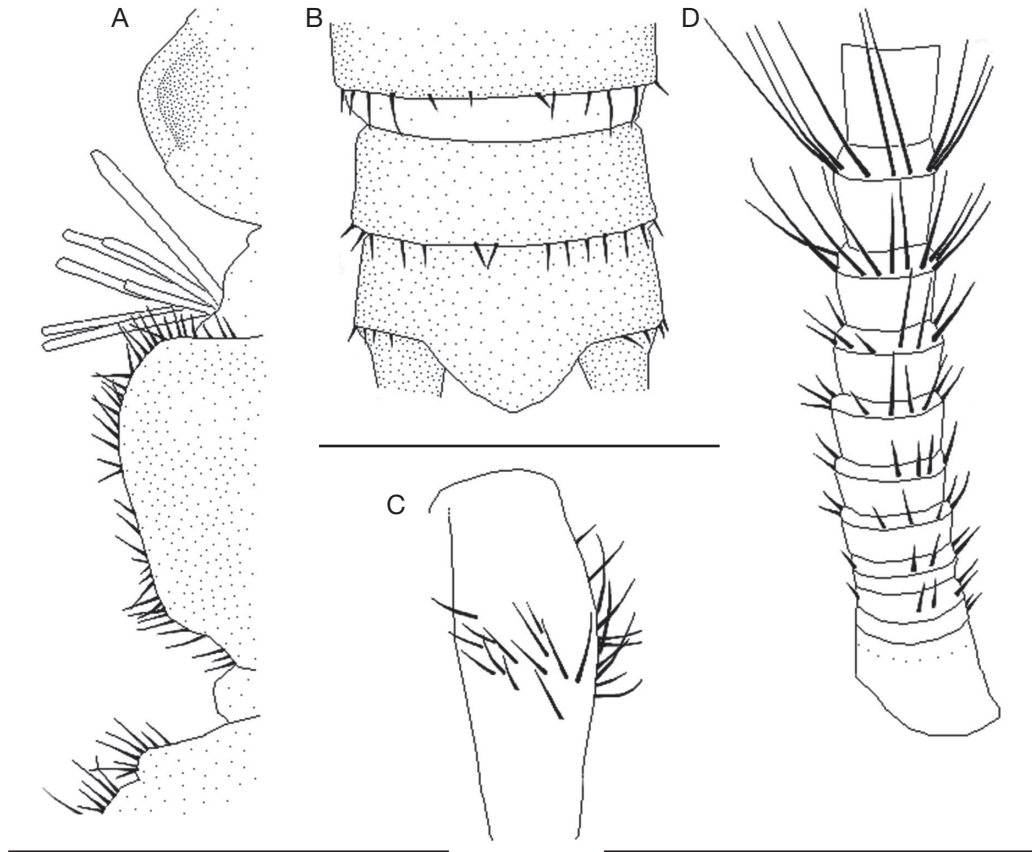


FIG. 2. — *Amphinemura berthelemyi* Vinçon, Yasri & Lounaci, 2013 larva: **A**, pro and meta-thorax dorsal view; **B**, tip of the abdomen dorsal view; **C**, anterior femora dorsal view; **D**, first segments of cercus (Yasri *et al.* 2013). Scale bars: A, C, D, 0.5 mm; B, 1 mm.

species since it is often retracted in the epiproct apex (Fig. 4A, B). It is very similar to *P. ruffoi* in all aspects; *P. ruffoi* differs by the longer, permanently exposed terminal filament of the epiproct (Consiglio 1961: fig. 2) and by the slender median and outer lobes of paraprocts, with the styles lying on the soft part of the median lobe and extending near the tip of the outer lobes (Consiglio 1961: figs 3, 11). *Protonemura drahamensis* differs very noticeably by the shorter stiles of paraprocts, freely arching over the median lobe (Fig. 4C-E). The female of *P. ruffoi* has a large pregenital plate on sternite VII instead of the narrow, rounded pregenital plate of *P. drahamensis* (Fig. 4F).

Protonemura talboti (Navás, 1929)
(Figs 6; 7; 8)

Nemoura talboti Navás, 1929: 230. — Claassen 1940: 64.

Nemoura (Protonemura) talboti Aubert, 1952: 239; 1956: 422; 1961: 219.

Protonemura talboti – Raušer 1963: 804. — Aubert 1964a: 72. (comparison); 1964b: 291. — Illies 1966: 243. — Meinander 1967: 45. — Berthélemy 1973: 1544. — Zwick 1978: 33. — Giudicelli & Dakki 1984: 54. — Nicolai, 1985: 249. — Gagneur & Aliane 1991: 312. — Zhiltzova 2003: 227. — Vinçon & Zhiltzova 2004: 193. — Lounaci & Vinçon 2005: 117. — Murányi 2007: 28.

MATERIAL EXAMINED. — **Central Algeria, Tellian Atlas**, SE Blida, Belkred, brook (Fig. 8), below Djebel Gueroumene, road to Chréa ski station, after the road sign “Glacières”, second brook to Belkred village, 1250 m, 14.IV.2012, 1 ♂, 2 ♀ (MNHN); 2.IV.2013, 1 ♂, 2 ♀ (coll. NY). Near Blida, Mouzaia river, below Djebel Mouzaia, 5.5 km above Hamdania village, 390 m, 21.III.2010, 3 larvae; 20.IV.2010, 8 larvae; 27.V.2010, 3 larvae (coll. NY). Chiffa river above confluence with “Ruisseau des Singes” brook, 5 km below Hamdania village, 270 m, 21.III.2010, 4 larvae; 20.IV.2010, 2 larvae; 27.V.2010, 1 larva (coll. NY). Boumaane river, below Djebel El Mokhfi, 700 m above Mactaa Lazrag village, 220 m, 22.IV.2010, 2 larvae; 29.V.2010, 5 larvae (coll. NY). Lakhra river, below Djebel Takramente, 700 m above Mactaa Lazrag village, 220 m, 27.III.2010, 4 larvae; 22.IV.2010, 3 larvae (coll. NY). Benyakhilil river, below Djebel Marmoucha, Mactaa Lazrag village, 210 m, 27.III.2010, 5 larvae; 22.IV.2010, 3 larvae; 29.V.2010, 2 larvae (coll. NY). El Harrach 1 river, 4 km below Mactaa Lazrag village and 4 km below confluence with Benyakhilil river, 165 m, 22.IV.2010, 4 larvae (coll. NY). El Harrach 2 river, 1 km below Hammam Melouane village and 2.5 km below El Harrach 1 river, 140 m, 27.III.2010, 3 larvae; 22.IV.2010, 8 larvae; 29.V.2010, 14 larvae; 19.VI.2010, 4 larvae (coll. NY).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY. — *Protonemura talboti* is a North African endemic species restricted to the Western part of Maghreb from the Moroccan Rif, Middle and High Atlas, up to the Algerian Blidean Atlas (Fig. 11). It occurs in various mountain brooks and springs of the Middle and High-Atlas from 85 m to 2900 m (Vinçon & Murányi 2009). We collected



FIG. 3. — Collecting sites of *Amphinemura berthelemyi* Vinçon, Yasri & Lounaci, 2013 and *Protonemura algerica bejajana* Vinçon & Murányi, 2009 in the El Kala National Park, El Taref, Eastern Algeria. **A**, Haddada brook (180 m); **B**, Dar Essalem brook (190 m).

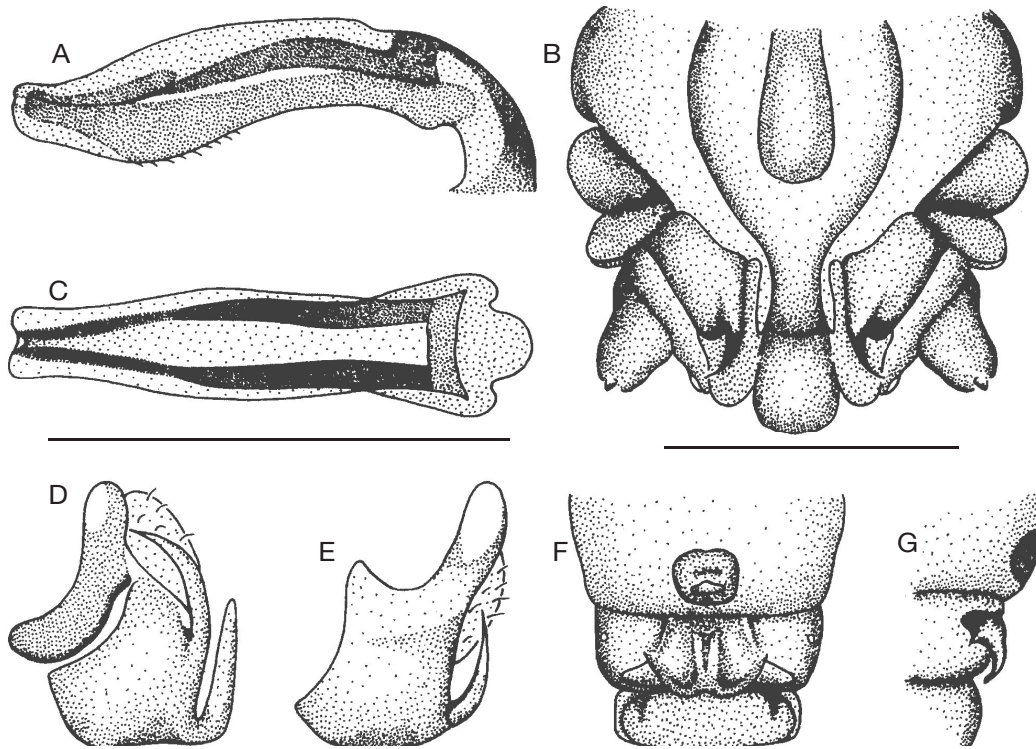


FIG. 4. — *Protonemura drahamensis* Vinçon & Pardo, 2006 ♂: **A**, epiproct, lateral, **B**, dorsal; **C**, abdominal tip, ventral view; **D**, paraprocts, ventral; **E**, lateral; **F**, ♀ sternite VII-IX, ventral; **G**, lateral (Vinçon & Pardo 2006). Scale bars: 0.5 mm.



FIG. 5. — Collecting site of *Protonemura drahamensis* Vinçon & Pardo, 2006: Ech chaba El Waara brook, 180 m, El Kala National Park, El Taref, Eastern Algeria.

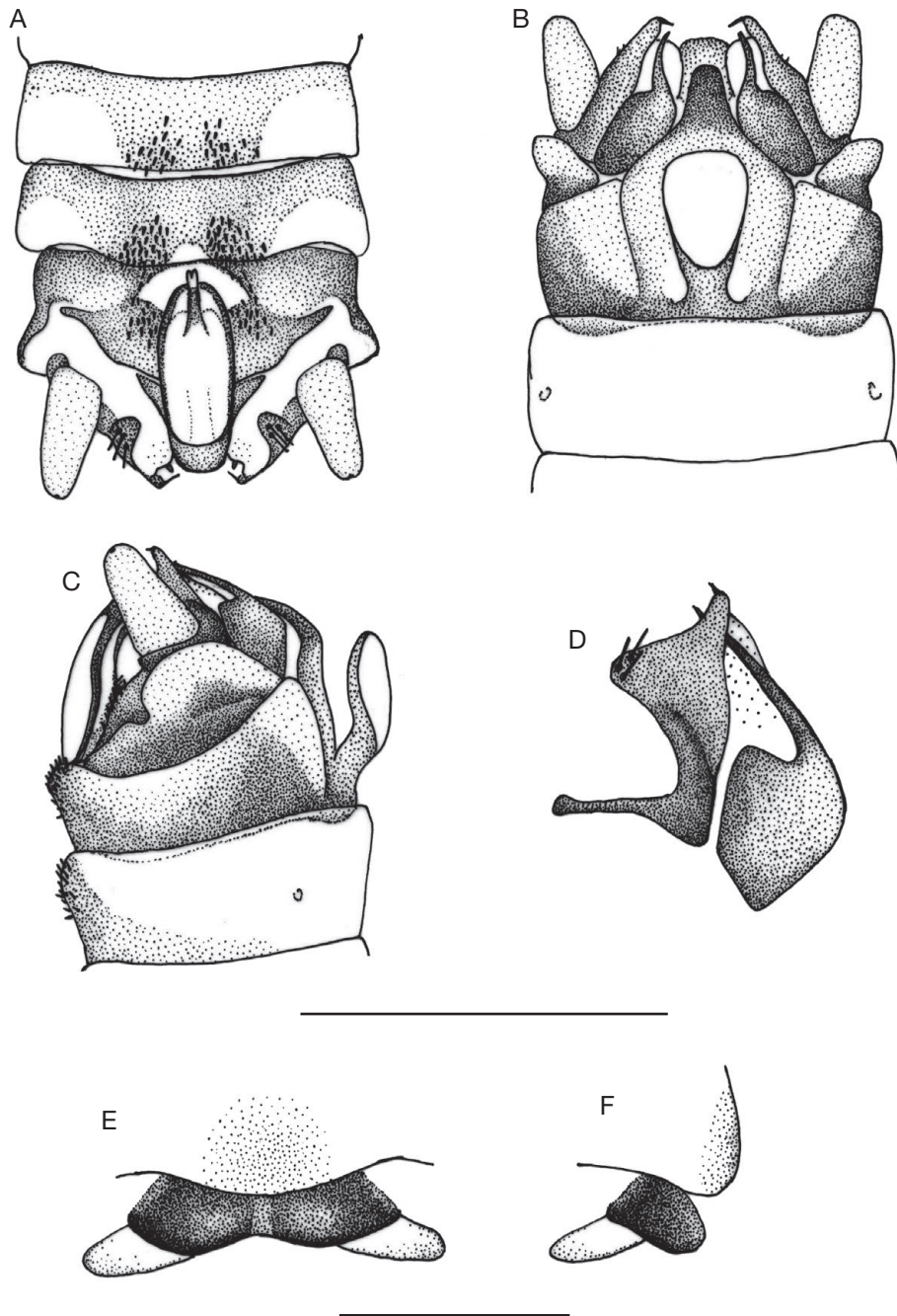


FIG. 6. — *Protonemura talboti* (Navás, 1929) ♂. **A**, terminalia, dorsal view; **B**, ventral view; **C**, lateral view; **D**, paraproct, ventro lateral view; **E**, ♀ subgenital plate ventral view; **F**, lateral view (Vinçon & Murányi 2009). Scale bars: 0.5 mm.

it for the first time in the central part of Algeria (Blidean Atlas), between 140 m and 1250 m (Fig. 12). The emergence period is very extended (XI-VIII).

DIAGNOSIS. — In the male, the outer lobe of the paraprocts has a characteristic ventral finger-shaped expansion with a strong spine at the tip (Fig. 6B-D). The epiproct is slender at the tip (Figs. 6A, 9A, B), while in *P. algerica algerica* and *P. algerica bejaiana*, it is much stronger at the tip, with wide apex (Fig. 7D, F).

Protonemura algerica algerica (Aubert, 1956)
(Fig. 9)

Nemoura (Protonemura) algerica Aubert, 1956:424; 1961 (partim): 218.

Protonemura algerica – Raušer 1963: 804. — Aubert 1964a: 72; 1964b: 291. — Illies 1966: 223. — Berthélemy 1973: 1544. — Zwick 1978: 33. — Nicolai 1985: 249. — Gagneur & Aliane 1991: 323. — Sánchez-Ortega & Azzouz 1998: 452. — Vinçon &

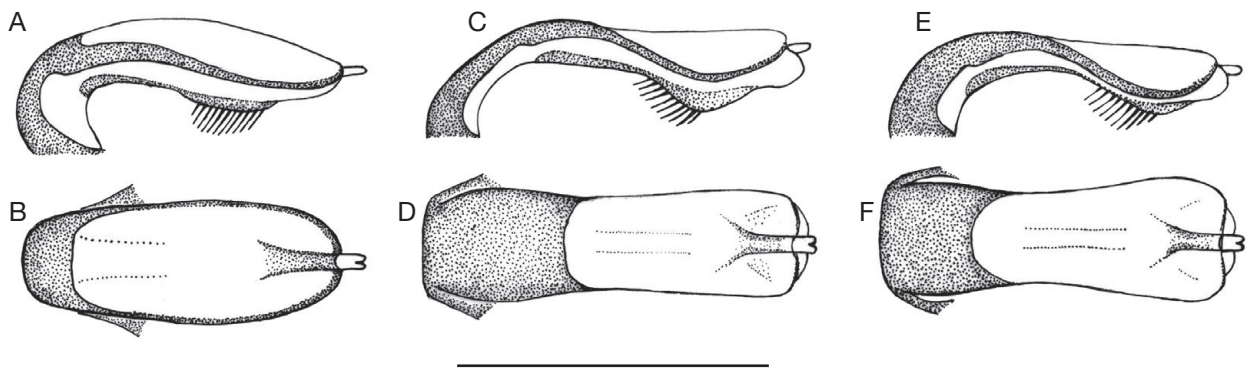


FIG. 7. — Epiprocts of the Algerian species of the *Protonemura talboti* (Navás, 1929) subgroup. **A, B**, *P. talboti*; **C, D**, *P. algerica algerica* (Aubert, 1956); **E, F**, *P. algerica bejaiana* Vinçon & Murányi, 2009 (Vinçon & Murányi 2009). Scale bars: 0.5 mm.



FIG. 8. — Collecting site of *Protonemura talboti* (Navás, 1929), Belkred brook, 1250 m, Chréa National Park, Blida, Central Algeria.

Sánchez-Ortega 1999: 233. — Zhiltzova 2003: 227. — Vinçon & Zhiltzova 2004:193. — Lounaci & Vinçon 2005. — Murányi 2007:28.

MATERIAL EXAMINED. — **Small Kabylia.** E Bejaïa: above Aokas, road W16, after Tizi n'Berber Pass, first brook, left side of road, 1000 m., 18.IV.2012, 1 ♂, 1 ♀ (MNHN MNHN). Above Aokas, road W16, after Tizi n'Berber Pass, second brook, left side of road, 1000 m., 18.IV.2012, 2 ♂, 5 ♀ (coll. NY).

Eastern Algeria, Aurès. Batna: Chaaba brook 1, below Djebel Berdjem, near forest house, 5.5 km above Ouled Chellih village, 1270 m, 2.V.2010, 82 larvae; 16.IV.2011, 58 l; 22.VI.2011, 32 larvae (coll. NY). Chaaba brook 2, 1.5 km below Chaaba brook 1, 1240 m, 2.V.2010, 20 larvae; 16.IV.2011, 17 l; 22.VI.2011, 12 larvae; (coll. NY). Hamla brook 1, below Djebel Enza: 6 km

above Hamla village; 1300 m, 2.V.2010, 4 larvae; 16.IV.2011, 12 larvae; 22.VI.2011, 9 larvae (coll. NY). Hamla brook 2.1 km below Hamla village, 1260 m, 2.V.2010, 3 larvae; 16.IV.2011, 5 larvae; 22.VI.2011, 4 larvae; 5.III.2012, 2 ♂; 26.III.2012, 1 ♀ (coll. NY).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY. — *Protonemura algerica algerica* is an endemic subspecies occurring in Central Algeria (Blidean Atlas and Kabylia Djourdjura) (Lounaci & Vinçon 2005) (Fig. 11). We collected it in Small Kabylia (Béjaïa) and in the Aurès region (Batna) (Fig. 12), that confirms the reports of Aubert (1956) in the same region. It seems to be absent from the Blidean Atlas where it could be replaced by *P. talboti*. In the El Kala region and in Tunisia, it is replaced by *P. algerica bejaiana*.

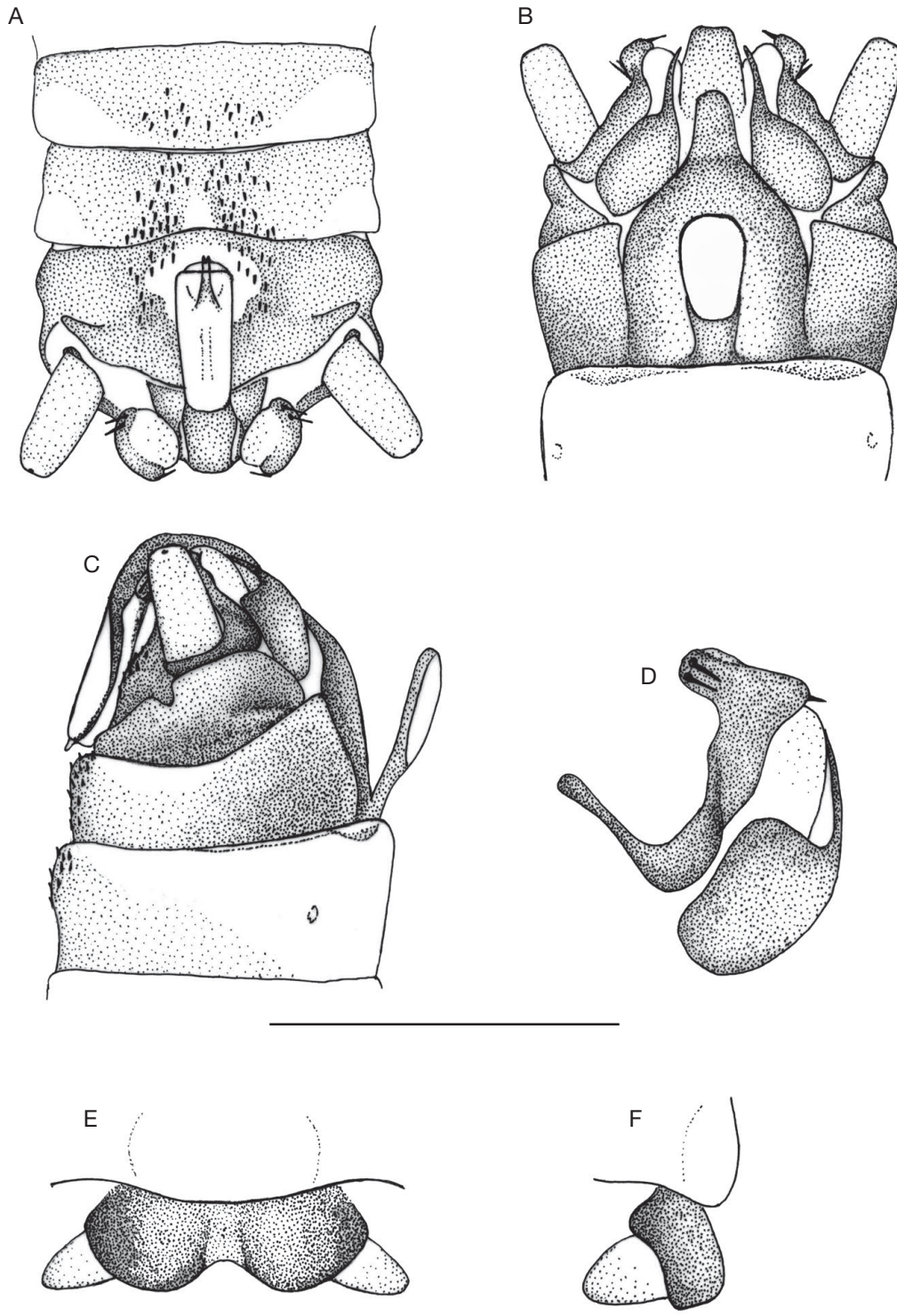


FIG. 9. — *Protonemura algirica algirica* (Aubert, 1956) ♂: **A**, terminalia, dorsal view; **B**, ventral view; **C**, lateral view; **D**, paraproct, ventro lateral view; **E**, ♀ subgenital plate ventral view; **F**, lateral view (Vinçon & Murányi 2009). Scale bars: 0.5 mm.

The Moroccan specimens previously assigned to *P. algirica* from the Rif belong to *P. berberica* or *P. talboti* (in Aubert, Sánchez-Ortega and Berthélemy collections); those from the Middle Atlas belong to *P. dakkii* Vinçon & Murányi, 2009 or *P. talboti* (in Aubert, Berthélemy and Dakki collections), and those from the High Atlas remain problematic since the Moroccan paralectotypes (ZML) are actually lost and since all studied

specimens from the High Atlas belong to *P. talboti* (Vinçon & Murányi 2009).

In the Djurdjura Massif (Kabylia), *Protonemura algirica algirica* occurs in mountain watercourses (480-1300 m) (Lounaci & Vinçon 2005), and according to our own collecting, it occurs in brooks and rivers above 1000 m and appears to be rheophilic and crenophilic. The adults emerge in spring (III-IV).

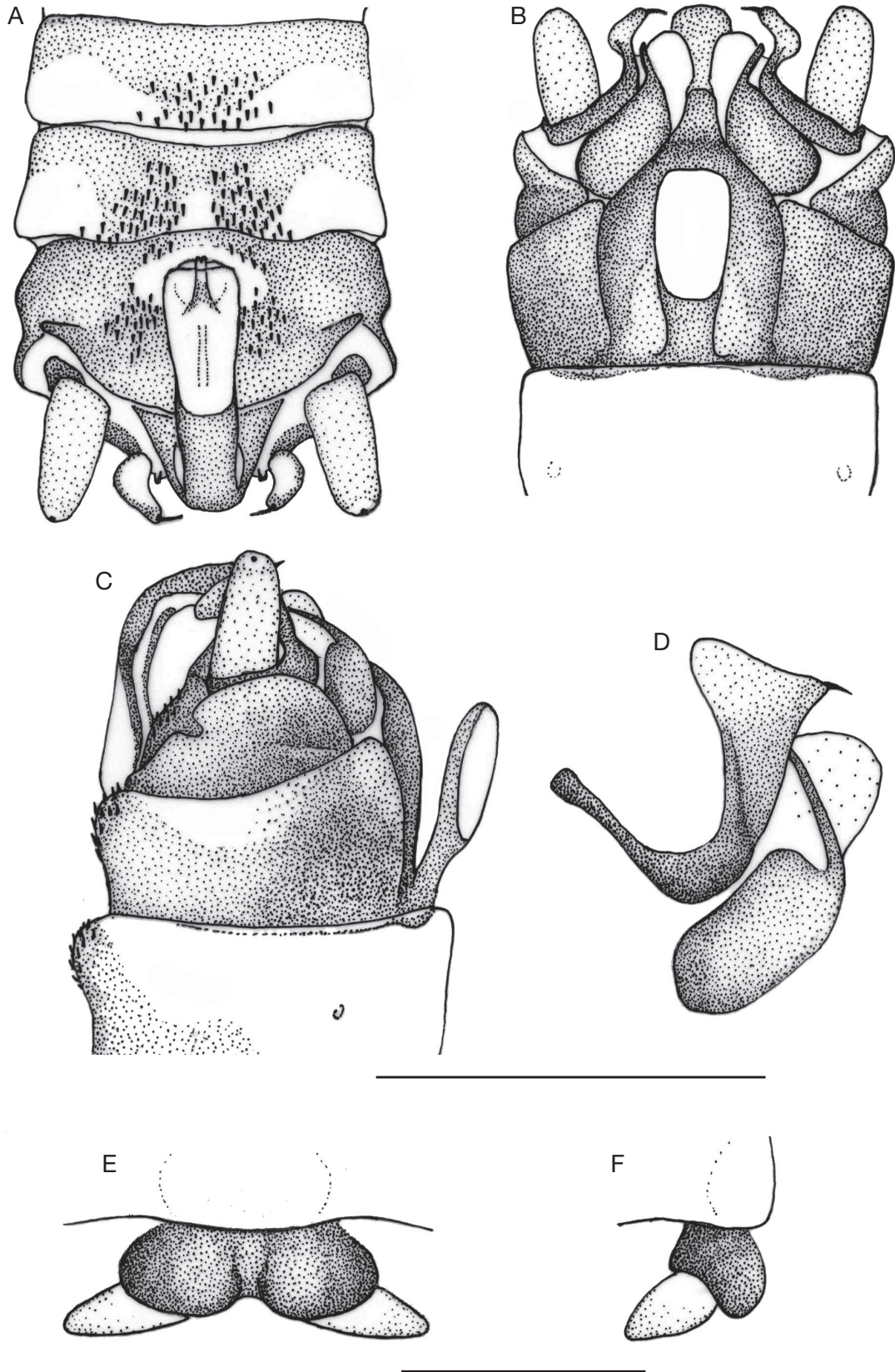


FIG. 10. — *Protonemura algirica bejaiana* Vinçon & Murányi, 2009 ♂: **A**, terminalia, dorsal view; **B**, ventral view; **C**, lateral view; **D**, paraproct, ventro lateral view; **E**, ♀ subgenital plate ventral view, **F**, lateral view (Vinçon & Murányi 2009). Scale bars: 0.5 mm.

TABLE 1. — Nemouridae distribution and endemism in the Maghreb (based on Lounaci & Vinçon 2005, Vinçon & Murányi 2009, Yasri *et al.* 2013, Vinçon *et al.* 2014 and Errochdi *et al.* 2014 a and b).

	Tell Atlas				Morocco			Endemic species
	Tunisia	Eastern Algeria	Central Algeria	Western Algeria	High Atlas	Middle Atlas	Rif	
<i>Amphinemura chiffensis</i> Aubert, 1956	–	–	–	–	*	–	–	*
<i>A. berthelemyi</i> Vinçon, Yasri & Lounaci, 2013	*	*	*	–	–	–	–	*
<i>A. yasriarum</i> Vinçon, 2014	–	–	–	–	–	–	*	*
<i>A. tiernodefigueroai</i> Vinçon, 2014	–	–	–	–	–	*	–	*
<i>Protonemura ruffoi</i> Consiglio, 1961	–	–	*	–	–	–	–	–
<i>P. drahamensis</i> Vinçon & Pardo, 2006	*	*	–	–	–	–	–	*
<i>P. berberica</i> Vinçon & Sánchez-Ortega, 1999	–	–	–	–	–	–	*	*
<i>P. dakkii</i> Vinçon & Murányi, 2009	–	–	–	–	*	*	–	*
<i>P. talboti</i> (Navás, 1929)	–	–	*	*	*	*	*	*
<i>P. algirica algirica</i> (Aubert, 1956)	–	*	*	–	–	–	–	*
<i>P. algirica bejaiana</i> Vinçon & Murányi, 2009	*	*	–	–	–	–	–	*
<i>Nemoura fulviceps</i> Klapálek, 1902	–	–	*	–	–	–	*	–
<i>N. lacustris</i> Pictet, 1865	–	–	–	–	–	*	*	–
<i>N. rifensis</i> Aubert, 1961	–	–	–	–	–	–	*	–
Total	3	4	5	1	3	4	6	10

DIAGNOSIS. — In the male, the outer lobe of the paraprocts has a wide rounded ventral expansion with a strong spine at the tip and a dorsal rounded expansion carrying two or more spines (Fig. 9B-D). The epiproct is nearly rectangular at the tip (Figs 7C, D; 9A), while in *Protonemura talboti*, it is much slender at the tip (Fig. 7A, B).

Protonemura algirica bejaiana
Vinçon & Murányi, 2009
(Fig. 10)

Protonemura algirica bejaiana Vinçon & Murányi, 2009: 64.

MATERIAL EXAMINED. — **Eastern Algeria.** El Kala, Algerian slope of Khroumir mountains: Oued Haddada (Fig. 3A), brook below Djebel Haddada, Haddada village, 180 m, 7.V.2010, 20 larvae; 25.III.2011, 56 larvae; 23.IV.2011, 20 larvae; 12.V.2011, 24 larvae; 3.III.2012, 1 ♂; 24.III.2012, 1 ♂, 3 ♀ (MNHN). Oued Dar Essalem (Fig. 3B), below Djebel Haddada, Haddada village, 190 m, 7.V.2010, 28 larvae; 25.III.2011, 150 larvae; 23.IV.2011, 100 larvae; 12.V.2011, 62 larvae; 28.01.2012, 1 ♂, 1 ♀; 3.III.2012, 1 ♀; 24.III.2012, 2 ♂, 4 ♀ (coll. NY).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY. — *Protonemura algirica bejaiana* is an endemic subspecies from the Central Maghreb (W Tunisia and E Algeria) (Fig. 11). In Algeria, it is restricted to the El Kala region (Fig. 12) and it is replaced by *P. algirica algirica* in the Kabylia Djourdjura. In Tunisia, it occurs in brooks and brooklets at moderate altitudes (350–600 m) in the Khroumirian mountains (Vinçon & Murányi 2009). We collected it in lowland watercourses (below 200 m), but having the same characteristics as mountain brooks (slope, speed, rough substratum and dense riparian vegetation). The adults emerge in winter and spring (XI–V).

DIAGNOSIS. — The male of *P. algirica bejaiana* differs from that of *P. algirica algirica* in the shape of the outer lobe of the paraprocts, having no spines on the dorsal expansion (Fig. 10B-D), while in *P. algirica algirica* it carries two or more spines (Fig. 9B-D). The epiproct tip is slightly more enlarged in *P. algirica bejaiana* (Fig. 7F) than in *P. algirica algirica* (Fig. 7D), but this character is rather variable. The females of both subspecies are similar.

Genus *Nemoura* Latreille, 1796

Nemoura sp.

MATERIAL EXAMINED. — **Central Algeria.** Kabylia Djourdjura, NE Tizi Ouzou, 6 km S Ain El Hammam village, Djemaa brook Aissi tributary, 900 m, III.2010, 7 larvae; V.2010, 8 larvae (coll. H&L).

GEOGRAPHICAL DISTRIBUTION. — *Nemoura* sp. is limited to the Kabylia Djourdjura, where it was collected in only one brook at 900 m a.s.l. It probably corresponds to *Nemoura fulviceps* Klapálek, 1902 (West Mediterranean species) already reported from the Kabylia Djourdjura (Lounaci & Vinçon 2005) in brooks between 1300 and 1680 m.

DISCUSSION

Table 1 gives the distribution area of the Maghrebin Nemouridae. The Algerian Tell Atlas is split into three parts: Eastern Algeria (from the Tunisian border to the Soummam River), Central Algeria (between the Soummam River and the Mina-Chelif River), Western Algeria (from the Mina-Chelif River to the Moroccan border) (Fig. 11).

The Nemouridae family, with 14 species belonging to three genera, is the most diversified in the Maghreb, followed by the Leuctridae Klapálek, 1905 with 11 species and two genera. This species richness is unevenly distributed. Among the 14 known species, nine are known from Morocco, seven from Algeria and only three from Tunisia (Table 1).

The higher diversity in Morocco compared to Algeria could be explained both by the proximity of Europe, through the Strait of Gibraltar, enabling the migration of European elements such as *Nemoura lacustris* Pictet, 1865 and by the wide separation of the three main Moroccan mountainous ranges (Rif, Middle Atlas and High Atlas) that favors orophilic isolation.

The 14 Maghrebin Nemouridae belong to three main bio-geographical groups according to the extent of their distributions:



FIG. 11. — Distribution map of *Amphinemura berthelemyi* Vinçon, Yasri & Lounaci, 2013 (✦), *Protonemura ruffoi* Consiglio, 1961 (◆), *P. drahamensis* Vinçon & Pardo, 2006 (★), *P. talboti* (Navás, 1929) (★), *P. algirica algirica* (Aubert, 1956) (○), *P. algirica bejaiana* Vinçon & Murányi, 2009 (▲) and *Nemoura fulviceps* Klapálek, 1902 (◻) in Maghreb (Lounaci & Vinçon 2005; Vinçon & Pardo 2006; Vinçon & Murányi 2009; Vinçon *et al.* 2014; Errochdi *et al.* 2014 a and b; present work).

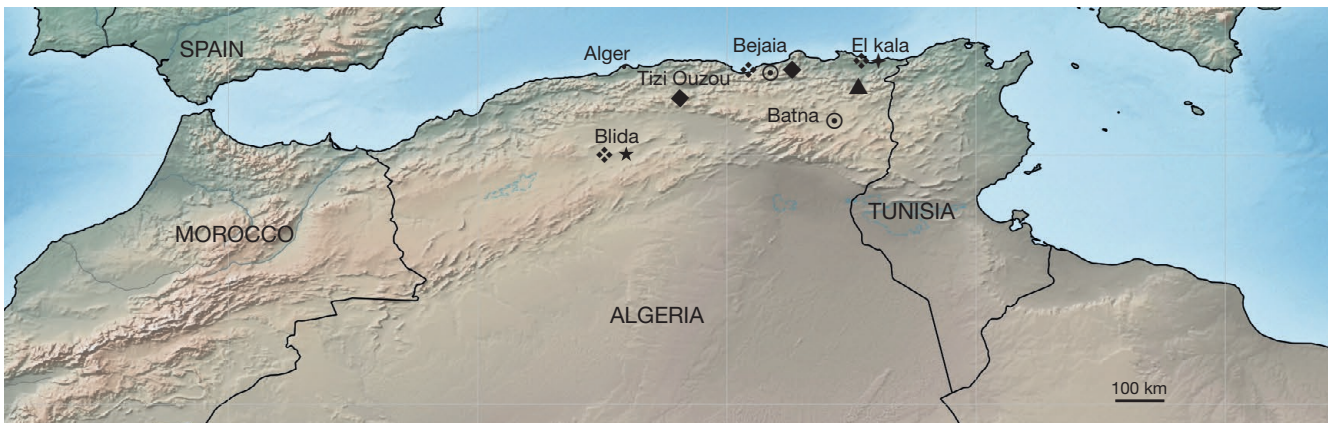


FIG. 12. — Distribution map of *Amphinemura berthelemyi* Vinçon, Yasri & Lounaci, 2013 (✦), *Protonemura ruffoi* Consiglio, 1961 (◆), *P. drahamensis* Vinçon & Pardo, 2006 (★), *P. talboti* (Navás, 1929) (★), *P. algirica algirica* (Aubert, 1956) (○) and *P. algirica bejaiana* Vinçon & Murányi, 2009 (▲) in Algeria (current study).

West mediterranean species (3)

- *Protonemura ruffoi*: Sicily, Italian peninsula and Central Maghreb (Algeria).
- *Nemoura fulviceps*: Iberian Peninsula, Sicily and Western Maghreb (Algeria, Morocco).
- *Nemoura lacutris*: France, Iberian Peninsula and Western Maghreb (Morocco).

Betico-rifan species (1)

- *Nemoura rifensis*: Andalusia (Spain) and Rif (Morocco).

Maghrebin endemic species (10)

- *Amphinemura chiffensis*: micro-endemic species from Moroccan High Atlas (Vinçon *et al.* 2014).
- *Amphinemura tiernodefigueroai* Vinçon, 2014: micro-endemic species from Moroccan Middle Atlas (Vinçon *et al.* 2014).
- *Amphinemura yasriarum* Vinçon, 2014 and *Protonemura berberica* Vinçon & Sánchez-Ortega, 1999: micro-endemic species from Moroccan Rif (Errochdi *et al.* 2014a).

- *Protonemura dakkii* Vinçon & Murányi, 2009: micro-endemic species from Moroccan Middle Atlas and Eastern part of High Atlas (Vinçon *et al.* 2014).
- *Protonemura algirica algirica*: micro-endemic species from Algeria.
- *A. berthelemyi*, *Protonemura drahamensis* and *Protonemura algirica bejaiana*: micro-endemic species from Central Maghreb (Eastern Algeria and Western Tunisia).
- *Protonemura talboti*: endemic species from Western Algeria and Morocco.

The level of endemism in the Maghrebin Nemouridae appears to be high (71%) (10 of 14 species) compared to the Maghrebin Leuctridae (64%) (7 of 11) and even much higher compared to the whole Maghrebin stoneflies (58%) (22 of 38) (Errochdi *et al.* 2014). In comparison, the global level of endemism in the Iberian Peninsula is also lower (50%) (Sánchez-Ortega & Tierno de Figueroa 1996). This high level of endemism in the Nemouridae could be related to orophilic and crenophilic isolation; indeed most Maghrebin

micro-endemic Nemouridae occur in small brooks or springs in high altitude mountainous areas.

FAUNISTIC BARRIERS

Among the seven species of Nemouridae present in Algeria, three occur in Tunisia (Fig. 11) and in the El Kala region belonging to the same Khroumirian Mountains (*A. berthelemyi*, *P. drabamensis* and *P. algerica bejaiana*); among them *A. berthelemyi* is the only one reported from Central Algeria. Indeed the main transversal valleys, Oued Seybouse (S Annaba), Oued El Kébir (NW Constantine), Oued Agrioun (N Sétif) and the wide Soummam Valley (S Bejaia) running down in the Eastern Tell Atlas are effective barriers preventing the dispersal of most Nemouridae within the Eastern part of Algeria. For the same reason, *P. algerica algerica*, *P. ruffoi* and *N. fulviceps*, occurring in Great Kabylia, have never been found in Small Kabylia, eastward of the Soummam Valley.

The Tell Atlas is widely separated from the Saharan Atlas and Aurès Mountains by a dry plateau and salt water lakes, impeding stonefly dispersal southward from the Tell Atlas. Indeed, only one Nemouridae species is reported from the Aurès Mountains (*P. algerica algerica*) and none have been reported from the Saharan Range.

Moreover, the wide Moulouya Valley between the Moroccan mountain ranges (Rif, Middle and High Atlas) and the Algerian Tell Atlas also constitutes a strong faunistic barrier. Indeed, seven Nemouridae present in Morocco west of the Moulouya Valley are not reported from Algeria: (*A. chiffensis*, *A. yasriarum*, *A. tiernodefigueroai*, *P. berberica*, *P. dakkii*, *N. lacustris* and *N. rifensis*) and only two Nemouridae occur in both areas (*P. talboti* and *N. fulviceps*).

SPECIES IN DANGER OF EXTINCTION

Among the ten Maghrebin endemic species, only one (*P. talboti*) has a wide distribution, while the nine others have a restricted distribution and are in danger of extinction since their habitats are exposed to increasing human impact and global warming (Errochdi *et al.* 2014b).

Moreover the Betico-rifan species *N. rifensis* is also in danger of extinction and is already on the Red List of Iberian stoneflies (Sánchez-Ortega & Tierno de Figueroa 1996). It was recently upgraded to a higher level of vulnerability (Tierno de Figueroa & López-Rodríguez 2011).

To prevent these endangered species from extinction, a biodiversity survey should be done, with the definition of “hot spots” in the most exposed regions because of their isolation, aridity and increasing human impact, as already proposed for southern Europe macro-invertebrates (Hering *et al.* 2009, Tierno de Figueroa *et al.* 2010), and this should be extended to the North African aquatic fauna (Dakki 2009).

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