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## A review of the Algerian Leuctridae with the description of *Leuctra dhyae* sp. n. from central Algeria (Plecoptera: Leuctridae)

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*Leuctra dhyae* sp. n., endemic to the central Algerian Tell Atlas near Blida, is described and compared with its closest relatives *L. khroumiriensis* Vinçon & Pardo, 1998 and *L. sartorii* Vinçon & Pardo, 1998. *L. khroumiriensis* and *L. sartorii* are new for the Algerian fauna that now comprises eight Leuctridae species. The distribution and the ecology of the Algerian Leuctridae are discussed. The Algerian Leuctridae fauna is compared to that occurring in the main mountain ranges of the West Mediterranean Region (diversity, endemism, brachypterism).

Keywords: *Leuctra*, *L. dhyae* sp. n., *L. khroumiriensis*, *L. sartorii*, new taxa, systematics, taxonomy, zoogeography, Algeria, Tunisia.

### INTRODUCTION

Intensive research on the Algerian stoneflies was undertaken between 2010 and 2012 by Nabila Yasri, leading to the first mention of *Leuctra sartorii* in eastern Algeria and of *L. medjerdensis* Vinçon & Pardo, 1998 in the Aurès Massif.

In April 2012, a complementary collecting trip to Central Algeria resulted in the discovery of *L. khroumiriensis* Vinçon & Pardo, 1998 in Small Kabylia (first report for Algeria) and *L. dhyae* sp. n. in the Chréa Massif upwards of Blida (Fig. 1).

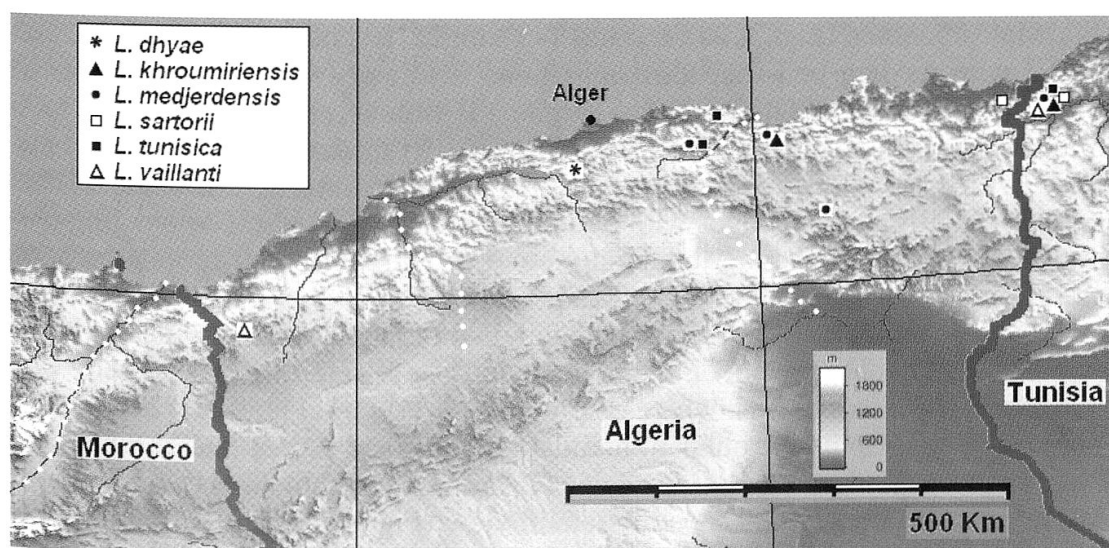


Fig. 1. Distribution map of *L. dhyae* sp. n., *L. khroumiriensis*, *L. medjerdensis*, *L. sartorii*, *L. tunisica* and *L. vaillanti* in Algeria and Tunisia.

Subsequently to the description of *L. dhyae* sp. n., the West Mediterranean Leuctridae populations are compared with each other, and put in relation to geographical and ecological aspects.

#### MATERIAL AND METHODS

The drawings are based on photographs made with a USB Digital Microscope (Veho Microcapture 20x–400x V1.3).

The specimens were preserved in 70 % ethanol. The holotype and one male, one female paratypes of *L. dhyae* are deposited in the collection of the Lausanne Museum of Zoology, Switzerland (LMZ), further paratypes are in the Nabila Yasri (NY) and Vinçon (VIN) collections.

*Abbreviations:* -> = flowing into, > = above, < = below, l. = larva, b. = brook, r. = river, E. = East, N. = North, S. = South, W. = West, v. = village, H&L = Haou-chine & Lounaci coll., NY = Nabila Yasri coll., S&L = Sekhi & Lounaci coll., VIN = Vinçon coll.

#### *Leuctra dhyae* Vinçon, Yasri & Lounaci sp. n.

(Figs 2, 3a–d, 4a–b)

*Material:* **Holotype** ♂: Algeria, South East Blida in direction of the Chréa ski station, after the road sign «Glacières», second brook to Belkred v., 1250 m a.s.l., 36°25'32 N, 2°52'36 E, 14.04.2012 (Yasri & Vinçon coll.) and **paratypes:** 1 ♂, 1 ♀, same locality and date, deposited in the Lausanne Museum (Switzerland). Other material: same locality and date, 2 ♂♂, 2 ♀♀ (VIN). Other material: Belkred, 1250 m, 02.04.2013, 11 ♂♂, 8 ♀♀ (NY); > Blida, Sidi El Kebir v., b., 500 m: 1 ♀ (NY).

*Description:* Medium sized species: body length: male 7.2–7.6 mm, female 7.5–7.8 mm. Brachypterous in both sexes (Fig. 2); wing length: male 2.1–2.5 mm, female 2.3–2.7 mm. General colour brown. Head brown, slightly darker on the front. Antennae blackish, covered with a crown of long erect bristles at the tip of each segment; bristles as long as segment width. Pronotum brown with dark pattern. Legs yellow but tarsi, basal and distal parts of femora and tibiae contrastingly dark brown; tarsal segments brown. Body, veins of wings and legs covered with long erect hairs.

Male abdomen (Fig. 3a–d): tergites I–V simple, tergites VI–X modified. Tergite VI with median bell-shaped membranous field and two pigmented spots on inner anterior corner of lateral edges. Tergite VII similar, also with two dark spots on inner anterior corner of lateral edges. Tergite VIII medially membranous; antecosta divided for about one fifth of segment's width; inner tips triangular, converging medially. Lateral edges with two finger-shaped processes, converging posteriorly and hardly projecting in lateral view (Fig. 3b). Two dark spots present on anterior part of lateral edges. Tergite IX: antecosta divided for nearly a third of segment's width; membranous median field with two rounded sclerites separated from each other by about the width of one of them. Tergite X anteriorly bilobed and with wide rounded posterior notch where epiproct is placed. Cerci normal, covered with long erect setae. Epiproct rounded, mainly membranous except lateral pigmented strips; its stalk very short (Fig. 3a). Styles of paraprocts with wide rectangular base, long thin expansion scythe-shaped in lateral view (Figs 3c–d) and a small sclerite beneath the posterior border of each base (Fig. 3c). Specilla slightly longer and more slender than styles, rectilinear, progressively getting thinner toward tip and ending in sharp point (Figs 3c–d). Sternite IX without a vesicle (Fig. 3b).

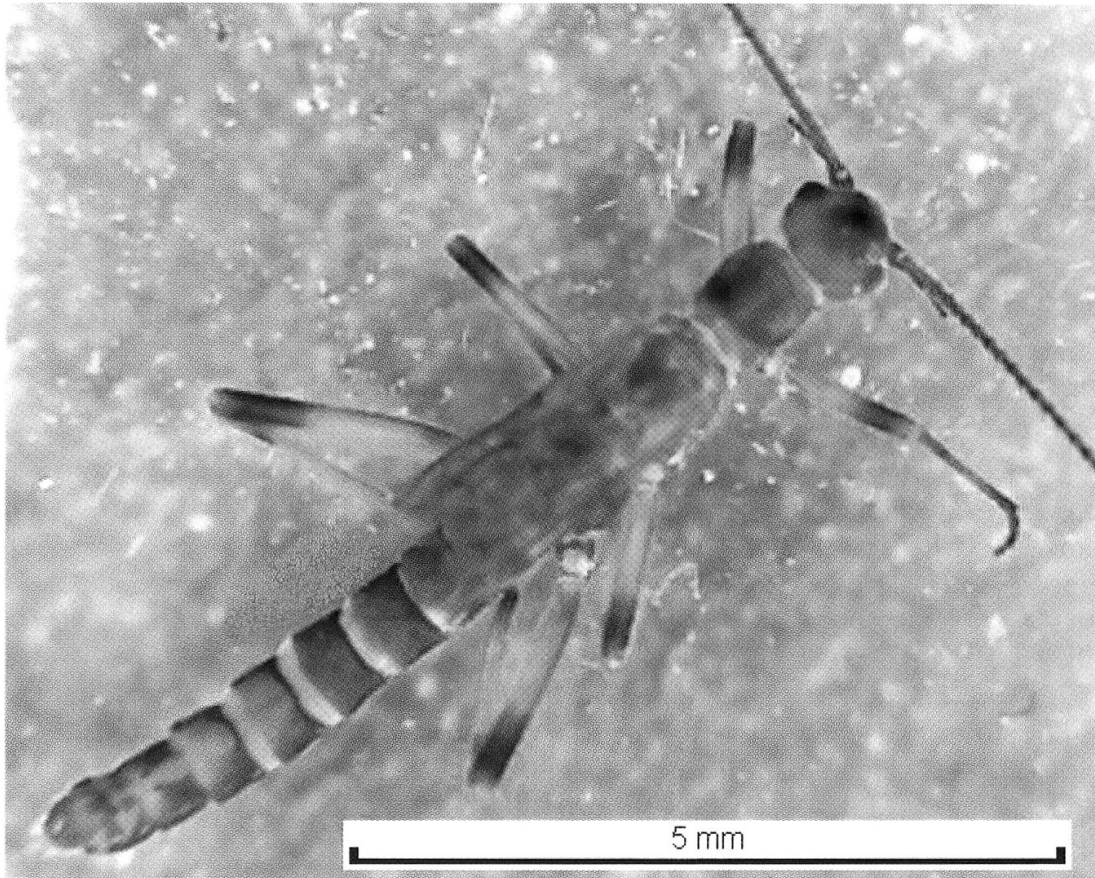


Fig. 2. Habitus of the *L. dhyae* sp. n. male.

Female abdomen (Figs 4a–b): sternite VII wide. Subgenital plate nearly trapezoidal, longer than wide, with sinuous edges and median anterior swelling more visible in lateral view (Fig. 4b). Plate sclerotized except median light strip; plate slightly more pigmented on edges than medially (Fig. 4a). Posteriorly, plate ending in two rounded lobes, longer than wide, slightly diverging, separated by a triangular notch followed by a deep U-shaped incision (Fig. 4a).

*Affinities:* In the *L. hippopus* group and *L. occitana* subgroup (Vinçon & Pardo 1998), *L. dhyae* sp. n. is closely related to *L. khroumiriensis* and *L. sartorii*, all three species having the same contrasted colours and long erect pilosity in common. The males of *L. dhyae* sp. n. differ from those of *L. khroumiriensis* by the processes of tergite VIII which are finger-shaped with a smooth tip (Fig. 3a), not erect in lateral view (Fig. 3b); in *L. khroumiriensis* they are shorter, sharply pointed at the tip, slightly projecting in lateral view (Vinçon & Pardo 1998: Fig. 1a–b), the two spots on tergite IX are rounded in *L. dhyae* and oval in *L. khroumiriensis*, the specilla are hardly longer than the styles in *L. dhyae* (Fig. 3d) and much longer than the styles in *L. khroumiriensis* (Fig. 3e). The female of *L. dhyae* has a median anterior swelling (Fig. 4b) instead of a strongly prominent bulge in *L. khroumiriensis* (Fig. 4c–d); the two lobes are also more widely separated in *L. dhyae*. The male of *L. dhyae* sp. n. is distinguished from that of *L. sartorii* by the two spots on tergite IX well separated in *L. dhyae* (Fig. 3a) and connected by a pigmented strip in *L. sartorii* (Vin-

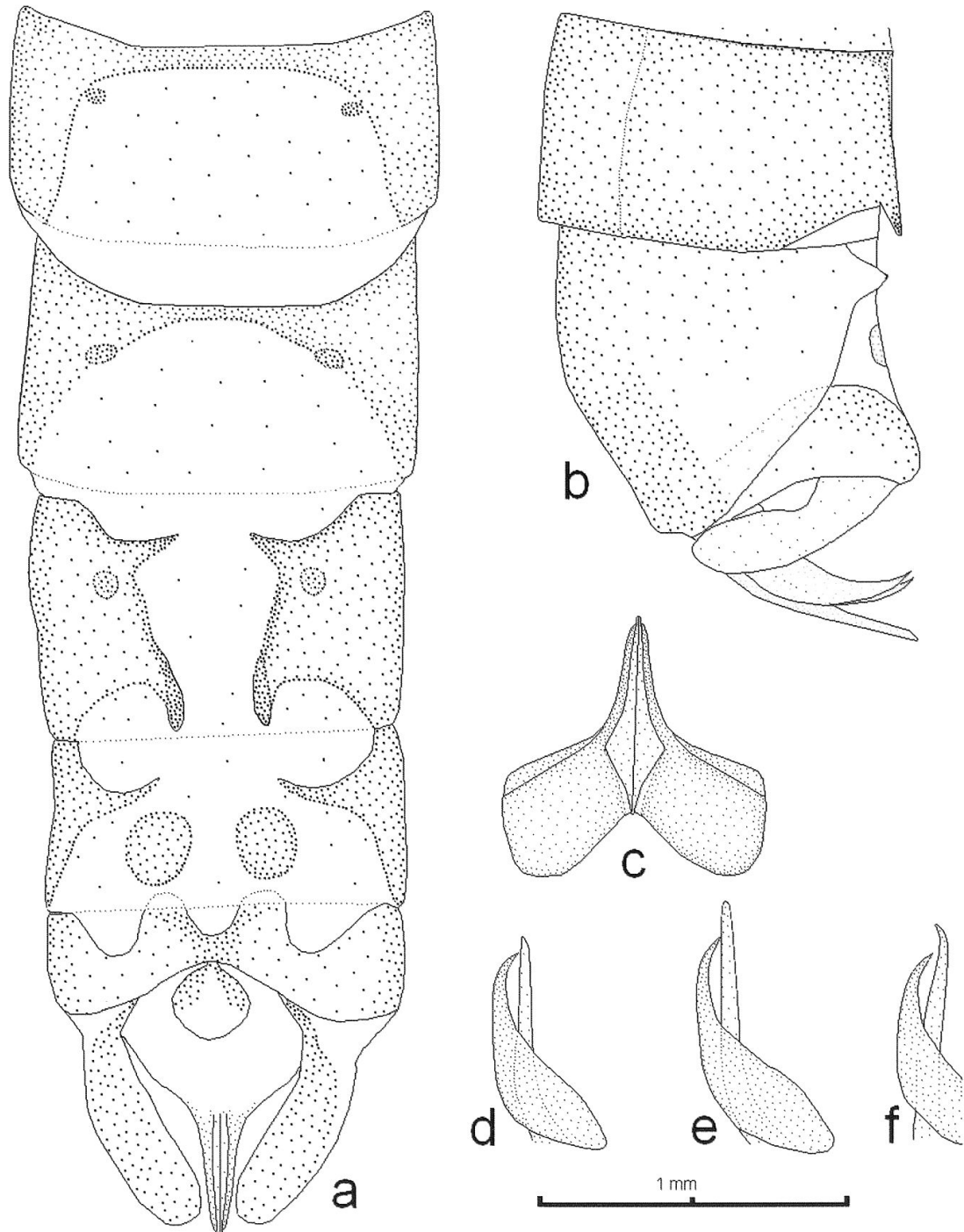


Fig. 3. — a-d. *L. dhyae* sp. n.: male abdomen in dorsal view (a), lateral view (b), paraprocts in ventral view (c), lateral view (d). — e. *L. khroumiriensis*: paraprocts in lateral view. — f. *L. sartorii*: paraprocts in lateral view.

çon & Pardo 1998: Fig. 2a), the specilla are almost rectilinear in *L. dhyae* (Fig. 3d) and curved backwards distally in *L. sartorii* (Fig. 3f). The female of *L. sartorii* is clearly distinguished by the shorter than wide plate and the two rounded lobes (Fig. 4e–f).

*Geographical distribution and ecology:* *L. dhyae* sp. n. occurs in fast flowing brooklets, tributaries of the Oued El Kebir and Chiffa Rivers on the northern slope

of the Guerroumène Djebel and Ferraoun Djebel (1630 m a.s.l.) in the central Tell Atlas. The type locality is surrounded by scattered conifers, at 1250 m a.s.l. (Fig. 5). *L. dhyae* occurs between 500 and 1250 m and may have a crenophilic tendency according to the small size of the brooks where it lives. The adults emerge in spring (IV). Since this species is brachypterous it could be restricted to the Chr ea Massif.

*Etymology.* This species is dedicated to Dr. Dhya Lounaci (Tizi Ouzou University) wife of Abdelkader Lounaci.

### *Leuctra geniculata* Stephens, 1836

*Material:* Central Algeria, **Djurdjura:** Ait Djema  v., Ouadhias b. -> Aissi r., 950 m, 42 l., 15.05.2009; 2 l., 3.06.2009; 60 l., 28.05.2010; 4 l., 21.07.2010 (H&L); Ait Oulhadj v., Ouadhias b. -> Aissi r., 680 m, 2 l., 10.06.2009; 30 l., 28.05.2010 (H&L); Ath Agad v., Ighzer Ath Agad b. -> Ouacif r. -> Aissi r., 900 m, 8 l., 21.07.2010 (H&L); 500 m > Ath Ouabane v., Thassifth Ath Ouabane b. -> El Djemaa b. -> Aissi r., 960 m, 18 l., 30.05.2011; 55 l., 18.06.2011 (H&L); 500 m > Ouacif v., Ouacif r. -> Aissi r., 380 m, 33 l., 3.05.2010; 67 l., 21.07.2010 (H&L), bridge 6 km < Ouacif v., Ouacif r. -> Aissi r., 300 m, 8 l., 1.06.2006 (H&L); 6 km < Thakhoukhth v., Ouacif and Ouadhias confluence, 140 m, 33 l., 28.05.2010 (H&L); 500 m > Ath Atsou v., Ath Atsou b. -> Halil b. -> Boubhir r., 1080 m, 1 l., 3.07.2010 (H&L); 500 m < Ath Ouaban v., Hammam Boudrar -> El Djemaa b. -> Aissi r., 750 m, 280 l., 18.06.2011 (H&L); 6 km S. Ain El Hammam v., Djemaa b., -> Aissi r., 900 m, 1 l., 22.05.2010; 1 l., 7.07.2010 (H&L); Iguersafen v., Ighzar Iguersafen b. -> Ousserdoun b. -> Boubhir r., 1000 m, 29 l., 15.05.2009 (S&L); 1 km < Tirourda Pass, Tirourda b. -> Halil b. -> Boubhir r., 1115 m, 14 l., 8.05.2010 (H&L). **Bli-dean Atlas,** Mouzaia r., 390 m, 5.5 km > Hamdania v., 3 l., 06.2007; 1 l., 09.2007; 16 l., 29.04.2010 (NY); Chiffa r. > confluence with « Ruisseau des Singes » b., 270 m, 5 km < Hamdania v., 3 l., 09.2007 (NY); El Harrach r., 140 m, 2 km < Hammam Melouane v., 2 l., 22.04.2010; 7 l., 29.05.2010 (NY).

Geographical distribution and ecology: Central and West European species, also occurring in the British Isles and the Maghreb. In Europe, it occurs more frequently in large rivers and streams of lowland regions (metarhithral - epipotamal) (Kis 1974 p. 85, Berth lemy 1966 p. 327, Tierno de Figueroa *et al.* 2003 p. 307, Graf *et al.* 2009 p. 107, Lubini *et al.* 2012 p. 267). Nevertheless, in the Iberian Peninsula it occurs between 20 and 1400 m, though more frequently under 1000 m a.s.l. (Aubert 1963b, S nchez-Ortega *et al.* 2003), and in Corsica it occurs in various kinds of water courses from nearly the sea level (Porto River, 5 m, 1 ♂, 1 ♀, 10.10.1995) up to 1700 m a.s.l. (< Alcludina Mount, 3 ♂♂, 3 ♀♀, 11.10.1995, Vin on coll.) this eurytopic tendency is also confirmed in Sardinia (Fochetti & Tierno de Figueroa 2008 p. 255).

In western Algeria, it mainly occurs between 800–1000 m a.s.l. (Gagneur & Aliane 1991), in central Algeria, Djurdjura Massif, between 1000–1460 m (Lounaci *et al.* 2000, Lounaci & Vin on 2005), in the Moroccan Rif, between 50–1520 m a.s.l. (S nchez-Ortega & Azzouz 1998, Errochdi & El Alami 2008), and in the Tunisian Khroumir Mountains at 450 m (Berth lemy 1973). Our new reports confirm that in the Maghreb, like in the Iberian Peninsula and Tyrrhenian Islands, this species is more eurytopic and orophilic than in the rest of Europe. The adults mainly emerge in autumn (VIII–XII).

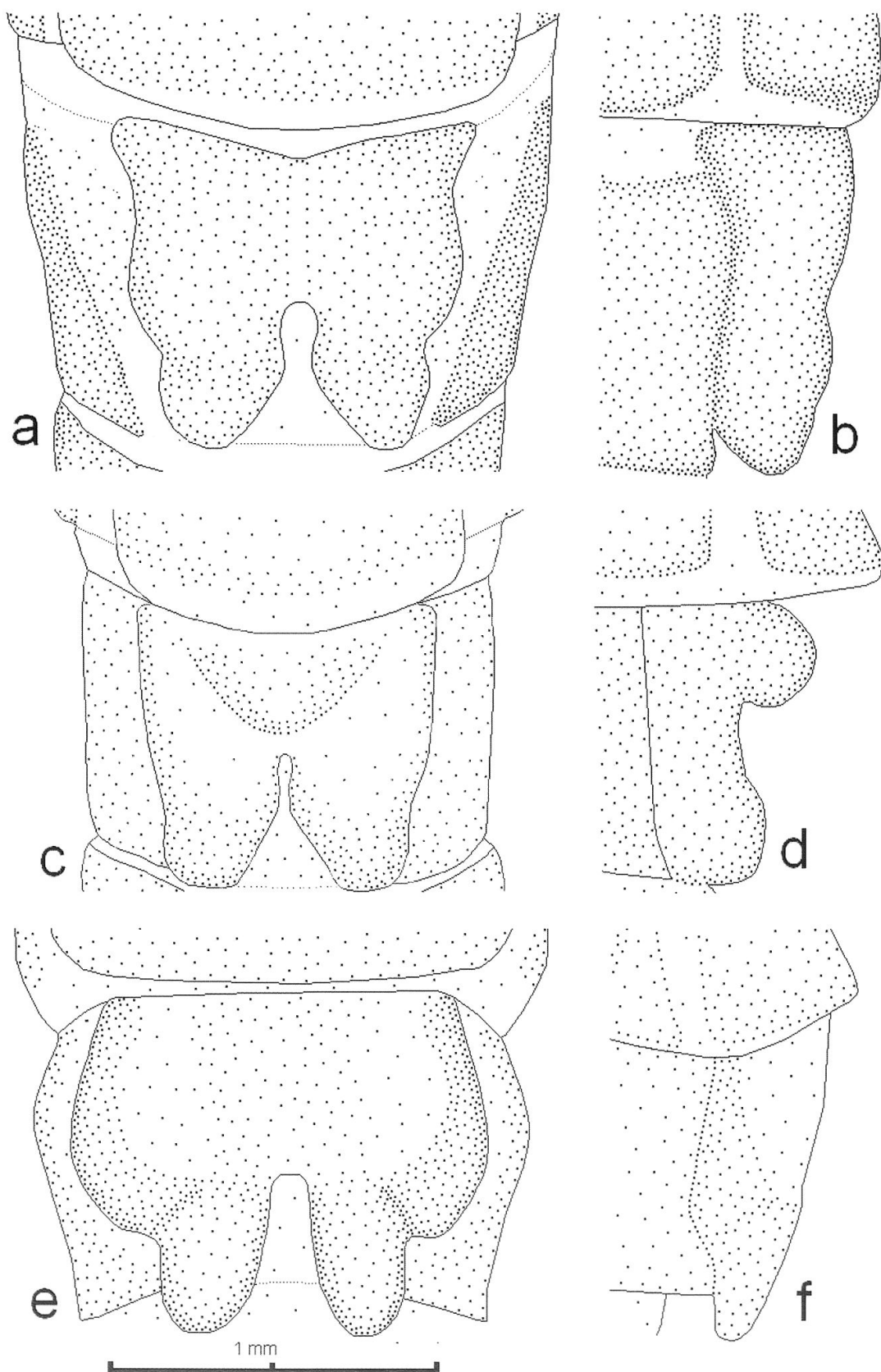


Fig. 4 — a-b. *L. dhyae* sp. n.: female subgenital plate in dorsal view (a) and lateral view (b). — c-d. *L. khroumiriensis*: female subgenital plate in dorsal view (c) and lateral view (d). — e-f. *L. sartorii*: female subgenital plate in dorsal view (e) and lateral view (f).

***Leuctra khroumiriensis* Vinçon & Pardo, 1998**

(Figs 3e, 4c–d)

First record for Algeria.

*Material:* **Small Kabylia**, E. Bejaïa, > Aokas, road W16, after Tizi n'Berber Pass, first brook on the left side of the road, 1000 m a.s.l., 2 ♀♀, 18.04.2012 (NY).

*Geographical distribution and ecology:* It is widely distributed from the Tunisian Khroumir Mountains up to the Algerian Small Kabylia (Fig. 1). It inhabits permanent mountain brooks and streams, between 450–1000 m a.s.l. Flight-period lasts from late autumn to early spring (X–IV).

***Leuctra medjerdensis* Vinçon & Pardo, 1998**

In Algeria, this species was reported from only one locality, in the central Djurdjura Massif (Lounaci & Vinçon 2005).

*Material:* **eastern Algeria**, Batna, Djebel Berdjem, Chaaba r., near forest house, 5,5 km > Ouled Chellih v., 1270 m, 16.04.2011, 1 ♂; 22.06.2011, 128 l.; 26.01.2012, 6 ♂♂, 1 ♀♀; 05.03.2012, 12 ♂♂, 21 ♀♀; 26.06.2012, 6 ♂♂, 9 ♀♀ (NY); Chaaba r., 1,5 km < Chaaba, 1240 m, 22.06.2011, 9 l.; 26.01.2012, 5 ♂♂, 5 ♀♀; 05.03.2012, 3 ♂♂, 7 ♀♀; 26.06.2012, 1 ♂, 3 ♀♀ (NY); Djebel Enza: Hamla r., 1300 m, 6 km > Hamla v.; 26.01.2012, 2 ♂♂, 4 ♀♀; 05.03.2012, 6 ♂♂, 9 ♀♀; 26.06.2012, 10 ♂♂, 7 ♀♀; Hamla r., 1260 m, 1 km < Hamla v., 26.01.2012, 9 ♂♂, 7 ♀♀; 05.03.2012, 5 ♂♂, 2 ♀♀; 26.06.2012, 1 ♂, 2 ♀♀ (NY). **Small Kabylia**, E. Bejaïa, > Aokas v., road W16, after Tizi n'Berber Pass, second brook on the left side of the road, 1000 m, 18.04.2012, 1 ♂, 4 ♀♀ (NY).

*Geographical distribution and ecology:* It occurs widely in the Central Maghreb, between the Tunisian Khroumir Mountains and the Djurdjura northward and the Aurès Mountains southward (Fig. 1). Its altitudinal range extends from 450 to 1200 m a.s.l. The adults emerge in winter and spring (I–IV).

***Leuctra sartorii* Vinçon & Pardo, 1998**

(Figs 3f, 4e–f)

First record for Algeria.

*Material:* **eastern Algeria**, El Kala, Algerian slope of Khroumir mountains that extend in western Tunisia, Ech chaba El Waara b., < Djebel Haddada Mount, Haddada v., 180 m, 24.03.2012, 4 ♂♂; 02.05.2012, 1 ♀; Haddada v., 180 m, 28.01.2012, 1 ♂, 2 ♀♀; 03.03.2012, 1 ♂, 3 ♀♀; 24.03.2012, 1 ♀ (NY); Dar Essalem b., Haddada v., 190 m, 28.01.2012, 10 ♂♂, 2 ♀♀; 03.03.2012, 6 ♂♂, 7 ♀♀; 24.03.2012, 2 ♂♂, 2 ♀♀ (NY).

*Geographical distribution and ecology:* *L. sartorii* might have a distribution area limited to the Khroumir Mountains, where it occurs on both the Tunisian and the Algerian slopes (Fig. 1). It inhabits brooks and streams between 180 and 550 m a.s.l. The adults mainly emerge in winter (X–III).

***Leuctra tunisica* Pardo & Zwick, 1993**

In Algeria, it was previously reported from a single locality, in the eastern Djurdjura Massif (Lounaci & Vinçon 2005).

*Material:* **eastern Algeria**, El Kala, Algerian slope of Khroumir mountains (W. Tunisia), Bougousse district, < Djebel Ghorra (1200 m), forest house of El



Ghorra, 5 tributaries of Bougousse r. -> Mexna dam, 900 m, 03.05.2012, 16 ♂♂, 35 ♀♀, other b., 900 m, 03.05.2012, 26 ♂♂, 29 ♀♀; other b., 900 m, 03.05.2012, 12 ♂♂, 23 ♀♀; other b., 950 m, 03.05.2012, 2 ♀♀; other b., 950 m, 03.05.2012, 9 ♂♂, 15 ♀♀ (NY). **N.E. Djurdjura**, between Azazga and El Kseur: b. between Tagma Pass and Kebouche (Adekar), < Djebel Toukra, 1100 m, 17.04.2012, 5 ♂♂, 9 ♀♀ (VIN). **Central Djurdjura**, Ath Agad, > Ouacif v., Ighzer Ath Agad b. -> Ouacif r. -> Aissi r., 900 m, 16.04.2012, 1 ♂, 1 ♀ (VIN).

*Geographical distribution and ecology*: It occurs from the Tunisian Khroumir Mountains up to the Algerian Djurdjura (Pardo & Zwick 1993) (Fig. 1). The adults were always collected in the close surrounding of springs between 350–1100 m a.s.l. suggesting that this species is crenophilic. The adults emerge in spring (IV–VI)

### *Tyrrhenoleuctra tangerina* (Navás, 1922)

From a morphological point of view, *T. tangerina* described from Morocco (Tanger) cannot be distinguished from *T. minuta* described from Spain (Cordoba). Indeed, all male and female distinctive characters mentioned by Aubert (1948, 1963a) are not valid and correspond to intra-specific variation or even to different levels of genitalia contraction (Puig *et al.* 1990, Tierno de Figueroa *et al.* 2003, Lounaci & Vinçon 2005). To better understand the *Tyrrhenoleuctra* genus, biochemical analyses were performed by Fochetti *et al.* (2004, 2009) and Fochetti & Tierno de Figueroa 2009, enabling the distinction of 5 different taxa. Among them, the only one reported with certainty from North Africa is *T. tangerina*. Since no morphological or biochemical characters justify the separation of *T. minuta* from *T. tangerina*, we consider that all the Maghrebini *Tyrrhenoleuctra* belong to this species. Nevertheless, other biochemical analyses are needed to confirm this hypothesis.

*Material*: **eastern Algeria**, El Kala, Algerian slope of Khroumir mountains (W. Tunisia), Ech chaba El Waara b., Haddada v., 180 m, 28.01.2012, 5 ♂♂, 2 ♀♀; 03.03.2012, 11 ♂♂, 7 ♀♀; 24.03.2012, 8 ♂♂, 10 ♀♀; second b., Haddada v., 180 m, 28.01.2012, 1 ♂, 1 ♀; 03.03.2012, 2 ♂♂; 24.03.2012, 2 ♀♀; Dar Essalem b., Haddada v., 190 m, 25.03.2011, 2 l.; 03.03.2012, 2 ♀♀ (NY). El Kala, Bougousse district, Ghora forest house, b., 900 m, 03.05.2012, 1 ♂, 2 ♀♀, other b., 900 m, 03.05.2012, 1 ♂, 1 ♀; other b., 950 m, 03.05.2012, 3 ♀♀ (NY). **Batna**, Chaaba r., 1270 m, 5,5 km > Ouled Chellih v., near forest house, 02.05.2010, 8 l.; 16.04.2011, 168 l.; 26.03.2012, 1 ♂ (NY); 1,5 km < Chaaba v., 1240 m, 02.05.2010, 4 l.; 22.06.2011, 1 ♂ (NY); Hamla r. < Djebel Enza Mount, 6 km > Hamla v., 1300 m, 02.05.2010, 80 l., 1 ♂; 16.04.2011, 90 l.; 26.03.2012, 1 ♂, 1 ♀; 20.05.2012, 12 ♀♀; Hamla r., 1 km < Hamla v., 1260 m, 02.05.2010, 52 l., 1 ♂; 16.04.2011, 100 l.; 22.06.2011, 20 l.; 20.05.2012, 3 ♂♂ (NY). **Small Kabylia**, E. Bejaïa, > Aokas v., road W16, after Tizi n'Berber Pass, b., 1 ♂, 18.04.2012 (NY). **N.E. Djurdjura**, between Azazga and El Kseur, > Yakourène in direction of Tagma Pass, 2 ♂♂, 2 ♀♀, 17.04.2012; b. between Tagma Pass and Kebouche (Adekar), < Djebel Toukra, 7 ♂♂, 5 ♀♀, 17.04.2012; other b. between Tagma Pass and Kebouche (Adekar), < Djebel Toukra, 2 ♀♀, 17.04.2012. Junction of two torrents between Tagma Pass and Kebouche, near Kebouche v., 11 ♂♂, 9 ♀♀, 17.04.2012 (VIN). **Central Djurdjura**: Iferhounène v., 5 Km > Souk El-Khemis v., Halil b. -> Boubhir r., 490 m, 14 ♂♂, 2 ♀♀, 10 l., 13.05.2009 (H&L). Iguersafen, Ighzar Iguersafen -> Ouserdoun b. -> Boubhir r., 1000 m, 12 l., 15.05.2009 (S&L); 750 m, 2 l., 1 ♂ nym-



Fig. 5. Type location, Chiffa tributary on the northern slope of the Guerroumène Djebel, under the Chréa ski station, 1250 m a.s.l.

pha, 13.05.2009 (S&L). **Central Algeria:** Blidean Atlas, Mouzaia r., 390 m, 5,5 km > Hamdania v., 05.2007, 3 l.; 27.03.2010, 1 l. (NY); Ben Yakhilil r. -> El Harrach r., 210 m, 27.03.2010, 1 l. (NY); Boumaane r. -> El Harrach r., 220 m, 27.03.2010, 4 l. (NY). Mouzaia r. -> Chiffa r., 19.04.2012, 1 ♀ (VIN).

*Geographical distribution and ecology:* *Tyrrhenoleuctra tangerina* occurs in central and western Maghreb, from Morocco to Tunisia, and in the southern extremity of Spain, in temporary water courses of moderate elevation (100–1400 m), corresponding to the thermophilous association of Aubert (1963a). Adults emerge in winter and spring (II–V).

#### DISTRIBUTION AND ENDEMISM WITHIN THE MAGHREB

In Tab. 1, the distribution area of the 11 Maghrebin Leuctridae is given, splitting the Algerian Tell Atlas into three parts, eastern Algeria (from the Tunisian border to the Soummam River), central Algeria (between the Soummam River and the Mina -> Chelif River) and western Algeria (from the Mina -> Chelif River to the Moroccan border) (Fig. 1).

The 11 Maghrebin Leuctridae belong to three main bio-geographical groups according to the extent of their distribution area:

Species with wide distribution (3):

- *L. geniculata*: western Europe and Maghreb
- *Tyrrhenoleuctra tangerina*: Southern Iberian Peninsula and Maghreb
- *L. maroccana*: Iberian Peninsula and Morocco (from the Pyrenees to the High Atlas)

Tab. 1. Leuctridae distribution and endemism in the Maghreb.

	Tell Atlas				Moroccan High Atlas	Moroccan Middle Atlas	Moroccan Rif	Endem. Species
	Tunisia	Eastern Algeria	Central Algeria	Western Algeria				
<i>L. dhyae</i> sp. n.			*					*
<i>L. franzi paenibaet.</i>							*	
<i>L. geniculata</i>	*	*	*	*	*	*	*	
<i>L. ketamensis</i>							*	*
<i>L. khroumiriensis</i>	*	*						*
<i>L. maroccana</i>					*		*	
<i>L. medjerdensis</i>	*	*	*					*
<i>L. sartorii</i>	*	*						*
<i>L. tunisica</i>	*	*	*					*
<i>L. vaillanti</i>	*			*	*		*	*
<i>Tyr. tangerina</i>	*	*	*			*	*	
Total	7	6	5	2	3	2	6	7

Betico-rifan subspecies (1):

- *L. franzi paenibaetica* Sánchez-Ortega & Roperó Montero, 1993: Andalucía and the Moroccan Rif. Its sister subspecies *L. franzi franzi* Aubert, 1956 occurs in the northern Iberian Peninsula.

Maghrebin endemic species (7):

- *L. vaillanti* Aubert, 1956: Central and Western Maghreb, from Morocco to Tunisia. It is not reported from central and eastern Algeria but probably due to lack of faunistic studies (Fig. 1)
- *L. khroumiriensis*, *L. medjerdensis* and *L. tunisica*: Central Maghreb, from the Tunisian Khroumir Mountains up to the Kabylia Mountains (Small Kabylia or Djurdjura) (Fig. 1).
- *L. sartorii*: Tunisian and Algerian Khroumir Mountains (Fig. 1).
- *L. dhyae* sp. n.: Tell Atlas southward to Blida (Fig. 1)
- *L. ketamensis*: Moroccan Rif.

*Faunistic barriers*

The 7 Leuctridae species occurring in Tunisia (Berthélemy 1973) extend more or less widely in the eastern Algerian Tell Atlas (Fig. 1), indeed the main transversal valleys, Oued Seybouse (S. Annaba), Oued El Kébir (N.W. Constantine), Oued Agrioun (N. Sétif) running down in the eastern Tell Atlas are not wide enough to act as a barrier to the dispersal of most Leuctridae. The wide Soummam Valley separating Small Kabylia and Great Kabylia (S.W. Bejaïa) is a more efficient barrier since a few species occurring eastward from the river were never reported westward to it (*L. medjerdensis*, *L. khroumiriensis*).

The Tell Atlas is widely separated from the Saharan Atlas and Aurès Mountains by dry plateaus and salt water lakes, impeding stonefly dispersal southward from the Tell Atlas. Indeed, only two Leuctridae species are reported from the Aurès Mountains (*L. medjerdensis* and *T. tangerina*) 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, 3 Maghrebin Leuctridae present in Morocco west of the Moulouya Valley are not reported further east in Algeria: *L. franzi paenibaetica* Sánchez-Ortega & Roperó Montero, 1993, *L. ketamensis* Sánchez-Ortega & Azzouz, 1997 and *L. maroccana* Aubert, 1956.

#### DISTRIBUTION AND ENDEMISM IN THE WEST MEDITERRANEAN REGION

The Maghreb mountainous chains are separated southward from the rest of Africa by the Sahara, a very effective faunistic barrier for aquatic insects. Therefore nearly all the Maghrebin stoneflies and other aquatic insects have a Mediterranean origin, a reason why Maghreb is considered as the south-western spurs of the West Palearctic Region. The main connection between Maghreb and Western Europe is through the Bético-Rifan mountainous system; indeed among the 11 Maghrebin Leuctridae, 4 species (36 %) occur in the Iberian Peninsula, *Leuctra franzi paenibaetica*, *L. maroccana*, *L. geniculata*, and *Tyrrhenoleuctra tangerina*. Nevertheless, regarding non Leuctridae stoneflies, connections with Sicilia are also noticed in the *Nemoura* genus (Lounaci & Vinçon 2005) and the *Protonemura* genus (Vinçon & Murányi 2009).

A comparison of the Leuctridae diversity in the main mountain ranges of the west Mediterranean region is given in Tab. 2, compiled from the following works (Sánchez-Ortega *et al.* 2003, Tierno de Figueroa *et al.* 2003, Fochetti & Tierno de Figueroa 2008, 2009, Vinçon & Graf 2011, Vinçon 2012) together with unpublished data.

The Leuctridae are much less diversified in the Maghreb (11 species and subspecies) than in the other main mountainous areas of the western Mediterranean region: Italian Peninsula (58), Iberian Peninsula (53) and Pyrenees (33). Nevertheless, the Maghrebin Leuctridae diversity is similar to that occurring in the 3 main islands of the west Mediterranean region (Sicilia + Sardinia + Corsica) (12 species and subspecies), and it is similar to that of the southern Apennines (13 species) and the Betic Cordillera (12). This low diversity is obviously linked to the very dry climatic conditions in the Maghreb and in the southern mountain ranges of Italy and Spain, a strong disadvantage for aquatic insects. Indeed the Leuctridae diversity increases rapidly from south to north in both the Italian and Iberian Peninsula, together with increasing humidity (Tab. 2).

On the other hand, Leuctridae endemism is much higher in the Maghreb (64 %) than in the neighboring massifs, the southern Apennines (31 %) and the Betic Cordillera (33 %), which is probably due to a higher degree of geographic isolation. Indeed, the Mediterranean Sea is a more efficient obstacle for insect migration than the transversal valleys that separate the Apennines or Iberian sierras from the rest of Europe. The endemism level in the Maghreb is also higher than in Sicilia (40 %) but lower than in the Tyrrhenian Islands, Sardinia (75 %) and Corsica (83 %), which are much more isolated.

#### *Crenophilic isolation and risk of extinction*

The increasing wetness from south to north in the mountain ranges of the Apennines and Iberian Peninsula, due to the Atlantic influence and northern latitudes, favors the development of dense and humid forests where numerous species are isolated in the crenal zone (micro-endemism) with low risk of extinction, though their

Tab. 2. Leuctridae distribution and endemism in the West Mediterranean Region.

	Leuctridae species + subspecies	Leuctridae endemic taxa	Leuctridae endemism level %
<b>Maghreb</b>	11	7	64
<b>Italian Peninsula</b>	58	25	43
Southern Apennines (Calabria, Puglia, Basilicata, Campania)	13	4	31
Central Apennines (Abruzzi, Lazio, Umbria, Marche, Toscana)	17	6	35
Northern Apennines (Emilia, Ligurian Apennines)	23	8	35
Italian Alps	55	22	40
<b>West Mediterranean Isles</b>	14	10	71
Sicilia	5	2	40
Sardinia	4	3	75
Corsica	6	5	83
Baleares	2	2	100
<b>Iberian Peninsula</b>	53	34	64
Betic Cordillera (Ronda, Nevada, Cazorla, Alcaraz, Morena)	12	4	33
Central Iberian Cordillera (Estrela, Gata, Gredos, Guadarrama)	18	9	50
Cantabrian Cordillera + Galicia	26	18	69
<b>Pyrenees</b>	33	16	48

distribution area is very narrow. This crenophilic isolation, often enhanced by wing reduction, is patent in the most humid regions of the Mediterranean and Black Sea surroundings (Vinçon & Ravizza 2000, 2001, Vinçon & Sivec 2001, Vinçon & Pardo 2004), but is rarely found, in contrast, in the driest regions like the Maghreb or the Aegean Isles (Zwick 1978, Pardo & Zwick 1993). Brachypterous specimens of *Protonemura talboti* occur in a few localities of the High Atlas and micropterous specimens of *P. dakkii* in the Middle Atlas (Vinçon & Murányi 2009), but in both cases this tendency is not stable since normal winged specimens occur in other localities. It is the same for *L. maroccana* which is brachypterous or even micropterous in few Moroccan and Spanish localities (Tierno de Figueroa *et al.* 2003 and unpublished data). Therefore the brachypterism of *L. dhyae* sp. n. appears rather exceptional and could be explained by high levels of snow and precipitation in the Chr ea region also famous for its ski station, the closest to the Mediterranean shore in Algeria. Considering its faunistic richness, this region should be protected, especially as it is susceptible to increasing human impact following the renovation of the ski station.

#### R SUM 

*Leuctra dhyae* sp. n., end mique de l'Atlas Tellien pr s de Blida (Alg rie), est d crite et compar e aux esp ces les plus proches *L. khroumiriensis* Vinçon & Pardo, 1998 et *L. sartorii* Vinçon & Pardo, 1998. *L. khroumiriensis* et *L. sartorii* sont nouvelles pour la Faune d'Alg rie qui comprend maintenant huit esp ces de Leuctridae. La distribution et l' cologie des Leuctridae Alg riens sont comment es. Les Leuctridae Alg riens sont compar s   ceux qui vivent dans les principaux massifs montagneux de la r gion ouest m diterran enne (diversit , end misme, brachypt risme).

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