



## A NEW *PERLODES* SPECIES AND ITS SUBSPECIES FROM THE BALKAN PENINSULA (PLECOPTERA: PERLODIDAE)

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### ABSTRACT

*Perlodes floridus* sp. n. is described on the basis of female, male, egg and larva from the Balkan Peninsula (Montenegro, Albania, Greece). Due to differences in egg structure and male paraprocts, populations from the Greek Peloponnes are described as *Perlodes floridus peloponnesiacus* ssp. n. Notes on some additional species of the genus are also given.

**Keywords:** Plecoptera, Perlodidae, taxonomy, *Perlodes*, new species, new subspecies

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### INTRODUCTION

During 2009 and 2010, the first author carried out investigations on the aquatic insect fauna in the Cijevna River of Montenegro, recommended as a notable habitat by Vladimir Pešić and Miladin Jakić. These collections yielded imagos, larvae and exuviae of a new species of *Perlodes* Banks 1903. Later it turned up that the new species was present in some other European collections and that its description was already in preparation, so the different concerned authors have joined together to complete this work. Investigation of the available material indicate that the new species is represented in the Peloponnes with a subspecies morphologically distinct from the nominal one distributed through

Montenegro, Albania and the western Greek mainland (Fig. 25).

The genus *Perlodes* has a disjunct Palaearctic distribution area. There are five species in the West Palaearctic: *P. dispar* (Rambur 1842), *P. intricatus* (Pictet 1841), *P. jurassicus* Aubert 1946, *P. microcephalus* (Pictet 1833) and *P. mortoni* (Klapálek 1906) (the later recently removed from synonymy by Zwick 2011), while two were described from the Far East: *P. frisonanus* Kohno 1943 and *P. kippenhani* Stark 2010. The new species increases the number of species to eight.

### MATERIAL AND METHODS

For collecting methods of larvae see Kovács et al.

(1998). The exuviae were collected by hand picking, adults were collected by hand picking, beating sheet or with sweeping net.

All material is stored in 70% ethanol. Holotype of *Perlodes floridus floridus* is deposited in the Mátra Museum, Gyöngyös, Hungary (MM), while holotype of *P. floridus peloponnesiacus* is in the Slovenian Museum of Natural History, Ljubljana, Slovenia (PMSL). Paratypes are held in the MM, PMSL, Gilles Vinçon Collection, Grenoble, France (CGV), Hungarian Natural History Museum, Budapest, Hungary (HNHM) and the Collection Museo Zoologia (sezione Entomologia), Sapienza University, Rome, Italy (SU) as indicated in the examined material.

SEM images were made using a Hitachi S-2600N scanning electron microscope (Hungarian Natural History Museum). Specimens for SEM study were critical point dried and sputter coated with gold-palladium.

Abbreviations: BC = Christoph Bückle, CSz = Szilvia Czigány, DL = László Dányi, EZ = Zoltán Erős, FZ = Zoltán Fehér, GR = Reinhard Gerecke, HA = András Hunyadi, HB = Bogdan Horvat, KJ = Jenő Kontschán, KT = Tibor Kovács, MD = Dávid Murányi, MG = Gábor Magos, NP = Paolo Nicolai, SI = Ignac Sivec, SzT = Tímea Szederjesi, UL = László Urbán, UZs = Zsolt Ujvári; L = larva, E = exuviae, O = ovum.

## RESULTS AND DISCUSSION

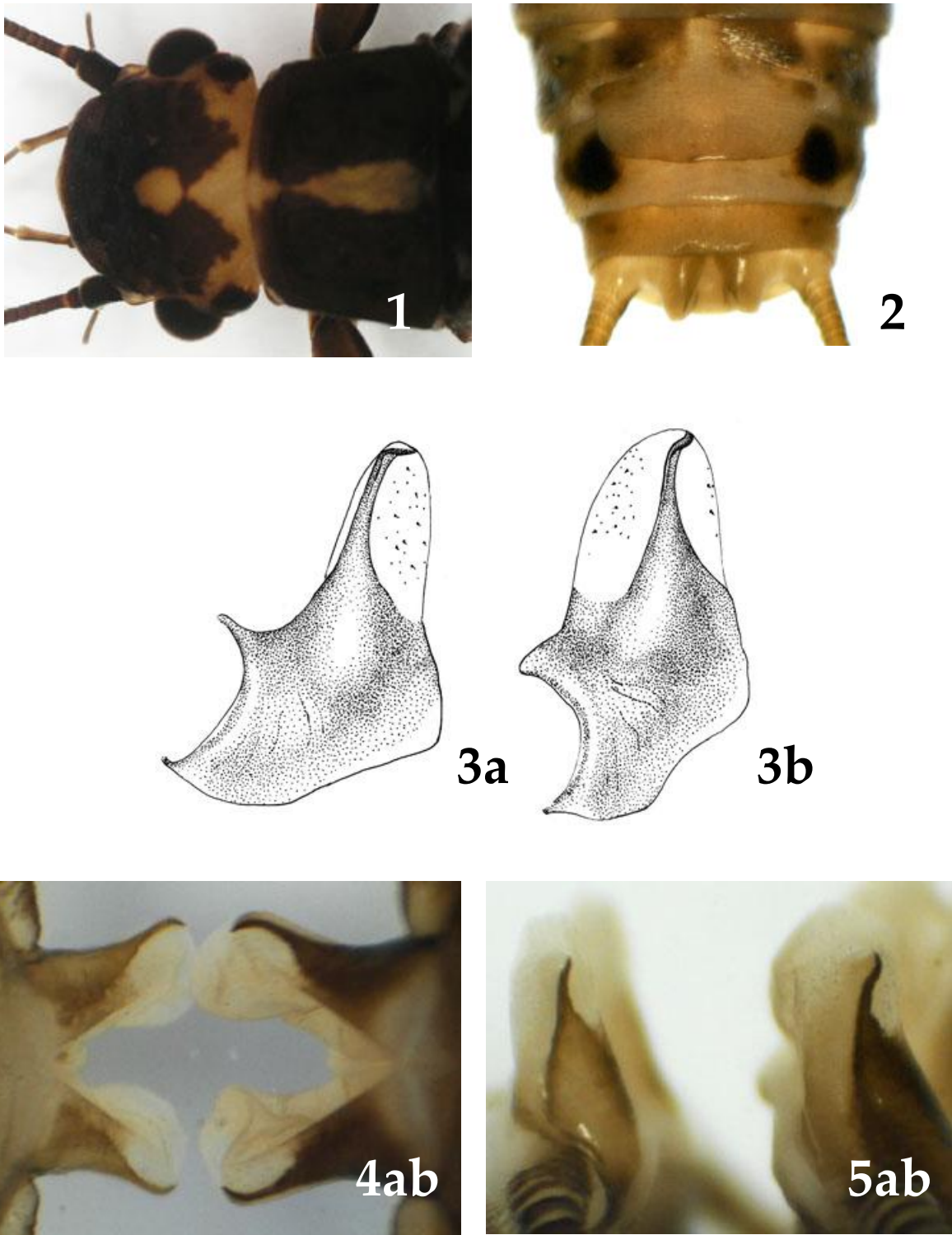
### *Perlodes floridus* Kovács & Vinçon sp. n. (Figs. 1-3ab, 4a, 5a, 6-7, 8-11, 16e)

**Material examined.** Holotype: MONTENEGRO, Podgorica municipality, Gornji Mileš, Rogamsko brdo, Cijevna River, N42°23'59.7", E19°18'42.6", 65 m a.s.l., 25.05.2009, 1♀+O (Figs. 8-9, 11, 16e), KT-MG-UL, MM: 2009-49. Paratypes: same locality and date: 2 E, 1♂ (Figs. 3ab), KT-MG-UL, MM: 2009-49; Dinoša, Cijevna River, N42°24'24.6", E19°20'56.1", 85 m, 29.05.2009, 1♂, 1♀+O, (Figs. 1-2), KT-MG-UL, MM: 2009-66; 13.04.2010, 6L (Figs. 6-7), KT-MG-UL, MM: 2010-31. Zlatica, Morača River, N42°28'40.2", E19°18'19.8", 50 m, 2010.04.17., 3L, KT-MG-UL, MM: 2010-40. ALBANIA, Librazhd district, Qukës Shkumbin, Shkumbin River, N41°05'45.7", E20°26'34.0", 380 m, (2006/4), 09.04.2006, 1 E, EZ-FZ-

HA-MD, HNHM: PLP 2184; Pukë district, Mertur, Mertur Stream at the influence to Koman Lake, N42°13'36.8", E19°54'18.0", 180 m, (2006/56), 15.04.2006, 1♀+O, EZ-FZ-HA-MD, HNHM: PLP 2246; Sarandë district, Çikë Mts, Borsh, Borsh River N of the village, N40°03'57.1", E19°50'53.5", 35 m, (2008/18), 12.03.2008, 1E, 1♂, CSz-MD, HNHM: PLP 2525. GREECE, West Macedonia, Grevena regional unit, Aetia, Venetikos River, N40°04'27.9", E21°12'06.0", 973 m, (2006/114), 14.05.2006, 1♀+O, DL-KJ-MD, HNHM: PLP 2135; Eleftherohori, Venetikos River, 24.04.1989, 1♀+O, HB-SI, PMSL: 03220; N40°03'06.6", E21°28'50.2", 475 m, (2006/111), 13.05.2006, 1E, 1♀+O, DL-KJ-MD, HNHM: PLP 2132; Kipourio, Venetikos River, 24.04.1989, 9E, 1♂, HB-SI, PMSL; Zakas, Venetikos River, N40°02'19.3", E21°17'19.2", 699 m, (2006/112), 14.05.2006, 1L, 1♂ (Figs. 4a, 5a), DL-KJ-MD, HNHM: PLP 2144; Thessaly, Trikala regional unit, Ambelia, Kalambaka, 20.04.1989, 9E, 6♂, 6♀, HB-SI (8E, 4♂, 4♀, O, PMSL: 03148; 1E, 2♂, 2♀, O (Fig. 10), CGV); Kastania, Kalambaka, 20.04.1989, 7E, 1♂, HB-SI, PMSL: 03141; Kato Palagokaria, 19.04.1989, 2♀+O, HB-SI, PMSL: 03119; Longiai, 19.04.1989, 3♀+O, (in very poor condition), HB-SI, PMSL: 03126; Karditsa regional unit, Sarantaporo, small river S of the village, N39°09'13.9", E21°49'50.7", 700 m, (2011/39), 08.05.2011, 1♂, KJ-MD-SzT-UZs, HNHM: PLP 3680; Central Greece, Phthiotis regional unit, Agios Georgios, Sperchios River W of the village, N38°57'00.5", E21°56'42.7", 365 m, (2011/35), 08.05.2011, 1♂, 1♀+O, KJ-MD-SzT-UZs, HNHM: PLP 3669; Timfristos, Sperchios River, (207), 29.04.1989, 1♀+O, HB-SI, PMSL; Phocis regional unit, Vardousia Mts, Stromi, 26.04.1990, 1E, 1♀+O, HB-SI, PMSL: 03212; Giona Mts, Lefkaditi, NW of Amfissa, 15.04.1987, 4♂, 2♀, O, Drosopoulos, PMSL: 03300.

**Diagnosis.** Head of the imago lacks yellow pattern by the M-line. Male macropterous, paraproct sclerite with long and straight apical part, apex angled. Female subgenital plate narrow. Larval hind femur long and narrow, last sternites with distinct setation. Egg with flower-like anchor, shape egg-like with cut-off base, FCIs distinct only on opercular part.

**Description** (Figs. 1-2). Dark brown with distinct yellow markings. A small sized *Perlodes*. Body length: males 12.5-18 mm, females 14.5-20.5 mm; forewing length: males 11.5-14.5, females 15-19.5 mm.



Figs. 1-5. *Perlodes floridus floridus* sp. n. (1-3, 4a, 5a) and *P. floridus peloponnesiacus* ssp. n. (4b, 5b) adults. 1. Female head and pronotum, dorsal view. 2. Female subgenital plate, ventral view. 3. Male paraproct, a: ventral view, b:  $\frac{3}{4}$  ventrolateral view. 4a-b. Male paraprocts, ventral view. 5ab. Male paraprocts,  $\frac{3}{4}$  ventrolateral view. Not to scale.

Dorsal part of head brown with two large pale patches (Fig. 1). One is a crown or tulip-shaped pattern on the occiput that laterally reaches the midline of the dark compound eyes, then deeply incised while central part pointed up to the postfrontal suture. Anterior pale patch is oval, delimited by the three, yellow ocelli. Occipital rugosities, tentorial callosities and M-line indistinct. Ventral part of head yellow, antennae and palpi brown.

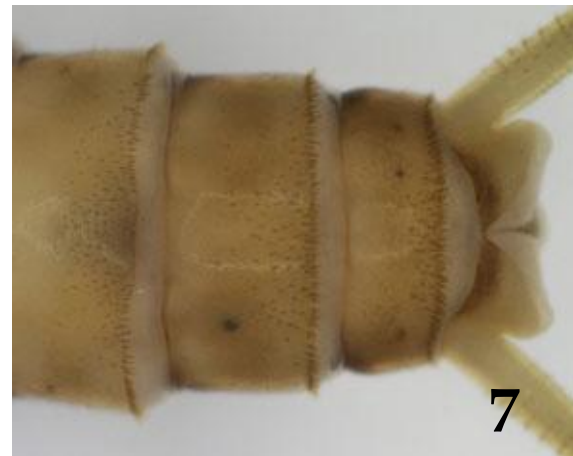
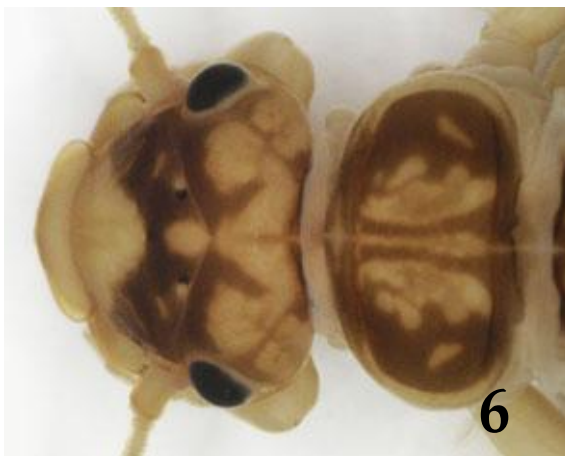
Pronotum brown with a median longitudinal yellow stripe (Fig. 1), prothorax ventrally yellow besides dark brown rhomboid or arrow-shaped dark patch anterior to furcasternum. Dorsal part of meso- and metathorax dark brown, ventrally mostly dark brownish. Legs all brown, wings normal sized, veins dark brown.

Abdominal segments 1-4 divided by pleural membrane (as well as in larvae). Abdomen dorsally brown; males bear transverse pale patches on tergites IX-X, paired medial spots on tergite VIII, these may be present also on tergites VI-VII. Abdominal sternites brown, gradually darkened towards apex in

males (transverse pale patches may be present medially); in females generally yellow while sternite I brown, sternites II-VII with a large anteromedial and variable lateral brown patches. Cerci brown in both sexes.

**Male genitalia** (Figs. 3a, b, 4a, 5a). Tergite X undivided, not raised. Paraproctal sclerite in ventral view with long and straight apical part that gradually narrows towards its apex; sides parallel and keeled beneath the apex that is strongly angled (120°) and sharply pointed (Figs. 3a, 4a). Apical part of paraproctal sclerite straight also in  $\frac{3}{4}$  ventrolateral view, while apex above angle forms a nearly half curve (Figs. 3b, 5a).

**Female genitalia** (Fig. 2). Subgenital plate pale, as wide as  $\frac{3}{5}$  of the abdomen at its base; nearly three time wider than long. Rectangular or trapezoid with rounded corners, posterior margin straight or slightly convex, occasionally medially notched. Sternite VIII bears two large brown patches near the subgenital plate base, sternite IX bears paired dark brown spots laterally.

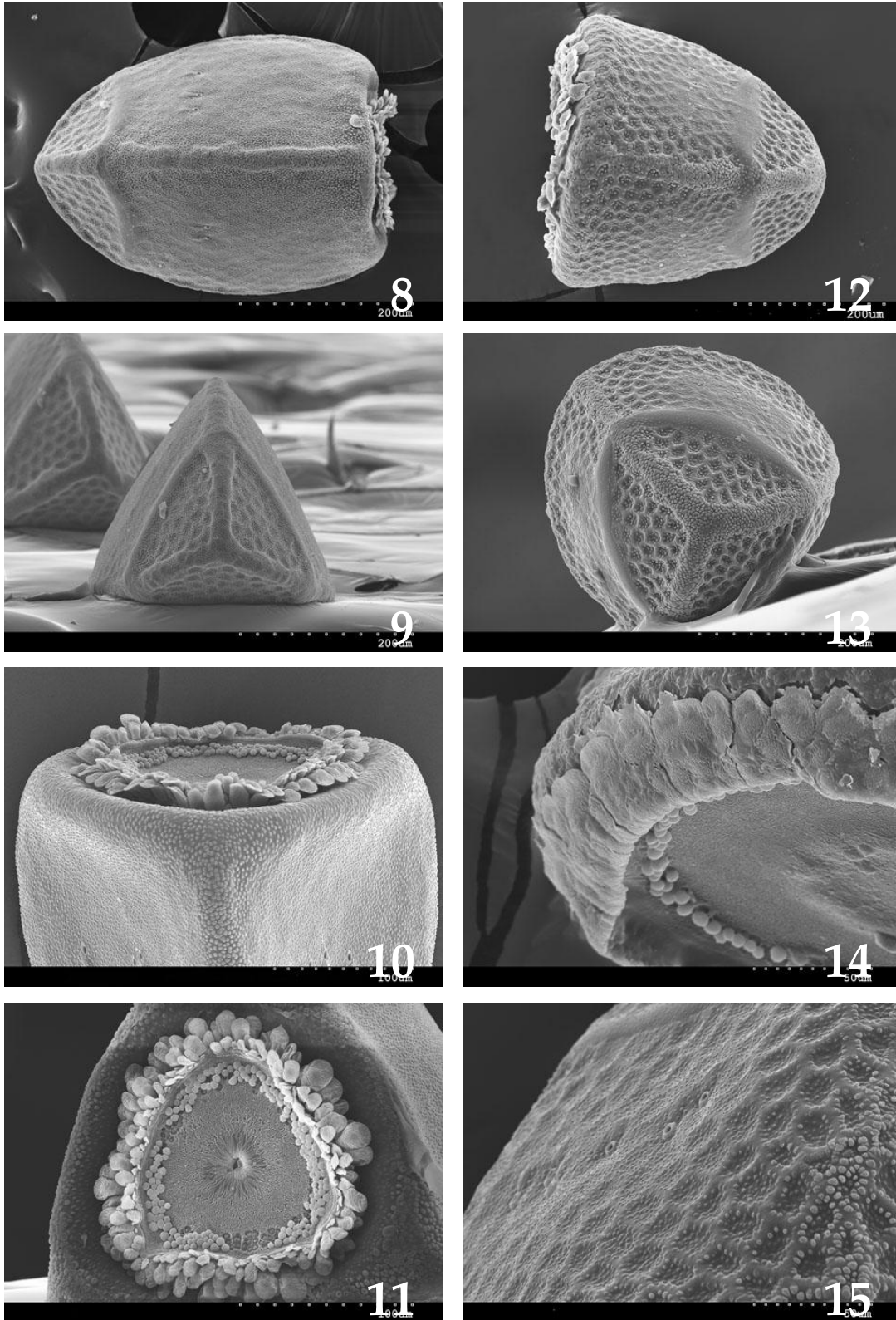


Figs. 6-7. *Perlodes floridus floridus* sp. n. larva. 6. Head and pronotum, dorsal view. 7. End of abdomen, ventral view.

**Larva** (Figs. 6-7). Pale with brown pattern. Pattern of head and pronotum consist of brown marks on yellow ground as illustrated (Fig. 6). Lacinia generotypic. Mediodorsal row of long, apically blunt hairs run from postfrontal suture to end of tergite 10; length of hairs one third of corresponding tergal length. Hind femur long and narrow, ratio of length

and width is 4.5:1. Row of marginal swimming hairs complete on both femur and tibia, nearly as long as femur's width and one and half longer than tibia's width. Apical row of setae on tergites as long as one tenth of corresponding tergite; setae mixed with blunt hairs similar to those of the mediodorsal row, their length 2-4 times longer than setae. Sternite 8





Figs. 8-15. *Perlodes flavidus flavidus* sp. n. (8-11) and *P. flavidus peloponnesiacus* ssp. n. (12-15) eggs. 8, 12. Egg, lateral view. 9, 13. Egg, apical view. 10. Anchor, basolateral view. 11. Anchor, basal view. 14. Anchor, basolateral view. 15. Chorion detail.

with medially incomplete apical row of setae, row complete on sternites 9-10.

Additional setae present on medial part of sternites 8-10 up to a quarter or half their length; these setae may be absent on sternites 8-9. Sternite also armed with long hairs curved outwards. Paraprocts lack distinct setation, but rarely with 1-2 strong setae (Fig. 7).

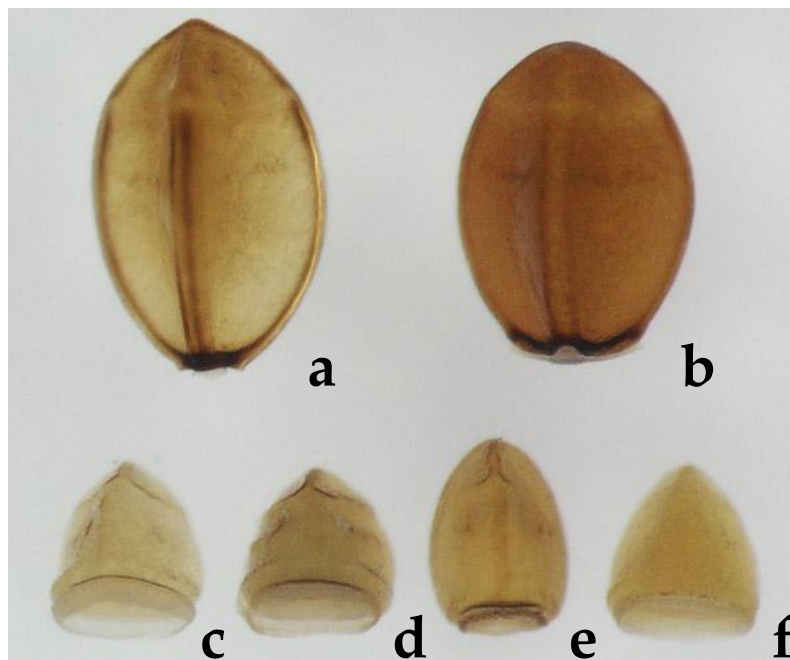
**Egg** (Figs. 8-11, 16e). Typical of the Perlodini tribe, trilateral (Figs. 8-9, 16e). Length 400 µm, width 300 µm. Shape egg-like with cut-off base, wider than the 2/3 of its length (Fig. 8); triangular in apical view (Fig. 9). Collar lacking. Anchor with several rows of rounded, petal-like plates on the disc edge; globular bodies arranged in 3-4 peripheral rows just inside the petal-like plates, anchor surface wrinkled (Figs. 10-11). Chorion covered with tiny warts; ornamentation of polygonal FCIs distinct on operculum but hardly visible on basal part (Fig. 8-9). Micropyles placed in a transverse row around midlength, not raised (Fig. 8).

**Affinities.** Size and head pattern of the new species is similar to *Perlodes dispar*. Both species lack the distinct, yellow C or V-shaped pattern by the M-line,

characteristic for *P. intricatus*, *P. jurassicus* and *P. mortoni*. Females separate themselves from *P. dispar* and all the European species by their narrower subgenital plate. *P. dispar* male is micropterous while *P. floridus* is fully winged. Male paraprocts reminiscent of *P. microcephalus* in ventral view (Zwick 1997:494., Fig. 6a), but sclerite has a distinct apical angle in *P. floridus* but is gently curved in *P. microcephalus*. Paraproctal sclerites are also distinctly curved in ¾ ventrolateral view in comparison with the other European species: *P. dispar*, *P. microcephalus* (Marten 1991:400., Fig. 10), *P. intricatus*, *P. jurassicus* (Knispel et al. 2002:186., Figs. 1, 4).

Identification of *Perlodes* larvae are not yet clear. Nevertheless, the larva of *P. floridus* seems to be distinctive by the setation of the three last sternites and the long, narrow hind femur.

Egg of *P. floridus* is rather distinctive and can be easily separated from the known *Perlodes* species by its size, shape and anchor: Figs. 16a-f; *P. dispar*, *P. microcephalus* (Kovács & Murányi 2008:117., Fig. 2a-b), *P. frisonanus* (Isobe 1988: 34., Fig. 9), *P. intricatus*, *P. jurassicus* (Knispel et al. 2002:187., Figs. 7, 10), *P. mortoni* (Zwick 2011:294., Fig. 5 mo-1-7).



Figs. 16a-f. *Perlodes* spp. eggs, lateral view. a. *P. intricatus* (France). b. *P. jurassicus* (Switzerland). c. *P. dispar* (Hungary). d. *P. microcephalus* (Hungary). e. *P. floridus floridus* sp. n. (Montenegro), 0,4 mm high. f. *P. floridus peloponnesiacus* ssp. n. (Greece).

**Etymology.** The name *floridus* (from the Latin word *flora*, meaning flower) refers to the flower-like anchor of the egg that distinguishes the new species from the hitherto known *Perlodes*.

**Ecological notes.** The specimens were found in different types of rivers between 35 and 975 m a.s.l. (Figs. 17-24). All of them have fast flow, even in the low altitudes, and stony substrate, but width varies between 5 to 20 meters. Larvae were found under big stones in the strongest current, life cycle seems to be one-year like in other *Perlodes* species. Adults occurred between 12th of March and 29th of May, and were captured on stones and vegetation close to the bank. Due to the wide range of its habitats, it was found together with many other stoneflies. The most species rich locality is the Sperchios River at Agios Georgios, where earlier (10.04.1967) the following species were found (Berthélemy 1971): *Brachyptera beali*, *B. helenica*, *B. graeca*, *B. phthiotica* (?), *Brachyptera* sp., *Protonemura mattheyi*, *Amphinemura sperchiana*, *Leuctra* sp., *Perlodes microcephalus*, *Isoperla tripartita*, *Perla marginata*, *P. pallida*, *Chloroperla* sp. (*tripunctata* ?); in 2010 we found there the species *Leuctra moreae*, *Protonemura intricata*, *Perla pallida*. In the other rivers *P. floridus* shares the habitat with the further species: *Brachyptera risi*, *Leuctra olympia*, *Capnia nigra*, *Amphinemura quadrangularis*, *Nemoura cinerea*, *Besdolus imhoffi*, *Isoperla grammatica*, *Perla abdominalis*, *Dinocras* sp., *Eoperla ochracea*, *Chloroperla tripunctata*, *Siphonoperla* sp.

**Remarks:** Berthélemy (1971) cited *P. microcephalus* from the Sperchios River where we found *P. floridus* only. Unfortunately, we had no access to study the specimens held in the Toulouse Museum, France.

***Perlodes floridus peloponnesiacus* Kovács  
et Vinçon sp. n.**

(Figs. 4b, 5b, 12-15, 16f)

*Perlodes dispar* (Rambur, 1842) Tierno de Figueroa & Fochetti (2001):214.

**Material examined.** Holotype: GREECE, West Greece, Achaia regional unit, Erimanthos Mts, 6 km W Agridi, 19.04.1990, 1♀+O (Fig. 14), HB-SI, PMSL: 03187 (22 O, MM: A2012-5). Paratypes: same locality and date: 20E, 6♂, HB-SI (14E, 3♂, PMSL: 03187; 3E, 1♂ (Figs. 4b, 5b), MM: A2012-5; 3E, 1♂ HNHM: PLP

3960); Ano Vlassia, Oberlauf des Selinous, N37°57', E21°47', 1000 m, (GR 59), 25.05.1992, 1♂, 1♀+O (Figs. 12-13), BC-GR, CGV; Kalavrita, Vouraikos River, 23.05.1985, 1♀+O (Figs. 15, 16f), NP, SU (Tierno de Figueroa & Fochetti 2001: 2♀, *sub nomen: Perlodes dispar*).

**Diagnosis.** Head of the imago lacks yellow pattern by the M-line. Male macropterous, paraproct sclerite with long and curved apical part, apex angled. Female subgenital plate narrow. Larval hind femur long and narrow, last sternites with distinct setation. Egg with flower-like anchor, shape short pyramidal, FCIs distinct on most surface.

**Description.** Both imago and larva similar to the nominal *Perlodes floridus* as described above. Differences are in male paraproct and egg structures.

**Male genitalia** (Figs. 4b, 5b). Paraproct similar to that of *P. floridus* but in ventral view, apex of the sclerite starts to curve inward before the sharply angled part (Fig. 4b); curve can be seen also in  $\frac{3}{4}$  ventrolateral view, making an appearance of a larger curved apex (Fig. 5b).

**Egg** (Figs. 12-15, 16f). Typical of the tribe Perlodini, trilateral (Figs. 13, 16f). Length 360 µm, width 370 µm. Shape short pyramidal, approximately tetrahedric, widest at its base (Fig. 12); triangular with concave sides in apical view (Fig. 13). Collar is lacking. Anchor with several rows of rounded, petal-like plates on the disc margin; globular bodies arranged in 3-4 peripheral rows just inward the petal-like plates, anchor surface wrinkled (Fig. 14 – egg is not completely cleared from follicular membrane). Chorion covered with tiny warts; ornamentation of polygonal FCIs distinct on all surfaces, though weaker beneath operculum and around microphyles (Fig. 15). Micropyles placed in a transverse row around midlength, not raised (Fig. 15).

**Affinities.** Imago and larva differ from other species of *Perlodes* as detailed under the nominal subspecies. The male differs from *P. floridus floridus* by the more curved apex of paraproctal sclerite. Egg is more similar to *P. dispar* and *P. microcephalus* in shape and size (Figs. 16c, d, f), but flower-like anchor and polygonal FCIs ornamentation distinguish it. Besides shape, more distinct FCIs all over the surface separate the egg from those of the nominal subspecies.





Figs. 17-24. *Perlodes floridus* sp. n. habitats. 17. Gornji Mileš, Cijevna River, 65 m, Locus typicus. 18. Qukës Shkumbin, Shkumbin River, 380 m. 19. Borsh, Borsh River, 35 m. 20. Koman Lake, Mertur Stream confluence, 180 m. 21. Agios Georgios, Sperchios River, 365 m. 22. Aetia, Venetikos River, 975 m. 23. Eleftherohori, Venetikos River, 475 m. 24. Zakas, Venetikos River, 700 m.



**Etymology.** The name *peloponnesiacus* refers to the distribution of the subspecies, the Peloponnes peninsula of Greece (Fig. 25).

**Further notes on the genus.**

Zwick (1997) calls attention to the systematic problems of genera in the *Perlodes* group. Many Central Asian and Far East species originally described in *Perlodes* were classified in closely related genera: *Filchneria amabilis*, *F. irani*, *F. kuenluensis*, *F. nuristica*, *F. shobhaae*, *F. stigmata* and *Zhiltzovaia cachemirica* (DeWalt et al. 2012, Illies 1966, Teslenko et al. 2010, Zhiltzova 1971, 1995, Zwick 1973), while three species are considered as species inquirenda or nomen dubium: *P. lobata*, *P. truncata*, *P. sinensis* (DeWalt et al. 2012, Hallan 2006, Illies 1966).

Division of abdominal segments 1-4 by pleural membrane was first reported by Hynes (1941) in case of *Perlodes mortoni* larvae. Since then, this character

used as a diagnostic larval feature of the genus by many subsequent authors regarding all the European species (Aubert 1959, Illies 1955, Lillehammer 1988, Raušer 1980, Steinmann 1968), and the entire genus in the Palaearctic (Teslenko & Zhiltzova 2009, Zhiltzova 1997, Zwick 2004).

Among the East Palaearctic *Perlodes* species, *P. frisonanus* has 1-4 abdominal segments divided (Ra et al. 1994, not mentioned in the original description). As only two segments divided in *P. kippenhani* larvae (Stark 2010), this species hardly belongs to *Perlodes* but cannot simply transfer to any of related genera. More material will be needed to solve its classification, especially the discovery of the hitherto unknown female.

It is worth mentioning that the figures in Kawai (1967:113., Figs. 64 a-c) show not *Perlodes frisonanus* but *Megarcys ochracea* (cf. Kohnno 1943: 49., Fig. 1 and Klapálek 1912: 10., Fig. 4).

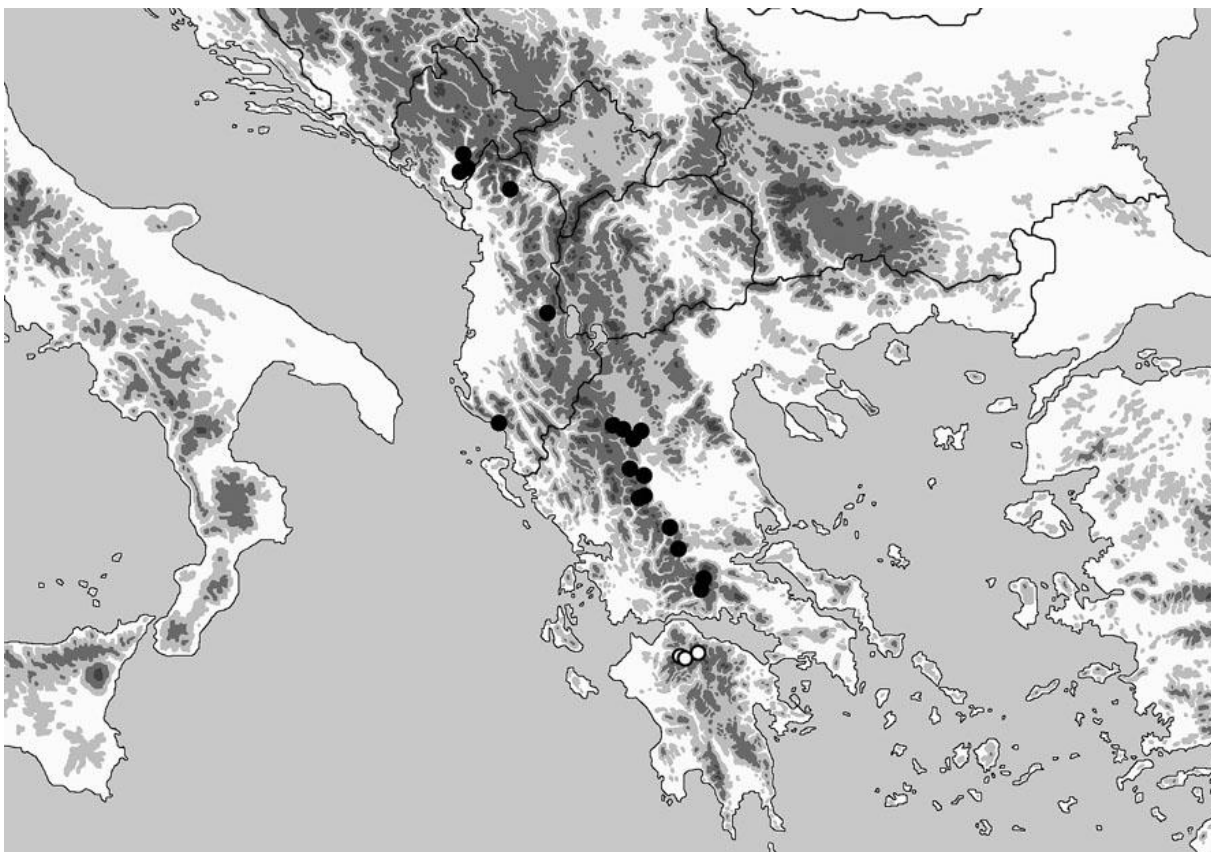


Fig. 25. Known localities of *Perlodes floridus floridus* sp. n. (dot) and *P. floridus peloponnesiacus* ssp. n. (circle).

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