

Larval and pupal morphology of *Pyraclonema nigripennis* Solier (Coleoptera: Lampyridae: Photinini) and comparative notes with other Photinini larvae

MIGUEL ARCHANGELSKY

CONICET-LIESA, Laboratorio de Investigaciones en Ecología y Sistemática Animal, Universidad Nacional de La Patagonia, San Juan Bosco, Sarmiento 849, 9200, Esquel, Chubut, Argentina. E-mail: hydrophiloidea@yahoo.com.ar

Abstract

The last larval stage and pupal stage of *Pyraclonema nigripennis* Solier, an endemic species from southern Chile and Argentina, are described and illustrated. *Pyraclonema* Olivier is included in the tribe Photinini, Subtribe Lucidotina, and the larva and pupa of *P. nigripennis* are compared to those of *Lucidota atra* (Olivier) and related lampyrid genera.

Key words: Lampyridae, firefly, *Pyraclonema*, Neotropical, larval morphology

Introduction

The genus *Pyraclonema* Olivier includes medium to large-size lampyrids distributed in southern South America. Following McDermott (1966), *Pyraclonema* is placed in the subtribe Lucidotina (Lampyrinae, Photinini). The genus was revised 50 years ago by McDermott (1960), who recognized 12 species. Most species were described from Chile, but two are known to occur in Argentine Patagonia (McDermott, 1966): *P. albomarginata* Solier and *P. obscura* (Olivier) (in Tierra del Fuego). Very little is known about the biology of these beetles, and no detailed descriptions of their larvae have been published. McDermott (1960) mentioned only very general characters for *Pyraclonema* larvae, which have little use in their identification.

Recently, I collected several larvae and adults of this genus in western Chubut Province, Argentina. Two larvae were reared to pupal and adult stages and identified as belonging to the *P. nigripennis* species-group. This group includes three species, distinguished in McDermott's (1960) key only by their size: *P. nigripennis* 14–19.5 mm, *P. bifenestrata* (Fairmaire & Germain) 10–15 mm, and *P. obscura* (Olivier) 5–11 mm. The reared adult (a female) keys to the *P. nigripennis* species-group, and its size (16.5 mm) falls within the range given for *P. nigripennis*. This female is larger than *P. obscura* females (ranging from 6–14 mm) and lacks the translucent areas (“windows”) on the pronotum that are characteristic of *P. bifenestrata*; therefore, it is identified here as *P. nigripennis* with a good degree of confidence.

The last larval instar and the pupa of *P. nigripennis* are described and illustrated for the first time. Larvae of this species are compared to those of *Lucidota atra* (Olivier), also belonging to the subtribe Lucidotina. Additional notes comparing known larvae of other species the tribe Photinini are also provided. This is also the first record of *P. nigripennis* for Argentina. This paper is intended to improve larval knowledge of lampyrids in order to provide new detailed larval descriptions that could be used in future phylogenetic studies.

Material and methods

Last instar larvae were collected in a mountainous area in western Chubut Province in the Experimental Field of INTA (Instituto Nacional de Tecnología Agropecuaria) near Trevelin (43° 06' S, 71° 33' O). They were

found under fallen wood and also collected with pit-fall traps in a wooded area composed mostly of introduced pines and native cypresses (*Austrocedrus chilensis*). Two larvae were transferred alive to the laboratory and placed in a large clear plastic container (20 cm long, 8 cm wide, 9 cm high), with a perforated lid; soil and small pieces of wood from the collection site were used as a substrate for the larvae. They were fed snails and earthworms until one pupa and one adult were obtained in order to confirm the larval-adult association. The adult was identified using McDermott (1960). The pupa and remaining larvae were fixed with boiling water, and stored in 75% alcohol.

Specimens were cleared in warm lactic acid, dissected and mounted on standard glass slides with Hoyer's medium. Observation and drawings were made using a Leica DMLB microscope equipped with a camera lucida. Scanning and editing of the drawings was made using a computer. The material studied is deposited in the larval collection of M. Archangelsky (LIESA, Universidad Nacional de La Patagonia, Esquel, Argentina). Interpretation and terminology of the thoracic and abdominal laterotergites follows Ballantyne & Menayah (2002).

Pyractonema nigripennis Solier

Description of last larval instar. Length: 15 to 17 mm, width 2.6 to 2.8 mm. Body elongate, almost parallel-sided, slightly flattened dorsoventrally (Fig. 1). Color dark brown dorsally, with light brown margins, ventrally light brown except for dark brown sternal plates and dark brown laterotergites.

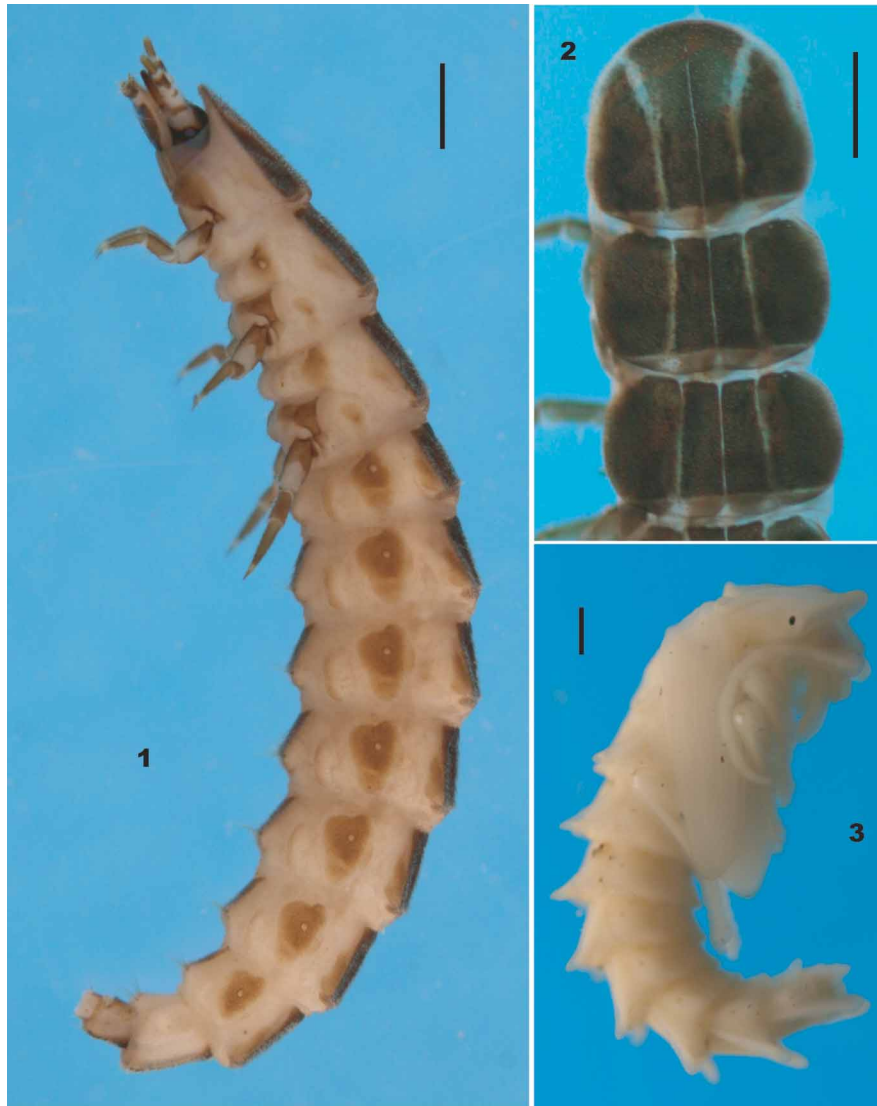
Head capsule: Length: 1.60 mm; width: 1.35 mm. Prognathous, subquadrate, dorsoventrally flattened, robust (Fig. 4); partially retractable within the prothorax (Fig. 1), leaving only antennae and mouthparts exposed. Head capsule not fused ventrally (Fig. 5), basal part of head softer (white areas on Figs. 4–5). Labrum and clypeus fused. Ecdysial line not developed in last instar larva. Head with three internal ridges, one transverse at midlength, the other forming a Y-shaped structure extending from the base of antennae and coming together at middle of transverse ridge. One pair of small lateral stemmata posterior to base of antennae. Epipharynx formed by two oval plates covered with several transverse rows of microtrichiae; hypopharynx as a small triangular sclerite covered by a dense pubescence.

Antennae: Large, three-segmented, partially retractable within membranous base (Fig. 8); originating on lateroapical edges of head capsule (Fig. 4); membranous base with sclerotized area on outer margin, covered by medium length setae. Basal antennomere widest, partially sclerotized, with basal dorsal sclerite separated from rest of antennomere by membranous area, all segments covered by setae, those in the middle larger and stouter than basal and apical ones. Second antennomere narrower, as long as basal one, also covered by setae, carrying across its apex both a large globular sensorium as long as third antennomere and the third antennomere, which is the shortest, with several short setae and three narrow sensoria.

Mandible: Symmetrical, strongly falcate, with an inner channel opening subapically on outer edge (Figs. 6–7). Retinaculum present, forming one sharp inner tooth on apical third of mandible. Inner margin of mandible and base of retinaculum with blunt cuticular projections which become setiform towards base of mandible in dorsal view. Basal half of mandible, in ventral view, with patches of dense pubescence (Fig. 7). One strong dorsal seta close to base of retinaculum. Sensory (hyaline) appendage on outer margin of mandible before channel opening, present in other larval Lampyridae, missing (Archangelsky & Branham 1998, 2001; Branham & Archangelsky, 2000). Base of mandible with an inner membranous lobe covered by a dense pubescence (Fig. 6).

Maxilla: Long and robust, closely attached along the sides of the stipes to the labium (Figs. 5, 9). Cardo elongate, irregularly shaped, bearing 13–15 setae on ventral surface; contacting a transverse basal plate. Stipes very broad, surface covered with small setae and bearing 14–15 strong and long setae on ventral and outer surfaces; dorsally with numerous setae and a longitudinal strip of pubescence on disk. Galea large (Figs. 9–10), two-segmented, basal segment about two times as long as second segment and bearing two setae on outer margin; distal segment short, subconical, bearing five stout setae and two slender apical sensoria. Lacinia large, membranous, twice as long as galea, covered by a dense pubescence. Palpus apparently three-segmented (Fig. 10), basal palpomere largest, subquadrate, longer than other two segments combined,

covered with numerous setae; second palpomere ring-shaped bearing several setae; distal palpomere subconical, bearing a globular sensorium-like structure at base on outer margin and four short, slender sensoria on dorsal side. Between second and third palpomeres there is a very small narrow plate dorsally (Fig. 11), bearing 3–4 setae, which could be interpreted either as a subdivision of the second or third segment, or as a vestigial palpomere (in which case the palpus should be considered as four-segmented).

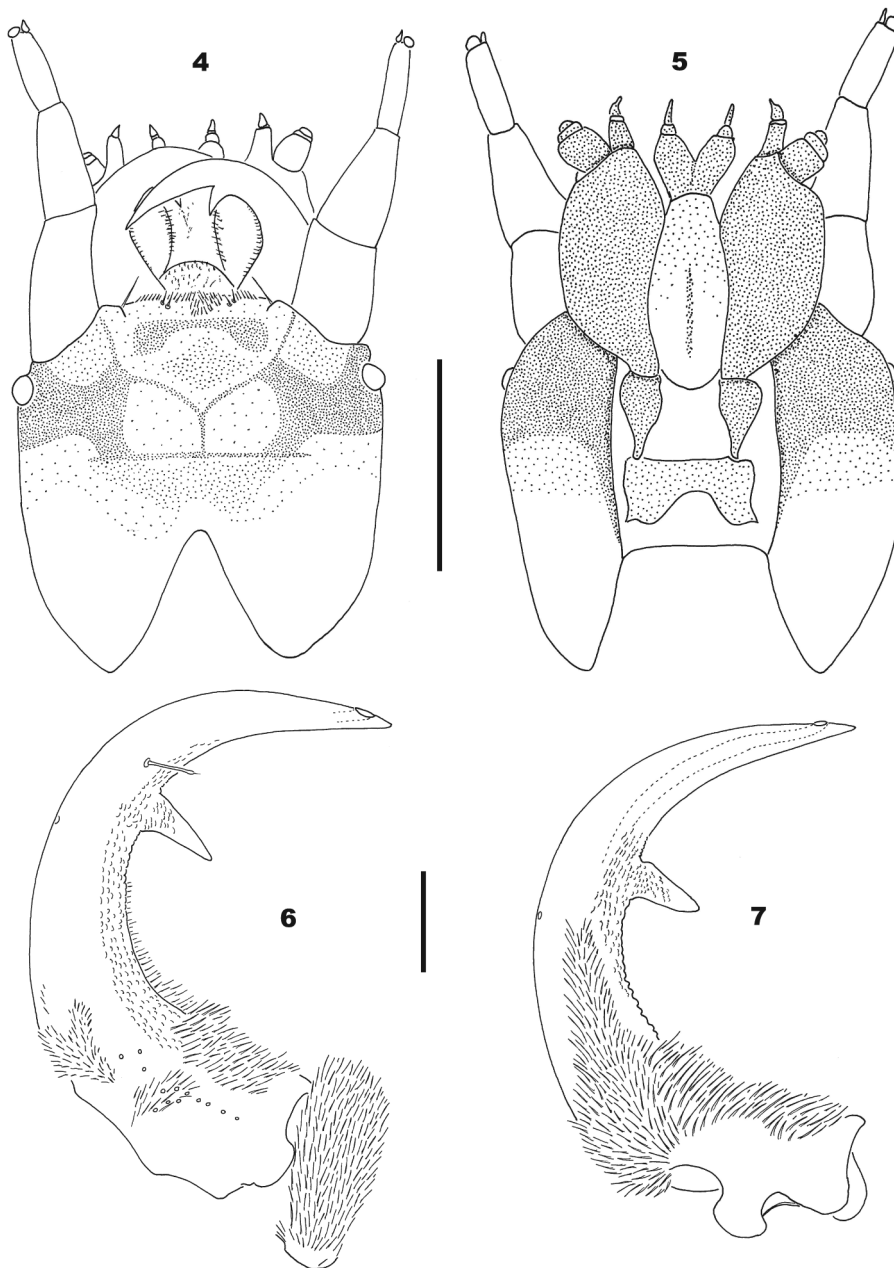


FIGURES 1–3. *Pyractonema nigripennis*. 1—Last larval instar, lateral view; 2—Last larval instar, detail of thoracic dorsal coloration; 3—pupa, lateral view. Scale bars: 1 mm.

Labium: Closely attached to maxilla, formed by a short and strongly sclerotized prementum, mentum (mostly membranous) and submentum. Prementum heart-shaped, in both dorsal and ventral views with a distal apical cleft (Figs. 5, 9); bearing numerous setae both dorsally and ventrally, lacking brushes of cuticular spines dorsally. Palpus two-segmented; basal segment short, wider than long, bearing several setae; distal segment longer and narrower, pointed and bearing a large, globose sensorium at base on outer margin (Fig. 12), lacking setae. Submentum longer than wide, strongly sclerotized, with a pair of very large setae on basal half.

Thorax: Three-segmented. Pronotum subcircular, wider at base, containing retracted head in repose (Fig. 1). Meso- and metanotum suboval, wider than long, with rounded margins. Thoracic tergites subdivided by sagittal line (that of pronotum incomplete), with one clear line on each side, subparallel to sagittal line (Fig. 2). Lateral areas of meso- and metathorax formed by two laterotergites, anterior one of mesothorax bearing a biforous spiracle (Fig. 1). Prosternum subtrapezoidal, poorly sclerotized, extending above and to the sides of

coxae, carrying a large episternum and a narrow epimeron. Meso- and metasternum subdivided by a transverse fold into an unsclerotized anterior basisternum, and a poorly sclerotized sternellum, subdivided into three plates, lateral ones carrying the episterna and epimera, medial one elongate, as an inverse Y.

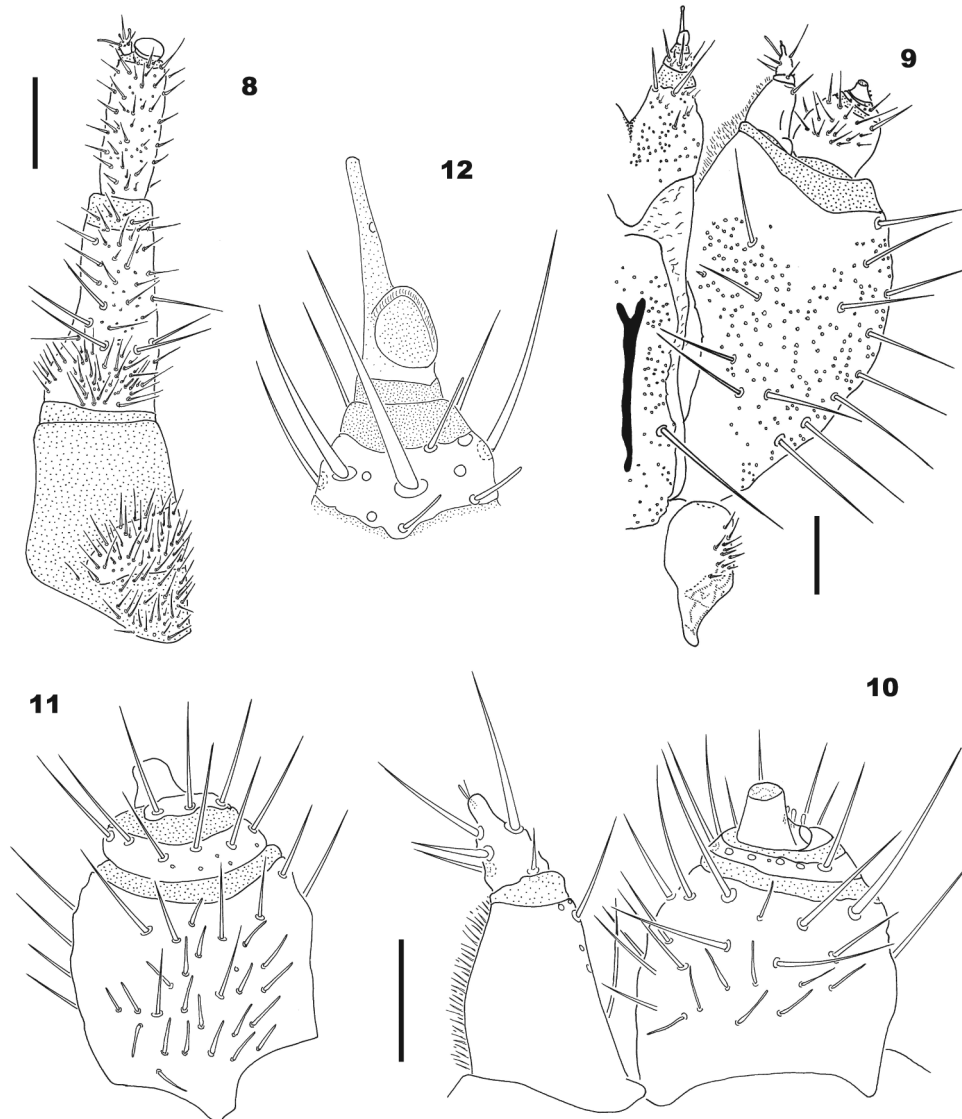


FIGURES 4–7. *Pyractonema nigripennis*, last larval instar. 4—Head capsule, dorsal view; 5—Head capsule, ventral view; 6—Mandible, dorsal view; 7—Mandible, ventral view. Scale bars, Figs. 4-5: 1 mm; Figs. 6-7: 0.2 mm.

Legs: Five-segmented, coxae long and robust, subtriangular; trochanters smaller, subtriangular in lateral view; femora larger than trochanters, subtrapezoidal, with a long seta in medial inner portion; tibiotarsi as long as femora, tapering towards distal end, with a double row of strong setae on inner margin; pretarsi strong, simple, with a pair of stout basal setae.

Abdomen: Ten-segmented, tapering towards posterior end (Fig. 1). Segments one to seven similar in shape, subrectangular, wider at posterior end; segment eight subquadrate, narrower than preceding segments; segment nine subquadrate, smaller than preceding segment; segment ten interpreted as the narrow ring surrounding anal region and carrying holdfast organ. Tergites one to eight with sagittal line, tergites one to seven with one clear line on each side, subparallel to sagittal line, segments eight and nine evenly dark.

Sternites one to nine small, subquadrate, dark colored except for lightly colored sternite eight. Pleural areas well developed, segments one to seven subdivided, upper plate (laterotergite) large, suboval, carrying spiracles, lower plate (laterosternite) small, narrowly subtriangular, that of segment seven very narrow; pleura eight membranous, bearing a round photic organ (Fig. 1); pleural areas of segments nine and ten reduced. Biforous spiracles present on pleurites one to eight.



FIGURES 8–12. *Pyractonema nigripennis*, last larval instar. 8—Antenna, dorsal view; 9—Maxillolabial complex, ventral view; 10—Maxillary palpus and galea, ventral view; 11—Maxillary palpus, dorsal view; 12—Apical sensorium of labial palpus, ventral view. Scale bars: Figs. 8–9: 0.2 mm; Figs. 10–11: 0.1 mm.

Description of pupa. Length: 13.5 mm, maximum width: 3.9 mm at base of pronotum. White in color, strongly curved, ventrally concave (Fig. 3).

Head: Completely covered by pronotum in dorsal view (Fig. 3). Eyes small, on sides of head; antennae inserted in front of eyes, extending to distal end of mesotibiae.

Thorax: Pronotum large, subcircular, covering head. Meso- and metanotum shorter, subrectangular, carrying wing pads on sides; wingpads reaching distal end of second abdominal segment. First and second pair of legs fully visible in ventral view; third pair of legs partially covered by wingpads. One pair of spiracles present on pleura of mesothorax.

Abdomen: Tergites one to seven subtrapezoidal, wider than long; segment eight subquadrangular; segments one to eight with posterolateral projections directed posteriorly. Sternite one reduced, sternites two

to eight subrectangular, becoming narrower towards end, with posterolateral corners projected posteriorly. Spiracles present on abdominal pleural areas of segments one to eight. Photic organs present on margins of segment eight, functional.

Discussion

The classification of Lampyridae, created by McDermott (1964, 1966) and followed since then by most authors, is not natural. McDermott himself thought so, but no attempts have been made to update it. Based on adult characters, Branham & Wenzel (2003) presented a phylogeny that clearly points out this problem with firefly classification. More recently Stanger-Hall *et al.* (2007), in a molecular study addressing the phylogeny of North American fireflies, reached a similar conclusion. Larval characters also suggest that the classification of Lampyridae needs to be revised (Archangelsky & Branham, 2001). This section includes some comparative notes with other genera related to *Pyracontema* whose larvae are known.

Comparative notes with *Lucidota atra*: Larvae of only two genera are known for the subtribe Lucidotina, *Pyracontema* and *Lucidota* (Branham & Archangelsky, 2000). Even though they seem very similar in shape and coloration there are several important differences between them, which are summarized in Table 1.

TABLE 1. Comparison between larvae and pupae of *Pyracontema nigripennis* and *Lucidota atra* (Subtribe Lucidotina).

Character Larva	<i>Pyracontema nigripennis</i>	<i>Lucidota atra</i>
Abdominal tergites I–VII	Clear line on each side of sagittal line complete	Clear line on each side of sagittal line incomplete
Abdominal tergites VIII–IX	Evenly dark	Lateral portions lightly colored
Antenna: antennomere II, ratio length/width	2.5	1.5
Antenna: sensory appendage	More than 2 times wider than antennomere III	Two times as wide as antennomere III
Mandible: channel opening	Narrow	Wide
Mandible: retinaculum	One strong inner tooth	Two inner teeth
Mandible: hyaline seta/sensory appendage	Absent	Present, behind channel opening
Labium: prementum	Without dorsal pubescence	With dorsal pubescence
Labium: palpomere II	Not forked	Forked
Maxilla: transverse basal plate contacting cardi	Present	Absent
Character pupa		
Pupa: pronotum	Without emarginations	With emarginations on either side of anterior apex
Pupa: antennae	Reaching distal end of mesotibiae	Reaching beyond mesotarsi

Comparative notes with other Photinini larvae: Table 2 summarizes the differences and similarities among several known Photinini larvae: *Pyropyga* LeConte, *Lucidota* Laporte, *Pyracontema*, *Lamprohiza* Motschulsky, *Phosphaenus* Laporte. This tribe includes 27 genera, but larvae of only five genera have been described with some detail. A comprehensive description of the larva of *Lamprohiza delarouzei* (Jacquelin DuVal) (= *Phausis delarouzei*) was provided by Bugnion (1929). The head capsule and mouthparts of a species of *Phosphaenus* (= *Phosphaena* sp.) were described by Beutel (1995). More recently, Branham and Archangelsky (2000) and Archangelsky & Branham (2001) described the last larval stages of *Lucidota atra* (Olivier) and *Pyropyga nigricans* (Say) respectively.

Based on what is known on larval body shape, color pattern, head capsule and mouthpart morphology, *Pyraclonema* resembles *Lucidota* and *Pyropyga*. According to Branham & Wenzel (2003), based on adult characters, *Lucidota* and *Pyropyga* are closely related to each other, while *Phosphaenus* and *Lamprohiza* appear closely related within a different clade. Since *Pyraclonema* was not included in that study, it is not possible to know if the larval characters are congruent with the adult characters coded by Branham & Wenzel (2003).

TABLE 2. Comparison among known Photinini larvae (*Pyraclonema*, *Lucidota*, *Pyropyga*, *Phosphaenus*, *Lamprohiza*).

Character	<i>Pyraclonema</i>	<i>Lucidota</i>	<i>Pyropyga</i>	<i>Phosphaenus</i>	<i>Lamprohiza</i>
Body shape	Narrow, parallel-sided	Narrow, parallel-sided	Narrow, parallel-sided	Narrow, parallel-sided	Wide, suboval
Ratio: body length/thoracic length	2.8–3.1	3.4–3.7	3.4–3.7	3.0–3.2	2.8
Head capsule	Short and wide, partially retractable within thorax	Short and wide, partially retractable within thorax	Short and wide, partially retractable within thorax	Short and wide, partially retractable within thorax	Long and narrow, completely retractable within thorax
Antenna	Stout, partially retractable within head capsule	Stout, partially retractable within head capsule	Stout, partially retractable within head capsule	Stout, partially retractable within head capsule	Slender, completely retractable within head capsule
Channel opening of mandible	On outer margin, subapical	On outer margin, subapical	On outer margin, subapical	On inner margin	On outer margin, far from apex
Number of mandibular retinacula	1	2	1	1	1
Maxillary palp	Three-segmented*	Three-segmented	Three-segmented	Four-segmented	Four-segmented
Thorax: tergite shape	Pronotum subcircular, meso- and metanotum suboval	Pronotum subcircular, meso- and metanotum suboval	Pronotum subcircular, meso- and metanotum suboval	Pronotum subcircular, meso- and metanotum suboval	Pronotum suboval, meso- and metanotum subrectangular
Thorax: color pattern	Dark, with three longitudinal, subparallel clear lines	Dark, with three longitudinal, subparallel clear lines	Dark, with three longitudinal, subparallel clear lines	Dark, without clear lines	Dark, without clear lines

* In *Pyraclonema* between second and third palpomeres, dorsally, there is a very small narrow plate bearing 3-4 setae, this plate could be interpreted either as a subdivision of the second or third segment, or as a vestigial palpomere (in which case the palpus could be considered as four-segmented).

Larval characters seem to support a closer relationship among *Pyraclonema*, *Lucidota*, and *Pyropyga*. Meanwhile the situation of *Phosphaenus* is less clear: it shares several characters with *Pyraclonema*, *Lucidota*, and *Pyropyga* (a narrow body shape, a short and wide partially retractable head capsule, a stout partially retractable antenna, and suboval thoracic tergites); but it also presents several differences (the unusual channel opening on the inner margin of the mandible, a four-segmented maxillary palpus, and a dark thorax without longitudinal clear lines). The only two characters shared between *Phosphaenus* and *Lamprohiza* are the four-segmented maxillary palpus and the dark coloration of the thorax. Once more, larval characters suggest that the taxonomic scheme for the Lampyridae proposed by McDermott (1964, 1966) is not natural and that the tribal and generic relationships need to be revised using a more comprehensive approach, as previously proposed by Crowson (1972). Larval morphology has proved important in phylogenetic studies of different families of Coleoptera (Marvaldi & Morrone, 2000; Archangelsky, 2004; Alarie & Michat, 2007), but to be able to use larval characters it is necessary to obtain enough material (by association or rearing) so as

to be able to complement the adult characters. Currently the knowledge of lamproyrid larvae is only a small percentage of the known species or even genera (approximately 2000 species and 80 genera), and this poses a big obstacle for undertaking combined analyses using larval and adult morphology. For example, a recent study by Ballantyne & Lambkin (2009) used a combined analysis, but since very few larvae were available (of 112 taxa only 28 had associated larvae), larval characters played a less important role, and the results were supported mostly by male genitalic characters.

Acknowledgements

I thank the authorities of the Experimental Field of INTA (Instituto Nacional de Tecnología Agropecuaria) for allowing access to the field for the collection of the material here studied. Marc Branham supplied valuable bibliography for this paper and is here acknowledged. Comments by two anonymous reviewers helped to improve the present contribution. Support for this paper is acknowledged to the grants PIP 5733 and PIP 112-200801-01907 from CONICET. This is scientific contribution number 69 from LIESA.

Literature cited

- Alarie, Y. & Michat, M.C. (2007) Phylogenetic analysis of Hydroporinae (Coleoptera: Dytiscidae) based on larval morphology, with description of first instar of *Laccornellus lugubris*. *Annals of the Entomological Society of America*, 100, 655–665.
- Archangelsky, M. (2004) Higher-level phylogeny of Hydrophilinae (Coleoptera: Hydrophilidae) based on larval, pupal and adult characters. *Systematic Entomology*, 29, 188–214.
- Archangelsky, M. & Branham, M.A. (1998) Description of the preimaginal stages of *Pyractomena borealis* (Randall, 1838) (Coleoptera: Lampyridae), and notes on its biology. *Proceedings of the Entomological Society of Washington*, 100, 421–430.
- Archangelsky, M. & Branham, M.A. (2001) Description of the last instar and pupa of *Pyropyga nigricans* (Coleoptera: Lampyridae: Photinini), and comparison with larvae of other Photinini genera. *Canadian Entomologist*, 133, 1–10.
- Ballantyne, L.A. & Menayah, R. (2002) A description of larvae and redescription of adults of the firefly *Pteroptyx valida* Olivier in Selangor, Malaysia (Coleoptera: Lampyridae: Luciolinae), with notes on Luciolinae larvae. *Raffles Bulletin of Zoology*, 50, 101–109.
- Ballantyne, L.A. & Lambkin, C. (2009) Systematics of Indo-Pacific fireflies with a redefinition of Australasian *Atyphella* Olliff, Madagascan *Photuroluciola* Pic, and description of seven new genera from the Luciolinae (Coleoptera: Lampyridae). *Zootaxa*, 1997, 1–188.
- Beutel, R.G. (1995) Phylogenetic analysis of Elateriformia (Coleoptera: Polyphaga) based on larval characters. *Journal of Zoological Systematics and Evolutionary Research*, 33, 145–171.
- Branham, M.A. & Archangelsky, M. (2000) Description of the last larval instar and pupa of *Lucidota atra* (Olivier, 1790) (Coleoptera: Lampyridae), with a discussion of abdominal segment homology across life stages. *Proceedings of the Entomological Society of Washington*, 102, 869–877.
- Branham, M.A. & Wenzel, J.W. (2003) The origin of photic behavior and the evolution of sexual communication in fireflies (Coleoptera: Lampyridae). *Cladistics*, 19, 1–22.
- Bugnion, E. (1929) Le ver-luisant provençal et la Luciole nicoise. *Association des Naturalistes de Nice et des Alpes-Maritimes; Memoire Supplement au "Riviera Scientifique"*, 131 pp.
- Crowson, R.A. (1972) A review of the classification of Cantharoidea (Coleoptera), with the definition of two new families, Cneoglossidae and Omethidae. *Revista de la Universidad de Madrid*, 21, 35–77.
- Marvaldi, A.E. & Morrone, J.J. (2000) Phylogenetic systematics of weevils (Coleoptera: Curculionidae): A reappraisal based on larval and adult morphology. *Insect Systematics and Evolution*, 31, 43–58.
- McDermott, F.A. (1960) Fireflies of the genus *Pyractonema* (Coleoptera: Lampyridae). *Proceedings of the United States National Museum*, 112, 133–157.
- McDermott, F.A. (1964) The taxonomy of the Lampyridae. *Transactions of the American Entomological Society*, 90, 1–72.
- McDermott, F.A. (1966) Lampyridae. In: Steel, W.O. (Ed.), *Coleopterorum Catalogus Supplementa second ed.* The Hague, Junk, pp. 1–149.
- Stanger-Hall, K.F., Lloyd, J.E. & Hillis, D.M. (2007) Phylogeny of North American fireflies (Coleoptera: Lampyridae): implications for the evolution of light signals. *Molecular Phylogenetics and Evolution*, 45, 33–49.