



Description of the larva of *Ilyobius chilensis* (McLachlan) (Megaloptera: Sialidae) and notes on the adult morphology

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Abstract

Ilyobius chilensis (McLachlan) is reported from western Chubut Province, Patagonian Argentina. The first description of the larvae of this species is provided supported by illustrations. Morphological comparisons with other known sialid larvae are included. Additional notes and illustrations of adult morphology and behavior of this species are provided.

Key words: *Ilyobius*, Sialidae, larva, Neotropical, Argentina

Introduction

The Sialidae (alderflies) and the Corydalidae (dobsonflies and fishflies) comprise the extant Megaloptera. Sialids have a worldwide distribution and include eight extant genera and 78 extant species. Several fossil genera and species have also been described, some of them dating back to the Jurassic Period (Liu *et al.* 2015a). Alderflies are smaller than corydalids, and their larvae are found in a variety of aquatic environments, ranging from lotic to lentic habitats. Larvae have a preference for soft substrates where they dig short tunnels that provide protection and allow them to stay close to their prey, usually other invertebrates (Neunzig & Baker, 1991; Flint *et al.* 2008). Larval alderflies have between seven to ten larval instars and take one to two years to complete their life cycle (Azam & Anderson 1969; Pritchard & Leischner 1973).

There are three currently recognized genera of sialids in the New World, *Sialis* Latreille with 22 species occurring in the Nearctic region; *Protosialis* van der Weele with only three species, one from Cuba and two from the United States; and *Ilyobius* Enderlein, exclusively Neotropical. *Ilyobius* was recently reinstated by Liu *et al.* (2015a) to include all Neotropical alderflies previously included in *Protosialis* (except *Protosialis bifasciata* (Hagen) from Cuba). *Ilyobius* currently includes nine extant species and several extinct species (Liu *et al.* 2015a, b). The extant species are known from Argentina, Bolivia, Brazil, Chile, Colombia, French Guiana, Mexico, Panama, Peru, and Venezuela (Contreras-Ramos 1999, 2008; Clavier *et al.* 2010; Liu *et al.* 2015a, b). Although adults of *Ilyobius* are relatively well known, the larvae of almost all species remain unknown; with only the larvae of *I. chilensis* (McLachlan) and *I. flammata* (Penny) being previously illustrated, but not described (Flint 1973; Azevêdo 2009, respectively).

Recently, larvae of *Ilyobius* were reported from Chubut Province, Patagonian Argentina (as *Protosialis*) (Archangelsky 2004). Subsequently, several more adults and larvae were collected and associated, confirming that only *I. chilensis* occurs in southwestern Argentina. Currently, there are no published descriptions of the larvae of the genus and of this species available. Herein, we present a detailed description of the mature larva and additionally list useful characters to compare *Ilyobius* larvae with those of *Sialis*, *Protosialis*, *Leptosialis* Lestage and *Indosialis* Esben-Petersen. Finally we include notes and illustrations on adult morphology and behavior of this species.

Material and methods

Larvae and adults of *I. chilensis* were collected on several dates and localities between 2004 and 2016. Larvae were collected with a D-frame kick net and preserved in 80% alcohol. Additionally, live larvae were transported to the laboratory and fixed using boiling water. Adults were collected with an aerial net and preserved in 80% alcohol. The larval description is based on the largest specimens (probably the last two instars). Larval specimens were cleared in warm lactic acid, dissected, and mounted on glass slides with Hoyer's mounting medium. Observations and pictures of larvae were prepared using a Leica S6D stereomicroscope and a Leica DMLB compound microscope, both with a Leica EC3 photographic camera attached. Adults were studied with a Leica MZ6 stereomicroscope; images were taken with a Leica S6D stereomicroscope with a Leica EC3 photographic camera. Photographs were assembled using the freeware program CombineZP (Hadley 2010). Specimens are deposited in the Laboratorio de Investigaciones en Ecología y Sistemática Animal (LIESA). Centro de Investigaciones Esquel de Montaña y Estepa Patagónica (CIEMEP).

We followed the larval morphological terminology of Neunzig & Baker (1991) and Beutel & Friedrich (2008). The terminology of the male genitalia follows Liu *et al.* (2015c). Information on other species of *Sialis*, *Indosialis* and *Leptosialis* was taken from the literature (Crass 1949; Leischner & Pritchard 1973; Elliot *et al.* 1979; Price *et al.* 2012; Jung & Bae 2012; Bowles & Sites 2015; Jung *et al.* 2016; Bowles & Contreras-Ramos 2016).

Material examined

Larvae: **Argentina**, Chubut Province. Nine mature larvae, Nant y Fall Creek at junction of Provincial Road 17 to Corcovado, 43°13'S, 71°25'W, 665 m, several dates between 2004 and 2015, M. Archangelsky leg. Five mature larvae, small creek near Brychan Pond, 43°03'S, 71°29'W, 470 m, 06.vi.2016, M. Archangelsky leg. One mature larva, Canales de Doña Rosa Stream (tributary of Rivadavia River, National Park "Los Alerces") 42°41'17" 71°42'13", 8.xi.2010, P. Pessacq leg. **USA**, Ohio. Unidentified larvae of *Sialis* come from a small pond in Franklin Co., 9.xi.1995, M. Archangelsky leg.

Adults: **Argentina**, Chubut Province. Two males, one female, Nant y Fall Creek at junction of Provincial Road 17 (41°13'S, 71°25'W), 1.xi.2011, M. Archangelsky leg. One male, same location but 30.xii.2010. One male, one female, Materno Stream close to Las Pampas (small tributary of Pico River), 41°13'39" 71°40'47", 28.xii.2011, P. Pessacq leg. Same as location but 3.xii.2010, N. Fliess leg. Three males, seven females, Canales de Doña Rosa Stream (tributary of Rivadavia River, National Park "Los Alerces") 42°41'17" 71°42'13", 8.xi.2010, P. Pessacq leg. One female, Rivadavia River (National Park "Los Alerces") 42°40'04" 71°41'30", 14.i.2007, P. Pessacq leg. One male, Río Grande at "Los Cipreces" camping, 43°10'40" 71°39'46", 22.i.2008 P. Pessacq leg. One male, Poncho Moro stream, 43°38'57" 71°24'41", 16.iii.2010 P. Pessacq leg.

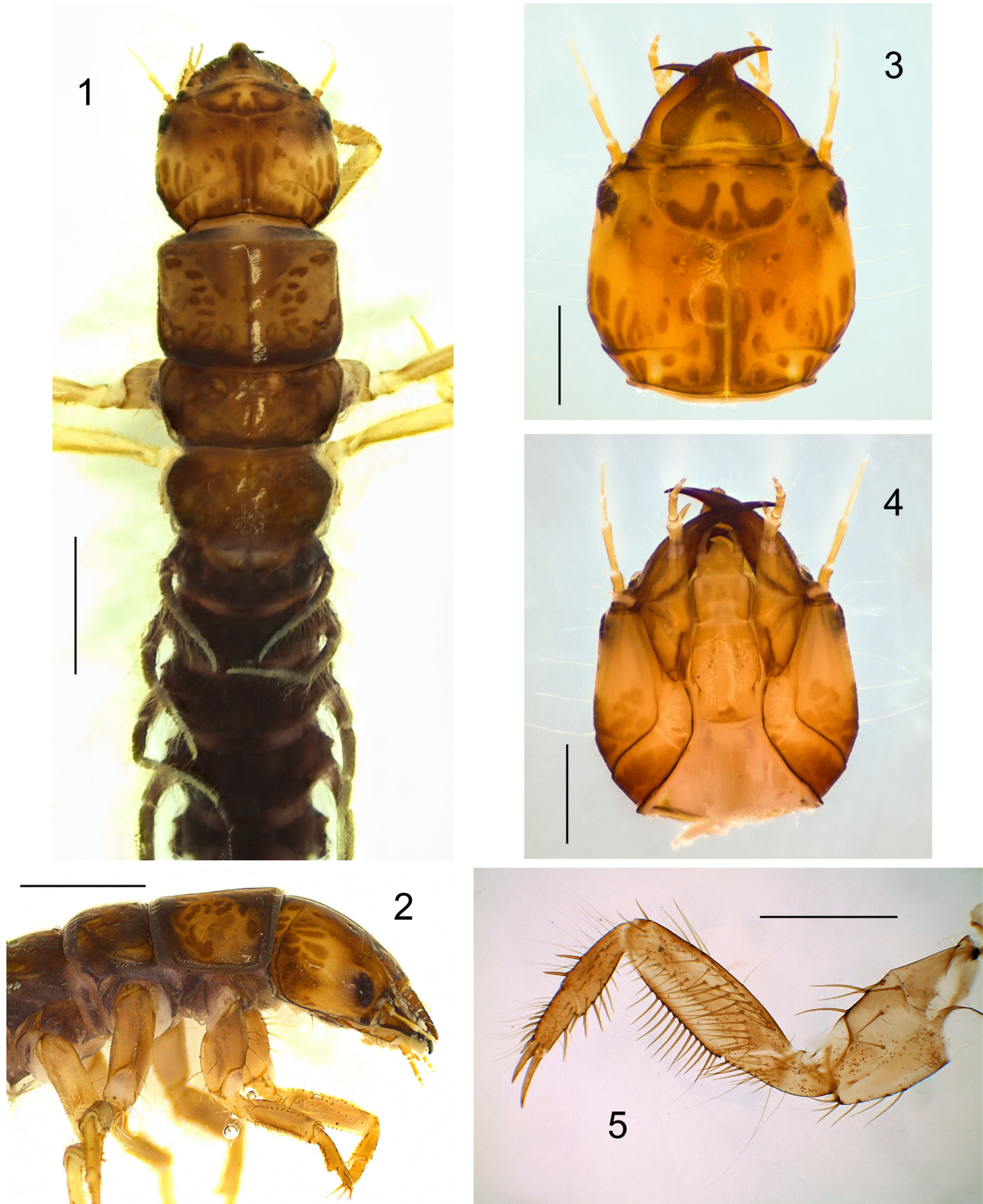
Description of the mature larva of *Ilyobius chilensis* (McLachlan)

Diagnosis. Head capsule subrectangular, slightly wider than long, flat, bearing six stemmata on each side arranged in semicircle; circular ridge long, almost reaching coronal line; gula absent. Labrum sharply pointed. Antenna with second antennomere longer than third; third antennomere subequal to fourth. Mandibles with two preapical teeth (retinacula), basal tooth more than half the size of distal one, with two preapical teeth. Maxilla with second palpomere slightly longer than third and fourth palpomeres combined.

General appearance (Figs. 1, 2): Length: 18–21 mm (not including caudal filament); maximum width: 3.0–3.3 mm. Larva campodeiform, head and thorax strongly sclerotized, abdomen poorly sclerotized, tapering towards posterior end, ending in a long caudal filament. Color: head capsule light brown to pale yellow, with distinct pattern of dark brown marks and two black ocular areas; thoracic tergites light brown with patterned areas extensive; ventral surface of thorax and all abdomen dark purplish brown, abdominal gills lighter ventrally; legs light brown. Body elongate, wider at prothorax, tapering towards abdominal apex.

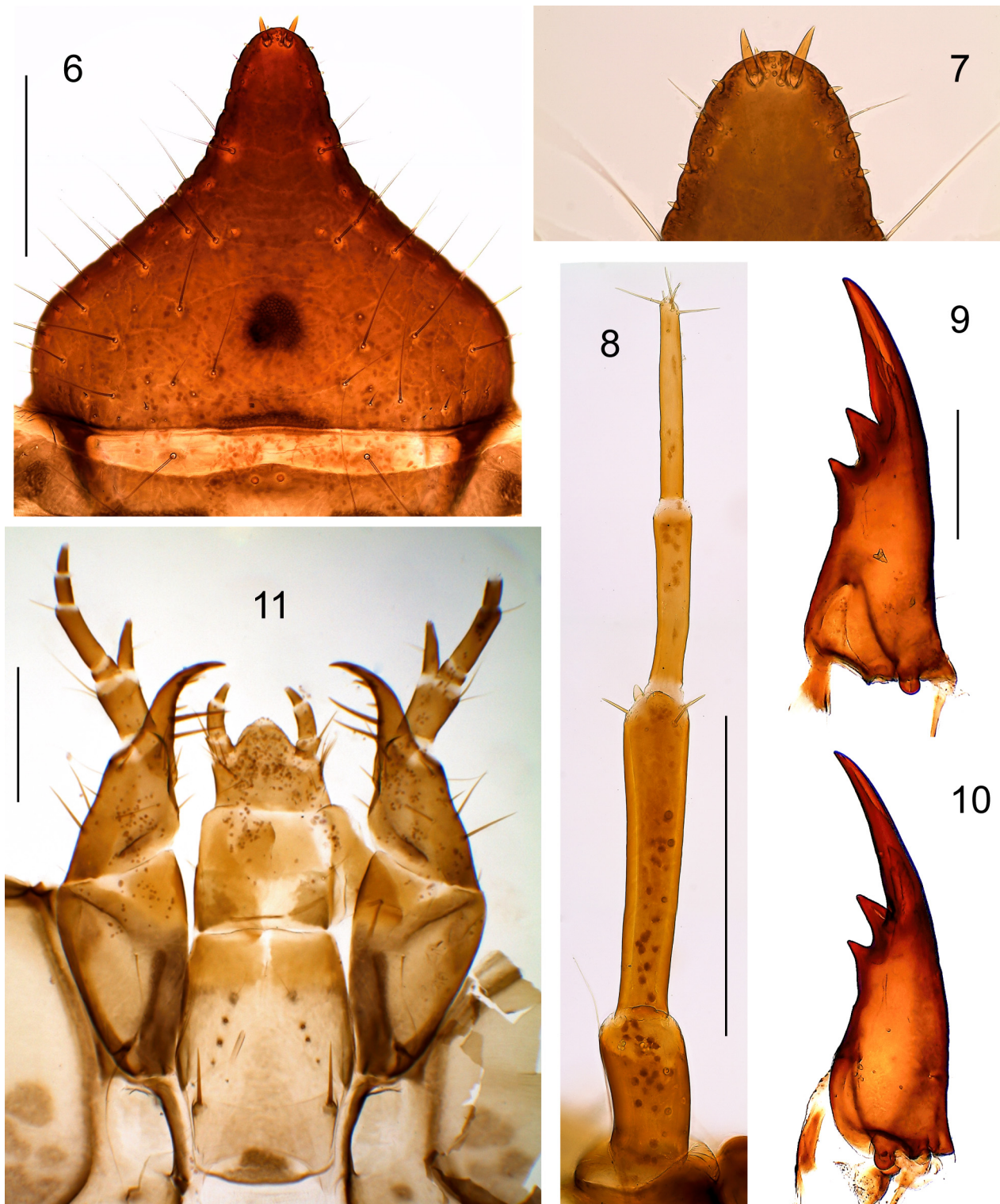
Head capsule (Figs. 2–4): Length: 2.6–2.7 mm (not including labrum); width: 3.0–3.3 mm. Subprognathous slightly retracted into prothorax. Light brown to pale yellow, smooth and shiny; clear areas smooth, darker areas

areolate-rugulose; several sparse slender setae distributed on head capsule. Subrectangular, slightly broader basally, flattened. Six stemmata arranged in a semicircle. Clypeus well developed, narrow and broad, separated from frontal region by the frontoclypeal suture. Frontal lines coming together before mid-head, fusing with long coronal line, demarcating a small subtriangular frons and two large parietal regions; an incomplete neck delimited by a ridge extending dorsally from the sides of the coronal line into the ventral side of head capsule, reaching the base of mandibular acetabulum. Gular sclerite absent. Foramen occipitale slightly narrowed, transverse and subtrapezoidal.



FIGURES 1–5. mature larva of *Ilyobius chilensis*. 1) Partial habitus, dorsal view; 2) head and thorax, lateral view; 3) head capsule, dorsal view; 4) head capsule, ventral view; 5) prothoracic leg, frontal view. Scale bars, Figs. 1–2= 2 mm; Figs. 3–5= 1 mm.

Labrum (Figs. 6, 7): Connected with clypeal margin by a narrow membrane; large, subtriangular, pointed distally, concave on lateral margins; basally with two sharp apophyses that serve for muscle attachment; dorsally with several long and slender setae (trichobothria) and two pairs of shorter apical setae, inner pair minute, outer pair short and stout; all outer margins bearing minute, peg-like setae.



FIGURES 6–11. mature larva of *Ilyobius chilensis*. 6) Labrum, dorsal view; 7) detail of apical portion of labrum, dorsal view; 8) antenna, dorsal view; 9) mandible, dorsal view; 10) mandible, ventral view; 11) maxillolabial complex, ventral view. Scale bars, Figs. 6, 8–11= 0.5 mm.

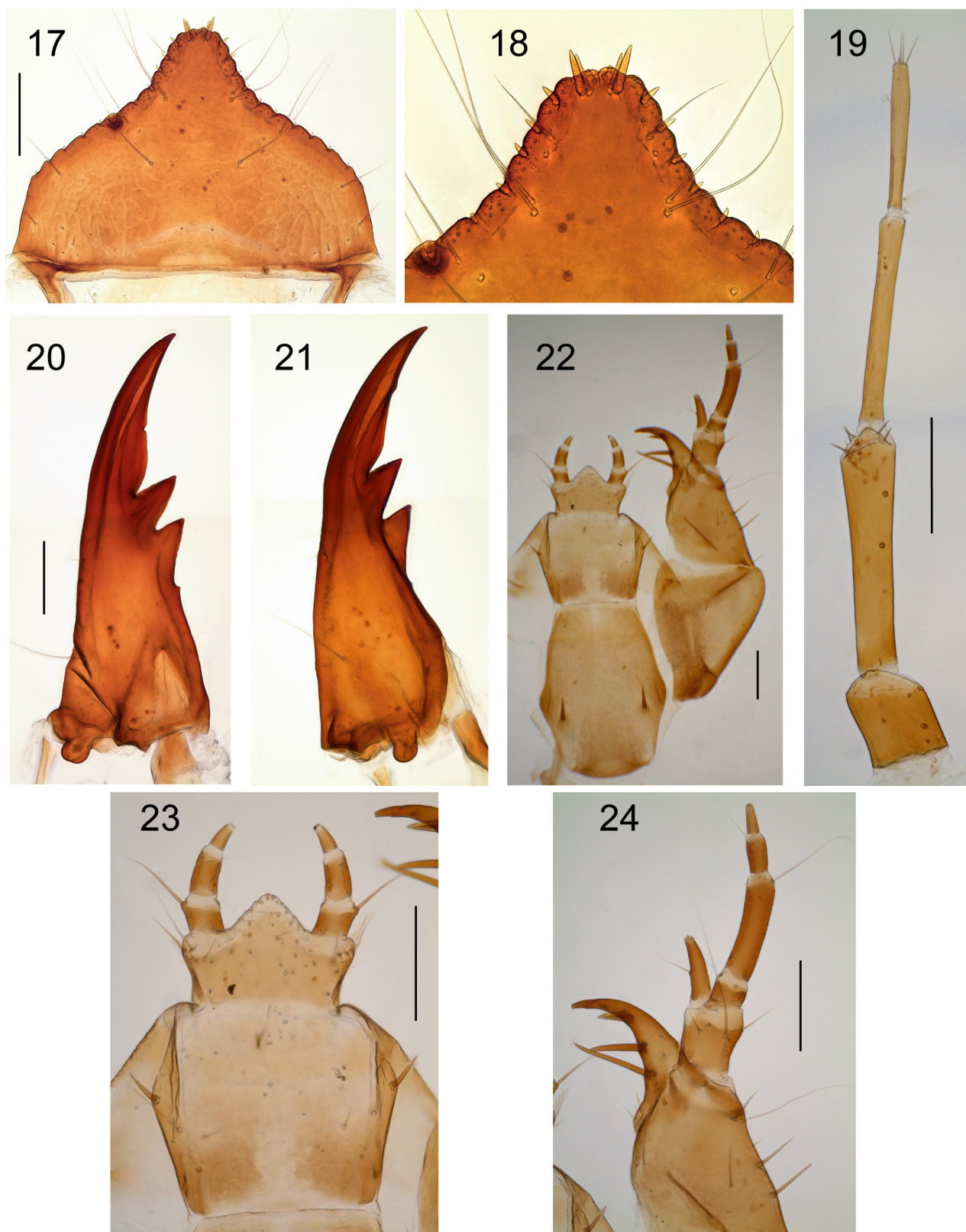
Antenna (Figs. 8, 12): Four-segmented, slender, about half as long as length of head capsule. Inserted on anterolateral corners of head capsule. First antennomere about twice as long as wide, wider than remaining antennomeres. Antennomere 2 the longest, about 5X long as maximum width, more slender basally, gradually widening distally; with one small apical conical sensillum, accompanied by several small peg-shaped sensilla and pores. Antennomere 3 slender, slightly longer than antennomere 1 and slightly shorter than 4, lacking sensilla. Antennomere 4 very slender, rounded apically, with 6 short setiform sensilla distally.

Mandible (Figs. 9, 10): Symmetrical, slender and long, reaching as far as antennae; sharply pointed, with two preapical teeth (retinacula) at about midlength, distal one stouter and slightly serrated; a minute toothlet may be visible at about basal third (difficult to see in specimens with worn out mandibles); outer margin convex, bearing one long and slender basal seta and one short slender seta at about midlength; inner margin concave.

Maxilla (Figs. 11, 13): Free, not connected with labium; formed by cardo, stipes, palpifer, a 4-segmented palpus, galea and lacinia. Cardo large, undivided, bearing one long, central seta ventrally. Stipes subtriangular, smaller than cardo, outer margin with five long setae; two additional setae ventrally, one near central area, the other subbasally on inner margin. Lacinia attached to dorsal inner margin of stipes, large, hook-shaped, basally with six rather large setae on inner margin, two very stout setae at midlength on inner margin, four or five more short and stout setae on distal half of inner margin. Palpifer attached to ventral distal margin of stipes, large, subrectangular, longer than wide, bearing three slender setae on ventral side. Galea one-segmented, cone-shaped, with one slender seta on inner margin at midlength and several small apical sensoria. Palpus four-segmented, palpomere 1 the shortest, wider than long, bare; palpomere 2 the longest, with one long apical seta on outer margin; palpomere 3 shorter, with two setae, one short on inner margin, the other long, apical, on ventral side; palpomere 4 as long as palpomere 3, narrower, cone-shaped, bare.



FIGURES 12–16. mature larva of *Ilyobius chilensis*. 12) Detail of apical portion of antennomere four; 13) detail of maxilla, ventral view; 14) detail of labium, ventral view; 15) dipteran head capsule from gut content; 16) proventriculus. Scale bars, Figs. 13–14= 0.25 mm.



FIGURES 17–24. larva of *Sialis* sp. 17) Labrum, dorsal view; 18) detail of apical portion of labrum, dorsal view; 19) antenna, dorsal view; 20) mandible, dorsal view; 21) mandible, ventral view; 22) maxillolabial complex, ventral view; 23) detail of labium, ventral view; 24) detail of maxilla, ventral view. Scale bars, Figs. 17, 19–24= 0.25 mm.

Labium (Figs. 11, 14): Formed by submentum, mentum and prementum. Submentum large, subrectangular, wider at midlength, twice as long as wide, ventrally with a pair of lateral stout and long setae on basal third, two

smaller and slender setae closer to midline at distal third. Mentum subquadrate, slightly narrower than prementum, incompletely sclerotized, distal half membranous; three lateral slender setae at midlength on each outer margin. Prementum wider than long, with well-developed membranous ligula, bearing several pairs of long and slender setae on dorsal, lateral and ventral sides. Palpus three-segmented, basal palpomere the shortest, slightly wider than long, with two apical setae on outer margin, one long and stout, the other very short; second palpomere the longest, twice as long as wide, curved inwards, bearing two long setae, one on basal third, the other subapical; third palpomere cone-shaped, bearing several apical sensoria.

Thorax (Figs. 1, 2, 5): All thoracic tergites with sagittal line. Pronotum large, subrectangular and slightly wider than long, anterior margin straight, posterior corners and margin slightly rounded; meso- and metanotum shorter, ca. 2X wider than long, anterior margins slightly concave, lateral and posterior margins rounded. Legs well developed, six-segmented, with unequal claws. Coxa the largest segment, those of meso- and metathoracic legs larger; trochanter narrow and elongate; femur large, flattened antero-posteriorly, with longitudinal rows of swimming hairs on dorsal and ventral margins; tibia shorter and narrower than femur, not flattened, with longitudinal rows of swimming hairs on dorsal and ventral margins; tarsus one-segmented, ca. 0.3–0.4X the length of tibia, bearing rows of swimming hairs; anterior claw longer in pro- and mesothoracic legs, shorter in metathoracic leg.

Abdomen: Ten-segmented, wider anteriorly, tapering towards posterior end; first segment the shortest, ca. 0.5X the length of second segment. Lateral abdominal filaments (gills) present on anterior seven segments, segments eight and nine lacking filaments, segment ten small, bearing a long terminal filament ca. as long as length of abdomen. Lateral filaments five-segmented, tapering, basal segment shortest. Spiracles: Present on mesothorax, ventrally just in front of procoxa, and in first eight abdominal segments, laterally, anterior to lateral filaments on first seven abdominal segments.

Notes on adults of *Ilyobius chilensis* (McLachlan)

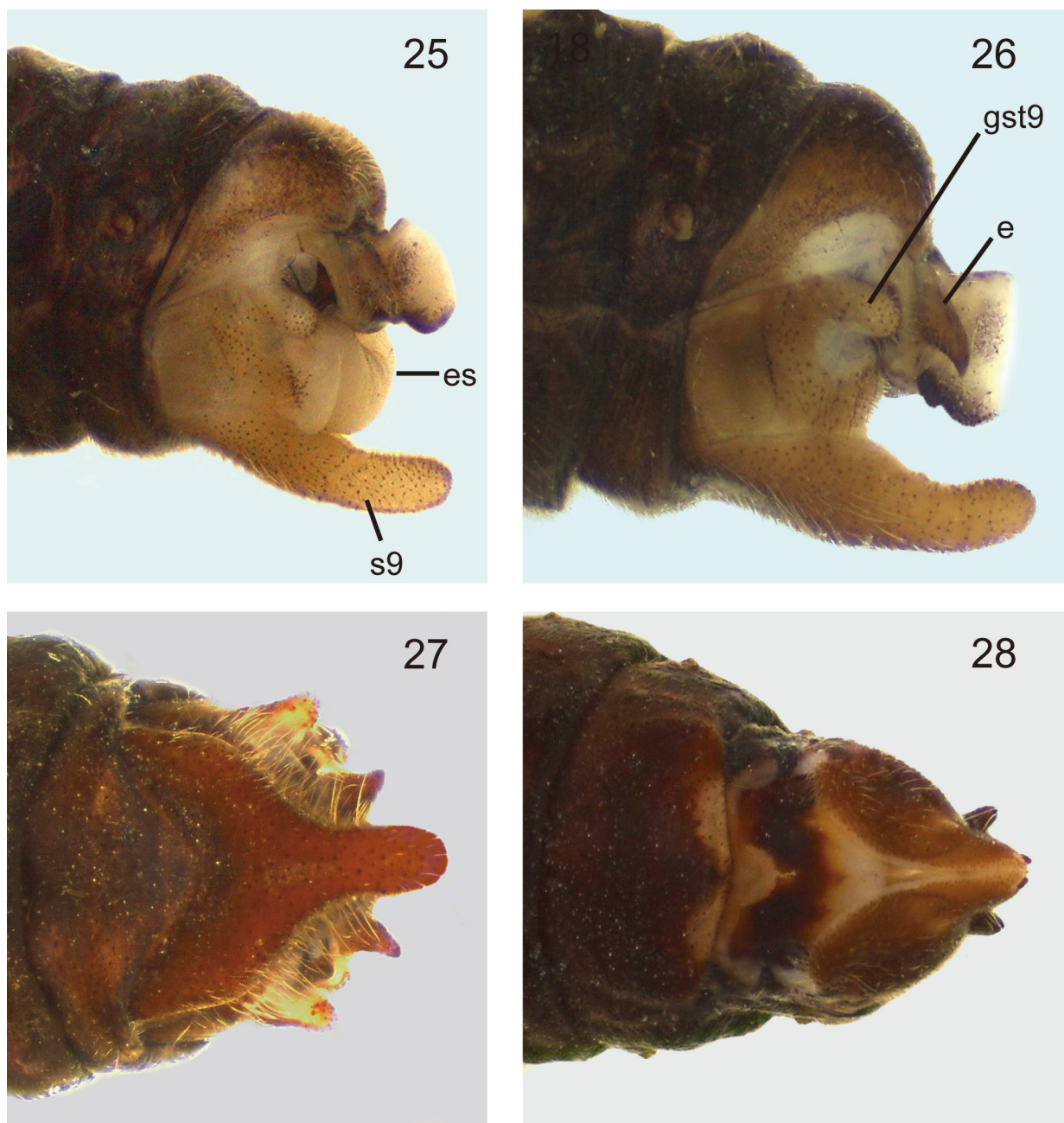
Adult illustrations in Flint (1973) are more schematic and those of Contreras-Ramos (2008) are based on dry specimens, with genitalia and eversible sac retracted. Here, we include images of the genitalia with the eversible sac protruded (Fig. 25) and retracted (Fig. 26). We also include a ventral view of male and female apex of abdomen (Figs. 27 and 28). The coloration pattern of head follows that described by Flint (1973) and Contreras-Ramos (2008), but in a few specimens it is less extensive. The description of Contreras-Ramos (2008) is adequate but in fresh specimens an ovoid, membranous, well developed lobe is observed between ectoprocts (Figs. 25 and 26).

Bionomical notes

The species is widespread and abundant in western Chubut Province. Larvae and adults are common in small rivers and montane creeks with muddy bottoms (e.g. “canales de Doña Rosa” and Nant y Fall Creek), or in the slower section of larger rivers (e.g. Río Grande, Río Rivadavia).

Larvae were collected from two microhabitats, at the margins of streams burrowing among instream vegetation or occurring in leaf packs at the bottom of small creeks. Larvae of different instars were collected throughout the year, suggesting a semivoltine life cycle. Larvae prey on small dipteran larvae and culicomorph head capsules (Fig. 15) have been recovered from the gut contents (the digestive tract has a well-developed proventriculus bearing several sharp teeth, (Fig. 16)). Larvae probably prey on other small aquatic arthropods. This information is in agreement with other studies of sialid larvae. *Sialis cornuta* Ross, 1937 has a two-year life cycle (Pritchard & Leischner, 1973) and their larvae feed mainly on chironomids, tubicid worms, and ostracods. Two other western Nearctic species, *S. californica* Banks, 1920 and *S. rotunda* Banks, 1920 either are univoltine or semivoltine (Azam & Anderson 1969). The life cycle of a Palearctic species, *S. lutaria* (Linnaeus, 1758) has been reported to have a three-year life cycle, and this species also feeds on small crustaceans, chironomids, and oligochaetes. We were unable to establish the total number of larval instars because of a lack of a suitable sample size and no first instars were collected.

Adults were observed flying between 9:00 am and 3:00 pm. Several adults were observed resting on apices of reeds (Cyperaceae), facing down with head and thorax touching the stem and the abdomen at an angle. Adults were active from November to January, with one adult recorded in March (Poncho Moro Stream).



FIGURES 25–28. adult of *Ilyobius chilensis*. 25) Male genitalia, lateral view; 26) male genitalia, lateral view; 27) male genitalia, ventral view; 28) female genitalia, ventral view. e: ectoprocts, es: eversible sac, gst9: gonostylus 9, s9: sternum 9.

Discussion

Alderfly larvae are poorly known. Of the eight extant genera of alderflies, only two are known from the Neotropical region: *Ilyobius*, widespread in the Neotropics, and *Protosialis*, with a single species in Cuba and two others distributed in the Nearctic Region. Larvae of *Protosialis* have not been described but Bowles & Sites (2015) illustrate the mandible; those of *Ilyobius* are only known from habitus illustrations or images (Flint 1973; Azevêdo 2009; Clavier *et al.* 2010). Other genera for which larvae have been described are *Indosialis* Lestage (Bowles & Contreras-Ramos 2016) from the Oriental region; *Leptosialis* Esben-Petersen (Crass 1949; Price *et al.* 2012) from South Africa and *Sialis* (Leischner & Pritchard 1973; Elliot *et al.* 1979; Jung & Bae 2012; Jung *et al.* 2016). Considering that only half of the extant genera larvae are known and that all known sialid larvae are similar morphologically, it is problematic to find diagnostic larval characters for generic characterizations. Nevertheless,

we present a comparative listing of characters that we consider useful to differentiate known larvae at the generic level (Table 1). Larvae of *Protosialis*, not included in the table, can be easily separated from all other known sialid larvae because their mandibles have three distinctive preapical teeth (Bowles & Sites 2015), larvae of the other known sialid genera bear two preapical teeth.

We can provide a more detailed comparison between larvae of *Ilyobius* and *Sialis* since we had access to larval material of an unidentified Nearctic *Sialis* species. We found several morphological and morphometrical differences in the head capsule and the head appendages. The most evident difference is the length of the median projection of the labrum, long in *Ilyobius* (Fig. 6, ratio width/length= 1.22) and short in *Sialis* (Fig. 17, ratio width/length= 1.52). The length of the apical stout setae on the labrum are also different, *Sialis* has both setae of the same length (Fig. 18) while *Ilyobius* has one pair short and the other longer (Fig. 7). In the antennae the first antennomere is shorter in *Sialis* (Fig. 19, as long as wide) while it is longer than wide in *Ilyobius* (Fig. 8); the second antennomere is distinctly longer than the third and fourth in *Ilyobius* while it is not distinctly longer in *Sialis*. In the maxilla of *Ilyobius* the second palpomere is slightly longer than the third and fourth palpomeres combined (Figs. 11, 13), while in *Sialis* the second palpomere is distinctly longer (Figs. 22, 24). The structure of the labium is also useful, in *Sialis* the prementum is much wider than the length of the prementum and ligula combined (Fig. 23); in *Ilyobius* the prementum is slightly wider than the length of the prementum and ligula combined (Fig. 14). The mandibles are similar, the only difference we could find is in the size of both inner retinacula; larger in *Sialis* (Figs. 20, 21) than in *Ilyobius* (Figs. 9, 10). Finally, the maculation on the head capsule and the pronotum is strongly defined in *Ilyobius*, in our specimens of *Sialis* these maculations are less defined, but they are more strongly defined in Palearctic species (Elliott *et al.* 1979).

This paper adds to the knowledge of sialid larvae. However, larvae of four of the genera are still unknown. Despite that all known sialid larvae are relatively similar morphologically; we did find several morphometric characters useful to distinguish known genera. More detailed descriptions of other sialid larvae will surely provide additional characters to diagnose larvae at generic and specific levels.

TABLE 1. Comparative table of morphological characters among known Sialidae larvae.

| Structure | <i>Ilyobius</i> | <i>Sialis</i> | <i>Indosialis</i> | <i>Leptosialis</i> |
|---|---|---|---|---|
| Labrum | Sharply pointed | Sharply pointed | Not strongly pointed | Sharply pointed |
| Antenna | A2 distinctly longer than A3 or A4 | A2 not distinctly longer than A3 | As <i>Ilyobius</i> | As <i>Ilyobius</i> |
| Maxillary palp | M2 slightly longer than M3+M4 | M2 much longer than M3+M4 | ? | ? |
| Preapical teeth | Basal one more than half the size of distal one | Basal one more than half the size of distal one | Basal one less than half the size of distal one | Basal one less than half the size of distal one |
| Circular ridge | Long, almost reaching coronal line | Longer, almost reaching coronal line | Short, ending far from coronal line | Short, ending far from coronal line |
| Maculation on head capsule and pronotum | Strongly defined | Variable, strongly to poorly defined | Poorly defined | Variable, strongly to poorly defined |

Acknowledgements

Atilano Contreras-Ramos and Boris Kondratieff are acknowledged for their useful comments on the original manuscript. We also thank David Bowles for providing information on the morphology of the larval mandible of *Protosialis*. We acknowledge financial support from CONICET through two grants: PIP 5733 and PIP 112-200801-01907. This paper is contribution number 130 from LIESA.

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