

**DESCRIPTION OF THE LARVA OF PHYLLOPETALIA
APOLLO SELYS AND REDESCRIPTION OF THAT OF
HYPOPETALIA PESTILENS MCLACHLAN
(ANISOPTERA: AUSTROPETALIIDAE)**

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The *P. apollo* larva is described for the first time and the larva of *H. pestilens* is re-described. These are the first records of these spp. for Argentina and for the eastern slope of the Andes. In order to determine the larval instars, length of inner wing pads was plotted against head width and a linear regression was estimated for both spp. 6 instars were identified for *H. pestilens* and 8 for *P. apollo*.

INTRODUCTION

The genus *Phyllopetalia* Selys, 1858 is currently composed of six known species (VON ELLENRIEDER, 2005) from the Subantarctic subregion. Only one of them (*P. pudu* Dunkle, 1985) was recorded from southern Argentina (Muzón & Debandi, 1992; Muzón, 1997; VON ELLENRIEDER, 2005; VON ELLENRIEDER & MUZÓN, 2008), while all six species are found in southern Chile. Knowledge of the larval stages for this genus is poor; only the larva of *P. stictica* Hagen *in* Selys, 1858 has been described to date (by supposition by SCHMIDT, 1941).

Hypopetalia McLachlan, 1870 includes only the species *H. pestilens* McLachlan, 1870, and was previously known only from the Subantarctic subregion of Chile (SCHMIDT, 1941; CARLE, 1996). Its larva was properly described by SCHMIDT (1941), who provided characters to separate it from *Phyllopetalia stictica*. Due to the fact that Schmidt's work lacks some morphological information and new information for *Phyllopetalia* is added here, we consider that it is worthwhile to provide its redescription.

MATERIAL AND METHODS

In order to determine the larval instars, head width (HW), labrum width, labium length and width, and length of inner wing pads (IWP) and external wing pads (EWP) were measured for each specimen of both species. Body measurements were estimated to the nearest 0.05 mm under a Zeiss binocular stereomicroscope equipped with an ocular micrometer.

Drawings were created with the aid of a camera lucida coupled to a Zeiss binocular stereomicroscope and to a Leika DMLB microscope. All specimens are deposited in the "Laboratorio de Investigaciones en Ecología y Sistemática Animal" (LIESA) collection.

Inner wing pads length (IWP) was plotted against head maximum width (HW) (RODRIGUES CAPÍTULO, 1983, 2000; PICKUP *et al.*, 1984) and a linear regression was estimated for both species to obtain the relationship between both variables. Other measurements (labrum width, labium length, labium width and external wing pads) were not used to separate larval instars because they presented a high overlap. The plot helped to visualize the size range for each larval instar, allowing the assignment of each specimen to a particular instar with reasonable accuracy.

HYPOPETALIA PESTILENS McLACHLAN

Figures 1-2

Material. — 5 larvae, Argentina: Chubut province, unnamed stream, 500 m before Epuyen Lake, access road to Puerto Patriada, 42°08'17"S, 71°31'56"W, 3-V-2005, Brand leg.; — 2 larvae, same data but, 5-XII-2005, Archangelsky leg.; — 1 larva, same data but 1-II-2006; — 4 larvae, same data but 20-III-2006; — 8 larvae, same data but 7-III-2007; — 6 larvae, same data but 3-X-2007; — 6 larvae, same data but 17-XI-2007, Pessacq leg.; — 1 larva, same data but 21-XII-2007; — 1 adult, same data but 18-XI to 17-XII-2007, Malaise trap; — 1 larva, Río Negro prov., Golondrinas stream, 41°59'33"S, 71°33'25"W, 3-V-2005, Brand leg.

REDESCRIPTION OF THE LAST INSTAR LARVA. — *Head* (Fig. 1a). — Brown, dorsally covered with scale-like setae; trapezoidal in shape, its anterior side wider; postero-lateral margins straight to slightly concave; posterior margin of cephalic lobes angulated or rounded, with short thick spine-like setae; posterior margin concave; a small triangular lobe below the eyes, usually visible in dorsal view; inner-ventral margins of cephalic capsule forming a narrow and ventrally directed process of moderate development at both sides of prementum. Ocelli brown. Antennae short, flagella with three annuli, proportions about 2.2:1:1.8. Anteclypeus bare, postclypeus covered with scale-like setae, except for two bare elongated areas on each side, anterior margin slightly convex. Labrum dorsally covered with scale-like setae, except for a small bare central area, anterior margin with a fringe of very short and thick setae, ventrally with a sub-apical fringe of long thin setae pointing posteriorly. Formula of mandibles (Figs 1b, 1c) as follows (*sensu* WATSON, 1956): L 1234 y a (m^{123456}) b, R 1234 y a (m^{123567}) b, the auxiliary tooth on left mandible (y) seen as sharply pointed in Figure 1c is blunt in some specimens. Maxillae with a simple galea, its outer margin covered with long thin setae; lacinia with a row of three dorsal teeth equal in size and a row of four ventral teeth, the apical one the strongest, the subapical one the weakest. Prementum (Fig. 1d) rectangular, about 1.48 times longer than wide with sides

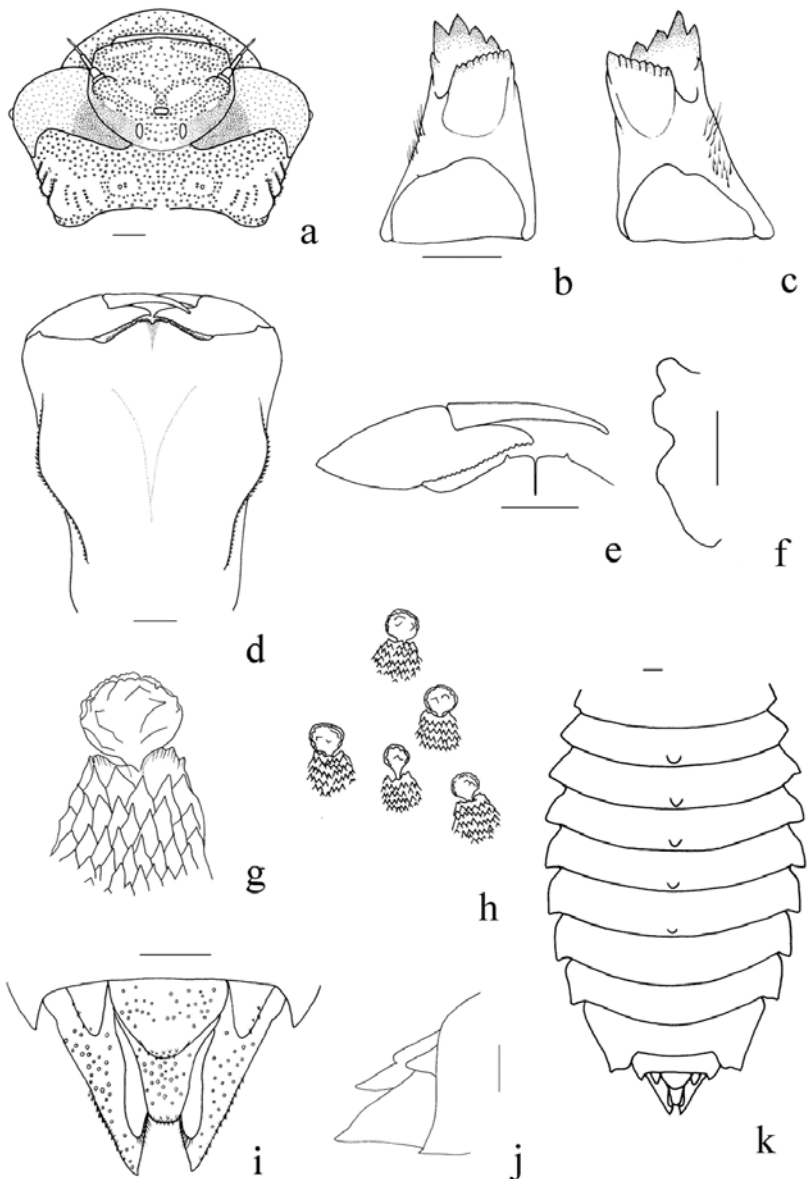


Fig. 1. *Hypopetalia pestilens* last instar larva (scale bars: 1 mm): (a) head, dorsal view; – (b) right mandible, inner view; – (c) left mandible, inner view; – (d) prementum, dorsal view; – (e) labial palp, dorsal view; – (f) ventro-lateral projection of prothorax; – (g) detail of abdominal scale-like setae; – (h) abdominal scale-like setae; – (i) terminalia, dorsal view; – (j) terminalia, lateral view; – (k) abdomen, dorsal view.

slightly convergent basally, reaching the base of coxa II, dorsal surface bare except for two lateral rows of scale-like setae; ligula markedly convex, with a dense fringe of short setae along margin, and a very narrow but deep medial cleft with one small knob on each side at some distance from it. Labial palp (Fig. 1e) short, inner margin with a row of short blunt teeth, end hook slightly larger than teeth or not differentiated, movable hook about 1.25 times as long as palp outer margin.

T h o r a x. — Brown, dorsally covered with scale-like setae. Pronotum rectangular, with two bare lateral areas. Sides with a ventro-lateral projection (Fig. 1f), divided into two lobes by a medial deep excavation, anterior lobe further divided into two less marked lobes. External wing pads slightly divergent, internal ones parallel, reaching mid-length of fourth abdominal segment. Legs short and thick, covered with short, thick curved setae; femur with variable development of dorsal knobs, usually with a larger basal one (more developed in hind leg) and from none to three smaller distal ones.

A b d o m e n (Fig. 1k). — Brown, elongated, and tapering caudally, covered with scale-like setae (Figs 1g, 1h), except for two oval bare areas close to lateral margins of each segment. Segments 2-6 two to six with a dorsal tubercle on middle line, the ones on segments five and six sometimes reduced. Each segment with postero-lateral projections of rounded to smoothly angulated apex, those on segment I-III directed externally, remaining directed posteriorly. Cerci short, paraprocots long and acute, triangular in section and with an inner concavity; epiproct

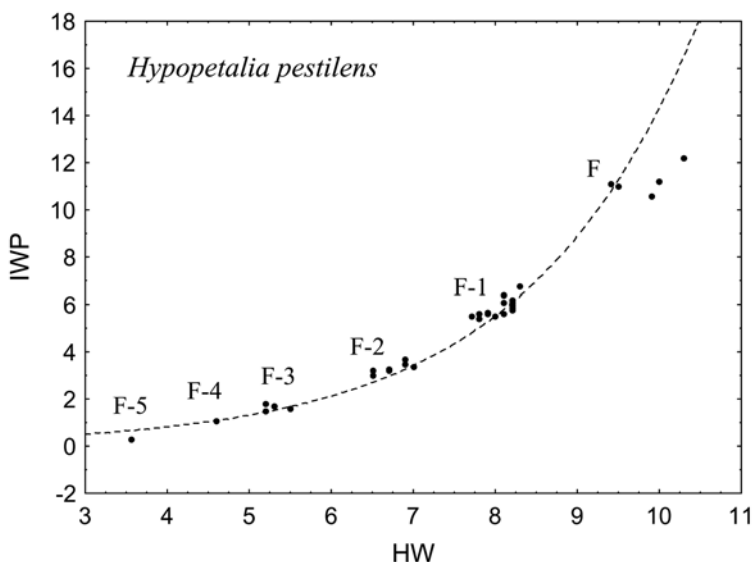


Fig. 2. *Hypopetalia pestilens*. Scatterplot between head maximum width (HW) and internal wing pads maximum length (IWP). Six larval instars (F to F-5) identified.

composed of a short, rounded dorsal lobe and a long ventral lobe, the ventral side of the latter concave (Figs 1i, 1j). The scale-like structures (Figs. 1g and 1h) mentioned through the redescription cover most body surface; they are smaller on ventral side and are directed posteriorly on entire body except on head, where they are directed anteriorly. They are composed of a basal and an apical part; the former is covered with small scale-shaped spines, while the apical part is rounded and has irregular margins (Fig. 1g). A ring of dark brown pigment is seen below these structures.

M e a s u r e m e n t s (mm, n = 5). Head max. width 10.14 ± 0.34 . Antennal annuli: I: 0.62 ± 0.02 , 2: 0.28 ± 0.02 , 3: 0.5 ± 0.03 . Prementum length 6 ± 0.35 , max. width 5.6 ± 0.37 ; labial palp inner margin length 1.675 ± 0.04 , movable hook 2.06 ± 0.04 . Femur I: 5.46 ± 0.08 , II: 6.28 ± 0.1 , III: 7.06 ± 0.12 . Internal wing pads 11.58 ± 0.69 , external wing pads 10.1 ± 0.48 . Cerci 0.79 ± 0.04 . Epiproct 2.01 ± 0.15 . Paraprocts 2.84 ± 0.18 . Terminalia max. width/max. length 1.14 ± 0.09 .

VARIATIONS IN EARLIER INSTAR LARVAE. — From the plotting of inner wing pads (IWP) length against head width (HW), six groups of larval sizes were delimited and assigned to instars F to F - 5 (Fig. 2). The relationship between IWP and HW from the linear regression, fitted best to the following formula: $IWP = 0.00665 - HW^{3.25}$, $\ln IWP = -5.013 + 3.25 - \ln HW$, (n = 33; $r^2 = 0.98$).

Earlier larvae resemble final instar in most morphological aspects except the following: instar **F-1**: lobes below the eyes are present but not visible dorsally in a few specimens; auxiliary tooth 'y' on left mandible poorly developed in some specimens; dorsal tubercles present on abdominal segments three and four, usually reduced on segments two and five, absent on six; superior lobe of epiproct usually reduced; basal knob present in hind femur, variable in middle and fore femora; terminalia max. width/max. length 1.21 ± 0.14 (n = 15). Instar **F-2**: lobes below the eyes not visible dorsally but present; auxiliary tooth 'y' on left mandible poorly developed in some specimens; dorsal tubercles on abdominal segment three and four present but poorly developed, usually absent on segments two and five; superior lobe of epiproct reduced; basal knob present in hind femur, variable in middle and fore femora; terminalia max. width/max. length 1.29 ± 0.13 (n = 7).

F-3: lobes below the eyes not visible dorsally and poorly developed; auxiliary tooth 'y' on left mandible poorly developed; dorsal tubercles only on abdominal segments three and four, poorly developed and usually absent; superior lobe of epiproct reduced or absent; basal knob present in hind femur, variable in middle and fore femora; terminalia max. width/max. length 1.35 ± 0.14 (n = 4). **F-4**: lobes below the eyes absent; dorsal tuber-

Table I
Hypopetalia pestilens larvae, measurements (in mm) of head maximum width and inner wing pads maximum length for every identified larval instar

Instar	Head max. width		Inner wing pads	
	mean	s. d.	mean	s. d.
F (n = 5)	9.82	0.37	11.22	0.59
F-1 (n = 15)	8.05	0.18	5.88	0.39
F-2 (n = 7)	6.74	0.20	3.33	0.23
F-3 (n = 4)	5.30	0.14	1.65	0.13
F-4 (n = 1)	4.60	0.00	1.10	0.00
F-5 (n = 1)	3.55	0.00	0.30	0.00

cles absent; auxiliary tooth 'y' on left mandible poorly developed; superior lobe of epiproct absent; basal knob present in hind femur, variable in middle and fore femora; terminalia max. width/max. length 1.39. **F-5:** Same as previous but terminalia max. width/max. length 1.44. For measurements of instars see Table I.

PHYLLOPETALIA APOLLO SELYS

Figures 3-4

M a t e r i a l. — 3 larvae, Argentina: Chubut prov., unnamed stream, 500 m before Epuen Lake, access road to Puerto Patriada, 42°08'17"S, 71°31'56"W, 3-V-2005, Brand leg.; — 3 larvae, same data but 7-III-2007, Pessacq leg.; 5 larvae, same data but 21-III-2007; 4 larvae, same data but 29-X-2007; — 10 larvae, same data but 17-XI-2007; — 2 larvae, same data but 21-XII-2007; — 5 larvae, same data but 3-I-2008; — 4 larvae, same data but 29-I-2008; — 1 larva, same data but 1-III-2008; — 6 , same data but 20-X to 18-XI-2008, Malaise trap; — 18 adult , 2 adult , same data but 18-XI to 17-XII-2008. — 1 larva, Río Negro prov., Golondrinas stream, 41°59'33"S, 71°33'25"W, 3-V-2005, Brand leg.

LAST INSTAR LARVA DESCRIPTION. — **H e a d** (Fig. 3a): brown, dorsally covered with scale-like setae; trapezoidal in shape, its anterior side wider; postero-lateral margins slightly concave to concave; posterior margin of cephalic lobes rounded, with short thick spine-like setae; posterior margin concave; inner-ventral margins of cephalic capsule forming a narrow and ventrally directed process at both sides of prementum. Ocelli light brown. Antennae short, flagella with three annuli, proportions about 3.9:1:1.2. Anteclypeus bare, postclypeus covered with scale-like setae, except for two bare oval areas on each side; anterior margin with two medial knobs, lateral angles projected anteriorly. Labrum dorsally covered with scale-like setae, except for a heart-shaped bare central area ; anterior margin with a dense fringe of pale, short, and thick setae and long hair-like setae on its sides; ventrally with a sub-apical fringe of long thin setae pointing posteriorly. Formula of mandibles (Figs 3b, 3c) (sensu WATSON, 1956): L 1234 0 a (m^{123456}) b, R 1234 y a (m^{123456}) b. Maxillae with a simple galea, its outer margin covered with long thin setae; lacinia with a row of three dorsal teeth equal in size and a row of four ventral teeth, the apical the strongest, the subapical the weakest. Prementum (Fig. 3d) rectangular, about 1.48 times as long as wide, sides slightly convergent basally; reaching the base of coxa II; dorsal surface bare except for two lateral rows of scale-like setae; ligula convex, with a fringe of short setae along margin and a very narrow but deep medial cleft with one small knob on each side beside it; the knobs are partially covered by the setae in dorsal view, but are clearly visible in ventral view. Labial palp (Fig. 3e) short, inner margin with a row of short blunt teeth, end hook not differentiated, movable hook about 1.2 times as long as palp outer margin.

T h o r a x. — Brown, dorsally covered with scale-like setae. Pronotum with two bare lateral areas; trapezoidal in shape, its anterior side wider. Sides with a

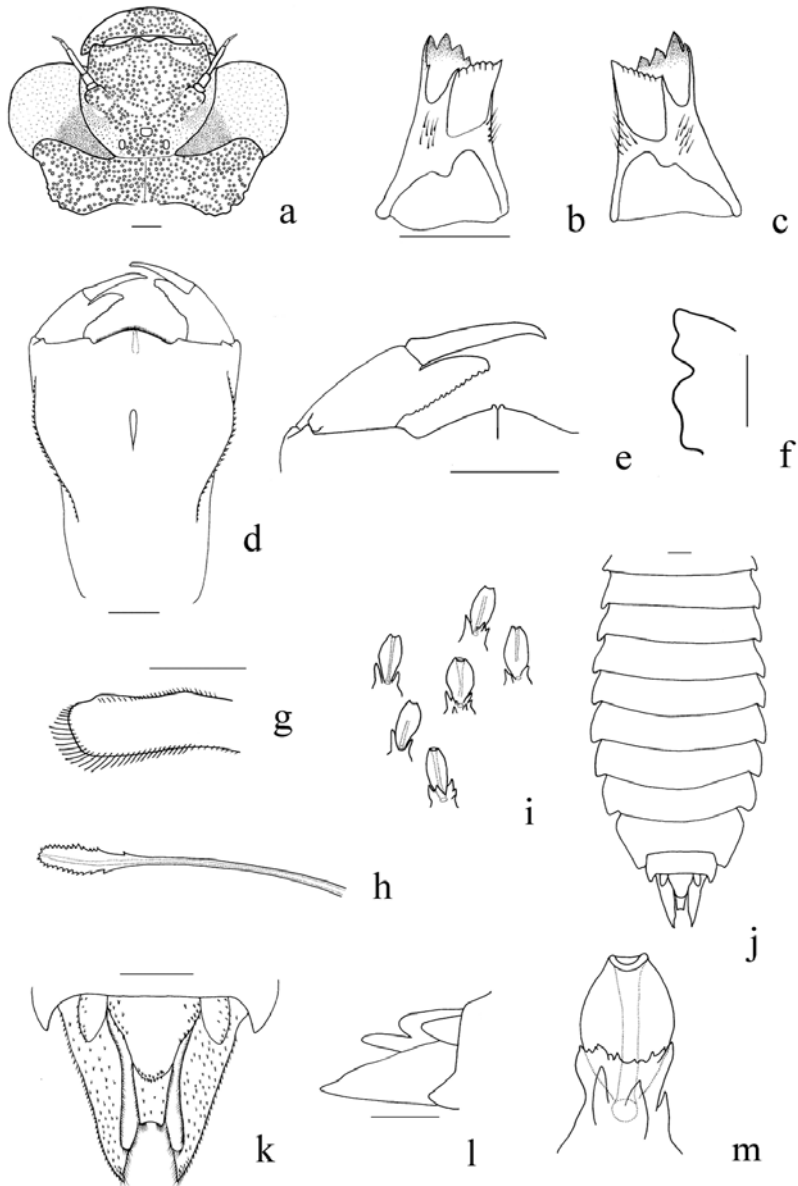


Fig. 3. *Phyllopetalia apollo* last instar larva (scale bars: 1 mm): (a) head, dorsal view; – (b) right mandible, inner view; – (c) left mandible, inner view; – (d) prementum, dorsal view; – (e) labial palp, dorsal view; – (f) ventro-lateral projection of prothorax; – (g) apex of fore tibia; – (h) setae of tibial apex; – (i) abdominal scale-like setae; – (j) abdomen, dorsal view; – (k) terminalia, dorsal view; – (l) terminalia, lateral view; – (m) detail of abdominal scale-like setae.

ventro-lateral projection (Fig. 3f), divided in two lobes by a medial deep excavation, each lobe further divided in two less marked lobes. Wing pads parallel, reaching mid-length of fourth abdominal segment. Legs short and thick covered with short and thick curved setae; femur with three dorsal knobs, one basal, one medial, and one distal; distal portion of tibiae (Fig. 3g) with a ventral dense concentration of long setae with serrated apex (Fig. 3h).

A b d o m e n (Fig. 3j). – Brown, elongated and tapering caudally, dorsally covered with scale-like setae except for two oval bare areas close to the segments lateral margins. Each segment with postero-lateral projections with rounded apex, sometimes with a small spine on their tips and directed posteriorly; those on segment X with sharp apex. Posterior margin of segments with tufts of hair-like setae. Cerci short and rounded, paraprocts long and acute; epiproct composed of a short, rounded dorsal lobe and a long ventral lobe, the ventral side of the latter concave (Figs 3k, 3l).

The scale-like setae structures (Figs 3i, 3m) mentioned above cover most body surface; they are smaller on ventral side and are directed posteriorly on entire body except on head, where they are directed anteriorly. They are composed of a basal and an apical part (Fig. 3m); the former possesses a few blunt spines, while the apical part is oval in shape and has an apical mouth and an inner channel as seen under the microscope. A ring of dark brown pigment is seen below these structures.

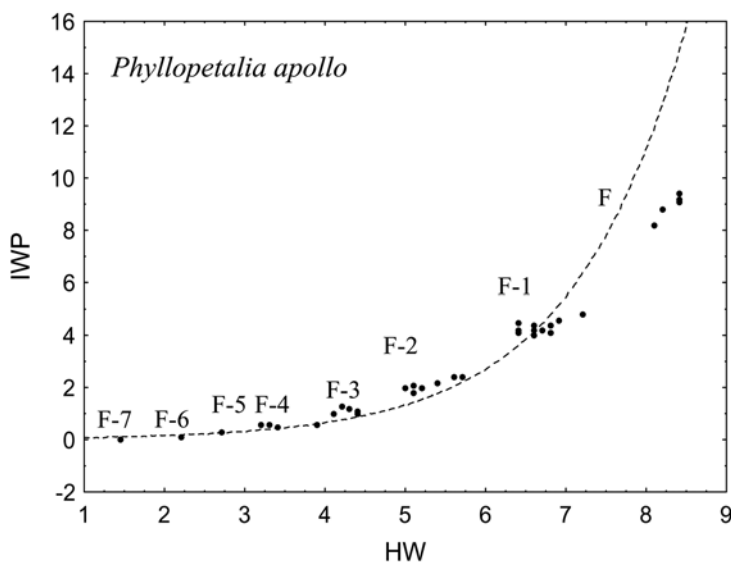


Fig. 4. *Phyllopetalia apollo*. Scatterplot between head maximum width (HW) and internal wing pads maximum length (IWP). Eight larval instars (F to F-7) identified.

M e a s u r e m e n t s (mm, n = 5). Head max. width 8.3 ± 0.14 . Antennal anuli: 1: 0.89 ± 0.11 ; 2: 0.23 ± 0.06 ; 3: 0.27 ± 0.03 . Prementum length 6 ± 0.13 , max. width 4.06 ± 0.13 ; labial palp inner margin length 1.09 ± 0.05 , movable hook 1.32 ± 0.11 . Femur I: 3.88 ± 0.24 , II: 4.48 ± 0.22 , III: 5.36 ± 0.22 . Internal wing pads 8.94 ± 0.47 , external wing pads 8.04 ± 0.26 . Cerci 0.54 ± 0.05 . Epiproct 1.73 ± 0.14 . Paraprocts 2.38 ± 0.13 . Terminalia max. width/max. length 1.16 ± 0.05 .

From the plotting of inner wing pads (IWP) length against head width (HW) eight groups of larval sizes were delimited and assigned

to instars F to F-7 for *Phyllopetalia apollo* (Fig. 4). The relationship between IWP and HW from the linear regression, fitted best to the following formula: $IWP = 0.0068 - HW^{3.42}$, $\ln IWP = -4.98 + 3.42 - \ln HW$, (n = 40; $r^2 = 0.97$).

Earlier instar larvae resemble final instar in all morphological aspects, the only significant difference being that the abdominal postero-lateral projections possess an acute apex in F-6 and F-7, and that superior lobe of epiproct is reduced or absent in F-1 to F-4 and absent earlier instars. For measurements of instars see Table II.

PHYLLOPETALIA PUDU (?) DUNKLE

M a t e r i a l. – 1 larva, Argentina: Chubut prov., unnamed stream at Pucon Pai camping, Provincial Route 71, Los Alceres National Park, $42^{\circ}29'44''S$, $71^{\circ}23'21''W$, 29-III-2007, Pessacq leg.

Only one intermediate stadium larva of another *Phyllopetalia* species was collected within the national Park Los Alceres. This larva may belong to *P. pudu*, the only species recorded from the area (MUZÓN & DEBANDI, 1992; MUZÓN, 1997; VON ELLENRIEDER, 2005). Even when the site of collection was visited in many occasions, no further larvae or adults were found. Given that the specimen collected is an intermediate instar and that the specific identity is not certain, it does not seem appropriate to include a full description. New species records for Argentina are possible, and there are records of other species in very close areas from Chile (VON ELLENRIEDER, 2005). Nevertheless, this specimen may add useful information regarding which characters can be of specific or generic diagnostic value for *Phyllopetalia* and *Hypopetalia* (see Tab. I).

Table II

Phyllopetalia apollo larvae, measurements (in mm) of head maximum width and inner wing pads maximum length for every identified larval instar

Instar	Head max. width		Inner wing pads	
	mean	s. d.	mean	s. d.
F (n= 5)	8.30	0.14	8.94	0.47
F-1 (n= 13)	6.62	0.16	4.27	0.18
F-2 (n= 10)	5.35	0.24	2.17	0.20
F-3 (n= 5)	4.28	0.13	1.12	0.13
F-4 (n= 3)	3.30	0.10	0.57	0.06
F-5 (n= 1)	2.7	0	0.3	0
F-6 (n= 1)	2.3	0	0.1	0
F-7 (n= 1)	1.45	0	0	0

DISCUSSION

All collected specimens were found in small streams (1-2 m wide), and the stream that provided most larvae (unnamed stream in Epuyén lake) flows through a pine tree plantation (*Pinus contorta*), with patches of native vegetation (*Notophagus dombeyi*, *Fuxia* sp., *Chusquea* sp., *Austrocedrus chilensis*) on its margin. CARLE (1996) mentions a semiterrestrial habitat for *Phyllopetalia*, but all larvae studied were collected in the water, mainly in crevices of small falls or clinging under logs. Nevertheless, in a set of samples taken on May 2008 to conduct a study on habitat selection, no *P. apollo* specimens were found, neither in the stream nor in the surrounding ground.

The only collected exuviae of *P. apollo* was found on the top of a pine tree cut at a height of about 2 m. No adults were observed in the field, but based on the Malaise trap data, it can be assumed that the flying season for *P. apollo* extends from mid-October to December. From the 26 specimens obtained, 20 were collected between 18 November and 17 December. The Malaise trap was in the field from beginning of October to April. Even when *P. apollo* larvae were about as abundant as those of *Hypopetalia pestilens*, only one adult specimen of the latter was collected (18 Nov.-17 Dec.); this can be explained by the larger size of the adults which prevents them from entering through the opening of the collecting jar of the Malaise trap.

As it was described above, *H. pestilens* earlier instar larvae show some morphological differences with final instar larva, mainly regarding development of lobes below the eyes, of abdominal dorsal tubercles, of superior lobe of epiproct, and proportions of terminalia. On the other hand, *Phyllopetalia apollo* shows little differences between larval instars, the most noticeable being the acute apex of abdominal postero-lateral projections in F-6 and F--7.

In the field, *P. apollo* and *H. pestilens* larvae are clearly distinguished by the larger size of the former, head shape, and labrum size.

In his key, SCHMIDT (1941) distinguished *Hypopetalia pestilens* and *Phyllopetalia stictica*(?) by the characters indicated in Table 3III and by size (*Hypopetalia* being larger), labrum width (wider in *Hypopetalia*), prementum length (longer in *Hypopetalia*), ligula shape (slightly pointed in *Phyllopetalia*), and head shape (strongly angulated in *Hypopetalia*). We have found that some of the characters used by SCHMIDT (1941) are variable within *H. pestilens* or are shared with *P. apollo*. Based on the present information, *Hypopetalia* and *Phyllopetalia* can be separated by distance of mentum knobs from mid-line, presence of postclypeal knobs, labrum width, mandibular formula, distal tibial setae, structure of basal segment of scale-like setae, and presence of tufts of hair-like setae on posterior margin of abdominal segments (Tab. III3).

A generic characterization of the larva of *Phyllopetalia*, subject to the description of the remaining species of the genus, can be as follows: body surface cov-

ered with scale-like setae composed of a basal and an apical part; labrum not reaching or barely surpassing inner margin of eyes (labrum width less than 60% of head maximum width, usually less than 50%); ligula with a deep and very narrow cleft and one knob on each side of it; left mandible lacking an accessory tooth 'y'; postclypeus with two medial knobs on its anterior margin; a dense concentration of setae on apex of tibia I; abdomen with postero-lateral projections with apex rounded or acute; posterior margin of abdominal segments with tufts of hair-like setae.

Hypopetalia can be characterized by: body surface covered with scale-like setae composed of a basal and an apical part, the former completely covered with scale-like spines; labrum clearly surpassing inner margin of eyes (labrum width more than 65% head maximum width); ligula with a deep and very narrow cleft and one small knob on each side at a certain distance from it; left mandible with a sharp or blunt accessory tooth 'y'; postclypeus anterior margin slightly convex.

Table III

Diagnostic characters for larvae of *Hypopetalia pestilens*, *Phyllopetalia apollo*, *P. stictica*(?) and *P. pudu*? (final instar, except for *P. pudu*?). For further details on characters see text. * indicates characters used by SCHMIDT (1941) to separate *Phyllopetalia* from *Hypopetalia*

Characters	<i>P. apollo</i>	<i>P. stictica</i> (?)	<i>P. pudu</i> (?)	<i>H. pestilens</i>
Antennal annuli ratio	3,9:1:1,2	?	3:1,25:1	2,2:1:1,8
Mentum knobs	2 at both sides of mid-line	2 at both sides of mid-line	3 at both sides of mid-line	2 at certain distance from mid-line
Clypeal knobs	Present	Present	Present	Absent
Lobes below the eyes	Absent	Present	Present, visible in dorsal view	Present, usually visible in dorsal view
Narrow process at prementum sides	Developed	Strongly developed	Strongly developed	Poorly developed
Auxiliary tooth 'y' on left mandible	Absent	?	Rudimentary	Present
Concentration of tibial setae	Present	?	Present	Absent
Shape of distal segment of scale like setae *	Oval	Hair like, short.	Hair like, long.	Rounded
Basal segment of scale like setae	Bare	Bare	Bare	Covered with scale-like spines
Shape of abdominal processes *	Rounded	Angulated	Angulated	Rounded to slightly angulated
Lateral abdominal processes on segments 1-3 *	Directed posteriorly	Directed posteriorly	Directed posteriorly	Directed externally
Dorsal abdominal tubercles *	Absent	Absent	Absent	Present
Hair tufts on abdominal segment posterior margin *	Present	Present	Present	Absent
Femur knobs *	3	3	3	Variable
Terminalia max with/ max length *	≈1,16	< 1?	1.09	≈1,14

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