International Journal of Odonatology 3 (1): 1-10, 2000
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THE LARVA OF *LEUCORRHINIA PATRICIA* WALKER (ODONATA: LIBELLULIDAE)[1]

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Received 01 March 1999; revised 05 May 2000; accepted 06 May 2000.
Key words: Odonata, dragonfly, larva, *Leucorrhiniaspatricia*, *hudsonica*, taxonomy, British Columbia, habitat.

Abstract

The final-stadium larva of *Leucorrhinia patricia* Walker is described from six exuviae with associated teneral adults collected in northern British Columbia. *L. patricia* belongs to the group of nearctic *Leucorrhinia* that has larvae with three ventral stripes. The larvae are very similar to those *L. hudsonica* (Sélys) larvae that are small and lack dorsal spines. Several characters help to separate these species, at least in the western part of their range: length of the epiproct and patterns of the profemora and abdomen. The preparation of a more definitive key awaits the analysis of more material of *L. patricia* and *L. hudsonica.*

Introduction

Leucorrhinia Brittinger is a holarctic genus of small to medium-sized, dark anisopterans with white faces and, often, bright red or yellow markings. Of the seven nearctic species, adults of six have been known since at least 1890 (Walker & Corbet 1975). By 1925, the larvae of those six species were known (Walker 1916, 1927) although the description of the larva of *L. glacialis* Hagen was not published until 1975 (Walker & Corbet 1975).

The adults of the seventh species, *L. patricia* Walker, were described in the 1940s (Walker 1940, 1942). *L. patricia* is the smallest nearctic *Leucorrhinia* and has the most northerly distribution, being found only in Canada and Alaska (Walker & Corbet 1975; Cannings & Cannings 1997). The adults of *L. patricia* are very similar to those of *L. hudsonica* (Sélys), except for the former's smaller size and more restricted dorsal abdominal spots (Walker 1940, 1942).

In mid-June 1987, one of the authors (SGC) collected three exuviae with associated, and three exuviae with "probably associated", teneral adults at Blue Lakes in northern British Columbia. Adult *L. patricia* were collected at a number of locations in

[1] Dedicated to G.G.E. Scudder on the occasion of his 65th birthday, 18 March 1999.

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Yukon Territory and British Columbia (Cannings et al. 1991; Cannings & Cannings 1994); unassociated exuviae were collected at several of these places. Every site with *L. patricia* also had *L. hudsonica* although some microhabitat separation was noted (Cannings et al. 1991).

Material examined

L. patricia

Three exuviae collected with associated adults in British Columbia (BC) at Blue Lakes, km 711 Stewart-Cassiar Highway, 19 June 1987, S.G. Cannings (SGC): 2 pinned exuviae, both male (one each, Spencer Entomological Museum [SEM] and Royal B.C. Museum [RBCM]) and 1 female exuviae (abdomen and labium separate, thorax of exuvia still attached to the adult) in alcohol [RBCM]; 3 pinned exuvia with "probably associated" adults, collection data as above: 2 females and 1 male, all SEM.

L. hudsonica

One pinned exuvia collected with associated adult: BC, Blue Lakes, km 711 Stewart-Cassiar Hwy, 19 June 1987 (SGC) female [SEM]; 6 exuvia with associated adults in alcohol: BC, Daisy Lake (near Squamish), 18 May 1976 (R.A. Cannings) male [SEM]; Yukon Territory (YT), Koidern, 31 May 1979 (SGC) female [SEM]; YT, Koidern, 2.7 km SE, 31 May 1979 (SGC) female [RBCM]; YT, Koidern, 2.7 km SE, collected 09 June 1979, emerged 12-14 June 1979 (SGC) female [SEM]; BC, Tutshi R., km 48.5 Skagway Rd, 24 June 1979 (SGC) male [SEM]; YT, Engineer Cr, km 175.5 Dempster Hwy, 26 June 1987 (SGC) female [SEM]. Two pinned exuviae with "probably associated" adults: BC, Blue Lakes, collection data as above, both female [SEM].

Indeterminate specimen

One exuvia with associated adult, both in alcohol: YT, Koidern, 2.7 km SE, collected 06 June 1979, emerged 07 June 1979 (SGC) female [SEM]; adult has vulvar laminae <1/4 the marginal length of A9 separated by a U-shaped notch and hind-wing length of 20.5 mm suggesting *L. patricia* (Walker 1942); it has a pale streak on the dorsum of A7 and a total length of 29 mm (abdomen length ~20 mm) suggesting *L. hudsonica* (Walker & Corbet 1975).

Description

Measurements are for exuviae that are associated or "probably associated" with identifiable teneral adults. The ranges are given in Table 1 with mean, standard error and number of measurements. Total lengths were measured from front of labial palps (in contracted position) to end of paraprocts. Heads of most exuviae were too damaged

to provide data on head width; maximum width across the eyes could be estimated for only two specimens, see Table 1. Antennae 7-segmented, segment 7 with a dark apex, segment 6 with a dark base, remaining segments with faint light and dark banding; length of segments: 1) 0.10-0.14 (0.12±0.02, n = 6) mm, 2) 0.20-0.22 (0.21±0.01, n = 6) mm, 3) 0.30-0.40 (0.34±0.03, n = 6) mm, 4) 0.22-0.24 (0.23±0.01, n = 6) mm, 5) 0.22-0.29 (0.26±0.03, n = 6) mm, 6) 0.31-0.40 (0.35±0.03, n = 6) mm, 7) 0.32-0.37 (0.34±0.02, n = 6) mm.

Folded labium extending posteriorly to middle of mesocoxae, mean length of prementum (along ventral surface excluding hinge) 3.20 mm, mean maximum width 2.9 mm; premental setae 12 + 12, fourth from lateral margin longest (single specimen only examined) and palpal setae 9 & 9; crenations on distal margin of labial palp very shallow, depth diminishing ventrally; each crenation associated with one large seta and 0-2 distinctly smaller setae dorsal to larger one; outer surface of labial palp marked with irregularly spaced small brown spots and a short diagonal brown bar, which is somewhat expanded or bent in a ventral direction at its ventromedial end; rear of head as described for *L. hudsonica* (Walker 1914).

Colour pattern on thorax absent except for a small brown patch at dorsal end of mesopleural sulcus; profemora darker on dorsal surface and with a subapical brown band (Fig. 1a) which is often more prominent on posterior side; protibiae brown with 2 pale bands, one each in distal and proximal halves; middle and hind legs less distinctly marked, but evidently with pattern similar to that of foreleg; metafemur and metatibia lengths given in Table 1.

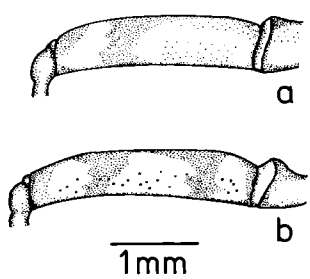

Figure 1. Pattern on the lateral surface of the profemur of final instar larvae; (a) *L. patricia* (b) *L. hudsonica.*

Abdomen widest at A6 and narrowing somewhat more rapidly posteriorly than anteriorly; without any hint of spines or mid-dorsal bumps at posterior margin on abdominal segments; A2 and A3 (in some specimens) with slightly "peaked" appearance, but these "humps" not at posterior margin of segments; typical pattern on dorsum of abdomen (Fig. 2a), with extent of dark marks somewhat variable, in some specimens extending to A7; venter of abdomen with three broad, dark longitudinal stripes similar to those found on *L. hudsonica*, *L. glacialis* and *L. borealis* Hagen, i.e. one medial and two lateral stripes extending along the length of abdomen; spines present at posterolateral corners of A8 and A9; lateral spines on A8 relatively small and varying from slightly divergent to convergent relative to mid-dorsal line; ratios of length of spines to length of lateral margins including spine for A8 are 0.20-0.27 (0.23±0.02, n = 12); lateral spines on A9 larger and with medial margins slightly to

strongly convergent; ratios of length of spine to length of the lateral margin including spine of A9 are 0.34-0.42 (0.38±0.02, n = 12); mid-dorsal lengths of A8 and A9 as in Table 1. Epiproct with usual variation with sex; lengths of epiproct, cerci and paraprocts given in Table 1.

Table 1. Values in mm of measurements on final-stadium *Leucorrhinia* larvae; mean and standard error given in parentheses.

Character	*L. patricia*	*L. hudsonica*	Indeterminate
Total length	13.5-15.3 (14.2±0.8, n = 4)	15.3-17.5(16.3±1.0, n = 6)	16.2
Head width	4.0-4.2 (4.1±0.14, n = 2)	4.5-5.0 (4.7±0.2, n = 8)	4.7
Length of metafemur	3.5-3.8 (3.7±0.08, n = 9)	3.7-4.25 (4.0±0.2, n = 16)	3.7/3.7
Length of metatibia	4.2-4.8 (4.5±0.22, n = 9)	4.35-5.5 (4.8±0.4, n = 14)	4.4/4.5
Width of prementum	2.8-3.0 (2.9±0.1, n = 6)	2.9-3.6 (3.3±0.2, n = 9)	3.2
Length of prementum	3.1-3.3 (3.2±0.07, n = 6)	3.1-3.8 (3.6±0.2, n = 9)	3.25
No. of palpal setae	9	9-10	9/9
No. of premental setae	12	12-13	12/13
Length of epiproct	1.04-1.11 (1.07±0.02, n = 6)	1.15-1.45 (1.3±0.10, n = 9)	1.17
Length of cercus	0.56-0.74 (0.66±0.07, n = 11)	0.55-0.70 (0.65±0.04, n = 18)	0.70/0.70
Length of paraproct	1.30-1.33 (1.30±0.01, n = 12)	1.30-1.70 (1.5±0.14, n = 16)	1.37/1.35
Length of lateral spine on A8	0.24-0.31 (0.28±0.02, n = 12)	0.30-0.60 (0.5±0.1, n = 18)	0.30/0.23
Length of lateral margin of A8 including spine	1.11-1.28 (1.18±0.05, n = 12)	1.30-1.74 (1.6±0.2, n = 18)	1.24/1.24
Mid-dorsal length A8	0.65-0.72 (0.70±0.03, n = 6)	0.73-0.90 (0.8±0.06, n = 9)	0.81
Length of lateral spine on A9	0.53-0.65 (0.58±0.03, n = 12)	0.62-1.13 (0.8±0.14, n = 18)	0.55/0.61
Length of lateral margin of A9 including spine	1.45-1.63 (1.55±0.05, n = 12)	1.63-2.25 (1.9±0.2, n = 17)	1.54/1.61
Mid-dorsal length A9	0.55-0.62 (0.57±0.03, n = 6)	0.55-0.70 (0.64±0.04, n = 9)	0.62
No. of abdominal segs with dorsal spines	none	0-4	none

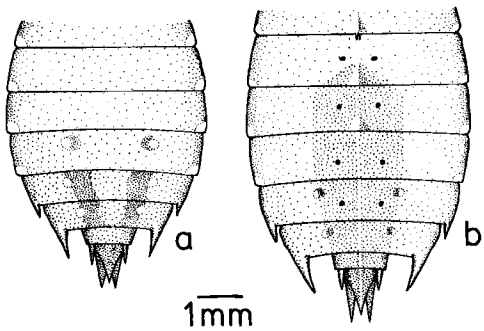

Figure 2. Pattern on the dorsal surface of the abdomen of final instar larvae. a) *L. patricia* b) *L. hudsonica.*

Discussion

Diagnostics

L. patricia larvae can be recognized as *Leucorrhinia* larvae by the lack of dorsal spines and the size of the lateral spines on A8 and A9 (Walker & Corbet 1975; Cannings & Stuart 1977), or by the lack of dorsal spines and the presence of three dark longitudinal stripes on the venter of the abdomen (Tennessen 1996). The latter pair of characters also serve to separate *L. patricia* from *L. proxima* Calvert, *L. intacta* Hagen and *L. frigida* Hagen (Walker & Corbet 1975). *L. patricia* is similar to the other nearctic *Leucorrhinia* with ventrally striped abdomens, namely, *L. borealis, L. glacialis* and *L. hudsonica.*

Just as *L. patricia* adults are the smallest nearctic members of the genus, so too do their larvae tend to be the smallest. In particular, *L. patricia* larvae can be relatively easily separated from *L. borealis* and *L. glacialis* by size. For example, total length: *L. patricia* 13.5-15.3 mm; *L. borealis* 19.0-23 mm (Walker & Corbet 1975), 18-21 mm (Needham & Westfall 1955); *L. glacialis* 20.8 mm (Walker & Corbet 1975), 16-18 mm (Needham & Westfall 1955), 17.6-20.6 (19.2±1.0, n = 8) mm (R.D. Kenner unpublished); or length of the metafemur: *L. patricia* 3.6-3.8 mm; *L. borealis* 5.0-6 mm (Walker & Corbet 1975), *L. glacialis* 5.5 mm (Walker & Corbet 1975), 4.4-5.1 (4.7±0.2, n = 6) mm (R.D. Kenner unpublished). This leaves only separation from *L. hudsonica* to be considered.

The published range for the length of *L. hudsonica* larvae suggests that values of this measurement differ between larvae of *L. patricia* and *L. hudsonica*: *L. hudsonica* total length 16-18 mm (Walker & Corbet 1975), 17-18 mm (Needham & Westfall 1955); length of metafemur 4.0-4.4 mm (Walker & Corbet 1975). However, *L. hudsonica* larvae can be smaller than indicated by those ranges, see Table 1. A comparison of the values in Table 1 shows that for almost every character, the mean is smaller for *L. patricia* than it is for *L. hudsonica,* but the ranges overlap. Thus, size can be used to separate some, but not all, *L. hudsonica* from *L. patricia.*

Because none of the *L. patricia* exuviae has any dorsal spines on any abdominal segment, we assume that, like those of *L. borealis* and *L. glacialis* (Walker & Corbet 1975), *L. patricia* larvae never have dorsal spines. This means that among the nearctic *Leucorrhinia* larvae that have three dark ventral stripes, only *L. hudsonica* larvae have dorsal spines. However, *L. hudsonica* larvae do not always have dorsal spines and the problem of determining *L. patricia* larvae is to distinguish them from *L. hudsonica* larvae that lack dorsal spines.

Previous keys for *Leucorrhinia* larvae have made use of various ratios of lengths or the relative orientation of the lateral spines on A8 and A9 (Needham & Westfall 1955; Walker & Corbet 1975). Those characters do not separate *L. patricia* and *L. hudsonica* larvae. However, three characters that do help to separate these two species are: the length of the epiproct, the colour pattern on the profemora and the colour pattern on the dorsum of the abdomen.

Fig. 3 shows a plot of the number of specimens as a function of the length of the epiproct for a series of 80 exuviae that were collected in BC and YT. This series contains both associated and unassociated exuviae; the unassociated exuviae were determined using a combination of the characters discussed in this paper. Although the difference between the length of the longest epiproct of *L. patricia*, 1.14 mm, and the shortest epiproct of *L. hudsonica*, 1.15 mm, is equal to the uncertainty in the measurements, there is no overlap. If the limits for the length of the epiproct are set at ≤1.12 mm for *L. patricia* and ≥1.18 mm for *L. hudsonica,* fewer than 10% of these specimens remain undetermined based on this character alone.

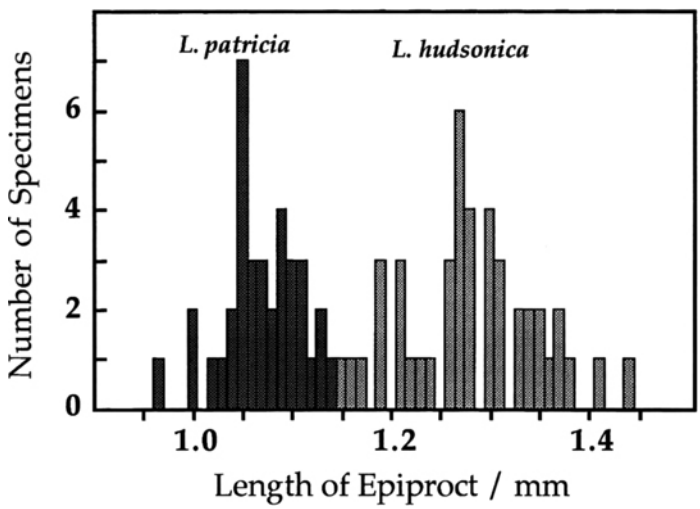

Figure 3. A plot of the number of specimens as a function of the length of the epiproct for a series of 80 exuviae collected in British Columbia and Yukon Territory. This series contains both associated and unassociated exuviae. The latter were determined using a combination of the characters discussed in this paper.

Typical patterns on the profemora of *L. patricia* and *L. hudsonica* are shown in Fig. 1. Because of the variability in the details of the pattern in each of the two species, this character can be somewhat difficult to interpret. Very occasionally, *L. patricia* has a dark spot near the ventral edge of the lateral surface in the same relative position as that of the basal band in *L. hudsonica*. However, such a spot is always separated from the dark dorsal surface by a paler area. The basal dark band in *L. hudsonica* is always connected to the dark dorsal surface, but sometimes extends only half of the way down the lateral surface. No pattern could be discerned on the profemora of most of the alcohol specimens.

The most useful character for separating *L. patricia* larvae from small *L. hudsonica* larvae without dorsal spines, at least for western specimens, is the pattern on the dorsum of the abdomen. The typical patterns for *L. patricia* and *L. hudsonica* are shown in Fig. 2. The critical feature is the contrast, or lack thereof, between the mid-dorsal area and the lateral areas on A6. This character is often best observed in a lateral view in which the dark mid-dorsal area extends across A6-A9 in a relatively straight line in *L. hudsonica,* but is more discretely segmental and rarely extends to A7 and never to A6 in *L. patricia*. The size of the white spots on A8 and A9 may be helpful as these spots tend to be larger in *L. patricia* than in *L. hudsonica*. On exuviae stored in alcohol, the pattern may be very faint or absent. In the series of 80 exuviae mentioned above, 11 have no apparent pattern, 7 are intermediate between the extremes shown in Fig. 2 and 2 have patterns slightly different to those shown in Fig. 2. The remaining 60 have patterns like either a or b in Fig. 2. In a sample of 9 larvae from Quebec (Masham Twp., Duncan L., bog N of Frances de Masham, 17 October 1982 (R.A. Cannings) [RBCM]), all of which have dorsal spines on one or more abdominal segments (hence assumed to be *L. hudsonica*), 8 have a pattern shown in Fig. 2b and one has no discernible pattern. One final-stadium larval specimen with ventral stripes and dorsal spines from Newfoundland (Cat Arm Drainage, 30 August-02 September 1982 (Grant and Larson) [RBCM]) has a dorsal pattern different from those shown in Fig. 2. It is not known whether this represents a geographical variation in the pattern for *L. hudsonica.* In Europe, abdominal colour patterns have been used to separate larvae of *L. dubia* (Vander Linden) and *L. rubicunda* (L.) (Norling 1984).

Table 1 contains measurements of the exuviae of the indeterminate female from Koidern. The measurements of the exuviae of this specimen are intermediate compared to those of the determined specimens. The total length, head width and length of the epiproct are all more consistent with values for *L. hudsonica;* the lateral spine lengths are more consistent with those for *L. patricia.* No dorsal pattern is visible on the abdomen, but the profemora have a faint pattern representative of *L. patricia.*

A tabular key for separating final-stadium larvae of *L. patricia* and *L. hudsonica* is given in Table 2.

Table 2. Tabular key for separating final-stadium larvae of *L. patricia* and *L. hudsonica*.
A value for a given diagnostic feature is indicative of the species at the top of that column; no entry means that there is no value of the diagnostic feature that is indicative of the species at the top of that column.

Diagnostic Feature	Conclusion		
	L. hudsonica	*L. patricia* OR *L. hudsonica*	*L. patricia*
Dorsal spines on abdomen	1 or more	none	—
Total length (mm)	16	<16	—
Length of metafemur (mm)	4	<4	—
Length of epiproct (mm)	1.18	between 1.12 and 1.18	1.12
Pattern on profemur	2 dark bands, see Fig. 1b	no pattern or not like Fig. 1a or b	1 dark subapical band, see Fig. 1a
Dorsal pattern on abdomen	darker mid-dorsal area contrasting with paler lateral areas on A6, see Fig. 2b	no pattern or not like Fig. 2a or b	mid-dorsal area not contrasting with lateral areas on A6 see Fig. 2a

Ecology and distribution in British Columbia and Yukon Territory

L. patricia has been placed in the northern boreal faunal element (Cannings & Cannings 1997), along with such species as *Coenagrion interrogatum* (Hagen), *Aeshna septentrionalis* Burmeister and *Somatochlora septentrionalis* (Hagen). Northern boreal species are those species that are "common near the northern tree line", but whose distribution lies north of the contiguous United States and the southeastern Atlantic Provinces of Canada. These species do not extend far south into the cordillera (Cannings et al. 1991).

In British Columbia and Yukon Territory, *L. patricia* is associated with shallow sedge/moss fens where shallow, open puddles occur (Cannings & Cannings 1994) and is restricted to "water bodies with mats of aquatic moss floating on or near the surface" (Cannings et al. 1991). Vogt describes the habitat in the Lac Mistassini region of Quebec as "shallow vegetated flarks in patterned fens". The flarks are dominated by *Sphagnum majus* (Russ.) C. Jens (submerged) and by various species of sedges, *Carex* sp. and *Eriophorum* sp. There was relatively little exposed peat or muck (T. Vogt personal communication 1998). In the west, emergence occurs throughout the second half of

June (Cannings et al. 1991) and the flight period lasts until the first week of August (Cannings & Cannings 1994). The flight period in Quebec is a little longer: 10 June to 22 August (Pilon & Lagacé 1998). Mating and oviposition occur throughout July and the females oviposit "into open water at the edge of the floating moss" (Cannings et al. 1991).

L. patricia appears to have been collected in British Columbia for the first time by G.G.E. Scudder on 27 June 1974 in the Blue River area, 19 miles S of the BC-YT border on Highway 37. The specimen, a mature female, remained undetermined in the collection of the SEM for more than 20 years. Subsequent collections of *L. patricia* in BC and YT have been detailed elsewhere (Cannings et al. 1991, Cannings & Cannings 1994) and show that the range for *L. patricia* extends south in BC to Heckman Pass in Tweedsmuir Provincial Park at about 52° N. A re-examination of the larvae and exuviae previously determined as *L. hudsonica* and of all undetermined final-stadium *Leucorrhinia* larvae and exuviae in the RBCM and the SEM has failed to identify any further localities for *L. patricia* in BC.

Acknowledgments

RDK thanks K. Needham and G.G.E. Scudder for helpful discussions, the use of facilities and unlimited access to the collections and references of the Spencer Entomological Museum at the University of British Columbia during this work. We thank G.G.E. Scudder for critically reading the manuscript and T. Vogt for information on the habitat of *L. patricia* in Quebec.

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