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NOTE

First occurrence of *Enallagma pictum* (Scarlet Bluet) (Odonata: Coenagrionidae) in Canada and additional records of *Celithemis martha* (Martha's Pennant) (Odonata: Libellulidae) in New Brunswick: possible climate-change induced range extensions of Atlantic Coastal Plain Odonata

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Over the past two decades there has been a surge of interest in the Odonata (dragonflies and damselflies) of Maritime Canada and adjacent regions, with much new information accrued (Brunelle, 1997; Brunelle 1999; Brunelle 2010). Much of this increased interest in the region can be attributed to the efforts of a single investigator and his collaborators in the Atlantic Dragonfly Inventory Project (ADIP; see Appendix 2 in Brunelle 2010) and the Maine Damselfly and Dragonfly Survey. In spite of the extensive database of records for the Odonata of the region that now exists (35,000 records for the Maritimes, a further 30,000 for Maine), new discoveries continue to be made (Catling 2002; Sabine et al. 2004; Cook and Bridgehouse 2005; Klymko 2007; Catling et al. 2009), testament to continuing survey effort and the natural and anthropogenic changes in regional biodiversity always in process. Here we document expansion in the geographic range of two Atlantic Coastal Plain Odonata; *Enallagma pictum* Morse (Scarlet Bluet) (Odonata: Coenagrionidae), shown to be resident in New Brunswick and new for Canada, and *Celithemis martha* Williamson (Martha's Pennant) (Odonata: Libellulidae), a species known previously from a single occurrence (Klymko 2007); and, comment on the significance of these records in the light of climate warming now in process.

On 24 July 2016 naturalists Jim Bell and Gail Taylor discovered numbers of adult *Enallagma pictum* mating and ovipositing, at Cranberry Lake, Charlotte County, New Brunswick (45.3089°, -67.2847°). On 1 August 2016 these same investigators, accompanied by Nancy Lawton, observed *Enallagma pictum* at nearby Moores Mills Lake (45.2801°, -67.2719°; Figure 1). Subsequently, to gain a better sense of extent of distribution, HSM and DLS searched for *Enallagma pictum* at 24 lakes in southwestern New Brunswick during August-September 2016 (Figure 2). The presence of *Enallagma pictum* was confirmed, with specimens collected, at five lakes, including Cranberry and Moores Mills Lakes on 7 August (NBM 52797, NBM 52798), Fidele Lake, Charlotte County (45.2117°, -66.6309°; NBM 52799) on 13 August 2016; Little New River Lake, Charlotte County (45.19660°, -66.62007°; Figure 3; NBM 52800, 52803) on 13 and 19 August, and Georges Lake, Queens County (45.5590°, -66.1275°; NBM 53801) on 20 August 2016. Adults in tow were observed on 7 and 13 August 2016 (Cranberry and Little New River Lakes, respectively) and ovipositing was observed on 7 and 19 August 2016 (Cranberry and Little New River Lakes, respectively). Associated Odonata observed in flight across the five sites during the same period included; *Argia fumipennis violacea* Hagen (Coenagrionidae: Variable Dancer); *Argia moesta* (Coenagrionidae: Powdered Dancer); *Celithemis martha* Williamson (Libellulidae: Martha's Pennant);

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Figure 1. *Enallagma pictum* in tandem, male left, female right, Moors Mills Lake, Charlotte County, New Brunswick, 1 August 2016. (**Photo credit**: J. Bell).

Figure 2. Collection and search sites in southwestern New Brunswick for the odonates *Enallagma pictum* and *Celithemis martha*. **NOTE**: Open circles = neither species, solid circle = *Enallagma pictum*, closed triangle = *Celithemis martha*, closed star = both species. 1. Cranberry Lake, 2. Moores Mills Lake, 3. Bacon Lake, 4. Goldsmiths Lake, 5. Little New River Lake, 6. Fidele Lake, 7. Woodard Lake, 8. Knight Pond, 9. unnamed lake, 10. Georges Lake, 11. Douglas Lake, 12. MacBeth Lake deadwater, 13. Williams Lake, 14. Jenkins Lake, 15. Henderson Lake, 16. Calvin Lake, 17. Walton Lake, 18. Bates Lake, 19. Little Rocky Lake, 20. Mud Lake, 21. Duck Lake, 22. Stevens Lake, 23. Otnabog Lake, 24. Nerepis DU Impoundment, 25. Kerrs Lake, 26. St Patricks Lake, 27. Round Lake-Nelson Lake [site of Klymko (2007) *Celithemis martha* record].

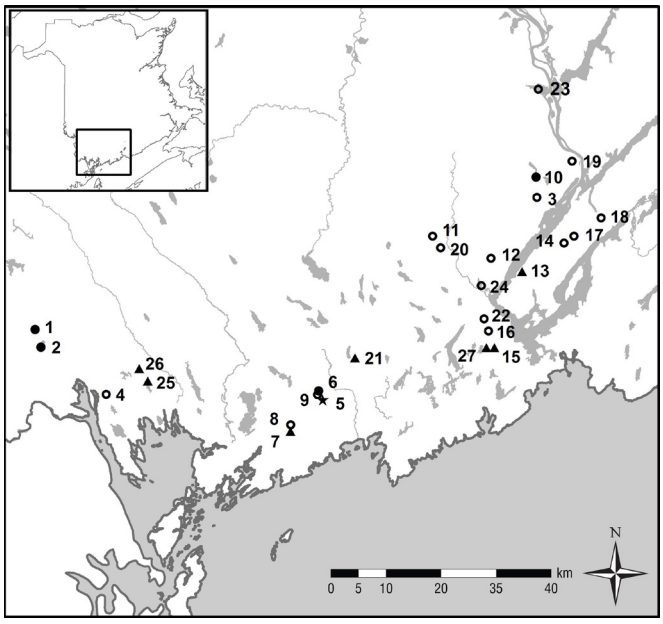

Figure 3. Little New River Lake, Charlotte County, New Brunswick, 19 August 2016, showing waterlily-dense habitat typical for *Enallagma pictum*. (**Photo credit**: D.L. Sabine)

Dorocordulia lepida (Hagen in Selys) (Corduliidae: Petite Emerald); *Enallagma civile* (Hagen) (Coenagrionidae: Familiar Bluet); *Enallagma exsulans* (Hagen) (Coenagrionidae: Stream Bluet); *Enallagma geminatum* Kellicott (Coenagrionidae: Skimming Bluet); *Enallagma hageni* Walsh (Coenagrionidae: Hagen's Bluet) *Enallagma signatum* (Hagen)(Coenagrionidae: Orange Bluet); *Enallagma vesperum* Calvert (Coenagrionidae: Vesper Bluet); *Ischnura verticalis* (Say) (Coenagrionidae: Eastern Forktail); *Lestes disjunctus* Selys (Coenagrionidae: Northern Spreadwing); *Lestes vigilax* Hagen in Selys (Coenagrionidae: Swamp Spreadwing); *Leucorrhinia frigida* (Hagen) (Libellulidae: Frosted Whiteface); *Libellula incesta* Hagen (Libellulidae: Slaty Skimmer); and *Sympetrum semicinctum* (Say) (Libellulidae: Band-winged Meadowhawk).

Between 22 July and 4 September 2016, we photographed or collected *Celithemis martha* at seven new sites in the southwest of New Brunswick, including Duck Lake, Charlotte County (45.2653°, -66.5472°; NBM 52792; HSM), Henderson Lake, Saint John County (45.28171°; -66.2255°; NBM 52793; HSM), Kerrs Lake, Charlotte County (45.2263°, -67.0244°; Figure 4a; JB, GT), Little New River Lake, Charlotte County (45.1966°; -66.6201°; NBM 52794; HSM), Williams Lake, Kings County (45.4050°; -66.1612°; NBM 52795; HSM), Woodard Lake (45.1483°, -66.6930°; NBM 52796; HSM, DLS) and St. Patricks Lake, Charlotte County (45.2464°, -67.0442°; Figure 4b; JB, GT). Adults ovipositing in tow were observed on 19, 25, and 27 August 2016 (Woodard, Williams and Henderson Lakes, respectively) and lone females ovipositing were observed on 19 and 25 August 2016 (Woodard and Williams Lakes, respectively).

Figure 4. *Celithemis martha*, female (a), Kerrs Lake, Charlotte County, New Brunswick, 22 July 2016 and male (b), St. Patricks Lake, Charlotte County, New Brunswick, 20 August 2016. (**Photo credit**: J. Bell).

Enallagma pictum is an eastern North American Atlantic Coastal Plain endemic with a limited range. Bick (2003), in reviewing at-risk Odonata in the United States, ranked *Enallagma pictum* as rare. The species is conservation-listed as Near Threatened by the International Union for the Conservation of Nature (IUCN; Abbot 2007) and Vulnerable by NatureServe (NatureServe 2017). Prior to the New Brunswick discovery, the range of *Enallagma pictum* was known to extend from New Jersey north to southern Maine (Nikula et al. 2007), being recorded in Maine for the first time as recently as 1999. The New Brunswick population represents a range extension of 180 km to the northeast. Southwestern New Brunswick, including Cranberry and Moores Mills Lakes, has been surveyed repeatedly for Odonata (20 and 12 visits respectively) by PMB and others from 1992-2015 during the known flight period for *Enallagma pictum* in southwest Maine (July and August). The most intense Odonata survey work took place during the 1990s, but the earliest Odonata collections for the region date to 1919. In 1923, E.M. Walker, of *The Odonata of Canada and Alaska* fame, spent about a month surveying for Odonata in southwestern New Brunswick. Concurrent with surveys for Odonata in New Brunswick through the 1990s, PMB undertook successful surveys directed at *Enallagma pictum* in southwestern Maine. Also notable, substantial survey in Washington County and central and eastern Maine in general by PMB and others, has failed to yield *Enallagma pictum*.

This history of prior, fairly intense, odonate survey in the region strongly suggests that the current presence of *Enallagma pictum* in New Brunswick is a recent range extension and that the species was not simply overlooked in the past. However, we must note that surveys that do not access the deeper, lilypad/watershield-dense [*Nymphaea odorata* Aiton (Nymphaceaceae), *Brasenia schreberi* J.F. Gmel. (Cabombaceae)] portions of the lakes, where this species occurs in New Brunswick, have a low probability of detecting *Enallagma pictum*. Sand-bottomed ponds and lakes characterized by abundant floating vegetation, particularly where lilypads and water-shield are present, are considered typical habitat for *Enallagma pictum* (Lam 2004, Nikula et al. 2007, Paulson 2011). Butler and deMaynadier (2008) report the species as habitat sensitive with a low tolerance for disturbance and a dependency on a diversity of floating plants, a narrow emergent zone, and fine substrates. Habitat at the five New Brunswick lakes where *Enallagma pictum* has been collected to date appears to be characteristic for the species with respect to the presence of abundant floating vegetation, but bottom substrates of gravel and cobble with organic mixes at these sites appear not to be typical. Survey for this conservation-listed species, at additional lakes of suitable ecology in southwestern New Brunswick, may well reveal *Enallagma pictum* to be more widespread in the province.

Although *Celithemis martha* also has a geographic range limited to the Atlantic Coastal Plain, the species is reported as remaining common in some areas and is IUCN conservation listed as Least Concern (Paulson 2009). NatureServe lists the species as Apparently Secure globally. Nonetheless, for those states for which conservation assessments are available, *Celithemis martha* is listed as Vulnerable to Critically Imperiled (NatureServe 2017). Habitat for *Celithemis martha*, reported as vegetated ponds and lakes, sand-bottomed lakes and ponds with emergent vegetation along the shore, and shallow coastal ponds (Carpenter 1991, Nikula et al. 2007, Paulson, 2011) suggest fairly catholic requirements. Klymko (2007) first recorded

Celithemis martha in New Brunswick at a muck-bottomed channel with emergent vegetation between Round Lake and Nelson Lake, Saint John County on 6 August 2006. The site was deemed typical breeding habitat for the species. Elsewhere in Canada, *Celithemis martha* has previously been restricted to southwestern Nova Scotia.

Klymko (2007) noted a concentration of Atlantic Coastal Plain-associated plants and insects in southwestern New Brunswick, with the records of *Enallagma pictum* and *Celithemis martha* reported here seeming to reinforce the ecological distinctiveness of this region of the province. Clayden et al. (2010), in re-interpreting hypotheses for the establishment of the unique Atlantic Coastal Plain flora of southwestern Nova Scotia, proposed a step-wise migration of coastal plain species through Maine and New Brunswick to Nova Scotia during a warmer early to mid-Holocene period. This was followed by subsequent climate cooling and the loss of certain Atlantic Coastal Plain community populations geographically intermediate between southwest Nova Scotia and the New England states. With climate warming now underway, and evidence of associated range shifts in Odonata in other regions (Hickling et al. 2005, Catling 2008), the re-establishment of long-absent Atlantic Coastal Plain species and expansion of remnant populations of such species, starting in the southwest of New Brunswick, seems likely. The recent records of *Enallagma pictum* and *Celithemis martha* reported here may be a precursor to greater prevalence and more widespread distribution in the Maritimes region of the Atlantic Coastal Plain flora and its associated insects. For example, those monitoring Odonata in New Brunswick should be attentive for *Enallagma laterale* (New England Bluet), another Atlantic Coastal Plain species that is well established in southwest Maine (first reported 1939) and has been recorded a mere 55 km southwest of the New Brunswick border.

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