

An Alvar Race of the *couperi* Subspecies of the Silvery Blue (*Glaucopsyche lygdamus couperi*) in Southeastern Ontario?

PAUL M. CATLING^{1,*} and ROSS A. LAYBERRY²

¹Agriculture and Agri-Food Canada, Environmental Health, Biodiversity, Saunders Building, Central Experimental Farm, Ottawa, Ontario K1A 0C6 Canada

²6124 Carp Road, Kinburn, Ontario K0A 2H0 Canada

*Corresponding author; email: catlingp@agr.gc.ca

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The *couperi* subspecies of the Silvery Blue (*Glaucopsyche lygdamus couperi*) has expanded its range southward in north-eastern North America using introduced legumes and open anthropogenic habitats. The discovery of a population of the Silvery Blue (*Glaucopsyche lygdamus*) in an eastern Ontario alvar woodland in 2011 suggests that the Silvery Blue may have been long established (although restricted) in southern Ontario. Three larvae from this population were reared from eggs deposited on native Neglected Milk-Vetch (*Astragalus neglectus*) by free-flying females in 2012. The three larvae, pupae, and single reared adult, as well as other adults from the alvar woodland, are described and compared with specimens associated with open anthropogenic habitat and introduced legumes. The alvar woodland specimens were closer to the northern Ontario subsp. *couperi* than to the subsp. *lygdamus* of the eastern United States. Although the alvar woodland larvae were darker green than subsp. *couperi* and the spots on the adults were on average larger than in subsp. *couperi*, the alvar woodland Silvery Blues could not be definitively distinguished from subsp. *couperi*, including specimens from northern Ontario and those from southern Ontario associated with open habitats. Nevertheless, there is a possibility that the alvar woodland population of the Silvery Blue dates from early postglacial times and represents a distinct race separate from the Silvery Blue of open habitats.

Key Words: Silvery Blue; *Glaucopsyche lygdamus*; *Glaucopsyche lygdamus couperi*; *Glaucopsyche lygdamus lygdamus*; alvar; Ottawa valley; Neglected Milk-Vetch; *Astragalus neglectus*; host plant; food plant; distribution; ecology; subspecies; southern Ontario

Most of the north and northeast of North America south of the Arctic and north and west of the prairie region is thought to be occupied by the northern subspecies *couperi* Grote 1873 of the Silvery Blue (*Glaucopsyche lygdamus* Doubleday 1841) butterfly (Lepidoptera: Lycaenidae). It is pale silvery blue above with a greyish underside, and it has relatively small spots on the underside of the hind wing (Howe 1975; Scott 1986) (see Dirig and Cryan (1991) for more details).

At the present time in southern Ontario, these butterflies are usually associated with open anthropogenic habitats and introduced legumes (Layberry *et al.* 1982, 1998). They are believed to have moved into southern Ontario relatively recently (Dirig and Cryan 1991; Layberry *et al.*, *in press*) in response to the recent and now widespread availability of introduced legume food plants (native legumes were likely uncommon and localized in pre-settlement times).

In June 2011, seven Silvery Blues were captured in Malaise traps as part of a pollinator study in an alvar woodland near Braeside, Ontario, north of Arnprior in the Ottawa River valley (at 45.48450°N, 76.45634°W, 9.6 km northwest of the bridge in Arnprior, Renfrew County). Two were seen flying through the woods and in small openings during this period.

A colony in natural alvar woodland habitat likely feeding on the native Neglected Milk-Vetch (*Astragalus neglectus* (Torr. & A. Gray) E. Sheld.), the only legume present in alvar woodland, is of interest since it raises

the possibility that the species may have been long established in southern Ontario but very rare and local in its restricted semi-open woodland habitats. It may also represent a more or less distinct race. This possibility was further explored in 2012 through field observations and comparisons.

Observations of ovipositing females

Two females were observed laying eggs on the leaves and flower buds of Neglected Milk-Vetch on 7 June 2012. One laid two eggs, both on young inflorescences of different plants; the other laid a single egg on foliage. The Neglected Milk-Vetch plants occurred in two small more or less circular woodland openings about 15 m² in extent in a woodland of Eastern White Cedar (*Thuja occidentalis*), Balsam Fir (*Abies balsamea*), and White Spruce (*Picea glauca*) with limestone at or very near the surface. The two openings had a sparse cover of Common Juniper (*Juniperus communis*). One opening contained 25 plants of Neglected Milk-Vetch and the other opening contained 9. Other small openings in the woodland nearby also contained Neglected Milk-Vetch, but this plant was absent from the more extensive and drier areas of open alvar pavement. Neglected Milk-Vetch was the only legume species in this area and for a distance of at least 500 m.

Each of the females occupied a different woodland opening, and each remained in it for most of a full hour of observation. Both females had wings damaged in a

particular way, making individual identification possible. The females flew every 5–10 minutes and rested within 2 m of the ground on surrounding woody plants or on Neglected Milk-Vetch. Occasionally they disappeared from view into the woods for 5–10 minutes, but then returned.

Rearing larvae

The three eggs were collected and larvae were reared using simple equipment, including a wide-mouth 12 L glass jar covered with gauze tightened and held in place with a broad elastic band. Inside this, a small 200 ml glass bottle of water was placed containing a sprig of the food plant. The top of the small bottle was covered with Parafilm M (American Can Company, Greenwich, Connecticut). A small opening was made in the Parafilm cover, and the stem of the food plant was pushed to the bottom of the jar. The close fit of Parafilm around the stem prevented larvae from falling into the water and drowning and also prevented the water from being fouled with larval excrement. Two moistened paper towels in a soft ball were placed in the larger jar to maintain high humidity. The jar was placed 20 cm beneath a 22°W Daylight fluorescent lamp (Sylvania) that provided continuous light.

Characteristics of eggs, larvae, chrysalids, and adults

The three eggs were whitish with a dark area and were covered with small tubercles. Larvae hatched within 24 hours (on 8 June) and commenced to feed on flower buds and, within a few days, on the inside of

flowers, leaving most of the outer calyx intact. Feeding on leaves by the two younger larvae was very limited, but more common in the older larvae. The larvae were protected from predators during this period by resting in the hollowed-out calyx tube.

By 14 June, one larvae was 12 mm long and by 17 June the largest larva was 17–20 mm (depending on whether it was extended or resting). Mature larvae were green with a series of diagonal pale lines along the sides of each segment enclosing darker areas (resembling a very young leaf) and a darker green line longitudinally down the centre of the back and paler greenish-white or yellow lines extending longitudinally on either side (Figure 1a). The black head capsule was withdrawn into the segment behind when at rest. Larvae had a sparse covering of simple hairs but a more continuous covering of stellate hairs and two retractable tubercles on the second last segment.

Two of the mature larvae attached with silk to the upper surface of a lower leaf and formed a green chrysalis, one on 18 June and one on 20 June. Two days after beginning formation, each chrysalis had assumed a distinctive chrysalis shape. They were at first cream-coloured with numerous grey or brownish speckles. After 3–5 days, the ground colour darkened to olive green and the speckles became black spots and flecks (Figure 2). Thus the shortest duration of the larval stage under the unusual rearing conditions was 10–11 days. The first butterfly emerged on 2 July (Figure 3), 15 days after formation of the pupa. There was no emergence from the other two pupae.



FIGURE 1. Final instar larvae of the *couperi* subspecies of the Silvery Blue (*Glaucopsyche lygdamus couperi*): (a) reared from an egg laid on *Astragalus neglectus* (Neglected Milk-Vetch) on 7 June 2012 in an eastern Ontario alvar woodland near Braeside; (b) pale green larva found and reared on *Lotus corniculatus* (Garden Bird's-foot Trefoil), *Melilotus albus* (White Sweet-Clover), and *Vicia cracca* (Tufted Vetch); (c) whitish larva with red dorsal stripe, frequently associated with *Vicia cracca*; (d) and purplish-pink larva found on *Medicago sativa* (Alfalfa) and *Vicia cracca*. All of the larvae in this figure were 17–20 mm long. Photo: Paul Catling (a) and Ross Layberry (b to d).

Relationship of alvar woodland Silvery Blues

In southern Ontario, the Silvery Blue is generally regarded as a recent invader using open anthropogenic habitats, such as old fields, pastures, roadsides, and woodland edges. Recent study has documented the expansion of its range southward (Layberry *et al.*, *in press*). Larvae from the Ottawa area were found and reared by RL on Tufted Vetch (*Vicia cracca*), White Sweet-Clover (*Melilotus albus*), Alfalfa (*Medicago sativa*), and Garden Bird's-foot Trefoil (*Lotus corniculatus*). Adults are also associated with Purple Crown-Vetch (*Securigera varia*) and Red Clover (*Trifolium pratense*) (PMC and RL, personal observations).

There are three possible ways in which the alvar woodland Silvery Blue may relate to the open countryside Silvery Blue: (1) they are the same, and the alvar woodland population of the Silvery Blue is recently derived from individuals of open countryside populations entering and using the alvar woodland; (2) the alvar woodland population of the Silvery Blue is long established, and this population is the source of the open countryside Silvery Blues; or (3) the alvar woodland population of the Silvery Blue is long established and is distinct and isolated from the open countryside populations.

Considering the second and third possibilities in a little more depth, the alvar woodland Silvery Blues may have been present in these habitats for a long period prior to settlement, but were always rare and local due to the restricted habitat (Catling and Brownell 1995). There are few natural habitats in southern Ontario where native legumes are common, and Neglected Milk-Vetch in alvar woodland is one of the few examples (Catling and Sinclair 2002). With regard to the third possibility, the alvar woodland Silvery Blues may have been too specialized (limited by a unique host and habitat) to expand into anthropogenic habitats, and they now exist as isolated pockets in a landscape where they are surrounded by a more aggressively expanding race of subsp. *couperi* from the north. Supporting this possibility is the fact that the nominate southern subsp. *lygdamus* is apparently unable to use non-native legumes as host plants and is restricted to a single native host plant (Dirig and Cryan 1991).

Comparisons of alvar woodland and open countryside Silvery Blues

The larvae reared from the three eggs (deposited on Neglected Milk-Vetch) were all deep green (Figure 1a), whereas the larvae from nearby open countryside sites in the Ottawa valley reared on *Lotus corniculatus*, *Melilotus albus*, and *Vicia cracca* were pale green (Figure 1b). When feeding on flowers of *Vicia cracca* or *Medicago sativa*, the larvae were either a purplish pink (Figure 1d) or white with a full or partial red dorsal stripe (Figure 1c).

It is possible that there is variation in the colour of the open countryside (*couperi*) larvae (variation among

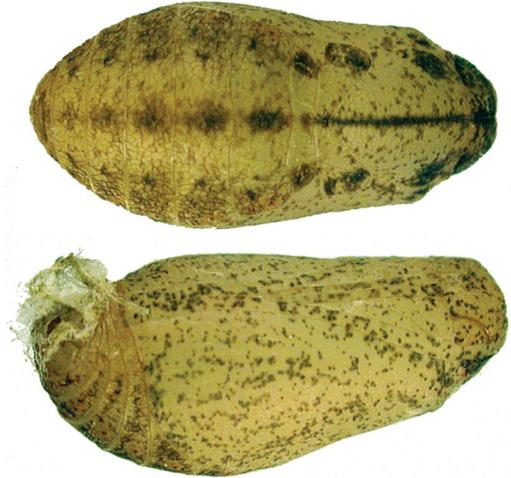


FIGURE 2. Chrysalis of the *couperi* subspecies of the Silvery Blue (*Glaucopsyche lygdamus couperi*) reared from an egg laid on *Astragalus neglectus* (Neglected Milk-Vetch) on 7 June 2012 in an eastern Ontario alvar woodland near Braeside. Photo: Paul Catling.

populations and/or based on the colour of the material consumed). The sample here is too small to allow definite conclusions to be drawn, but it does raise the interesting possibility that the larvae from alvar woodland populations always differ in being dark green.

The chrysalids of the alvar woodland Silvery Blues (Figure 2) were similar to a few photos of those of the open country populations taken by RL.

The seven adult specimens (two males and five females) from the alvar woodland near Braeside in 2011 as well as the one female that laid two eggs and the one male reared from one of those eggs in 2012 (Figure 3) had larger spots on average than many adult specimens from northern and southern Ontario, but as a group the adult specimens from Braeside could not be definitively distinguished from subsp. *couperi* or subsp. *lygdamus*. However, they seem closer to the former. There is generally too much white around the black spots on the hindwing, the spots are too small, and the ground colour of the wings beneath is not sufficiently brownish to qualify clearly as subsp. *lygdamus*. The subsp. *lygdamus* also has a more squared-off wing shape with a darker grey ground colour, and the forewing macules are relatively closer to the margin than in subsp. *couperi*. We place the alvar woodland specimens with subsp. *couperi*.

An alvar woodland race?

The alvar woodland Silvery Blue females appear to be very localized to a particular and very small site and may even exhibit territorial behaviour. One perched female rose to meet another small butterfly (likely another female), which departed within seconds. The *Astragalus neglectus* food plants are sparse and have

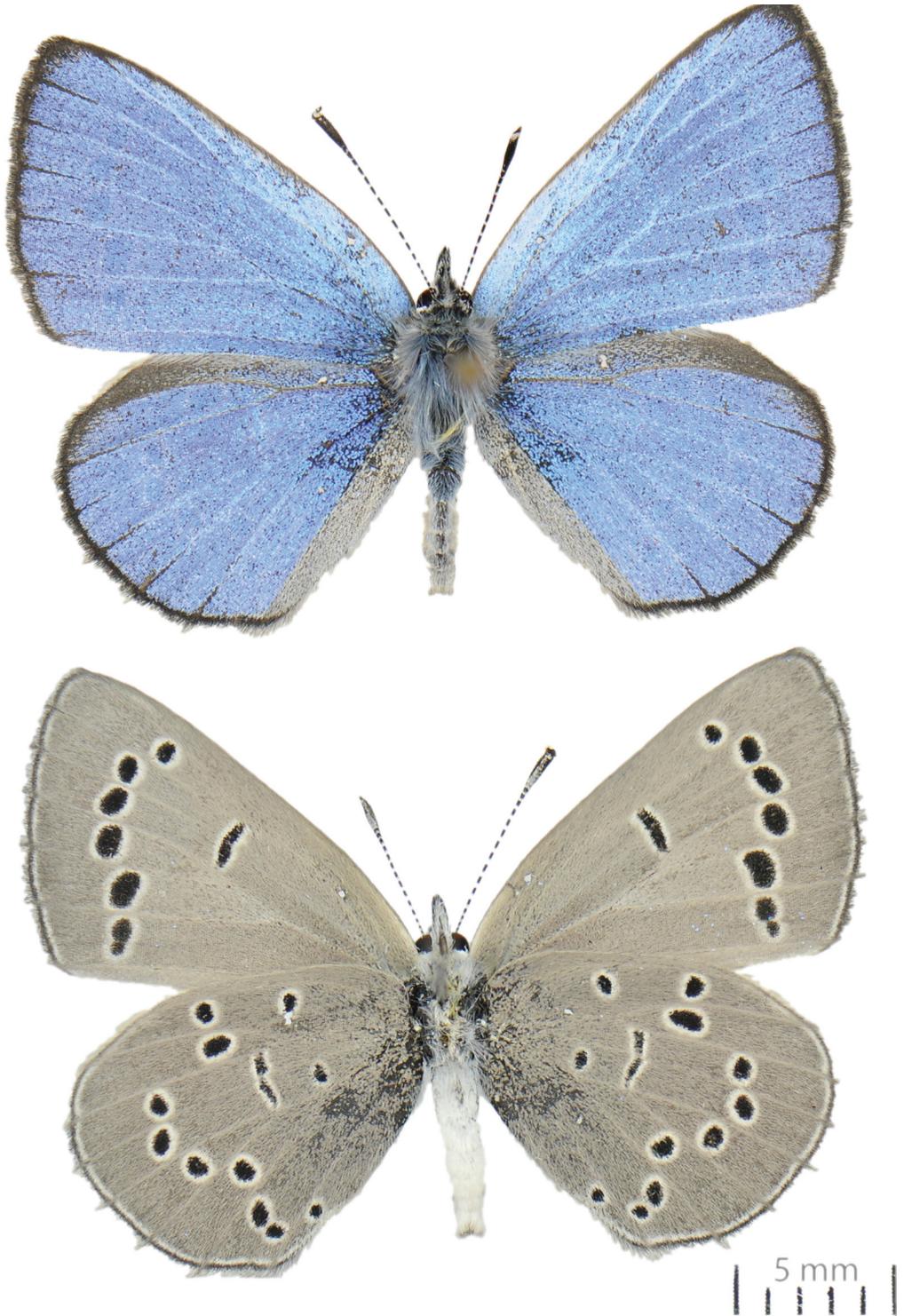


FIGURE 3. Adult of the *couperi* subspecies of the Silvery Blue (*Glaucopsyche lygdamus couperi*) reared from an egg laid on *Astragalus neglectus* (Neglected Milk-Vetch) on 7 June 2012 in an eastern Ontario alvar woodland near Braeside. Photo: Jocelyn Gill.

relatively few inflorescences with relatively few flowers, and thus food resources are sparse, unlike the situation in open countryside habitats, where food plants are often frequent and large and have many inflorescences.

The isolated and very distinctive habitat and different food plant may have led to specific adaptation over thousands of years. Although two kinds cannot be definitely demonstrated, there is a possibility that the alvar woodland Silvery Blue is a distinct race that dates from early postglacial times, in contrast to the Silvery Blues elsewhere in Ontario (these Silvery Blues have originated recently from the north). Much additional work will be required to determine if this is the case, possibly including microsatellite DNA (not simple DNA barcode fingerprinting, which may not provide sufficient resolution), oviposition experiments with different hosts, study of variation in larval colour, and field studies of behaviour.

The occurrence of locally adapted races of *G. lygdamus* as well as widespread variable races has led to some degree of uncertainty in the classification of this group, but it is also of substantial evolutionary significance. Some races deserve recognition as subspecies and others do not. At least 17 variously recognized subspecies have been described (list in Miller and Brown 1981 or Pelham 2008), and several forms and aberrations have also been described. *Glaucopsyche lygdamus* also includes famous subspecies such as the Xerces Blue (subsp. *xerces* Boisduval 1852), formerly of the San Francisco region of California and for which the Xerces Society is named, and the rediscovered (Mattoni 1992) Palos Verdes Blue (subsp. *palosverdesensis* E. Perkins and J. Emmel 1977) from Los Angeles.

Regardless of the results of future taxonomic work, the possibility of a more or less distinctive race of *Glaucopsyche lygdamus couperi* being long established in southern Ontario and present in pre-settlement times is of interest in a many ways. In particular, we are unaware of the origins of a number of butterflies of open countryside that use introduced host plants. In some situations, we have seen huge increases in numbers when a butterfly switches to an introduced host (e.g., Catling *et al.* 1998). These kinds of observations relate to an understanding of the evolution and management of phytophagous insects.

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