BEHAVIOUR OF A POPULATION OF *CYPRIPEDIUM PARVIFLORUM* SALISB. *PUBESCENS* (WILLD.) KNIGHT IN GATINEAU PARK, QUÉBEC, CANADA - A 12-YEAR OVERVIEW

M. H. S. LIGHT and M. MACCONAILL

Summary

Cypripedium parviflorum var. *pubescens* is a long-lived perennial orchid. Colonies of these large, multi-stemmed plants offer a good opportunity for investigating variables affecting plant behaviour. Not only are the plants easy to locate but they persist for many years while new recruits continue to be added to the population. We present the distribution patterns of one such colony in Gatineau Park, Québec, Canada, over the years 1991-2002 and discuss soil temperature as one variable which might play a role in colony behaviour. An analysis of distribution within colonies can suggest mechanisms underlying initial plant establishment including tree fall which may have occurred decades previous.

Zusammenfassung

Cypripedium parviflorum var. *pubescens* ist eine langlebende Orchidee. Populationen dieser großen vielstengeligen Pflanzen bieten eine gute Gelegenheit zur Untersuchung von Variablen, die das Pflanzenverhalten beeinflussen. Die Pflanzen sind nicht nur leicht zu finden, sondern sie leben auch viele Jahre, während immer wieder Jungpflanzen die Population verstärken. Wir stellen die Verbreitungsmuster einer solchen Population in Gatineau Park, Québec, Kanada, in den Jahren 1991-2002 dar und besprechen die Bodentemperatur als eine Variable, die eine Rolle im Verhalten der Population spielen könnte. Eine Analyse der Verbreitung innerhalb von Populationen könnte die Mechanismen zu Tage bringen die der anfänglichen Besiedlung zu Grunde liegen, einschließlich Baumstürze, die Jahrzehnte zurückliegen könnten.

Samenvatting

Cypripedium parviflorum var. *pubescens* is een langlevende orchidee. Kolonies van deze grote, veelstengelige planten bieden een goede gelegenheid om de variabelen te onderzoeken die het gedrag van planten beïnvloeden. De planten zijn niet alleen gemakkelijk te vinden, maar ze leven ook vele jaren, terwijl ook jonge planten de populatie telkens versterken. We beschrijven de verspreidingspatronen van zo'n kolonie in Gatineau Park, Québec, Canada, in de jaren 1991-2002 en bespreken de bodemtemperatuur als een variabele die een rol in het gedrag van de kolonie zou kunnen spelen. Een analyse van de verspreiding binnen de kolonie zou de mechanismen aan de dag kunnen brengen die te gronde liggen aan de oorspronkelijke vestiging van de planten, inclusief het omvallen van bomen vele tientallen jaren geleden.

Introduction

Cypripedium parviflorum Salisb. var. *pubescens* (Willd.) Knight is a long-lived, rhizomatous, shallow-rooted perennial orchid (Catling and Catling 1991; Curtis 1954; Light and MacConaill 1996, 1998, 2002; Tremblay 1994). The orchid colony discussed in this paper is located in Gatineau Park, Québec, Canada (Lat.?° 30' N, Long. 75° 45' W). Approximately 290 flowering genets of *C. parviflorum* var. *pubescens* occupy a patch measuring 21 m x 23 m at the head of a forested valley that slopes down from west to east. The forest canopy is ca. 30 m high and somewhat irregular. Major species include Sugar Maple (*Acer saccharum* Marsh.) and Red Oak (*Quercus rubra* L.). Understory trees growing in the orchid colony consist of one 3.5 m tall White Spruce (*Picea glauca* (Moench) Voss), several small Ironwood (*Ostrya virginiana* (Mill.) K. Koch), and some seedling Basswood (*Tilia americana* L.). Other companion plants include *Aster macrophyllus* L., *Rhus radicans* L. and *Trillium grandiflorum* (Michx.) Salisb. Marble is the principal underlying rock. In January, 1998, a major ice storm caused many large trees to break under the mass of clinging ice. Three major tree falls occurred in the site consisting of two trunks snapped off about 10 m above the ground and one entire tree taken down with the fall of another (Fig.1). The orchid colony is exposed to direct sunlight in early spring until the leaves of the overstory have fully expanded which in most years, is about three weeks after the orchids have emerged. Light at the level of the orchid plants measured as photosynthetic photon fluence rates (PPFR) at noon sun time during the blooming period before the overstory has closed, ranges from 25 to 1600 μmol◊m^{-2}◊s^{-1} (unpublished data). There can be considerable variation in direct sunlight exposure according to the time of day but a few plants are consistently more shaded than others. In Gatineau Park, *C. parviflorum* var. *pubescens* begins flowering in mid to late May. We had observed that flowers opened over a span of one to several weeks depending on the weather and the location of the plants (Light and MacConaill, in press) and wondered if soil temperature might be implicated in the behaviour.

Some 200 flowering genets in the population were identified and tagged as part of the 1991 investigation into the consequences of multi-parental pollination (Tremblay, 1994). There has been both recruitment and loss of flowering plants over the past 10 years. Since 1996, we have located and mapped both tagged individuals and new flowering plants as part of a long term study. This paper centres about the distribution and behaviour of genets including recently tagged individuals.

Methods

Plants were located, tagged and mapped when in flower in 2000, 2001 and 2002. Minimum and maximum temperature for air and soil recorded during the previous 24 hours were measured using a calibrated dual recording sensor (SMART® Dual Display, Tandy) located at flower height within a plant or within the rooting zone at 3 cm depth at 32 locations representative of the range of flowering opening dates (early to late opening) within the colony. Daily precipitation was measured using a standard rain gauge. Available light in terms of photosynthetic photon fluence rates (PPFR) as μmol m^{-2} s^{-1} was measured using a LI-COR meter at 16 locations representative of the range of habitat within the colony.

Results and Discussion

If we are to develop conservation strategies to adequately identify and manage orchid populations, we must acquire a comprehensive knowledge of population biology and of individual plant behaviour. Where numbers are small or where distribution is sparse, it is especially important to apply the most appropriate investigative methodologies to gather as much useful data as is possible. Unfounded or inappropriate assumptions at this critical data gathering stage can bias conclusions, confound management strategies, and perhaps jeopardize the future of a species. One way to test investigative methodologies is to apply them to species that are common, locally available and not especially endangered. A population of locally common *Cypripedium parviflorum* var. *pubescens* was therefore selected as a suitable candidate to study constraints on distribution and behaviour.

In 2002, the total flowering population consisted of 287 plants with 1239 flowers overall. Flowering began on May 24, 2002 and continued over 19 days until June 11. A majority of flowers had opened by May 30 but a week of unseasonably cool weather in early June may have retarded the opening of remaining buds. By year class, the 2002 emergent population consisted of 141 flowering and 4 non-flowering plants originally tagged in 1991 and 8 additional flowering plants re-tagged in 1996 since their 1991 tags were lost; 87 flowering and 8 non-flowering plants of the 103 genets first tagged in 2000; 15 flowering and 2 non-flowering plants of the 20 genets tagged in 2001; and 36 new flowering plants tagged in 2002. Eleven of the tagged plants, 3 and 8 respectively, from the 2000 and 2001 year classes did not emerge in 2002. The positions of all tagged individuals including those first tagged in 1991 and those tagged in 2000, 2001 and 2002 are shown in Fig. 1.

The date of first flower opening in the population for the period 1996-2001 ranged from May 1 in 1996 to May 28 in 1997. Flowers opened over contracted to extended periods ranging from 5 days in 1997 to 19 days in 2002 (Light and MacConaill, 2002). In the year 2000, flower opening was spread over 18 days with a very few plants flowering early and a similar number flowering late. We attributed the extended 2000 season to weather conditions (Light and MacConaill, in press) although flower opening dates of particular plants seemed to be related to soil temperature. Although we did not excavate in the vicinity of early or late-blooming plants, we could easily note whether the plants were close to large rocks. We hypothesized that soil temperature could be a complex function of insolation, air temperature, and possibly also influenced by the presence of large rocks or tree trunks and large tree roots beside or beneath the orchids that would act as thermal sinks. On May 8, 2002, the plants were at the emergent shoot stage. Shoot length was relatively uniform within a genet and ranged from about 7 cm to 25 cm. Soil temperatures taken on that day from within the rooting zone of 32 selected emerging genets across the patch ranged from 9.7 to 16.8°C, mean 12.6°C. The weather was sunny and air temperature measured at the same time and locations ranged from 20 to 25°C, mean 22.8°C. The location of six plants selected for more detailed discussion is shown in Fig. 2. Plant I is located in a well drained, exposed location where there is no large rock, tree trunk, or large roots: the air temperature at this plant was 24°C while the soil temperature was 16.9°C. This plant subsequently withered before developing

further. Plant II, which consistently opens flowers early, is located in an exposed location at the western foot of a tree: the soil temperature was 13.3°C. Plant III is situated to the east side of a large fallen tree trunk where the plant crown and roots are partly covered by the trunk: air temperature was 24°C but the soil temperature was 9.7°C. Plant IV grows within a shrubby, shaded patch where the nearest rock, fallen trunks or living trees are more than one metre from the orchid: the air temperature was 23°C while the soil temperature was 11.1°C. Plants in this location opened their flowers beginning May 29, 2002, 5 to 8 days after those where the soil temperature was higher whereas Plant V (soil temperature 15.6°C; air temperature 22°C) and neighbouring genets that are located in an open, slightly raised patch of gravelly soil, opened their flowers from May 24 to 26. In an open location but with a large boulder located within 50 cm of the plant and a fallen tree trunk located just to the west (Plant VI), air temperature was 22°C while the soil temperature was 9.9°C. The flowers of Plant VI opened May 29. This preliminary evidence suggests that a more intensive study of soil temperature and its relationship to plant behaviour is justified.

An examination of new flowering plants found in 2000, 2001 and 2002 revealed that numbers were particularly high in 2000. It is highly unlikely that all the 101 new plants tagged in 2000 were plants completely new to the colony. Some of these individuals may have flowered for the first time between 1992 and 1999, when they were unrecorded. Some may previously have been non-flowering individuals or had been persisting below ground during some of the first four years the study. Re-emergence patterns over the 2000-2002 interval suggest that about 90% of the year 2000 single-stemmed plants could be first-time bloomers while the remainder could have bloomed one or more years before this study began. Distribution of plants across the site is not random. In particular, distribution of the 2001 and 2002 year classes suggests that particular parts of the space are being colonized (Fig. 1). We found genets representing all year classes clustered around the few large boulders, around trees or arranged somewhat linearly in a NW to SE pattern. The linear arrangement suggests that some underlying feature such as fallen trees long since decayed, tree roots, mineral deposits or water are driving this distribution pattern whereas the clustering around large objects points to a possible role in the long term survival of plants in their early stages of growth. A more extended study of recruitment patterns should help to resolve these hypotheses.

Cypripedium parviflorum var. *pubescens* is a long-lived perennial orchid. Colonies of large, multi-stemmed flowering plants offer a good opportunity for investigating variables affecting plant behaviour. Not only are the plants easy to locate but they persist for many years while new recruits continue to be added to the population. An analysis of plant distribution within such colonies can suggest mechanisms underlying initial plant establishment which may have occurred decades previous. This can also provide a guideline for those hoping to re-introduce the species.

Literature cited

Catling, P. M. and V. R. Catling (1991). A synopsis of breeding systems and pollination in North American orchids. *Lindleyana* **6**: 187 – 210.

Curtis, J. T. (1954). Annual fluctuation in rate of flower production by native cypripediums during two decades. *Bulletin of the Torrey Botanical Club* **81**: 340 – 52.

Light, M. H. S. and M. MacConaill (1996). Reproductive constraints in Cypripedium: horticultural and conservation viewpoints. Pages 77 – 90 in C. Allen (ed.), *North American Native Terrestrial Orchid Propagation and Production*. Washington, DC. NANTOC, April 1996.

Light, M. H. S. and M. MacConaill (1998). Factors affecting germinable seed yield in *Cypripedium calceolus* var. *pubescens* (Willd.) Correll and *Epipactis helleborine* (L.) Crantz (Orchidaceae). *Botanical Journal of the Linnean Society* **126**: 3 – 26.

Light, M. H. S. and M. MacConaill (2002). Population ecology of Canadian orchids. Pages 229 - 233 in J. Clark, W. M. Elliott, G. Tingley and J. Biro (eds.), *Proceedings of the 16th World Orchid Conference*, Richmond, BC, Canada.

Light, M. H. S. and M. MacConaill (in press). Climatic Influences on Flowering and Fruiting of *Cypripedium parviflorum* Salisbury var. *pubescens* (Willd.) Knight. In P. Kindlmann, D. Whigham, and J. Willems (eds.), Underlying Mechanisms of trends and fluctuations in terrestrial orchid populations.

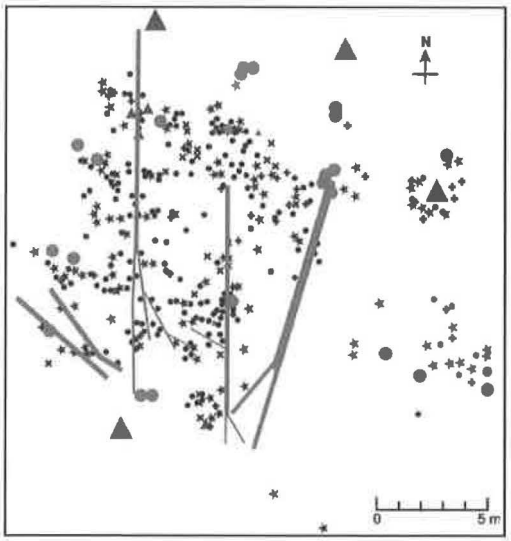
Reddoch, J.M. and Reddoch, A.H. (1997). The Orchids in the Ottawa District: Floristics, Phytogeography, Population Studies and Historical Review. *The Canadian Field-Naturalist* **111**: 1 – 185.

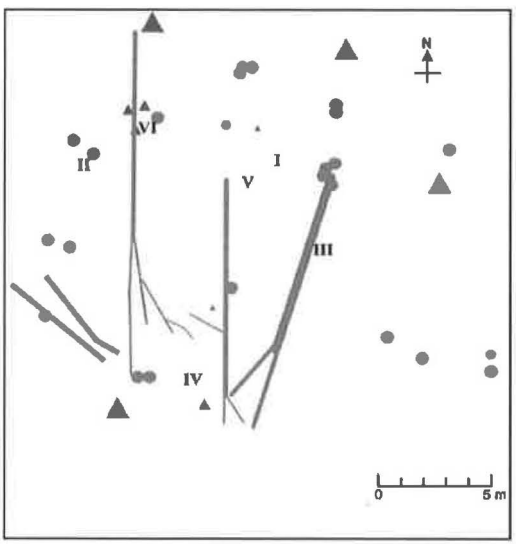
Tremblay, R. L. (1994). Frequency and consequences of multi-parental pollinations in a population of *Cypripedium calceolus* var. *pubescens* (Orchidaceae). *Lindleyana 9*: 161 – 167.

Legends

Figure 1: Sketch map of study site showing distribution of *Cypripedium parviflorum* var. *pubescens* plants in year classes 1991-96 (●), 2000 (★), 2001(✕) and 2002 (✚). Also shown are the locations of significant rocks (triangles), standing trees (grey circles) and tree trunks and large branches felled by the January 1998 ice storm (grey lines).
Figure 2: Location of plants I – VI in study site: rocks and trees as in Fig. 1.

M. H. S. Light and M. MacConaill
174 Jolicoeur St.
Hull QC Canada
J8Z 1C9


N
0
5 m


N
VI
II
I
V
III
IV
0
5 m

VERKLARING VAN ENIGE TERMEN

In het voorafgaande artikel van J.H. Willems en in het hierna volgende van M. Light komt de term "genet" voor. Ook de definitie van het begrip "plant" verdient nadere toelichting.
De heer Willems schreef op verzoek van de redactie naar aanleiding van zijn artikel over *Spiranthes spiralis*:

"Wat de kwestie "plant" en "rozet" betreft: een plant kan uit een rozet of verscheidene rozetten bestaan, dat kan van jaar tot jaar wisselen of ook hetzelfde blijven. Stel je hebt een plant bestaande uit een enkel rozet en op diezelfde plaats staan het volgend jaar twee rozetten. Deze zijn door vegetatieve vermenigvuldiging ontstaan en derhalve genetisch identiek. Ik beschouw een dergelijke verzameling van rozetten als één plant. In het Engels wordt daarvoor de term "genet" gebruikt, en de individuele rozetten heten "ramets". Als je een plant van *Goodyera repens* hebt met uitlopers met (bloeiende) rozetten, dan is dat toch ook één enkele plant. Hier zie je duidelijk de verbinding met elkaar. Dit laatste is wat moeilijk bij *Spiranthes*, maar de verbindingen zijn er ondergronds wel degelijk. We hebben dit op kleine schaal in Italië ondergronds nagegaan, op een plaats waar duizenden planten stonden. Ondergrondse tubers of knollen kunnen met de rozetten in alle mogelijke combinaties voorkomen: 1 rozet-1 knol, 1 rozet-2 knollen, 1 rozet-3 knollen, 2 rozetten-1 knol, enz. enz. Als je elk rozet als plant beschouwt kom je in de problemen met de interpretatie van de afwezigheid ervan gedurende een of meer jaren. Stel in jaar x heeft een plant 3 rozetten, in jaar x+1 slechts een enkel rozet en in jaar x+2 weer drie rozetten, dan kun je niet zeggen dat twee planten dormant, ondergronds aanwezig waren. Zo is Terry Wells aan dormantie bij *Spiranthes* gekomen in zijn artikel van 1967, terwijl dit geen echte dormantie is, zoals bijv. bij *Orchis simia* die gedurende een of twee jaar bovengronds als groene plant afwezig kan zijn. Omdat *Spiranthes* elk jaar zijn ondergrondse knollen geheel vernieuwt, kan zo'n plant niet dormant zijn, hij is er in een gegeven jaar of anders is hij dood, bv. door beschaduwing. Je moet een plant van *Spiranthes* zien als een individu met de mogelijkheid van jaarlijks wisselende aantallen spruiten, de rozetten. Wat voor factor die wisseling bepaalt, willen we graag te weten zien te komen. Maar het zal nog wel wat voeten in de aarde hebben voordat we dit weten.
Tenslotte: De termen "genets" en "ramets" zijn o.a. uitvoerig beschreven in het klassieke boek: POPULATION BIOLOGY OF PLANTS, door J.L. Harper, 1977. Academic Press, London. 892 pp. Een aanrader om te raadplegen!!"