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# FLOWERING SEQUENCE OF THE ORCHID GENUS *GOODYERA* IN THUNDER BAY DISTRICT, ONTARIO

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ABSTRACT

A two-year field study (1987 and 1989) of mixed populations of *Goodyera repens, G. tesselata,* and *G. oblongifolia* and a study of relevant herbarium material showed that the flowering sequence of these three species is different in Thunder Bay District, Ontario, from what has been reported for several areas in somewhat more southern regions. The sequence in more southern regions is *G. tesselata* to *G. repens* to *G. oblongifolia.* The sequence in this northern area is *G. repens* to *G. tesselata* to *G. oblongifolia.* As *G. tesselata* arose through hybridization of the other two species, this latter sequence could have important consequences for the reproductive biology of the group.

Key Words: *Goodyera,* phenology, hybridism, northwestern Ontario, Canada

## INTRODUCTION

In 1986, funds made available from a bequest by Dr. Gaëtan Harvais allowed a study of the orchid genus *Goodyera* to begin. There are three species present in the Thunder Bay area: *G. repens* var. *ophioides* ($2n = 30$), *G. tesselata* ($2n = 60$) and *G. oblongifolia* ($2n = 30$). The first two species are quite common, but *G. oblongifolia* is rare and is known only from a few local populations. It has been established first by Fernald (1899) and later in detail by Kallunki (1976, 1981) that *G. tesselata* is a tetraploid (rarely a triploid) derived through hybridization between the other two species. However, some backcrossing does still occur. Kallunki (1976, 1981) has shown that in most respects *G. tesselata* is both intermediate and more variable than either of the parent species. Theoretically then, *G. tesselata* should be intermediate in its phenology, especially in flowering period, to the parent species. Kallunki (1976) did not find this assumption to be true for northern Michigan populations, but showed that *G. tesselata* flowers earlier than *G. repens* and much earlier than *G. oblongifolia.* Therefore, the order of flowering she reported was *G. tesselata, G. repens* and finally *G. oblongifolia.* Kallunki (1981) considered that this order of flowering is important in preventing backcrossing in mixed *Goodyera* populations, thereby leading to genetic stability in *G. tesselata.* Brown (1985), in a twenty-year study, showed the

same order of flowering occurring in Ontario's Bruce Peninsula, and Whiting and Catling (1986) in *Orchids of Ontario* stated that *G. tesselata* is ". . . the earliest blooming of our rattlesnake-plantains." Our studies in the more northerly Thunder Bay area of northwestern Ontario show a different situation occurring here; this paper describes some aspects of the phenology of the three *Goodyera* species in this area.

## METHODS

### Study Area

The Thunder Bay District is in northwestern Ontario north of western Lake Superior. It is an area of cold winters and cool to warm summers. Precipitation is moderate with about one-third falling as snow. The whole area is underlain by rocks of the Canadian Pre-Cambrian Shield and is moderately rolling. There are areas of rock outcrops but there are also deposits of glacial drift, clay, silt, sand, and gravel. The soils are mainly brunisols and organic soils, but podzols and luvisols are also common.

Two sites were used in this study: 1. Hawkeye Lake is inland and 30 km northwest of Thunder Bay city; 2. Ravine Lake, Sibley Peninsula, is 30 km east of Thunder Bay city across part of Lake Superior.

The Hawkeye Lake biogeochemical study area is a monitored headwater catchment basin (48°40′N, 89°29′W). It is in the Port Arthur Hills at an elevation of 460 m, considerably higher than Lake Superior (183 m). There are rock outcrops, but most of the catchment is covered by morainic material with brunisols being the most common soil type. Hawkeye is in the Superior section of the Boreal Forest Region (Rowe, 1972) and is dominated by balsam fir (*Abies balsamea* (L.) Mill.), trembling aspen (*Populus tremuloides* Michx.), and white birch (*Betula papyrifera* Marsh.). The phenology study area is about 20 × 30 m on a slightly west-facing slope under a canopy of balsam fir and black spruce (*Picea mariana* (Mill.) BSP). The understory vegetation is sparse and is locally dominated by *Goodyera repens* (L.) R.Br. and *G. tesselata* Lodd. There is no *G. oblongifolia* Raf. at Hawkeye Lake.

Ravine Lake, the second study area, is at the southern end of the Sibley Peninsula (48°21′N, 88°51′W). It is one km from Lake Superior at an elevation of 260 m. The area climate is modified

by Lake Superior and tends to be cooler and damper than inland areas (Wilson, 1970, Master's thesis, Lakehead University, Thunder Bay, Ontario). There is a mixed population of *Goodyera repens, G. tesselata,* and *G. oblongifolia* present on this site. There are sedimentary rocks in this area and the vegetation is dominated by balsam fir, eastern white cedar (*Thuja occidentalis* L.) and white spruce (*Picea glauca* (Moench) Voss).

## Field Methods

The methods used in the two study areas had some differences. Hawkeye Lake studies were carried out in 1987 and in 1989 during the months of June to September. Fifty plants with developing scapes were marked for both *Goodyera repens* and *G. tesselata.* Initially the species were identified by leaf colour and reticulation, and after flowering began were confirmed by floral morphology. The plants were checked usually once a week until the midpoint of anthesis could be determined for each plant.

As there was high mortality due to herbivory or a pathogen in 1989, an additional 10 plants of *Goodyera repens* and 3 of *G. tesselata* were marked after the study began. If more than half of the total number of buds of a plant failed prior to anthesis, then the plant was excluded from calculations.

The Ravine Lake site is less accessible than Hawkeye Lake; weekly observations were carried out only in 1989 and did not begin until 7 August 1989. Although there are good populations of all three species of *Goodyera* at Ravine Lake, relatively few could be found with developing scapes. Plants were marked in three small areas. There were 16 *G. repens*, (all past midpoint of anthesis) 9 *G. tesselata* and 14 *G. oblongifolia.*

The midpoint of anthesis for both study areas was determined using the method of Kallunki (1981):

$$\text{Midpoint} = t\varnothing + \frac{(t1 - t\varnothing)(0.5 \times Y+ - Y\varnothing)}{(Y1 - Y0)}$$

where

$t\varnothing$ is the observation date before the midpoint of anthesis
t1 is the observation date after the midpoint of anthesis
Y+ is the total number of buds in the inflorescence
Y0 is the number of flowers at $t\varnothing$
Y1 is the number of flowers at t1

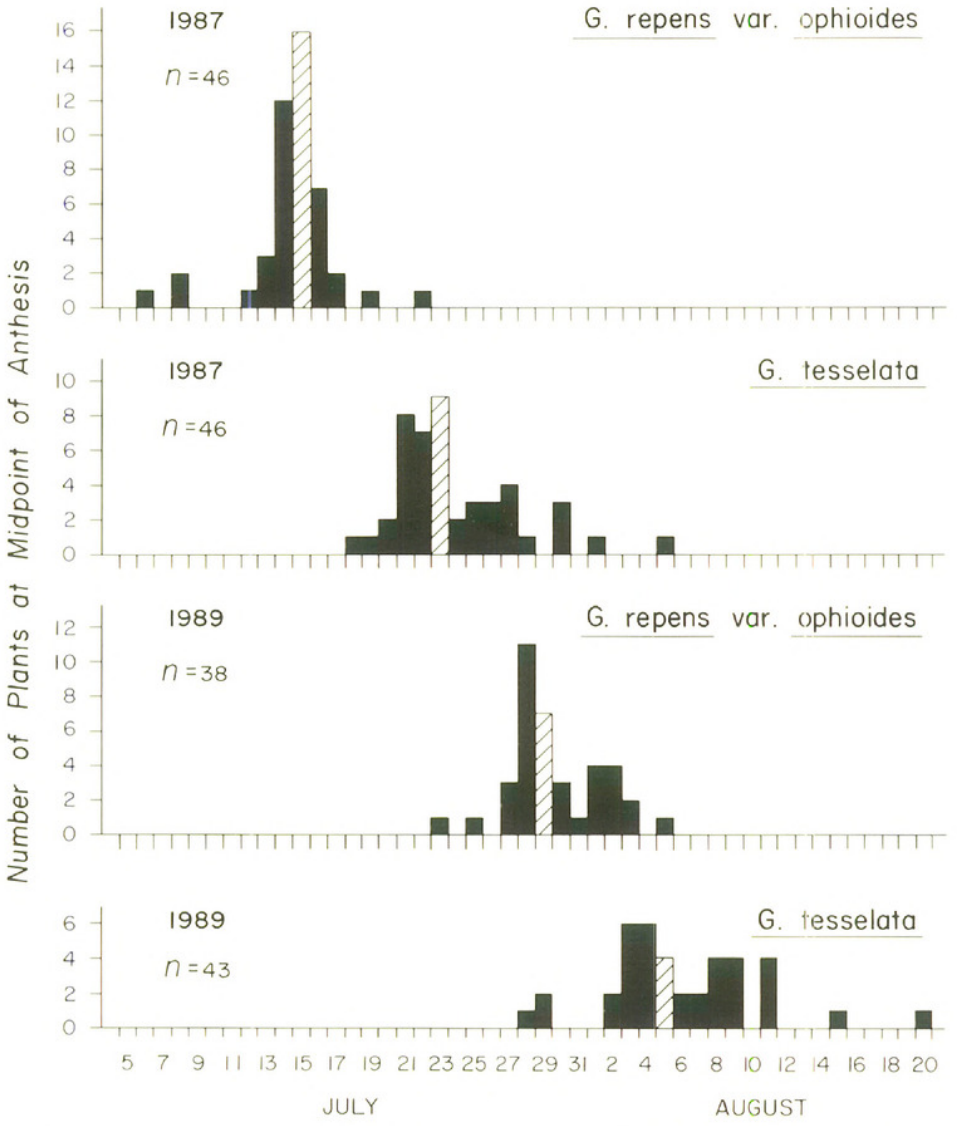


Figure 1. Flowering period at Hawkeye Lake in 1987 and 1989, based on the number of plants at midpoint of anthesis, for *Goodyera repens* var. *ophioides* and *G. tesselata*. The cross-hatched bar is the midbloom date.

Note: the "midbloom" date (Figure 1) is the arithmetic middle date of the flowering period.

## Herbarium Methods

All collections of the three *Goodyera* sp. present in the Lakehead University Herbarium and collected from Thunder Bay District were checked for dates and flowering status. Variation may exist between parts of Thunder Bay District; however, comparisons were made for the district as a whole.

## RESULTS

The results of the phenological study are presented in three parts in the same order as listed in the methods.

### Hawkeye Lake

Figure 1 shows a 13–14 day difference in midbloom flowering dates when 1987 data are compared to 1989 data for both *Goodyera repens* and *G. tesselata.* Also, there is a significant 7–8 day difference ($P \leq .005$) between the two species in midbloom flowering dates in both study years, with *G. repens* being earlier than *G. tesselata* in both cases. When *G. repens* and *G. tesselata* are further compared there is considerable overlap in midpoint of anthesis flowering periods for these two species in both years.

### Ravine Lake

At this site all 16 of the *Goodyera repens* were past the midpoint of anthesis prior to 7 August, 1989, all 9 *G. tesselata* flowered and 12 of the 14 *G. oblongifolia* flowered. The midpoint of anthesis flowering period is the same for both *G. tesselata* and *G. oblongifolia* and in 1989 was 8 August to 20 August. The midbloom date for *G. tesselata* was 11 August and for *G. oblongifolia* was 10 August. There is no significant difference between the two species in midbloom dates. The midbloom date for *G. tesselata* is six days later at Ravine Lake than at inland Hawkeye Lake.

### Herbarium Study

The material in the Lakehead University Herbarium has 36 sheets of *Goodyera repens* var. *ophiodes* in flower. Dates of the collections cover the years 1936 to 1982. The flowering period for these years is shown to be 13 July to 6 September with the midbloom date being 9–10 August.

There are 23 flowering collections of *Goodyera tesselata* for the years 1951 to 1981. The flowering period begins 27 July and ends 13 September with 11–12 August as the midbloom date.

There are only four sheets of *Goodyera oblongifolia* in flower. They cover the years 1960–1982. The flowering period is 17 August to 6 September. The midbloom date appears to be the first week in September.

The midbloom dates for *Goodyera repens* and *G. tesselata* are therefore very close together. There is large overlap in flowering periods for these two species (and also with *G. oblongifolia*) but the flowering period for *G. tesselata* is later than for *G. repens.*

These data also show that the 1987 flowering period for Hawkeye Lake for both *Goodyera repens* and *G. tesselata* is one of the earliest on record for Thunder Bay District.

## DISCUSSION

The most significant result of this study of flowering periods of the three *Goodyera* species is that there is a different sequence in northwestern Ontario from that of Michigan and the more southerly areas of Ontario. In Thunder Bay District the sequence is *G. repens* to *G. tesselata* to *G. oblongifolia.* This order is supported by the Hawkeye Lake data, the Ravine Lake data, and by the data from the herbarium study.

It is also clear that in Thunder Bay District there is great annual variability in time of flowering for at least *Goodyera repens* and *G. tesselata.* This variability is shown not only by the herbarium study but also by the 1987 and 1989 data from Hawkeye Lake. Flowering was two weeks later in 1989 than it was in 1987.

Temperature records for 1987 show all the months April to August had above-average temperatures, with April and June having the highest means ever recorded. In contrast, the same months in 1989 were close to the mean. It would seem logical that the warmer temperatures of more southern areas could be a cause of the differing sequences. However, in the above normal temperatures in Thunder Bay District of 1987, *Goodyera repens* was even earlier in its midbloom date than was *G. tesselata.*

All the northwestern Ontario studies show there is considerable overlap of flowering between the three species. Both *Goodyera repens* and *G. oblongifolia* overlap into the flowering period of the intermediate hybrid *G. tesselata,* and *G. repens* may even overlap into the flowering period of *G. oblongifolia.* The studies also show that as predicted by Kallunki (1976), *G. tesselata* is more variable than *G. repens* and has a longer flowering period.

What important consequences this difference in flowering sequence and the accompanying overlap in flowering periods has on the reproductive biology of mixed populations of *Goodyera* is not yet known. It is possible to state, however, that the north-

western Ontario flowering sequence of these *Goodyera* species is different from that of the areas to the south.

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