Life History of the Orchid *Cyrtopodium Broadwayi*

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INTRODUCTION

THE Botany group of the Trinidad and Tobago Field Naturalists' Club was organized in 1977 for the purpose of carrying out field work on the vegetation of Trinidad. The group consists of the six persons whose names head this article together with Vilma and Judith Lastique who have not been involved with this work on *Cyrtopodium*. We decided that our first project would be a study of the terrestrial orchid *Cyrtopodium Broadwayi* which is endemic to Trinidad and thought to be in some danger of extinction. Schultes (1967) records it from the Piarco Savanna, the Caroni Savanna, the Botanic Gardens (presumably cultivated) and near Mt. Tamana, in addition to the Aripo Savanna, the locality from which most of the specimens in the National Herbarium have come. Since the Piarco Savanna is now an airport and the Caroni Savanna cultivated in sugar cane, the Aripo Savanna is now the only locality where the orchid occurrs in some abundance. Mining activity in the area is a constant threat to the site so that the danger of extinction is real. We now report on the first four years of the project.

Our first visit was made on 1st May 1977, On this visit we learned to recognize the orchid and we also made a census of the plants in two small areas of one of the large savannas. The first of these, in a small bay cut off from the main savanna by a drain, produced 53 plants. The second in a similarly sized area nearer the middle of the savanna produced 17 plants. so the first area became the study area. It had other advantages besides the seemingly greater number of plants. (1) It was clearly delimited. (2) It was reasonably easily accessible to the naturalist prepared to work there but sufficiently difficult of access to deter the casual orchid collector. (3) Its separation from the main savanna by a drain seemed to afford greater protection from fire and in the years since 1977 there has, in fact, never been a fire in this area though there have been fires on the main savanna. Its exact location is being deliverately withheld in the interest of protecting the orchids there.

After the first visit, access to the site by the route we had taken was blocked and it was only on 15th Jan. 1978 that an alternative route in was found. From then on we have visited the site about the middle of every month.

THE STUDY AREA

The Aprio Savannas lie in the triangle formed by Valencia, Cumuto and Guaico. The surrounding vegetation is palm-marsh forest; the savannas occur where white sand overlies an impermeable clay pan. As a result, plants growing there are subjected to particularly severe conditions; in the dry season from January to May they suffer from drought and in the wet season they are waterlogged. The vegetation consists mainly of grasses and sedges with some shrubs. some dicotyledonous herbs and several species of terrestrial orchid. The savannas have been studied by Beard (1946) and by Richardson (1963) and have been described in articles for the general reader by Quesnel (1979) and in the Forestry Division's Management and Development Plan 1980. The study area is approximately 1.5 ha in extent. It is divided into two more or less equal parts by a drain dug by the American Armed Forces in World War II (ca. 1941). We plan to give a more detailed account of the site in another report on the ecology of the orchid.

THE METHODS

Our methods are very simple. We first made a map of the site by means of compass and tape measure. Over a period of seven months, we located 100 plants, labelled them with plastic or aluminium labels and plotted them on the map. At each visit we counted the number of living leaves on each plant and beginning in 1979 recorded also an estimate of the size of the leaves (small, medium and large). When a leaf was more than half dry it was not counted. We recorded the appearance of flowering shoots and counted buds, open flowers, drying flowers and fruit. We also noted anything else that was affecting the plants and anything unusual. We recorded deaths and labelled additional plants to keep the number under observation at approximately 100. All observations were kept in tabular form but growth, flowering and fruiting were also displayed in graphical form (Fig. 1). On these graphs numbers of leaves over ten were recorded as ten for convenience. These graphs convey an impression of the behaviour of the plants that cannot be got from the tables.

RESULTS

Vegetative growth

We have never seen a seedling of *Cyrtopodium broadwayi* in its first year of growth and have no idea of the size attained after one year's growth. As we saw it in the field each plant was a collection of pseudobulbs of varying ages with one, two or three vegatative shoots. Typically, each year's growth begins from a bud on the pseudobulb of the preceding year. The bud increases in size puts out several leaves in a fan shape and after some weeks the stem enlarges to form another pseudobulb which provides the food store for the next season's growth.

The plotted results of growth, a sample of which is shown in Fig. 1, show clearly that most of the plants begin growing early in the year (Jan. — March), produce their maximum number of leaves by mid-year and then gradually lose leaves until only a pseudobulb remains by November or December. Some begin to grow earlier, in December, and a much smaller number begin in mid-year. Of plants beginning to grow at mid-year there were 17 in all, 3 in 1978, 4 in 1979, 3 in 1980 and 7 in 1981. These numbers do not include plants that produced mid-year shoots alongside existing shoots.

A given clump does not always behave consistently. Thus, No. 40, first seen in March 1978 dried up in August 1978, produced a plant with 6 leaves by Oct. 1978 which lasted until April 1979. A new shoot began growing in June 1979 and it dried up by November. Thereafter, this plant followed the normal pattern of producing new shoots early in the year and drying up by November. No. 96 behaved similarly. By way of contrast, No. 50 produced two vegetative shoots from April to October

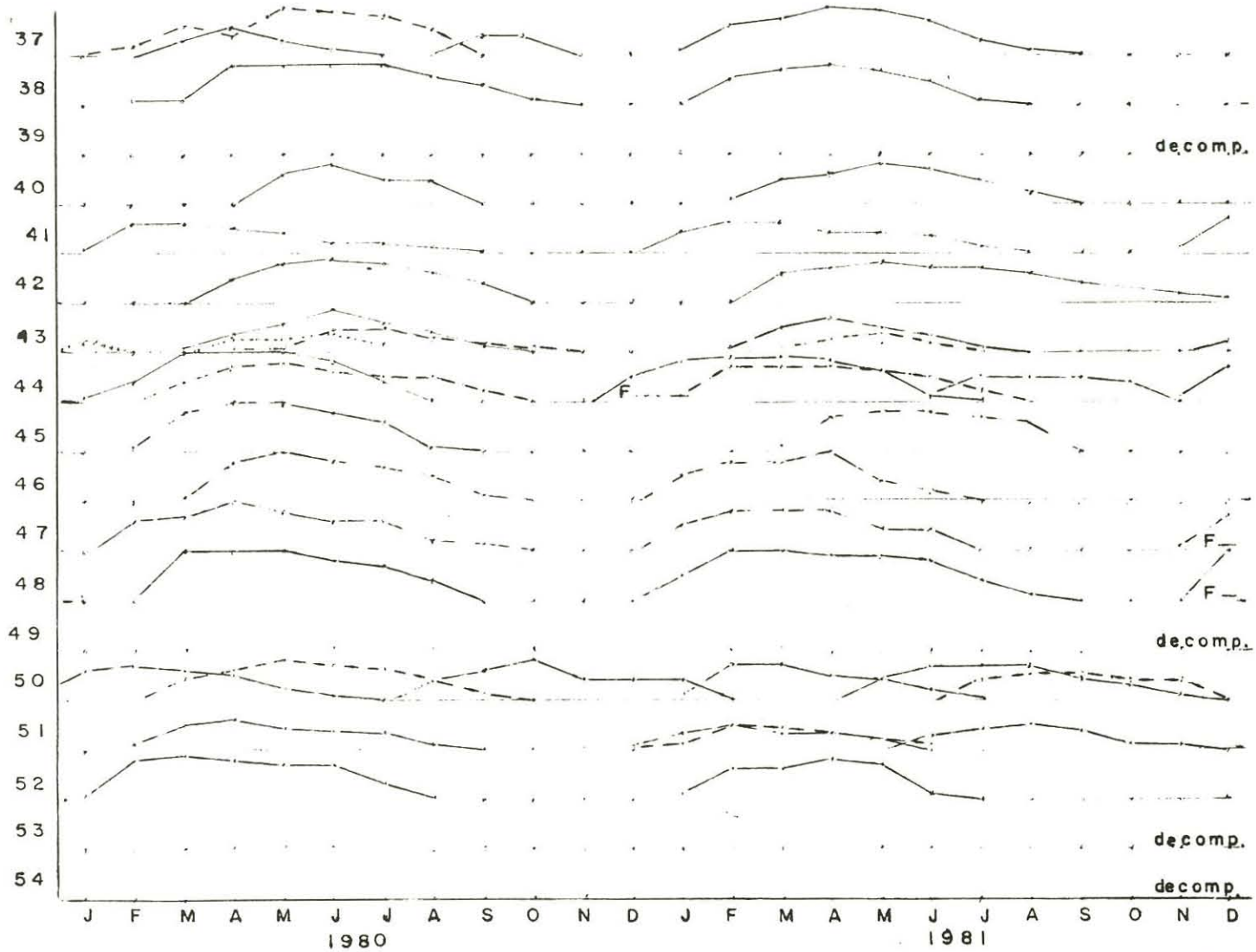

FIG. 1. A sample of the results in graphical form showing clearly the normal patterns of growth and the abnormal behaviour of No. 50. F = flowering shoot.

1978 and two more from March to September 1979, thus following the normal pattern. It then produced one from December 1978 to June 1980, one from March 1980 to September 1980, one from August 1980 to January 1981, one from January 1981 to June 1981, one from May 1981 to November 1981 and one from July 1981 to November 1981. Therefore, shoots of this plant were growing in all months from December 1979 to November 1981.

Of the 17 plants mentioned above that began to grow at mid-year, one (No. 90) produced two shoots simultaneously, giving a total of 18 shoots. Of those that grew in 1981 four were still growing in December when our study ended and their periods of growth were not determined. The mean period of growth for the remaining 14 was 6.6 mo. (shortest 5 mo;. longest 9 mo.). To obtain a comparabe figure for plants following the normal cycle where many more results were available, we used the following procedure. We ignored the data for 1978, the first year of the study, because most of the plants had been found some time after growth had begun.

Starting with the data for 1979 we took the first 18 single-shooted plants and totalled their growth periods. Taking the 1980 data we continued down the list of plants taking the next 18 single-shooted plants and added their growth periods to the previous total. We proceeded likewise with the 1981 data and then divided the grand total by 54 to get the mean period of growth which was 8.6 mo. (shortest 6 mo., longest 11 mo.). Thus on average, the plants that followed the regular cycle lasted two months longer than those that followed the abnormal cycle of growth. One plant lasted an exceptionally long time, from January 1980 to January 1981 and the new shoot produced in January 1981 lasted to the end of the study in December 1981.

Some vegetative shoots had only a few small leaves and died quickly, others had many more and larger leaves. The maximum number of leaves observed on any plant has been thirteen. We did not routinely measure the size of leaves but Schultes (1967) gives the maximum length as 45 cm and this seems about right to us. So far, we have not attempted to meausre the growth of pseudobulbs.

Reproduction

Flowering occurs mainly in the dry season (Table I). In 1978 and 1980 the peak month was March and in 1979 and 1981 the peak month was February. There has been some flowering also in December, normally a transitional month from rainy season to dry, and in 1981 one plant was in flower on 14th November. In 1979 one plant flowered in June and in 1981 No. 79 flowered in August in the middle of the rainy season. No. 79 had not behaved abnormally before but the vegetative shoot that had sprung up in December 1980 had dried up completely by the time of our visit in June 1981 and the new vegetative shoot produced in July flowered in August. Plant No. 79 was remarkable too in another respect. Normally, when a plan is going to flower it produces the flowering stalk early in the growth of the vegetative shoot and in the axil of a scale leaf but in No. 79 the

flowering stalk was terminal.

Table II summarizes the observations on flowering and fruiting. With visits only once a month it was impossible to get accurate counts of the number of flowers on each inflorescence. However, by counting buds and drying flowers as well as open flowers it was possible by adding all the figures to get an estimate but one that is undoubtedly low.

TABLE I

The numbers of inflorescences that flowered in every month of each of the four years of the study. Numbers in brackets indicate inflourescences on which buds were counted in one month but on which no flowers were seen in the following month.

	1978	1979	1980	1981
January	0	1	0	3+(1)
February	2	7+(1)	2+(2)	5+(4)
March	12+(2)	6	10+(2)	5
April	2	3	2	1
May	1	0	1	0
June	0	1	0	0
July	0	0	0	0
August	0	0	0	1
September	0	0	0	0
October	0	0	0	0
November	0	1	0	0
December	0	0	0	2
Total.	19	20	19	22

TABLE II

Summary of reproductive performance

The figure in brackets (19) in the 1981 column is the number of buds and flowers counted on the two inflorescences that flowered in December 1981 (see Table I) whose fruits, if any, would have matured outside the study period. Therefore, this figure is subtracted from the total number of flowers counted in 1981 (568) before calculating the figures for number of fruit set and matured per 100 flowers.

	1978	1979	1980	1981
1. No. plants flowering	21	22	23	23
2. No. of inflorescences	21	23	23	24
3. No. infl. on which buds & flowers counted	19	20	19	22
4. No. of flowers counted	570	546	445	568 (19)
5. Av. No. flowers per inflorescence 4/3	30.0	27.3	23.4	25.8
6. No. of fruit set	10	1	4	13
7. Av. No. of fruit/ 100 flowers	1.75	0.183	0.899	2.36
8. No. of fruit matured	6	1	4	11
9. Av. No. of matured fruit per 100 flowers	1.05	0.183	0.899	2.00

Sometimes a flowering stalk would be recorded on one visit but not on the next. When looked for, most of these stalks were found to have been eaten, possibly by grasshoppers. This accounts for the difference in Table II between the figures for the number of inflorescences produced and the number on which flowers or buds were counted. The table shows the greatest mean number of flowers per inflorescence as 30.0. A particularly handsome specimen that flowered outside the study area and which we must have encountered at the peak of its flowering had 95 flowers and buds. Although others may not normally bear so many flowers it gives some idea of the extent to which our counts may be underestimates. One of the striking features of the table is the low number of fruit set in any one year in relation to the number of flowers produced A particularly bad year was 1979 with only one fruit set. The number of fruit that mature may be even fewer than the number that set. We do not know what causes the disappearance of fruit between visits. Other ground orchids on the savanna such as *Epistephium parviflorum* and *Otostylis brachystalyx* set very many more fruit and it may be well worthwhile in the future to get comparative figures for these orchids. These facts suggest that the pollinator of *Cyrtopodium* is very much rarer than those of other orchids. We do not know what it is and, barring a stroke of luck, finding out would require an enormous investment of time. We do not know either how long flowers last and how long the stigma remains receptive. Very frequent, even perhaps daily, visits would be required to find out.

Not one of the plants that flowered did so in all four years of the study. Twenty-eight flowered once, 21 flowered twice and four flowered three times. Table III compares with respect to size those plants that flowered with those that did not. It is seen that no small plant flowered and only four in the small to medium category did so. The other 49 plants that flowered were medium sized or larger. On the other hand only one large plant (No. 100) did not flower. It was observed for only two years and died an untimely death as will be described later.

Fruit take 5.8 months to mature. This is the mean time taken for all the 19 fruit in which we observed the fruit shortly after setting and recorded its dehiscence. Of the other nine fruit observed three were first seen long after setting, two were not recorded as having dehisced (though observed for seven months) and four disappeared before dehiscing.

Since *Cyrtopodium* sometimes produces two or three shoots simultaneously the possibility exists that in time subsequent shoots may separate and the connections decompose so that two independent plants become established. We observed no instance of this during the four year period but the clumped distribution of the plants in the field suggests that many of the plants we now consider separate were not always so.

TABLE III

The numbers of plants in the different size categorises flowering and not flowering: s = small, sm = small-medium, m = medium, ml = medium-large, l = large. Small-medium plants are those sometimes assessed as small sometimes as medium. Medium-large plants are those sometimes assessed as medium sometimes as large.

	s	sm	m	ml	l	Total
Flowering	0	4	19	9	21	53
Not flowering	16	7	15	11	1	50
Total:	16	11	34	20	22	103

Hazards and Death

The environment in which *Cyrtopodium broadwayi* grows is so hostile that it may of itself be considered a hazard. In the course of the study 18 plants died and decomposed and two others, though not recorded as having decomposed, remained dried up for more than a year and are presumed to have died. Of these 20 plants six died in the first year before we started recording the size of the plant. Of the others, eight are small, three small to medium, two medium sized and one large. All but the large plant seemed to have died of inanition — a failure to maintain themselves in the harsh environment. The large one (No. 100) died after termites attacked the pseudobulbs and demolished them. On 17th May 1981 we found plant No. 71 partially dug up. A termite nest built among the old pseudobulbs had been torn open and we speculated than an anteater had been responsible. We must have visited the plant shortly after the incident for termites were still moving around within the hollow shells of old pseudobulbs. We knew that this plant too

would go the way of No. 100. It survived throughout 1981 and well into 1982 but by November 1982 had died from termite damage. Plant No. 59 was last recorded in leaf on 8th July 1979. Termites were noticed on 13th April 1980 and it was recorded as decomposed on 12th October 1980 so this plant too may have been killed by termites.

This may well be the first published report of termites devouring living orchid pseudobulbs but since none of the members of the group is an orchid enthusiast with wide knowledge of orchid literature we cannot be certain of this. However, it should also be reported that three plants (nos. 46, 47 and 50) were recorded as having been attacked by termites on 16th September 1979 but they all survived until the end of the study.

Love vine *(Cassytha americana)* parasitized two plants but both survived to the end of 1981. We have never seen any damage to leaves that may be attributed to caterpillars but flowering stalks have been cut off and leaves infrequently eaten in such a way as to suggest that grasshoppers are the culprits. Fire is a hazard on the open savanna. Shortly after we began work in 1978 there was a fire in the main savanna near the study area and we observed and marked an orchid that had been burned. The orchid later produced a new shoot so we assume that many of the orchids must survive fire. This seems clear, too, from the fact that orchids are found there at all, because recruitment to the population from seed must be very low.

In the list of hazards we should not exclude man. *Cyrtopodium broadwayi* is a beautiful orchid (see cover) and collectors could easily decimate the population. We know of no one who has succeeded in growing it for any length of time outside its native habitat even when a column of the original soil is taken with it. We advise orchid collectors, therefore, to admire it in its habitat and refrain from experimenting with it or, alternatively, to try propagating it from seed.

DISCUSSION

This study has revealed that *Cyrtopodium broadwayi* in its natural habitat grows for about nine months beginning approximately with the beginning of the dry season at year's end and ending with the "petit careme" (little dry season) in October. It flowers mainly in the dry season with a peak in the period February — March. However, a few plants begin growing at mid-year and may flower then. This explains the seemingly strange flowering behaviour recorded by Schultes (1967). Our studies have shown, too, that the flowering period is more extensive than that recorded in the Flora. But this pattern of growth and flowering presents a paradox. Either the plants respond to the same stimulus at both periods of the year when to us conditions seem so different that a similarity is hard to imagine, or they respond to different stimuli which would be a very unusual state of affairs. If we reject external stimuli and opt for an explanation based on internal ones we are faced with the question why do the plants not begin growth and flower each with its own rhythm all through the year? Obviously this is an area for further research.

But more important to us is the question with which we began. Is *Cyrtopodium broadwayi* in danger of extinction? It is true that the orchids in our study area were more numerous than expected. It is true, too, that we found them in the adjoining large savanna and in another savanna and it was good to see that the orchid can survive fire at least sometimes. On the other hand, however, the rate of fruit production seems to be much lower than in other savanna orchids and so too, we must assume, must be the rate of seedling production. In addition, hazards from termites and anteaters were revealed that were unsuspected before the study was begun. The rate of death has also been fairly high 20 out of 117 plants in four years and No. 71 is known to have died since. As recorded above, two of the 20 died from termite damage. There was no obvious cause of death for the other 18. Only one of the latter was associated with an island of taller vevegation. The remainder were either in open areas where the main vegetation was the small grass *Paspalum pulchellum* or in areas were the sedge *Lagenocarpus tremulus* was dominant. We therefore ansume that these plants died of inanition — a failure to extract sufficient nutrient from the impoverished soil to enable them to survive. All were in the small to medium categories.

One of the features of the distribution of the orchid that is not apparent at first sight is its tendency to be associated with dicotyledonous shrubs in small islands of higher vegetation and to be more common where *Lagenocarpus tremulus* is abundant. In addition, those associated with larger plants seem on average to be larger than those that are not. Whether they benefit from the larger plant or grow better simply because the soil is slightly better in the patch is an open question. In this connection it may be relevant to note that larger plants such as fat pork, *Crysobalanus icacao*, provide perches for birds whose droppings would improve the fertility of the soil in the immediate vicinity.

It seems too much to expect that a seedling from the minute seed of a *Cyrtopodium* could establish itself in the open savanna. It seems to us more likely that seeds will find their symbiotic fungus and germinate only in the more favourable areas where a greater variety of plants exists. There the seedlings will manage to establish themselves and in time grow into large plants. These will gradually over the years, or even centuries, spread out into the open by asexual reproduction but because of the poorer supply of nutrients there the pseudobulbs will in time store less food, the plants will become less vigorous and eventually die. If this view is correct the wastage will be made good by growth from more favourable areas *as long as they remain.* It would be crucial, therfore, in any plan to preserve the savannas to preserve the palm-marsh forest that surrounds them and the islands of tall vegetation within the savannas. If this is done *Cyrtopodium broadwayi* may well be safe. If it is not done, it may vanish forever.

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