THE LIFE HISTORY OF THE STREAK LIZARD,

Gonatodes vittatus (LICHT.)

BY V. C. QUESNEL

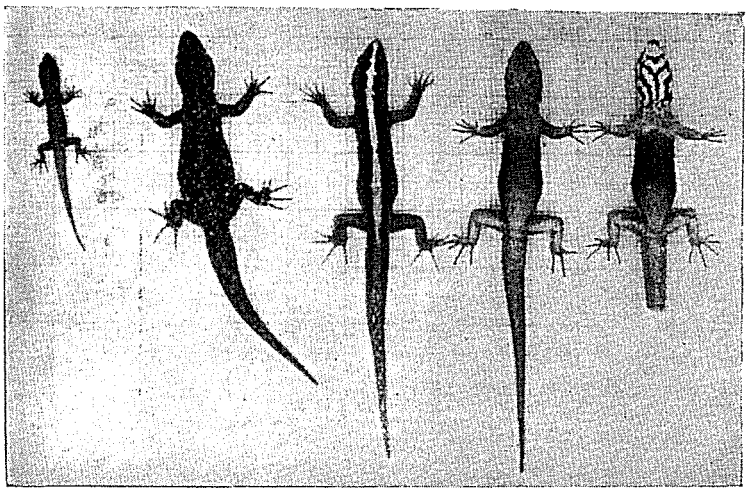
IN many ways the Streak Lizard, *Gonatodes vittatus,* is an ideal animal for study. It is widespread in Trinidad and very common in many localities so that specimens are easily obtained; unlike some other geckoes it is diurnal and, thus readily observed in the field; it is hardy in captivity and lives well with a minimum of attention; it is small enough so that its housing makes no great demands on space, and since it is common about buildings and sometimes occurs within them, the conditions it encounters in even a very simple cage are not much different from those under which it frequently chooses to live. Thus, the results obtained with captive animals may be taken as applying also to other lizards in the locality.

My study of the Streak Lizard began on 18th May 1954. It has continued uninterrupted since then, involving both captive specimens and field studies. The following pages are devoted mainly to observations on the basic facts of the life history. Later on, I hope to present a detailed account of some topics which are here merely touched upon or omitted altogether, particularly courtship, territorial behaviour and fighting.

The captive specimens were kept in wooden cages with glass fronts and wire mesh backs. The furniture consisted of several stones to provide hiding places and a shallow cardboard box filled with dry leaf mould. The lizards were fed usually once a day between 4 p.m. and 7 p.m. Their diet consisted of small insects and other arthropods including termites, both workers and winged forms, winged ants, moths, grasshopper, cockroach and earwig nymphs, small beetles, silverfish, flies, isopods, spiders and caterpillars. The staple items were grasshopper, cockroach and earwig nymphs and termites.

My lizards have more than once gone without food for several days, including one period of two weeks. At another time when I was away on holiday for 3 weeks they each received only two cockroach nymphs half way through. After each of these long fasts they were obviously thin but recovered rapidly with regular feeding.

Their capacity to do without water is also surprising. When I first began keeping these lizards in captivity I provided them with water but during several months I never saw them drink so I removed the containers. The lizards then remained without water for two or three months at the height of the dry season, after which, from other observations, I decided that drinking was a normal habit and so supplied them with water which they immediately drank. It has remained my practice to supply water only about once a week. The lizards suffer no ill effects, and it is their ability to do without food and water for such long periods that makes their upkeep so easy. Their faeces and urine are solid and the excreta is always deposited in one particular spot in the cage thus making cleaning a simple operation and one that may be done at infrequent intervals.



Gonatodes vittatus (x ¾)

Left to right: Day old lizard; Adult female; Adult male (dorsal view); Adult male with golden throat (ventral view); Adult male with black & white throat (ventral view).

(Photo by H. Hinds.)

DISTRIBUTION AND HABITAT

Both of these topics require much more detailed work if an understanding is to be gained of the factors which control the distribution of this lizard and its choice of habitat. I will merely set down a few observations which will help others to find specimens, should they wish to do so.

My notes record the species from the following localities: Port-of-Spain, Couva (Brechin Castle Estate), Maracas Valley, Caura (dam site), Monos (Avalon and South Sea), Chacachacare, Arima Valley (Spring Hill Estate and Simla), O'Meara Savanna (Sierra Vista Rd.), Heights of Guanapo, St. Augustine, Stauble's Bay, Diego Martin (River Estate), Sangre Grande (El Cedro Estate), Mayaro (St. Joseph Estate), Tabaquite (Charuma Rd.), Princes Town (Hindustan Rd.). This list indicates that the species occurs throughout the island wherever a suitable habitat is available. It includes two of the small islands to the west of Trinidad, providing the link with continental South America where it has been recorded in British Guiana (1) and Colombia (2). The species is known also from the Dutch West Indies (1) but the record for Grenada, B.W.I. is incorrect (2) the specimens having come, in fact, from New Grenada, Colombia. Despite intensive searching it has not been found in Tobago (3).

The Streak Lizard favours buildings walls, fences, tree trunks, and rocky places where there are numerous small crevices in which it may hide. I have not found it in the hut at the top of El Tucuche (3075 ft.), where *G. ocellatus* is common, or in rain forest, though I have seen it in more open areas close to forest as at Guanapo. At three localities, Chacachacare, Monos and Stauble's Bay, it occurs practically at the water's edge, at Stauble's Bay in a wall that is certainly partly covered at high tide.

SIZE AND COLOUR

There is no noticeable difference in size between the mature male and the mature female. The average weight is about ⅕ g. and the average length from snout to vent is about 34 mm. The undamaged tail is about 40 mm. long.

In this species, as in all the members of the genus, there is a marked sexual dichromatism. The males have a conspicuous white stripe which runs from the tip of the snout along the middorsal line to the tail where it fades out about half way. Narrow black lines border the white for most of its length. Dorso-laterally, the colour is brown with an orange tinge and laterally it is grey. The belly is black, rather paler in the mid-ventral line than elsewhere.

This general pattern is subject to some variation particularly in the width of the stripes. Thus, for instance, my notes record that "one male had very little brown, the sides (being) tinged with blue-green", and that "I saw a very beautiful male, silver-grey with no brown whatever and only the thinnest of black markings bordering the white dorsal stripe". There is a possibility that this appearance may have been caused by the loosening of the epidermis just before moulting.

The throat colour of the male is even more variable; it has been commented upon by previous writers ((4) (5). The throat may be plain or patterned. In the first case it may be almost white, grey or golden-yellow. In the second case the pattern consists of a tracery of confluent black lines on a white background. Both types may be observed in any month of the year and there is no indication that one type may change into the other. Thus, one golden-throated male was kept in captivity from 14th August, 1954 to 26th May 1955 with no sign of a change to the patterned throat and another caught on 24th March 1955 died on 4th August 1955 also without change. Two males with patterned throats which could be identified by characteristic irregularities of the dorsal stripe were first seen at the end of June 1956 and several times subsequently up to 7th February 1957 when one was seen for the last time. The other was last seen on 21st March 1957. Throughout the periods of observation their throats remained patterned.

The female is more modestly coloured. The head and back are grey, greenish-grey or straw-coloured with a paler dorsal stripe. On each side of the stripe there are two series of composite spots; each spot consists of a dark blackish or brownish marking with a small, compact, whitish marking behind it. There are smaller, less distinct markings on the sides. The tail is usually straw coloured and the underside almost white.

LIFE HISTORY

Breeding Season

I have never seen these lizards actually mating, though I have several times seen behaviour which I assume to be courtship. Thus, I cannot fix the extent of the breeding season from observations on mating. Eggs may be found during every month of the year, and my notes record egg-laying by captive specimens during every month of the year. However, this does not indicate that the breeding season, i.e., the mating season, is necessarily the year long as the following observations will show.

A gravid female captured on 23rd June 1956 laid on 26th June and again on 17th July. On 19th October I decided that this lizard was gravid again and removed the male which was in the cage with her. She laid on 23rd October, on 15th November, on 9th January 1957, on 8th February and on 7th March all in the absence of a male. All the eggs were fertile. Thus, the Streak Lizard may lay several fertile eggs after one mating and the time of the year at which eggs are laid is no indication of the mating season which may be the year long or may be restricted to a few months only. Long-term viability of sperm in the female has been recorded for one other lizard, the Old World Chameleon *Microsaura p. pumila* (6).

The series above shows laying at approximately monthly intervals. Other captive lizards have shown this rhythm and there is some evidence that the same is true of non-captive specimens.

It should be noted that the eggs are laid singly, never in pairs. This is true also of *G. ocellatus, G. humeralis* and *Sphaerodactylus molei* in Trinidad and of the following species which have been observed by Underwood (3): *G. fuscus, Sph. argus, Sph. goniorhynchus* and *Sph. parkeri*. The laying of eggs singly is thus pretty general in the genera *Gonatodes* and *Sphaerodactylus*

and may be characteristic of Underwood's family Sphaerodactylidae (7) as Oliver (8) has suggested, but is, nonetheless, not confined to this family as it has been recorded also for *Aristelliger* (3).

Behaviour of the Female towards the Eggs

My captive lizards usually lay in the cardboard box in their cage and cover the egg with the dry leaf mould. I have watched this operation three or four times and on one occasion actually saw the egg laid. When I arrived the lizard was standing on stiffly-extended legs. Ten minutes later, she deposited the egg near a stone in the box. In the same second of laying she jerked her left foreleg in a scratching motion and then remained still for 3 minutes. She turned around, "examined" the egg and then began to scrape the leaf mould over it. She continued at this for 9 minutes then moved away from the egg, still scraping, and continued at it spasmodically for 50 minutes, during which time she sometimes scraped mould away from the egg rather than towards it. She returned to the egg three or four times presumably to make sure it was being covered, and frequently protruded her tongue. An hour and a half after laying she had retired for the night.

I wondered what would happen if the egg were laid where there was nothing with which to cover it. Two weeks after the above-mentioned incident I got my chance. For a different lizard I had provided as a laying place a hollow breadfruit twig sawn off to a height of about half an inch and jammed into a corner of the cage with a stone and a small block of wood of the same height. The lizard had laid one egg there on 17th December 1956. On 10th January 1957 I visited the cage and found her in the act of laying. I went away, and on returning about 10 minutes later I found her "examining" the newly-laid egg. She turned around so that her hindquarters were in the hole and her forefeet gripping the wooden block. She then made scratching motions alternately with fore and hind-feet in spite of the fact that here was nothing to scrape over the egg. This lasted only a few seconds. A couple of minutes later she left the site.

These apparently instinctive scratching movements may seem to indicate a habitual preference for laying on the ground and covering the eggs with earth. However, I do not think that there is such a preference, for nests of eggs are most frequently found on tree trunks, deposited in crevices formed by loose, peeling bark. They are usually well hidden from a casual glance but are not covered.

There is another aspect of this behaviour which deserves some comment. I was expecting the hatching of an egg which I had left in the box in the lizard's cage and had uncovered it the better to note its time of hatching. The next time I visited the cage the egg was covered up. I uncovered it again and the lizard covered it once more. This happened six times in all. I uncovered the egg for the seventh time. The young lizard hatched leaving a piece of shell lying on the surface looking just like a partially-buried egg, and this, too, was diligently covered up. One other lizard twice covered an egg I had exposed, and unaccountably failed to cover another. Two months later the same lizard did not cover an egg which I exposed in the box. It would seem that covering an egg is not an automatic action following the mere sight of an exposed egg but is determined at least partly by other events.

There is one question posed by the nests of eggs which remains unanswered: Do the lizards prefer to lay their eggs in groups, or do the groups result from a lack of available sites? I believe that a lack of available sites is not the cause of the nests for there seem to be many unused sites on the same trees where the nests are found but worthwhile information on this point can probably be gained only by experimentation.

There is apparently no favoured time of the day for egg deposition. Of all the eggs laid by captive lizards the time of deposition of only five are known with reasonable accuracy and these are 11 a.m., noon, 1 p.m., 5 p.m. and 6 p.m. Several notes say "before midday" or "before 8.30 a.m."

The Eggs

The eggs of the Streak Lizard are hard-shelled, white when laid, elliptical and, on the average, 7.7 x 6.3 mm and 173 mg in weight. As already mentioned, they are always laid singly, but are usually laid in the same spot as previous eggs so that groups of eggs result. My notes record groups of 3, 5, 6, 8, 9, and 12. It is impossible to tell how many of the same group are laid by the same female, but it is possible to say that any group of more than four must have come from more than one, since the female lays at approximately monthly intervals and, as shown below, the eggs hatch after about 3 months.

The eggs are white when laid but become pink after about 2 weeks, presumably because of the development of blood vessels in the yolk sac. Later on, a small bluish-grey patch appears and grows larger as the embryo develops so that near the end of the incubation period the egg is almost entirely bluish grey in colour. When the lizard hatches, the egg does not break in any regular manner. Sometimes it splits in half transversely, sometimes it breaks into several fragments and occasionly only a small "cap" comes off at one end.

The weight which was given above for the egg is the mean weight of eight eggs of different ages. However, the weight of the egg decreases with advancing incubation so that the figure is not representative of the average for newly-laid eggs. One egg weighing 170 mg 8 days after deposition was 156 mg after a further 73 days (2 days before hatching), and another which weighed 160 mg 35 days after deposition was 155 mg after a further 26 days.

Period of Incubation

By noting the dates of deposition and hatching of all eggs laid by captive lizards I soon found that the duration of incubation varied considerably, the shortest being 75 days and the longest 94 days. When the duration of incubation was plotted against the month in which the mid-point of the period fell the graph shown in Fig 1 was obtained. Also shown in the figure are graphs for the average monthly temperatures and the three-monthly moving average. The average monthly temperatures were got by calculation from the figures for the average monthly maximum and minimum temperatures over the fifty years 1900—1948 and 1950 inclusive (9) A comparison of the graphs for temperature and duration of incubation strongly suggest a dependence of duration of incubation on the mean temperature.

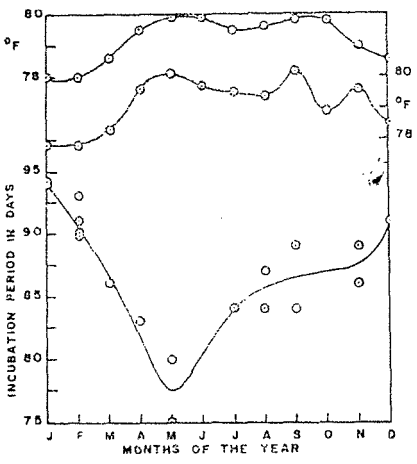


Fig. 1
Annual cycle of temperature changes and changes in duration of incubation of eggs of *G. vittatus*. Bottom graph: Variation of the duration of the incubation period with the month in which the mid-point of the period falls. Middle graph: Mean monthly temperature, (see text). Top graph: Three-monthly moving average of the mean monthly temperature, (see text).

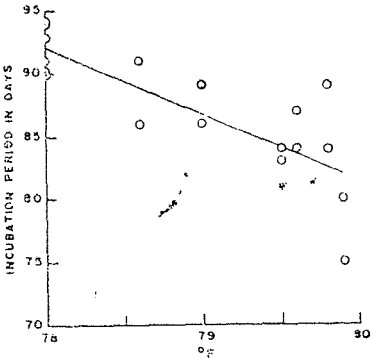


Fig. 2
Relationship between the duration of the incubation period and the average temperature of incubation.

To test this further, the duration of incubation was plotted against the three-monthly moving average which was chosen as the most convenient representation of the mean temperature during the period of incubation. Fig. 2. The best straight line was fitted to the points by the method of least squares (10), and the correlation coefficient was calculated (10) and found to be –0.626. The result tested by student's t test (10), is statistically significant at the 1% level, indicating a dependence of the duration of incubation on the mean temperature.

As a test of the validity of this result, the temperature coefficient of the incubation process was calculated from the data in Fig 2. The temperature extremes shown in Fig. 2 are 78.0°F (25.55°C) and 79.9°F (26.60°C). At the lower extreme the average period of incubation is 92 days and at the higher extreme 82 days. The reciprocals of these figures, 0.0109 and 0.0122, are proportional to the rates of incubation at the two temperatures 25.55°C and 26.60°C and can be used to calculate the temperature coefficient, Q10 of the process from the equation

$$\log Q_{10} = \frac{10\ (\log k_1 - \log k_2)}{t_1 - t_2}$$

in which k_1 and k_2 are the rate constants at the temperatures t_1 and t_2 (11). When this is done, the figure 2.93 is obtained which falls within the range normally associated with biological reactions. Thus, it is reasonable to assert that variations in the mean temperature which occur in a regular manner during the course of the year cause the observed variation in the duration of incubation.

The Young

On hatching, a young lizard is about 35 mm. long and very dark, almost black, in colour. On each side of the mid-dorsal line are two rows of tan spots and other spots on the head. The colour lightens during the course of a day or two to one which is not very different from the adult female colour already described; the pattern is the same but more distinct. In the young female this pattern becomes gradually more diffuse and is indistinguishable from that of the adult female when the lizard is about two months old.

The development of the male pattern was followed in one captive specimen which unfortunately did not live to maturity. At 3 months, the grey dorsal stripe was becoming more prominent. Two weeks later, black dots had appeared between the spots in the rows immediately bordering the grey dorsal stripe and the spots themselves were breaking up into small dark dots. A cinnamon colour was becoming apparent on head and neck. At 4½ months, the black streaks were well developed but still interrupted by paler "nicks" from the original pale spots. The pale spots in the more lateral of the two rows on either side were barely visible and the brown colour was beginning to fill the area between them and the black streaks. At 5½months the male dorsal colour pattern was fully established and the belly was the black colour of the adult. There were no markings on the throat up to the time of his death at the age of 172 days.

The female becomes sexually mature less than a year after hatching. One female which was reared in captivity laid her first egg one week short of her first birthday. A male had been placed in the cage with her 116 days previously. No male has yet been reared from the egg up to the breeding state.

A newly-hatched lizard continually protrudes its tongue and touches the surrounding objects with it. Mature lizards also behave in this way when placed in a new cage and it seems clear that this behaviour is an important element in the process by which the lizard familiarizes itself with its environment. It is very probable that the female's "examination" of a newly-laid egg, already mentioned, includes tasting.

Although I have examined several newly-hatched lizards, I have never seen anything resembling an egg tooth.

Longevity

As mentioned above, one female lizard attained sexual maturity at the age of about 11 months. She lived to the age of 1 yr 148 days and was gravid at the time of death. Another female which was gravid when caught lived in captivity 1 yr 25 days and her minimum age at death, assuming an eleven month period of immaturity, was 2 years. A third female, also gravid when caught is still alive at the time of writing 1 year and 42 days later. It seems to me unlikely that the maximum reproductive period of this species is only as long as its period of immaturity and is possibly up to three times as long. On this reasoning the life span could be about four years.

Wild lizards are, of course, subject to all sorts of hazards which may prevent the attainment of old age, chief among these being predatkion by snakes and birds. Nevertheless, they may live for many months; one mature male was observed intermittently for 9 months,

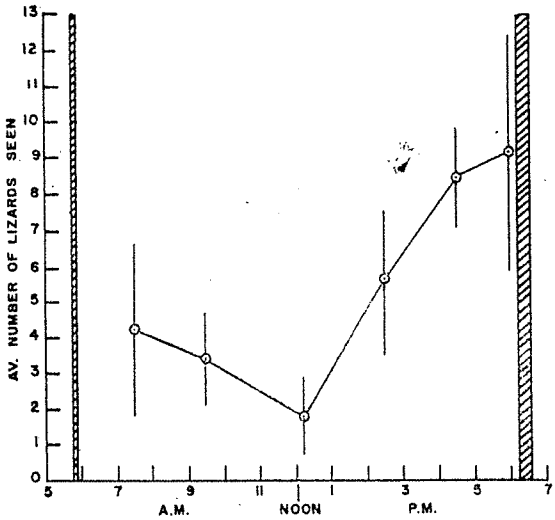


Fig. 3
Relationship between the activity of the lizards and time of day. Seven counts were made at 9.30 a.m. and nine at all other times. The vertical lines through the points represent the standard deviations. The shaded areas at right and left show the extent of variation in times of sunrise and sunset during the period of the survey.

DAILY CYCLE OF ACTIVITY.

The family Geckonidae has both nocturnal and diurnal members. The genus *Gonatodes* is diurnal. To get some idea of the daily cycle of activity of the Streak Lizard I conducted a survey of the population around my house at different times of the day. I simply walked slowly around the house, beginning and ending at the same point, and recorded all the lizards I could see about the base of the house and along a length of fence which ran near the east side. The surveys were done in the months of June, July and August, mainly on Saturdays and Sundays. Mature males, mature females and young were noted separately as far as possible but, since immature specimens may sometimes have been mistaken for mature ones, there is some uncertainty in the results.

Fig 3 shows the results for the total numbers seen at different times; the separate graphs for mature males, mature females and young all have the same general shape. The graph shows two peaks of activity, a minor peak at about 7.30 a.m. and a major peak in the late afternoon. At mid-day there is very little activity. These results refer to a habitat which has both sunny and shady places at all times of the day and the curve is probably typical of such habitats. Where the area is shaded througout the day the pattern of activity may well be somewhat different. Activity decreases shortly after sunset and ceases altogether with darkness. The lizards I have seen at 10.30 and even 11.00 p.m. have all been in areas illuminated by electric light.

The study of activity enabled an estimate of the composition of the population to be made. After the first few surveys the population was estimated to be between fifteen and twenty, and the figure seventeen is obtained by totalling the figures for the greatest number of males, females and young seen at any one survey. These figures are; males—four, females—seven, young —six. From them the ratio of male to female is 0.57 and the ratio of adult to young is 1.83. From the total records of male, female and young counted in the complete set of surveys the same ratios are 0.43 and 2.04. Thus, we may say that there are twice as many females as males and twice as many adult as young.

SUMMARY

The life history of the Streak Lizard has been studied. Eggs are deposited continually throughout the year, the female laying a single egg at approximately monthly intervals. Several fertile eggs follow a single mating and the mating season, if not the year long, cannot be determined by observations of egg deposition. The eggs are frequently deposited in groups, several females contributing to each group. The most favoured sites are small crevices on three trunks but the eggs may be laid in the earth. Some observations on the behaviour of the female towards the eggs have been made.

The duration of the incubation period varies with the time of the year at which the egg is laid and it is shown that the varations are correlated with variations in the mean temperature. The temperature coefficient of the incubation process calculated from the observations is 2.93.

The pattern of the newly-hatched young approximates that of the adult female. In the female, the pattern becomes more diffuse and is indistinguishable from that of the adult at about 2 months. The adult male pattern is fully established at 5½ months. The female becomes sexually mature at the age of 11 months. The duration of the period of reproductive activity is not known but is over 1 year long. The life span is deduced to be about 4 years.

The daily cycle of activity was studied in a wild population. There are two peaks of activity, a minor one in the morning and a major one in the late afternoon. In the same population there were twice as many females as males and twice as many adult as young.

SUMMARY OF WEIGHTS AND MEASUREMENTS

Eggs, young and mature lizards were measured with an ordinary ruler, the eggs to the nearest 0.1 mm (by estimation), the lizards to the nearest 0.5 mm. Weighings were made to the nearest milligram on an analytical balance. In the table below, the first figure in a column is the mean, the second the standard deviation and the last (in brackets) is the number of specimens in each sample. Tail length is variable because of the frequency of regenerated tails; the standard deviation for weights of females is greater. than for males presumably because of the variable contribution of eggs in gravid females. Two in the sample of females were obviously gravid. Symbols: W=weight; L=length; B=breadth; S-V= snout to vent length. All weights are in milligrams, all measurements in millimetres.

Eggs			Hatchling			Adult male			Adult female		
W	173	14 (8)	W	126	13 (6)	1029	131 (6)		1075	191 (5)	
L	7.7	0.3 (10)	S-V	16.5	1.0 (6)	34.0	1.0 (6)		33.5	1.5 (5)	
B	6.3	0.2 (10)	Tail	17.5	1.0 (6)	39.0	2.5 (6)		33.5	3.5 (5)	

ACKNOWLEDGMENT

I heartily thank Dr. J. A. Oliver for reading the manuscript and suggesting improvements in presentation, and also for informing me of the papers by Atsatt and Underwood which I have incorporated as references 6 and 7 though I have not seen them.

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BOTANICAL PROBLEMS FOR THE AMATEUR NATURALIST

BY N. W. SIMMONDS

I am going to spend much of this talk discussing flowering times in plants and I hope to be able to show how the amateur naturalist can assemble really valuable information on this topic. But first let us have some of the facts, so far as they are known.

Before going further afield, let me start with my own garden. Down one side of it I have growing on a tall fence seven vines which show, between them, four distinct flowering behaviours. First there is *Ipomoea learii,* one of the biggest and most handsome of the Morning Glories, which flowers abundantly every morning throughout the year; like the *Ipomoea* (in the sense that they flower steadily) but unlike it (in that they do not flower so abundantly) are *Thunbergia grandiflora, Quisqualis indica* and *Saritaea magnifica;* in general appearance another of the vines, *Phryganocidia corymbosa,* is rather like the *Saritaea* and indeed it belongs to the same family (Bignoniaceae) but it differs markedly in its habits—it flowers in short brilliant bursts of a few days at a time at frequent intervals during the year; *Phryganocidia,* incidentally, is a common woody climber native to Trinidad and may be seen along the Churchill-Roosevelt road. Finally, two of the vines show markedly seasonal behaviour, one of them *(Mucuna rostrata)* flowering magnificently in January and February, the other *(Solandra guttata)* flowering through the wet season, with a peak about November. The *Mucuna* is a Trinidad plant—though I have never seen it in flower in the native state; the *Solandra* is not native, but a close relative *(S. grandiflora)* has rather similar flowering habits and is a conspicuous feature of the wooded limestone country around Tamana and Aripo late in the year.

Other examples of plants which have limited flowering periods readily come to mind, for example: conspicuous Christmas flowers are *Poinsettia* and *Porana paniculata,* the latter a member of the Convolvulaceae but very

*Talk to the Trinidad Field Naturalist's Club, Thursday 14th February, 1957,