natural habitat, and of its anatomy, I cannot believe that the enormous bill has any special adaptive function. I have examined all of the various theories which have been put forth and I find that none of them will stand the test of critical examination. It seems hardly worth while to refute each one in detail for most of them have admittedly been mere guesses and none has received any particular support. It is obvious that hardly a size or shape of bill could be devised which would not have certain useful features in particular situations and in the case of the toucan there seem to me to be two such useful functions. As a means of defence the powerful beak is no mean weapon. I have attempted to pick up a wing-tipped toucan and learned at first hand the damage it can inflict. But nevertheless, it is too much to ask that we believe that the clumsy, slow-flying toucan maintains its great numbers in the face of serious competition from large predacious animals. I saw absolutely no evidence of such enemies and I feel convinced that the toucan population is controlled mainly by parasites, available nesting sites, and similar factors.

A second useful function of the toucan's beak seems to be that it enables the bird to reach with greater ease some of the fruits which form its food, but this again can hardly be a very important factor because of a great abundance of food available without such reaching. It is probably an incidental convenience rather than an important adaptation."

I have four additions of my own to make to these theories; first the bill was undoubtedly useful as a weapon of defence in the case of the 1938 pair; secondly, that when the babies are large there must be very little room in the nest for the mother to clean out the excreta, and a long beak would certainly be useful to delve underneath the baby birds in a conjested hole; thirdly, it would be of great use as a lever or hook when clambering out of the nesting and roosting holes. Lastly, I must mention an isolated but very significant incident bearing on this problem. I actually saw a toucan drinking from a vase shaped bromeliad on a high tree. A long beak would surely be a great help in collecting water from such a narrow container. Both Dr. Van Tyne and myself never saw a wild toucan come down to water to drink although captive birds require a large amount. Dr. Wetmore, a distinquished American ornithologist, has recorded that he has seen the large Red-billed Toucan in British Guiana drinking from a forest stream. It is quite conceivable that water in bromelaids, such a problem for malarialogist, might serve a useful function after all.

OBSERVATIONS ON THE LIFE HISTORY OF THE CITRUS KING PAGE

BY V. C. QUESNEL

In Trinidad there are two very similar black and yellow butterflies that are called by the name King Page. Kaye (1) lists only the larger of them, *Papilio thoas neacles* Roths & Jord., whose caterpillars feed on leaves of *Piper emarginatum* and *Piper tuberculatum* (chandelles); the smaller is *Papilio cresphontes* Cram. whose caterpillars feed on the leaves of citrus plants. Kaye (1) states that "at Para *thoas* is found on both bitter and sweet Citrus",

but it seems probable to me that the two species have been confused and that this observation really refers to *P. cresphontes.* At any rate, *P. cresphontes,* which I shall call the Citrus King Page, is the subject of the observations recorded here.

My observations began on 14th August, 1954, when I happened to see a female laying eggs on the lime tree in my back yard. Some of the caterpillars were placed in jam jars and given lime leaves to feed on; others were left on the tree for comparison. Over thirty individuals were studied.

Eggs

Eggs were laid singly on very young leaves, most frequently on the upper surface. On one or two occasions two eggs were found on the same leaf, but one egg to each leaf is the rule. The female flutters her wings while laying and flies off after depositing each egg, so that eggs on the same leaf are probably laid at different times. My notes record the time of laying on five occasions, four between 12.10 p.m. and 12.45 p.m., the other at 10.40 a.m. It is very probable that the period between 10.00 a.m. and 2.00 p.m. is the preferred time for laying; I never saw butterflies around the tree earlier than 9.30 a.m. and later than 4.00 p.m.

The eggs varied in size from 1.0 to 1.3 mm. They were spherical, with smooth, shiny shells, and of a colour varying between red-gold and greenish gold. Their appearance changed slightly during development as the young caterpillar became dimly visible inside. They hatched in four days.

Caterpillars

Growth

There were wide variations in the rate of growth and the final size attained. On hatching, the caterpillars varied in length from 2.3 to 3.0 mm. They moulted four times, attaining a final length of from 40 to 52 mm, a fifth moult bringing them to the pupal stage. Pupation began from 16 to about 26 days after hatching. Details of measurements and times of moulting are given in a subsequent section.

Appearance

On emerging from the egg, the caterpillars were yellowish-brown and hairy. The hairs shortened during growth and disappeared at or before the second moult. Hairs persisted on the caterpillars in the second instar in spite of the fact that the skin cast at the first moult was hairy, as I observed when I happened to examine one just after the first moult.

The basic colour pattern remained the same throughout larval life, but with variations in detail. It was indistinct up to the second day but thereafter became clearer. The ground colour was brown with three patches of yellow or cream, one at each end and one in the middle. The forward patch covered the first segment dorsally and ran backwards as a narrow line on to the second and third segments dorso-laterally. The middle patch was saddle-shaped, covering nearly all of the sixth segment and most of the seventh, and running on to the fifth laterally. The hindmost patch covered the eleventh and twelfth segments and extended forward dorso-laterally on to the tenth.

After losing their hairiness, the caterpillars took on a shiny appearance which became very pronounced during the fourth instar. At the fourth moult they emerged as really beautiful caterpillars with velvety skins of delicate colouring. The yellowish patches were now vaguely patterned and the areas between them were rich chocolate brown with smudgings of yellow-brown and lavender and a tracery of fine orange-brown lines. There was, too, on each of these dark segments, a pair of very small lavender spots.

At this stage the shape of the caterpillar is quite characteristic. The body enlarges rapidly behind the head up to the third segment which is the largest, and then tapers off gradually. The third and fourth segments together form a raised plaque. There are numerous small protuberances.

Behaviour

Immediately after hatching the caterpillars ate the eggshell. Several hours later the first vegetable meal was taken, a piece of leaf no bigger than the head of a pin. No notes were made of the times of feeding, the length of the interval between feeds, or any changes in these with the growth of the caterpillar. Before moulting there was a period of quiescence of from twelve to twenty-four hours during which there was no feeding. The moulted skin was invariably eaten.

When still young, the caterpillars which were allowed to stay on the tree remained on the leaves even when not feeding. Later on, they rested low down on the main branches or the trunk, returning to the leaves only to feed. The caterpillars kept in jam jars showed a tendency to quit the leaves to rest on the glass as early as the third instar.

Slight disturbances usually caused the caterpillars to arch up the fore part of the body; more violent disturbance stimulated the protrusion of a pair of horns from a spot just behind the head. These gave off a strong smell of rancid butter. The horns were straw-coloured or brownish in the young caterpillars, but became bright orange after the fourth moult.

The caterpillars went nowhere without spinning a thread of silk from glands near the mouth. One, only half emerged from the egg, was already doing this. Before settling down to rest in a place, each caterpillar laid down a relatively thick mat of silk. This was done by figure-of-eight movements of the head, the "eights" always starting from the upper left going to the bottom right then up to the top right and down to the bottom left. When a caterpillar was ready to pupate, it spun a mat of silk with concentrations of silk at head and tail, as was well seen when pupation occurred in the jam jars. It then spun a loop around its body, and, with the claspers firmly attached to the support, remained suspended in the position shown in Fig. 1(a). It moulted to the pupal stage about twenty-four hours after assuming this position.

Pupae

The pupae were peculiarly shaped, and protectively coloured in browns, greys and grey-greens. One is illustrated in Fig. 1(b). Four specimens, the only ones to complete pupation, emerged in thirteen days, but it is possible that pupation may sometimes last much longer, as happens in the Orange Dog, *Papilio anchisiades anchisiades* Roths. & Jord.

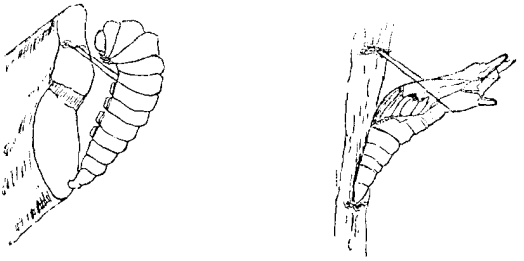

Fig. 1 (a) The caterpillar just before pupation. (b) The pupa.

Mortality

Mortality was high. Many caterpillars which were allowed to remain on the tree disappeared after two or three days, presumably eaten by lizards which were abundant. One newly-hatched caterpillar disappeared when the leaf on which it was resting was eaten by a larger caterpillar. Several eggs never hatched, and two were not found after a heavy shower of rain and were presumed washed off the leaf.

Breeding Season

The normal breeding season is apparently a long one. From the start of the study in August 1954, eggs were found up to the 4th March, 1955. No eggs were found for three months afterwards, until 4th June. Thus, the breeding season seems to correspond with the wet weather.

DETAILS OF THE OBSERVATIONS

Incubation period of the eggs

Specimen No. 9: Egg laid at 12.20 p.m. on 3rd Sept., 1954; hatched before 8.00 a.m. on 7th Sept. though unhatched on 6th Sept. Incubation period 3+ days.

Specimen Nos. 21, 22, 23: Eggs all laid between 12.10 and 12.15 p.m. on 28th Dec., 1954; at 12.55 p.m. on 2nd Jan., 1955, one egg had disappeared, one caterpillar was just emerging, and a hole had been eaten in the third egg preparatory to emergence of the caterpillar. Incubation period 4 days.

Specimen No. 20: Egg laid at 12.45 p.m. on 5th Dec., 1954; hatched some time before 12.30 p.m. on 10th Dec., 1954, because at that time the shell had disappeared and the caterpillar had already eaten a small section of leaf. Incubation period 4+ days.

Specimen No. 18: New-laid egg found on 28th Oct., 1954; hatched on the morning of 1st Nov., 1954. Incubation period 4 days.

Growth of the caterpillars

The resting caterpillars were measured at mid-day as accurately as possible with an ordinary ruler. Specimen No. 15 was the only one measured every day; its growth curve is shown in Fig. 2. Measurements on specimens Nos. 1, 11 and 18 were taken nearly every day and the same type of graph obtained. The graph for specimen No. 18 is included in Fig. 2.

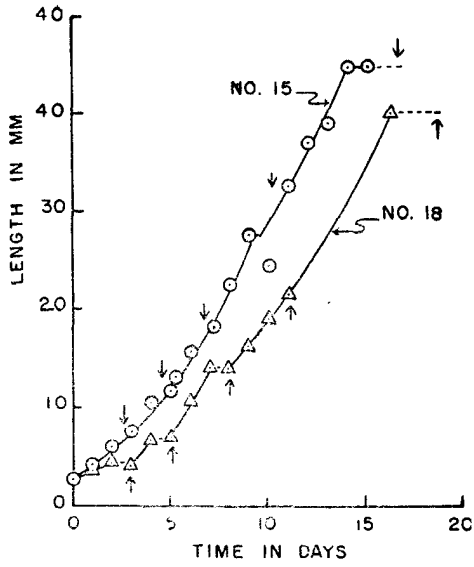

Fig. 2 The growth curves for caterpillars Nos. 15 and 18. The vertical arrows indicate the times of moulting.

The graph for specimen No. 15 is shown as a smooth curve with a single "break" in it at the position of the fourth moult. That for No. 18 has been drawn as a series of "steps". The latter is probably the better representation of the actual growth process, since the necessity of moulting implies a certain maximum size at the end of each instar at which growth ceases until moulting allows a further increase of size. However, the "steps" in the growth curve for specimen No. 18 are probably exaggerated. There is no sign of a slowing down of growth before the final moult.

The first three moults were missed in the earlier caterpillars, but all were recorded for Nos. 15 and 18. The age and size of the caterpillar on moulting are given for four specimens in Table 1. The differences in final size and length of larval life are obvious. I do not know whether these differences are connected with sex; male adults are smaller than female. Specimen No. 15 which was sent to the British Museum (Nat. Hist.) was identified as a female. The figure of 26 days for the length of larval life of specimen No. 11 is a minimum one, because this specimen, which had been left on the tree, disappeared after that time and may not have pupated until two days later.

TABLE 1

Length (in mm) and age (in days) of caterpillars just before moulting.

Specimen	*First Moult*		*Second Moult*		*Third Moult*		*Fourth Moult*		*Fifth Moult*	
	Length	*Age*	*Length*	*Age*	*Length*	*Age*	*Length*	*Age*	*Length*	*Age*
No. 15	6.0	3	10.5	5	15.5	7	24.5	10	45	19
No. 18	4.2	3	7.0	5	14.0	9	21.5	14	40	22
No. 1							25	10	46	16
No. 11							26.0	20	48	26

Length of pupal stage

Specimen No. 1: Moulted to pupa between 4.15 and 7.15 p.m. on 3rd Sept., 1954; emerged on 16th Sept. between 8.30 and mid-day. Pupal period 12+ days.

Specimen No. 15: Moulted to pupa on night of 11th Nov., 1954; imago emerged in the afternoon of 25th Nov. Pupal period 13+ days.

Specimen No. 18: Moulted to pupa on night of 22nd Nov., 1954; imago emerged before 8.30 a.m. on 6th Dec. Pupal period 13 days.

Specimen No. 29: Moulted to pupa on the night of 29th Jan., 1956; imago emerged between 7.30 and 8.30 a.m. on 12th Feb. Pupal period 13 days.

SUMMARY

The life history of *Papilio cresphontes* has been studied. Observations on the caterpillar include measurements of growth and certain points of behaviour. The duration of the stages are: egg, 4 days; larva, 16 to 26 days; pupa, 13 days; total, 33 to 43 days.

ACKNOWLEDGEMENTS

I wish to thank Mr. F. Ambard for bringing to my attention the early moults and Mr. A. G. Gabriel of the British Museum (Nat. Hist.) for identifying the butterfly.

REFERENCE

(1) Kaye, W. J. A Catalogue of the Trinidad *Lepidoptera Rhopalocera* (Butterflies). Memoirs Dept. Agric. Trinidad & Tobago, No. 2, 1922.

BATS OF TRINIDAD

BY ARTHUR M. GREENHALL

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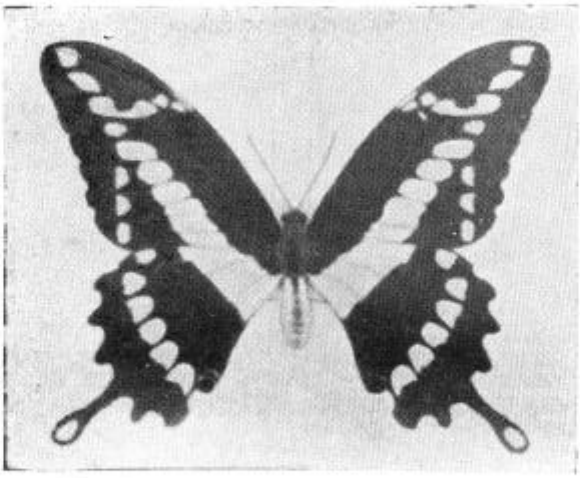
The purpose of this paper is to list the bats of Trinidad and to record those which have been reported or collected since the last comprehensive list of mammals of Trinidad appeared in 1936 (1). The first list of Trinidad Mammals appeared in 1892 (2).

During the course of bat investigations in connection with the anti-rabies programme of the Department of Agriculture several species new to Trinidad have been collected and need to be recorded. Several of our finds are still unidentified and will not be included. Identifications in other instances have not been clarified but have been included. As an aid to zoologists, the species listed by Vesey-FitzGerald and Thomas will be added.

1956 LIST	1936 VESEY-FITZGERALD	1892 THOMAS
EMBALLONURIDAE—Sac-Winged Bats		
1. *Rhynchiscus naso* (Wied)	*R. naso* Wied	*Rhynchonycteris naso* .. Wied
2. *Saccopteryx bilineata* (Temminch)	*S. bilineata* Temm.	*S. bilineata*, Temm.
3. *Saccopteryx leptura* (Schreber)	*S. leptura* Schreber	*S. leptura*, Schr.
4. *Peropteryx macrotis trinitatis* (Miller)	*P. trinitatis* Miller	*Saccopteryx canina*, Wied.
5. *Diclidurus albus* (Wied) or *virgo* Thomas	*D. albus* Wied	
NOCTILIONIDAE—Fish-Eating Bats		

The Sulphur and White-Breasted Toucan at its Nesting Hole.
—(Photo by the Author—see p. 4)



The Citrus King Page — Female.
—(Photo by H. Hinds; specimen from the collection of F. Ambard—see p. 11)