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BEHAVIOUR AND NATURAL HISTORY OF *GRETA OTO* IN CAPTIVITY (LEPIDOPTERA: NYMPHALIDAE: ITHOMIINAE)

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ABSTRACT.– The life cycle of *Greta oto* (Hewitson) (Nymphalidae: Ithomiinae) and the suitability of various foodplants are described. Its behaviour in captiviy is discussed. The ability of this species and other butterflies to display apparently natural behaviour and breed in a small greenhouse emphasises the value of captive populations for behavioural research as well as for public exhibition.

KEY WORDS: Apocynaceae, breeding, Buddlejaceae, butterfly house, captivity, Central America, Coccidae, Compositae, courtship, egg, Homoptera, immature stages, larva, Neotropical, oviposition, Papilionidae, pupa, pyrrolizidine alkaloids, Rubiaceae, Solanaceae, Verbenaceae.

Since the early 1980's, butterfly houses have become very popular, and have been a source of interest for lepidopterists worldwide. A butterfly house is a simple and ingenious idea, consisting of a glasshouse planted with various flowering plants for adult butterflies and various larval foodplants so that the butterflies can breed in a controlled enviroment. There are two types of butterfly houses: the exhibition butterfly house, which is often a very large glasshouse working on the same principle as a zoo, with the public paying to enter (Collins, 1987), and the amateur butterfly house, which is often a small greenhouse on private property, run for the sole interest of the owner.

A butterfly house seems the ideal place to study butterfly behaviour and natural history, but one must remember that this is an unnatural environment. Butterflies often behave in a very different manner from that observed in the wild. Because the butterflies are enclosed, this makes them easier to monitor and more data can be obtained in this way than in the wild.

The subject of this paper, *Greta oto* (Hewitson), is a clearwing ithomiine from Central America. It is bred, mainly in Costa Rica, and then exported, as pupae, to butterfly houses around the world. It has been available for many years now. The life cycle of *G. oto* has been recorded (DeVries, 1987), but to my knowledge this species has not been described in detail. Young (1972) has described fully the life cycle of the close relative *Greta nero* (Hewitson) (as *Hymenitis nero*).

METHODS

The results were obtained in an amateur greenhouse, 8ft (2.4m) x 12ft (3.6m) with an eve height of 5ft 4ins (1.6m) to an apex of 7ft (2.1m). The greenhouse is insulated with a layer of bubble polythene, with an inner layer of Papronet [1]. It is heated by a 3KW fan heater, and lit by two 5ft (1.5m) flourescent lights, situated near the apex. The greenhouse contains many butterfly nectar sources and larval foodplants of species other than those used by *G. oto*. The observations took place over a three month period, from November to January. The temperature in the greenhouse varied from a minimum of 4.4°C (40°F) at night to a maximum of 30°C (86°F) during the day; the temperature outside went to minimum -5°C (23°F) to a maximum 11°C (52°F). A few specimens of the Papilionidae *Parides photinus* (Doubleday) and *Atrophaneura alcinous* (Klug) were also flying and breeding alongside *G. oto*.

The specimens of *G. oto* studied were the F_1 generation from two gravid females. These were obtained thanks to the generosity of Stratford-Upon-Avon Butterfly Farm, which has kept a breeding nucleus of *G. oto* for nearly two years. Their initial stock came from Costa Rica. Approximately 50 specimens were studied over the three month period. A maximum of 30 specimens were under observation at any one time. To assist in observations, the individuals were marked with several waterproof marker pens. The marks were placed on one of the hindwings and the combination of colours as well as the number and location of the marks were recorded alongside the available data on the individual, such as the time and date of emergence and sex. This enabled me to track these butterflies relatively easily.

1. Papronet is a special netting made from cross-laminated polythene. It is used primarily as greenhouse shading. In strong sunlight, it cuts out 25% of the bright light, but in dull condition it lets 94% of the light in. This material also acts as an insulator, saving on heating costs during cold weather. Papronet is extensively used in butterfly houses. Available from Direct Wire Ties Ltd., Hull, England HU9 P5NL.

RESULTS

Larval Foodplants

The larval foodplants of *G. oto* belong to the genus *Cestrum* (Solanaceae). In the wild, several *Cestrum* species have been recorded as hostplants, notably *C. standleyi* (Morton) and *C. lanatum* (Mart. & Gal.) (DeVries, 1987; Drummond and Brown, 1987). In captivity, *G. oto* use many *Cestrum* species, including *C. elegans* (Schlecht.), *C. aurantiacum* (Lindl.), *C. parqui* (L'Herit.), *C. newelli* (Nicholson), and *C. nocturnum* (L.). All these were present in the greenhouse. By far the preferred larval foodplant of *G. oto* was *C. nocturnum*. The other four species were only very occasionally used and many of the larvae on them died in the first instar, or developed more slowly. Various butterfly houses which have bred *G. oto* reported that development went extremely well in the past on *C. elegans*, contrary to

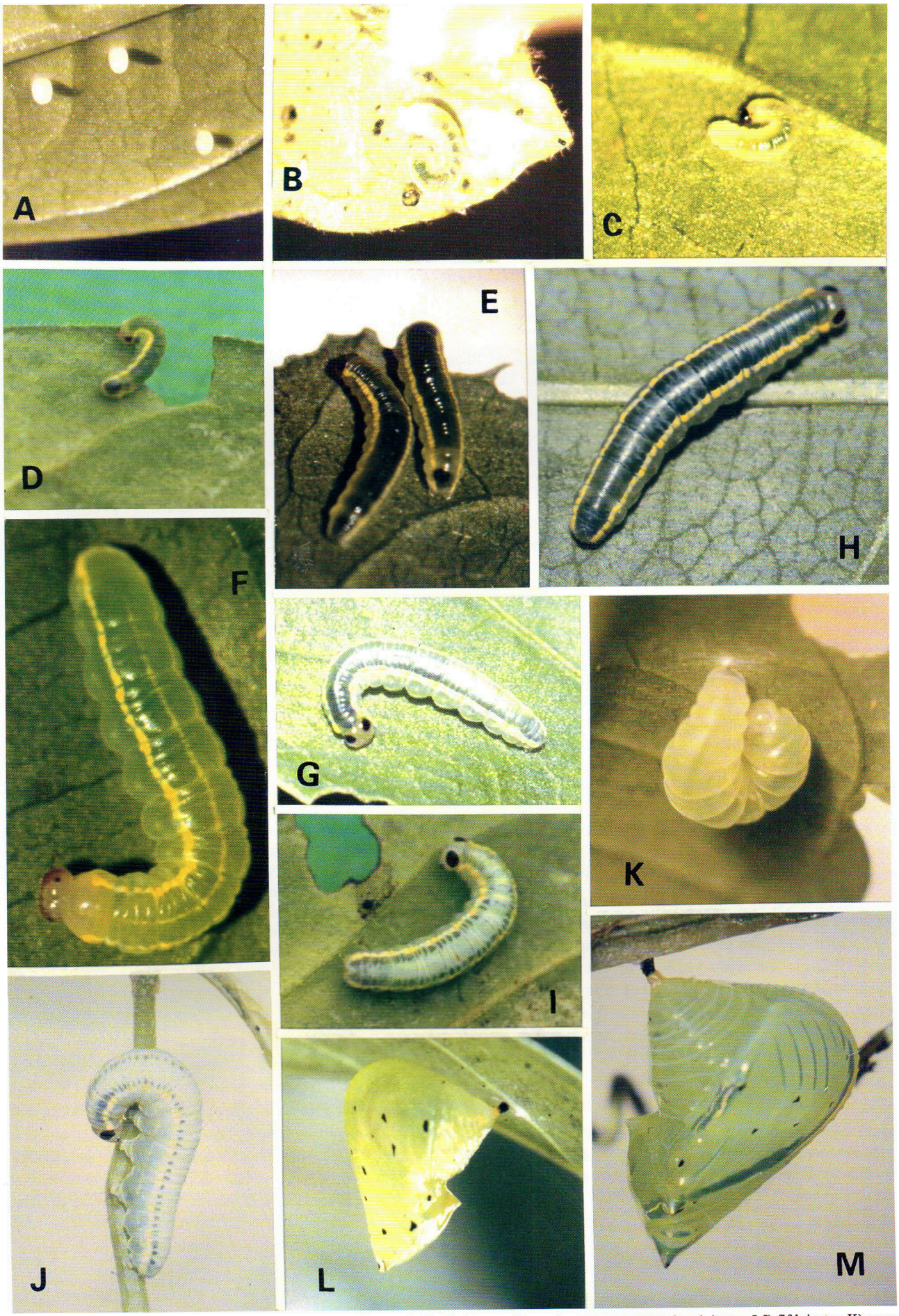

Fig. A-M. *Greta oto* early stages: A) egg; B) first instar; C) second instar; D-E) third instar; F) pre-fourth instar; G-H) fourth instar; I-J) fifth instar; K) prepupa; L-M) pupa.

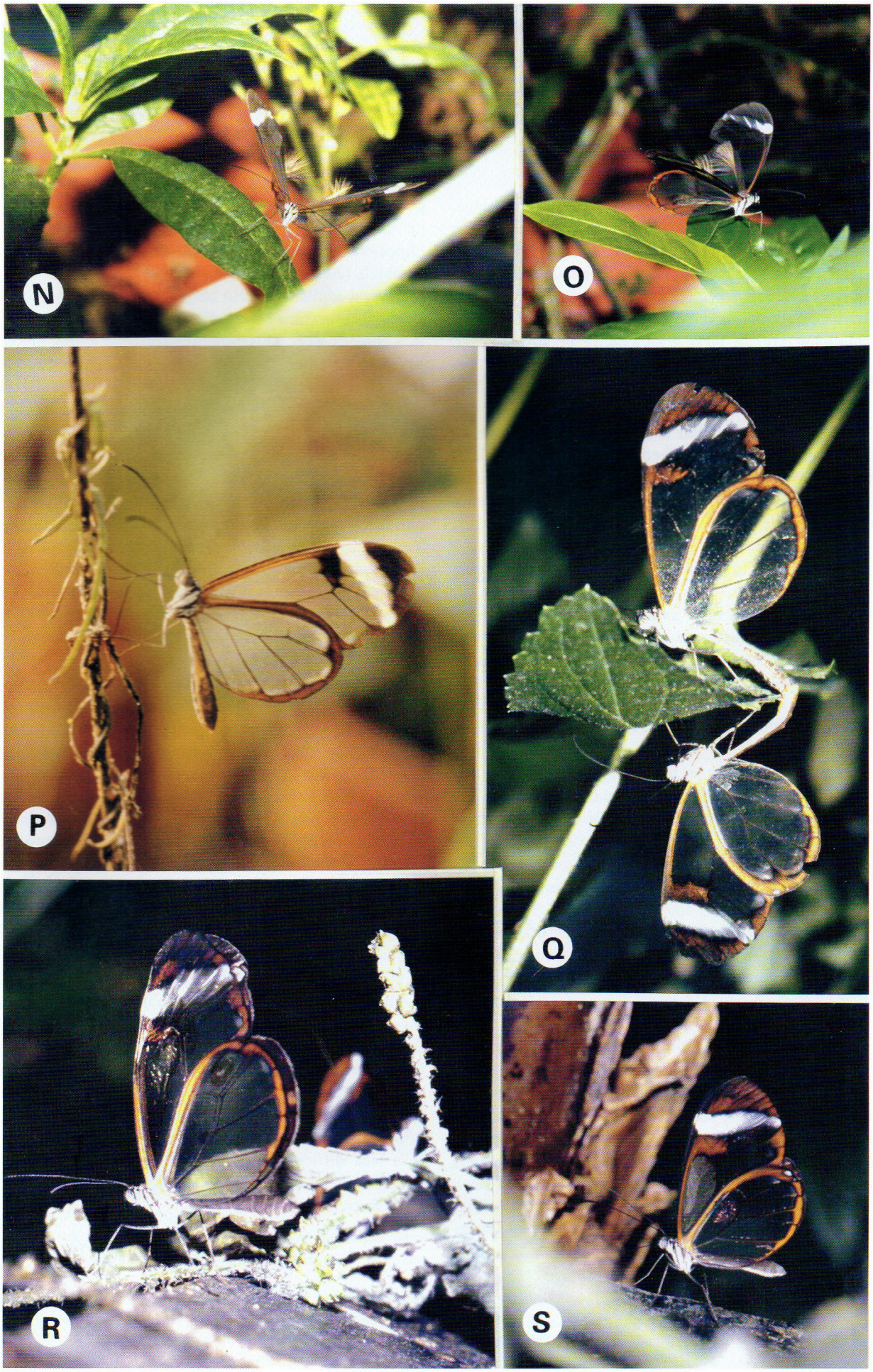

Fig. N-S. *Greta oto* adults: N-O) males displaying the subcostal androconial brushes; P) adult feeding on the sugary excretion from a scale insect infested plant; Q) mating; R) a male feeding upon a cut *Heliotropium indicum* stem; S) adult showing a blue identification marking on the cell area of the hindwing.

my experience. But these butterfly houses usually had only one species of *Cestrum*, so that the butterflies were not given a choice.

Natural History of the Early Stages

Egg: The eggs are white at first, turning cream after a few days. Oviposition is singly on the underside of *Cestrum* leaves. There seems to be no rule as to what age of leaf is used, although a preference for more mature leaves was observed. The egg stage lasts on average for seven days.

Larva: After hatching, the larva will proceed to eat its own egg shell. The following day, the larva grazes on the underside of the *Cestrum* leaf, often producing a hole in it. After its first meal, the midgut of the larva becomes evident, which is dark green. The first instar lasts an average of four days.

The second instar is very similar to the first, and also lasts an average of four days. Later instars feed on the edge of the leaf. The feeding pattern of all the instars is very erratic. It seems as though the larva feeds in a different area of the leaf or from a new leaf each day. The whole leaf is rarely eaten. All instars, especially the earlier instars, rest in the typical 'J' shape, a common behaviour noted in other species of Ithomiinae (Brown and Freitas, 1994).

The third and fourth instars are similar to each other, bearing similar markings and lack the translucent qualities of the previous instars. The head of all the instars are adorned with conspicuous black "eyespots". The duration of the third instar is, on average, five days, whilst the fourth instar usually lasts four days. On the approach of ecdysis, the later instars become swollen and are bright green.

The fifth instar usually feeds on the younger leaves on the top of *Cestrum* hostplant, but rests generally on the lower leaves. The fifth instar lasts about three or four days. On the approach of pupation the larva turns green and loses all of its markings.

The prepupa will then find a suitable pupation site, usually underneath mature leaves of the hostplant. The prepupa stage usually lasts three days.

Pupa: The pupae are green, marked with several black speckles which seem to vary between the individuals. The wing cases are edged with silver. The pupal stage lasts, on average, twenty days.

Adult Biology

The adults are mainly nectar feeders: *Buddleja* (Buddlejaceae), *Lantana* (Verbenaceae), *Pentas* (Rubiaceae), and the Compositae, *Eupatorium*, *Vernonia* and *Heliotropium*, were all used. In addition, freshly dried flowers and stems of *Heliotropium indicum* attracted many *G. oto*, generally males, though occasionally females. *Vernonia, Eupatorium* and especially *Heliotropium*, contain pyrrolizidine alkaloids, which are sequestered by most ithomiine adults, usually the males. The source of the alkaloids is nectar from the flowers or more often from the damaged stems (Brown, 1984). In captivity, cut *Heliotropium indicum* is usually hung up to dry in the flight path of the adults. I have observed as many as 20 adults feeding from these dead *Heliotropium* stems. The functions of these pyrrolizidine alkaloids sequestered in the butterfly are defensive and reproductive (Brown, 1984; Drummond, 1984). Some of these alkaloids are employed in the manufacture of pheromones by the adult male which are used to subdue the female during courtship. It has been suggested that the female may be able to assess the alkaloid content of the courting male, and therefore choose the male with the greatest potency. Alkaloids are contributed to the females via the male spermatophore (Brown, 1985, 1987). *G. oto* have been observed feeding on the stems of *Parsonsia capsularis* (Endl. Ex Deless) (Apocynaceae), which is also known to contain pyrrolizidine alkaloids (Ackery and Vane-Wright, 1984).

Several adults were also observed perilously feeding on a dead *Dryadula phaetusa* (Linnaeus) (Nymphalidae) caterpillar caught in a spider's web. This penchant for dead insect fluids has been observed in other ithomiine species (Drummond, 1976). In the absence of flowers, it was found that sugary secretions from scale insects (*Coccus hesperidum*) (Homoptera: Coccidae), and other plant pests, helped to sustain the adults, yet pads soaked in sugar and water or honey and water pads, commonly used to feed captive butterflies in the absence of flowers (Turner, 1974; Rothschild and Farrell, 1983) failed to attract *G. oto*. Finally, *G. oto* has been seen feeding on bird droppings in captivity (J. Young, pers. comm.), a common habit seen in other Ithomiinae (Ray and Andrews, 1980; Young, 1984; Ross, 1995).

Courtship and mating generally took place in late afternoon, around 1500h. These observations took place during the winter months when it was dark by 1630h and, although there were artificial lights in the greenhouse, these were switched off at 1600h. By mid afternoon, the butterflies would become increasingly restless; the males would position themselves horizontally on a leaf and open their wings to an angle of 45°. This was the only time that *G. oto* ever remained motionless with their wings open. On closer inspection, the reason for this became apparent. The hindwing subcostal androconial brush, normally hidden, was raised and the scent hairs erected. The male was observed to sit for a very short while until a butterfly flew past. It would then respond rapidly to investigate this 'intruder.' If it was a female, a furious aerial chase would commence, featuring many aerobatics. This would only last for about 20 seconds, after which the female would alight on a leaf with the male hovering above, beating its wings with scent hairs extended. If the female was not interested in the advances of the male, she would walk underneath the leaf she had just alighted on, and the male would then fly off and try his chances elsewhere. The above sequence happened very frequently. But approximately one in four courtship rituals ended in a successful copulation. If the female was subdued by the attention of the male, she would let the male settle beside her where copulation would take place. The pair would remain joined, often beneath a leaf, for at least an hour, sometimes overnight.

It was difficult to assess the longevity of the adults. The average life span was three to four weeks, but one individual lived for over ten weeks.

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