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ON THE HOST ASSOCIATION AND IMMATURE STAGES OF *HORAGA RARASANA* (LEPIDOPTERA: LYCAENIDAE: THECLINAE)

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ABSTRACT.– The larval host of *Horaga rarasana* Sonan is proven to be *Symplocos sumuntia* (Symplocaceae). Immature stages of this Taiwan endemic lycaenid has unusual characters, which are considered autapomorphic in *Horaga*.

KEYWORDS: biology, Cheritrini, endemism, *Horaga*, Horagini, hostplants, Hymenoptera, immature stages, Iolaini, Oriental, parasitoids, *Rathinda*, Rutaceae, Symplocaceae, Taiwan, taxonomy, Trichogrammatidae.

Eleven species of *Horaga* Moore are known to occur from India across Southeast Asia to New Guinea (Takanami, 1991). All species inhabitat tropical or subtropical forests except *H. rarasana* Sonan (Fig. 1), which is endemic in Taiwan and confined to a very restricted range of the temperate climate zone in the northern part of the island (Hsu *et al.*, 1986).

The confirmed records of *H. rarasana* show a sporadic distribution within a radius of only 30 km, located in Taipei Hsien (= county), Ilan Hsien, and Taoyuan Hsien (Fig. 10) (data from Yamanaka, 1980, and NTU, NTNU specimens). There is only a single record outside of the above area, in central part of Taiwan (Yamanaka, 1980), but this record has yet to be clarified.

The life histories of several *Horaga* species are known and summarized by Cowan (1966). Nothing has been reported on the life history of *H. rarasana*, however. We discovered the eggs of *H. rarasana* on *Symplocos sumuntia* (Symplocaceae) in the autumn of 1987, and subsequently reared out this lycaenid the following summer. The description and biological notes for this rare species are given here, based on observations on the population at Mt. Lala (Lala-shan), 1500-1900m, Wulai, Taipei Hsien (rearing lots: HSU 87K5, 88C2, 96M14) and Mt. N. Chatien, 1600-1727m, Wulai, Taipei Hsien (HSU 96E3, 97A42, 97C15).

Immature stages of *H. rarasana*

MORPHOLOGY. *Ovum* (Fig. 2): white, semi-spherical, slightly depressed, 0.82 ± 0.03mm in diameter (n = 10), 0.45 ± 0.03mm in height (n = 10). Surface of chorion prominently sculptured with hexagonal patterns, bump-like processes present at junctures of bee-hive--like network. Micropyle depressed, with surrounding areas sculptured with small, round or pentagonal pattern.

First instar larva (Fig. 3): somewhat cylindrical, but prominent, bump-like processes present at mesothorax, metathorax, and A1 through A7 dorsally; throacic segments with double processes, abdominal segments with single, process of A7 comparatively small. Body pale creamy yellow, distal ends of processess brown, a narrow, brown line present laterally. Prothoracic shield diamond-shaped, anal shield nearly oblong. D1, D2, SD1 strongly curved backwards, arranged in a longitudinal, straight line, D2 much longer than D1, SD1. Head dark brown throughout.

Second instar larva (Fig. 4): body setose with brown hairs. Anterior margin of prothorax with a medial cleft. Processess strongly elongated into "horn"-shape; thoracic process pointing forward, with mesothoracic approximately half length of metathpracic process; processes of A1 through A5 errect, A6 pointing posteriorly; a pair of prominent, lateral-pointing processes present at A9, process of A8 undeveloped. Length formula of body process as follows: 2 T1 = T2 = 3/4 A1 = 3/4 A2 = A3 = A4 = A5 = 3/4 A6 = A9. Body color turning pale green, with distal portion of processes purplish red. Head pale green with black stemmata and brown moth parts. Spiracles elliptical, brown.

Third instar: All abdominal processes except A6 pointing anteriorly, otherwise similar to second instar.

Fourth (last) instar larva (Fig. 5): approximately 18.0mm in length toward maturity, body stout but attenuate toward caudal end. Processes of A1 through A5 appressed toward the body. Spiracles creamy yellow. Ground color of body green, with complex patterns of white and purplish red markings dorsally; a creamy white lie present beneath spiracles. Processes of prothorax, 6th abdominal segment green, others purplish red.

Pupa (Fig. 6-7): stout, strongly down-curved, with prominent cremaster at caudal end, approximately 12.0mm in length. Minute bumps present dorsally. Ground color green, with creamy white patches edged by purplish brown present dorsally. A patch of white present along dorsum of wings. Spiracle brown or creamy yellow in color.

HOST ASSOCIATION: Larval host is *Symplocos sumuntia* (Symplocaceae) (Fig. 9) (HSU 87K5, 88C2, 96E3, 96M14, 97A42, 97C15).

Biological Notes

The ovum is laid singly on small twigs or branches (Fig. 2). Larvae consume young growth or other soft tissues of the host. The pupa does not have a thoracic girdle, and is attached to a twig or branch only by means of an enlarged cremaster. The butterfly has one generation per year; generally is on the wing from May through October (Shirôzu, 1960; NTNU specimens). The univoltinism of this species is unique in the genus *Horaga*. Adults frequent flowers of *Tetradium ruticarpum* (Rutaceae) for nectar (Hsu *et al.*, 1986).

Diapause: Overwinters as diapausing eggs, which hatches in spring in accord with the spring new growth of the host (HSU 87K5, 96M14, 97A42).

Parasitism: Eggs were parasitized by an unidentified Trichogrammidae species (HSU 96M14, Fig. 8).

Discussion

The larvae of *Horaga* are reported to have 11 "horns" (Eliot *et al.*, 1992), which actually do not include the less prominent processes present on the mesothorax, and on A3 and A7. The number of processes will be 15 had these processes counted (see Pl. 5, fig. 7,

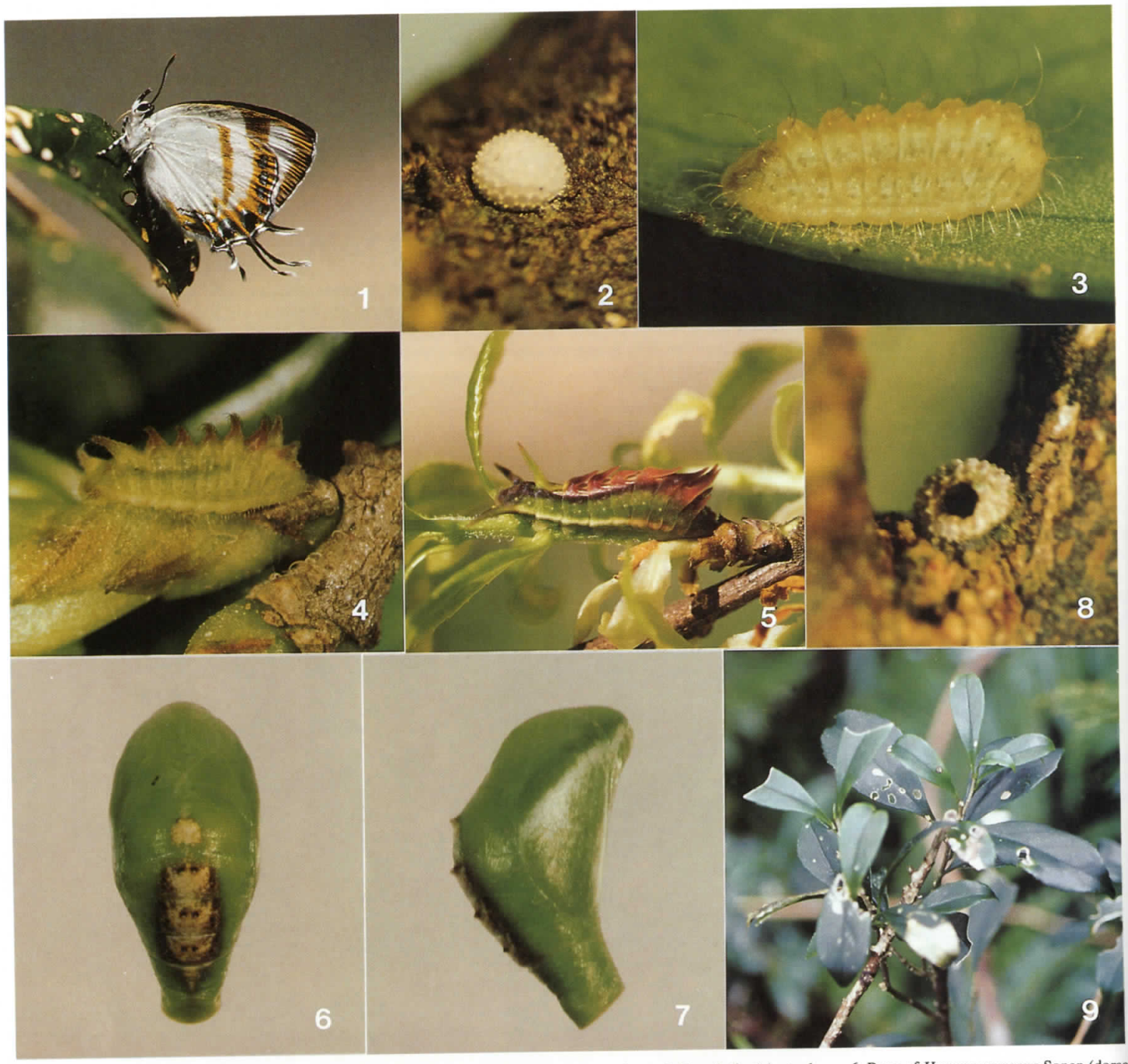

Fig. 1-9. *Horaga rarasana* Sonan: 1. Adult. 2. Ovum. 3. First instar larva. 4. Second instar larva. 5. Fourth (last) instar larva. 6. Pupa of *Horaga rarasana* Sonan (dorsal view). 7. Same (lateral view). 8. Ovum of *Horaga rarasana* Sonan with a hole showing parasitism by an undetermined Trichogrammidae wasp. 9. Larval host of *Horaga rarasana* Sonan, *Symplocos sumuntia*.

in Davison *et al.*, 1896). The total number of processes of *H. rarasana* is 13. A notable difference between the larva of *H. rarasana* and previously recorded *Horaga* species is that the lateral processes of A2 are absent in *H. rarasana*. The condition in *H. rarasana* probably represents an apomorphic character state in *Horaga*, since the larva of *Rathinda*, the sister genus of *Horaga* according to Eliot (1973), possesses 15 processes, with lateral A2 processes present (Davison *et al.*, 1896). Considering the lateral A2 processes does not exist in Cheritrini, the sister tribe of Horagini, nor in further distantly related groups such as Iolaini (data resource: Clark and Dickson, 1971; Igarashi and Fukuda, 1997), the possession of the lateral A2 processes could be a synapomorphy of Horagini member. The condition in *H. rarasana* probably involved a secondary loss during the evolution of the ancestor of this butterfly adapting to the temperate climate zone from the ancestral, more tropical environment for heat preservation. Another difference is that A3 process is fully developed in *H. rarasana*, but not in the other known *Horaga* as well as *Rathinda* (Davison *et al.*, 1896). The character state in *H. rarasana* is also probably an autapomorphy in *Horaga*.

The univoltinism of *H. rarasana*, which is not found in the other *Horaga* and *Rathinda*, may also suggest an adaptation to the shifting from tropical to a temperate environment. These observations, combined with the fact that *H. rarasana* is the sole *Horaga* represented in a temperate zone, show *H. rarasana* represents a highly modified, terminal lineage in the phylogenetic history of the genus.

Abbreviations:

A	Abdomen
NTNU	National Taiwan Normal University
NTU	National Taiwan University
T	thorax

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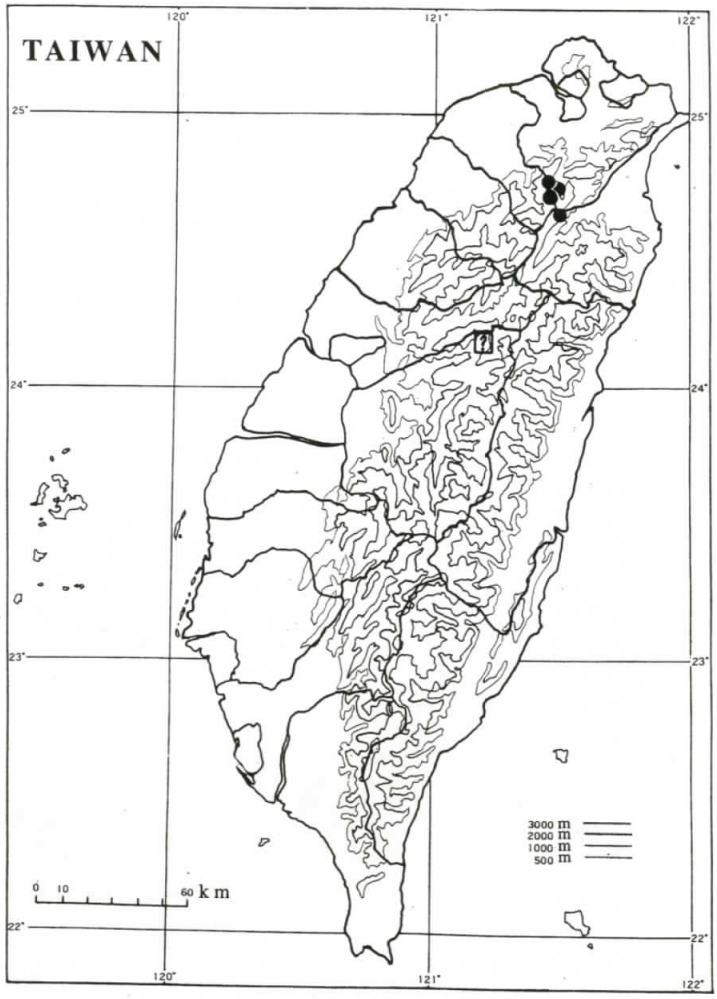

Fig. 10. Distribution of *Horaga rarasana* Sonan. Closed circles denote confirmed records, open square with a question mark indicates an unclarified record.