Discovery of *Ectomyelois ceratoniae* (Lepidoptera, Pyralidae) in a peach orchard in Japan

YUTAKA YOSHIYASU and RUI KITATSUJI*

Abstract : Descriptions of the immature stages and biology of *Ectomyelois ceratoniae* on *Prunus persica* are presented based on field observations and specimens collected from dry fruits in an orchard. This is the second faunal record of this species from north-eastern Asia, and *Prunus persica* is recorded as a host for the first time. The field survey confirmed that this species is commonly found in fields of Kyoto, Central Japan. The larva exploits the host fruit not only in the dry condition, but also partly in the flesh condition. The feeding habit of this species is discussed with reference to other Japanese phycitine species.

(Accepted October 1, 2008)

Key words : Phycitinae, larval habit, stored-product pest, *Prunus persica*, Japan.

Introduction

During field surveys of lepidopterous pests in a *Prunus* orchard in Kyoto, we found a phycitine species boring into the dry fruits of *Prunus persica* on which it has not been recorded from Japan. Through the examination of adults that emerged from the fruit, we determined the phycitine as *Ectomyelois ceratoniae* (Zeller, 1839). Though the species exhibits a world-wide distribution and represents one of the famous stored-product pests (Heinrich, 1956), only one specimen (female adult) has been collected from Japan, feeding on fruit of the Japanese Cheesewood in Central Honshu (Yamanaka, 2001). There is also a report of an adult female found on dried fruit of the English walnut imported from Italy to Nagasaki, Kyushu, which was intercepted by the quarantine station in 1963 (Sonda, 1963). Until now, this species has not been known as a stored-product pest in Japan, and is not distributed in other north-eastern Asian countries. However, the species is listed as a pest in China according to the Quarantine Pest List. It is known that *E. ceratoniae* has a relatively wide range of hosts such as carobs, oranges, walnuts, dates, grapefruits, pomegranates and figs (Heinrich, 1956; Gothilf, 1969; Goater, 1986; Nay & Perring, 2006). Our survey revealed that the species already occurs in Japan, in addition to the formerly known distribution that includes Europe, the Middle East, North America, Jamaica, South America (Argentine), Hawaii, South Africa, Southeast Asia, and Australia (Heinrich, 1956; Roesler & Küppers, 1981; Goater, 1986; Yamanaka, 2001). This species could therefore become a pest of fruit trees and dried fruits in Japan. However, there is little information on the species, especially the immature stages, though morphological characters of larvae were briefly described by Hasenfuss (1960). In this paper, we present descriptions of the larva and pupa, together with biological notes, and provide a redescription of the adults of *E. ceratoniae* to facilitate its identification.

Materials and Methods

(1) Observation of adult genitalia and larval morphology

The whole abdomen of each specimen was removed, and transferred to a 5% KOH solution and boiled for approximately 10 minutes. The material was then transferred to water in a Petri dish and the scales were carefully removed. The material was moved to 75% ethanol and carefully dissected and cleaned to allow observation of the

* Laboratory of Applied Entomology, Graduate School of Life and Environmental Sciences, Kyoto Prefectural University, Shimogamo, Kyoto 606-8522, Japan

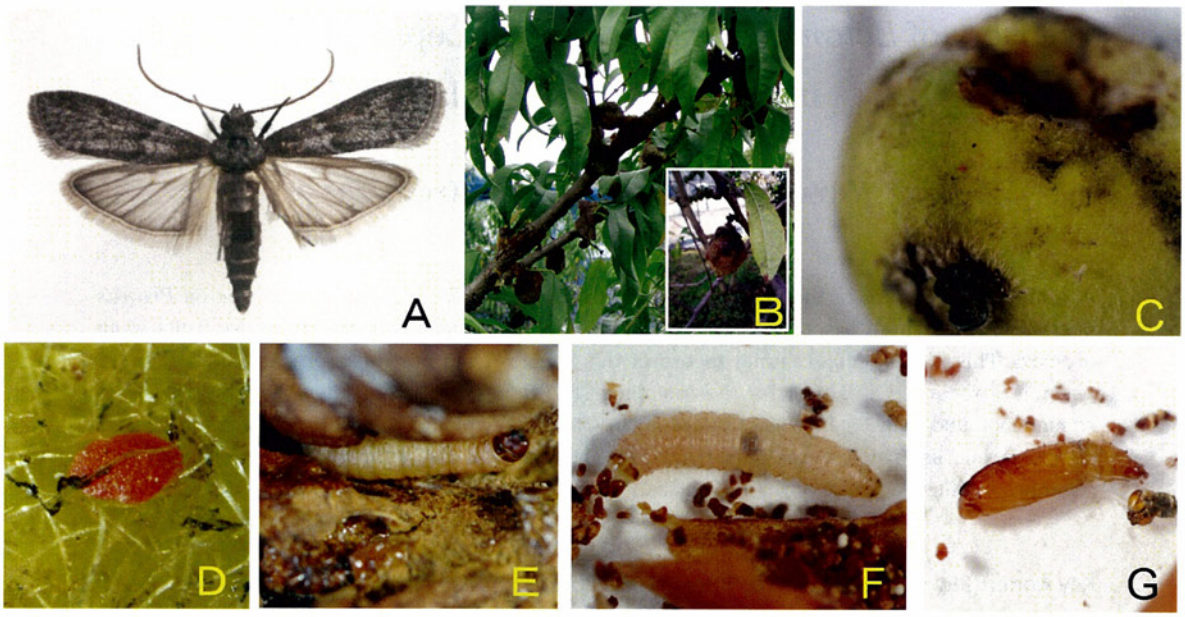

Fig. 1. Adult, habitat and immature stages of *Ectomyelois ceratoniae*. A. adult male; B.damaged fruits by larvae in the field, with enlarged picture; C. eggs on fruit surface; D. *ditto*, enlarged; E. mature larva; F., *ditto*, male; G. pupa.

genitalic characters. The drawing of the genitalia was made in 75% ethanol under a binocular microscope. The larva was also treated in a 5% KOH solution for 10 minutes and then transferred to 75% ethanol. The organs inside the body were then removed, and the general morphology and setae of the body were checked and drawn. Terminology used for genitalia and immature stages, with abbreviation of morphological terms, follows that of Yoshiyasu (1991).

(2) Rearing of moth larvae inside fruits

Field observations of the damaged fruits of peach were conducted in summer to autumn in 2007 and May to September in 2008, in the Experimental Farm of Kyoto Prefectural University, Shimogamo, Kyoto. In 2007, we collected 91 flesh fruits from July to September at irregular intervals, and 101 dry fruits on shoots or from the ground on 15 October. In 2008, 5 to 10 damaged fruits per survey day were selected and collected every week from 22 May to 12 September (Fig. 1B).

Fruits damaged by the lepidopteran larvae were individually placed in a plastic cup (diameter: 9 cm, height: 7 cm) on filter paper. They were preserved under 25℃ , 15L-9D laboratory conditions. Host condition and adult emergence were checked every two days. Adults that emerged from the samples were sorted into species.

Results and Discussion

1. Redescription of *Ectomyelois ceratoniae*

Although the adults were already figured and described in Heinrich (1956) and Roesler & Küppers (1981), we redescribed the species based on the Japanese population for comparison.

(1) Adult (Fig. 1A). Forewing length ♂ 7.8 mm (n=4), ♀ 7.9 mm (n= 9).

♂♀ . Head with frons round, dark brown; vertex smoothly scaled, dark brown. Antenna of both sexes filiform, ca. 2/3 as long as forewing, with short sensory setae on flagellum, rather thicker in male than female. Labial pulpus upturned, brown, with 3rd segment narrow and acute at apex. Maxillary palpus short, dark brown. Thorax and abdomen above greyish dark brown, beneath paler. Forewing grey; antemedial line broad, oblique outwardly, more or less indented, in some specimens represented by indistinct 3 dark brown spots; discocellular lunule constricted to a faint blackish spot; submarginal line indistinct, sinuous. Hindwing semi-hyaline, evenly pale grey except for

darker costal area.

Male genitalia (Fig. 2): Tegumen broad, membranous dorsomedially. Vinculum short and wide, with saccus undeveloped. Uncus rather wide and short, with many short setae dorsally on apical portion. Gnathos well developed, with midventral process long, its apex extending upwards. Transtilla well developed to form a sclerite, inverted-Y in shape. Valva long, costa curved; the apical portion broadly rounded, and inner surface with many setae. Phallus short, without corntus in vesica.

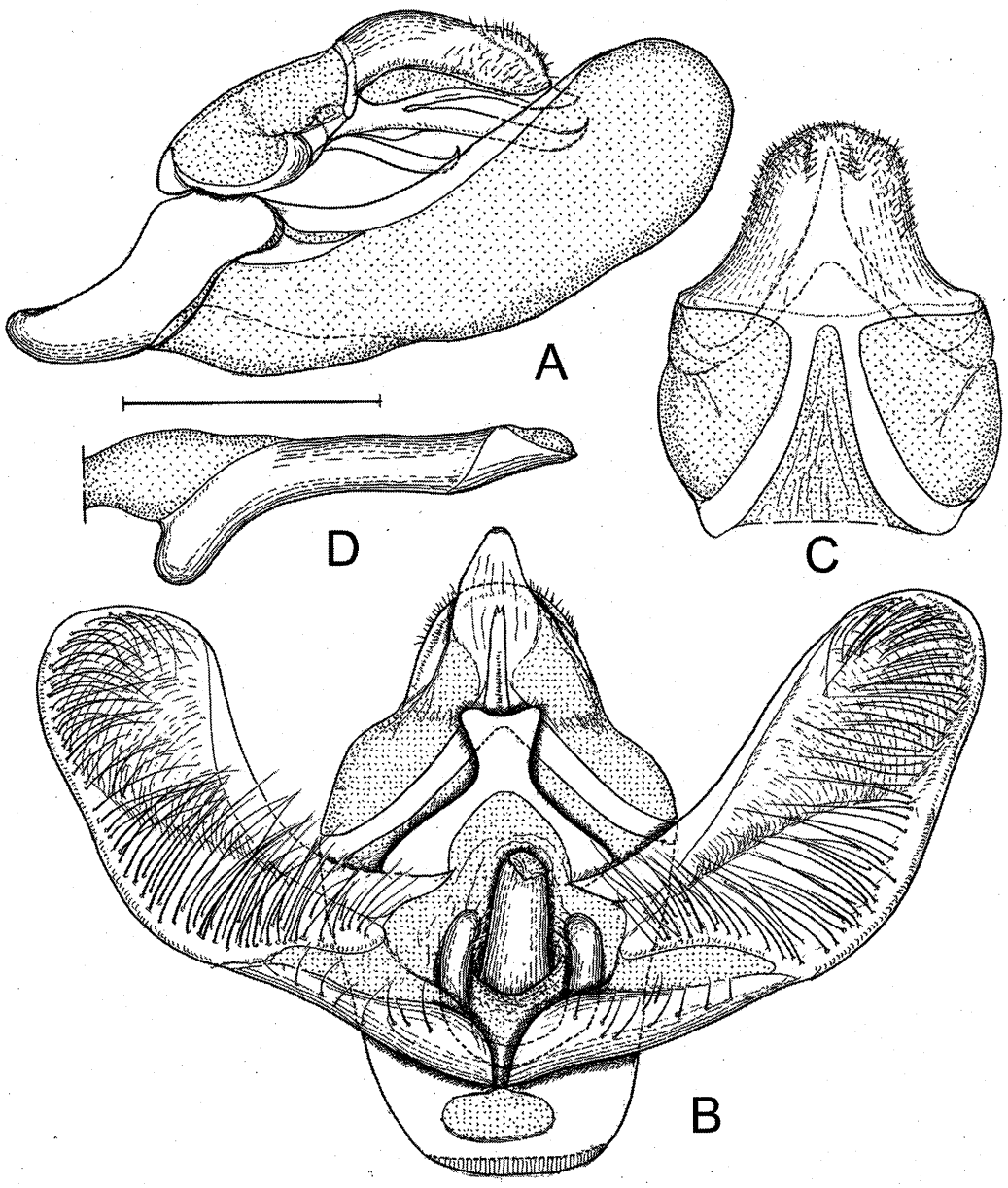

Fig. 2. Male genitalia of *E. ceratoniae*. A. lateral; B. ventral; C. tegumen and uncus, dorsal; D. phallus, lateral. Scale: 0.5 mm.

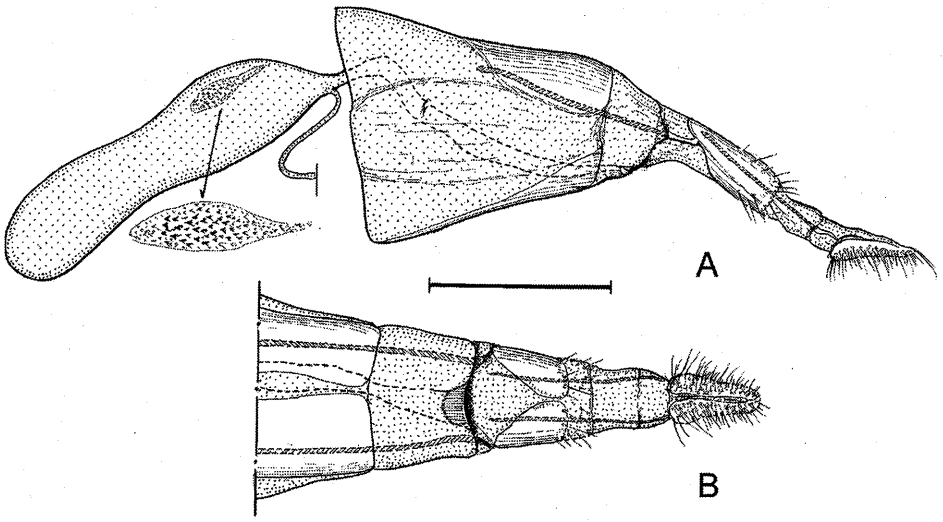

Fig. 3. Female genitalia of *E. ceratonae*. A. lateral; B. 7th to 10th abdominal segments, ventral. Scale: 1 mm.

Female genitalia (Fig. 3): Ostium bursae wide, weakly sclerotized ventrally. Ductus bursae narrow, moderate in length. Corpus bursae swollen, with a group of minute spines of signa. Eighth tergum short, with several setae posteriorly. Papilla analis long and slender, somewhat flattened, with dorsal portion a little narrower. Apophysis anterioris long, ca. 1.3 times as long as apophysis posterioris.

(2) Egg (Fig.1D). 0.63 mm × 0.30 mm (n= 5). Elliptical, somewhat variable in shape. Newly deposited egg yellowish white, then becoming reddish just before hatching.

(3) Mature Larva (Fig. 1E, F). Body 12 mm in length, with head width of 1.5 mm. Head pale brown to light brown, with irregular marking dorsolaterally. Body milky white, semi translucent as in *Plodia interpunctella*, one of the famous phycitine stored-product pests. Pinacula on body weakly developed. Prothoracic shield and anal shield pale brown. Thoracic legs light brown. Prolegs rather short, with crochets arranged circularly, biordinal, ca 35 in number.

Chaetotaxy (Fig. 4): T1 with prothoracic shield distinct, with 6 setae. L seta 2 in number on a dark brown pinaculum; 2 SV setae on a same weak pinaculum. T2 with D2 just ventrad of D1; long SD1 and short SD2 setae on a crescent-shaped pinaculum. D2 long, lateroventrad of D1 on A1 to A6, lateral to D1 on A7 and A8, and dorsad of D1 on A9. SD1 longer than other setae, emitting on semicircular blackish pinaculum. L setae 3 in number. SV setae 3 in number on A1 to A6, 2 on A8 and A9.

(4) Pupa (Figs. 1C & 5). 8.5 mm in length, 2.4 mm in width. Body rather slender, pale brown to light brown. Head with vertex round, with a pair of short setae. Antenna and foreleg reaching to wing tip; apex of hindleg visible from apical portion of wing. Thorax with mid-dorsal line narrowly swollen characteristically (Fig. 5B, D) along ecdysial line. Abdomen with a pair of thorn-like spines on 1st to 7th segments dorsally, with several surrounding small punctures. Tenth segment with a pair of thorns, larger than those of preceding segments.

2. Biology and life cycle of *E. ceratoniae*

In 2007, *E. ceratoniae* was not found in flesh fruits and adults emerged only from fallen dry fruits collected in October. In total, 61 adults of this species emerged from 102 fruits examined.

In 2008, 2 adults of this species emerged from 34 flesh fruits collected in mid-August and 10 adults emerged from 98 dry fruits collected in late-August to September. Judging from the 45 moths collected and emerging during the survey, 28.9% of the fruits were injured by *Conogethes punctiferalis* (Guenée) (Crambidae), 26.7% by *E. ceratoniae*, 24.4% by *Grapholita molesta* (Busck) (Tortricidae), 13.3% by *Anatrachyntis japonica* Kuroko

(Gracillariinae), and 6.7% by *Carposina sasakii* Matsumura (Tortricidae).

These results and our field observations reveal that the larva of this species is a borer of decayed or dropped fruits of peach during autumn in the orchard. They enter the fruits and feed on the rotted portion inside. After developing to mature larvae, they make thin cocoons with silk for pupation inside the damaged fruits. Most of the adults were collected in autumn. We observed eggs on dry fruits in the field during this season (Fig. 1C). The oviposition behavior of female adults is thought to be induced by the volatile components of fungi developing on dry fruit (Cosse *et al.*, 1994). In the laboratory, the female adult also laid eggs individually on mature fruit as in the orchard. The larvae fed on the surface for a short time after hatching, and then entered the fruits. The larvae fed inside the fruit and passed the winter there during the young to mid-instar larval stage in 2007. The overwintering generation of larvae emerged the following January to February under laboratory conditions.

Since we did not find larvae in flesh fruits during May and June of 2008, and a small number of larvae were found on flesh fruits collected during early August in the field, we suggest that the overwintering generation probably emerges in July and lays eggs. The species increases in number on dry fruits in autumn. According to these results, we estimate it has two generations a year in the field in Central Japan. However, details of the life history in the field, especially from winter to summer, are still uncertain.

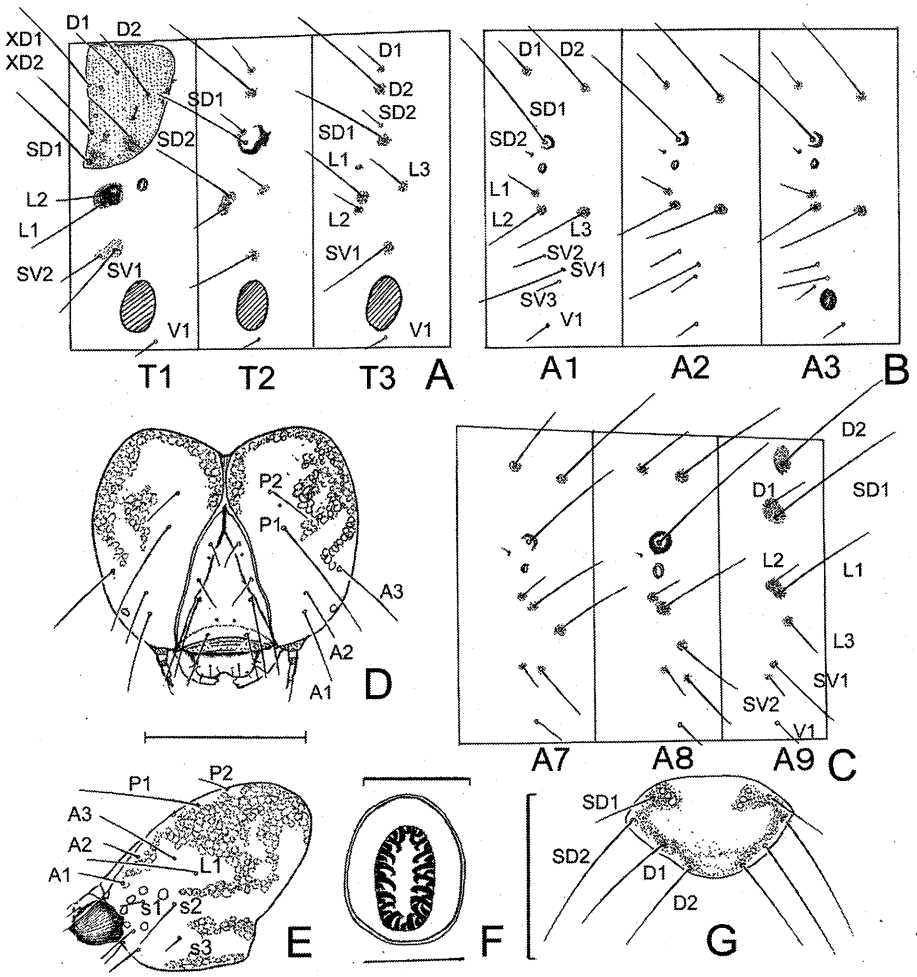

Fig. 4. Larva of *E. ceratoniae*. A. chaetotaxy, pro- to metathorax; B. *ditto*, first to 3rd abdominal segments; C. *ditto*, 7th to 9th abdominal segments; D. head, frontal; E. *ditto*, lateral; F. crochets of proleg: G. anal shield on 10th abdominal segment. Scales: D, E & G, 1 mm; F, 0.2 mm.

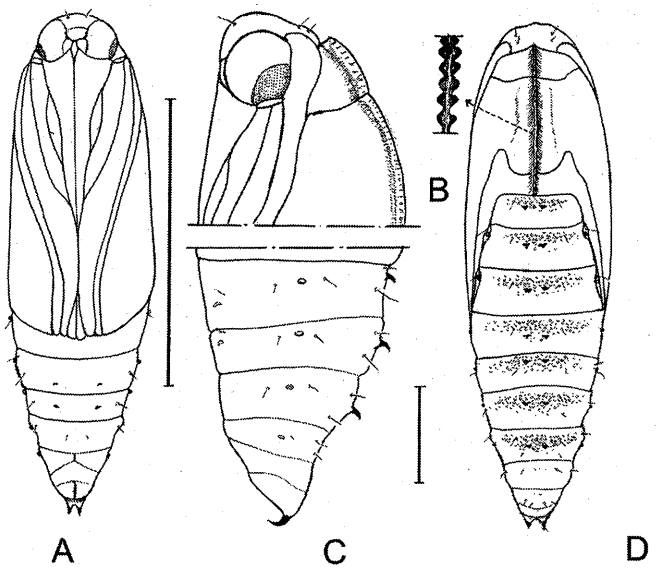

Fig. 5. Pupa of *E. ceratonae*. A. ventral; B. lateral, anterior portion; C. *ditto*, posterior portion; D. dorsal. Scales: A & D, 5 mm; B & C, 1 mm.

3. Status as a fruit pest and its feeding habit

As mentioned in the Introduction, the larva is well known as a stored-product pest. But there have been no reports of this species on dried fruits in Japan. The first record of this species from Japan was as a borer on fruit of the Japanese Cheesewood, *Pittosporum tobira* (Pittosporacea) in the field (Yamanaka, 2001). *Prunus persica* is the first host record for this species. The effect of this species on production of peach was not very high in the *Prunus* garden. However, the congener *E. privora* is known to feed on the flesh fruit of *Pyrus pyrifolia*, and is listed as a pest of the Japanese pear. Therefore, *E. ceratoniae* in Japan may become an agricultural pest on fruit of other horticultural plants such as oranges, figs and other *Prunus* species, or on dried fruits.

The larvae of the Phycitinae represent 172 species in Japan and have a wide range of hosts (Inoue, 1982), among which the larvae of *Cadra* and *Ephestia*, and related genera, are known as stored-product pests. However, little information is available concerning their exploitation of both dry and flesh fruits. For example, summer-generation larvae of the phycitine *Assara korbi* feed on the flesh of the aphid gall made by *Schlechtendalia chinensis* (Bell), but its autumn generation hibernates during the larval stage in the gall, falling down in autumn (Yoshiyasu, 1986). Larvae of the latter generation feed on the completely dried gall during the following spring and emerge in May. The feeding habits observed in this study might suggest that *E. ceratoniae* is a transitional form from a flesh plant tissue feeder to an exclusively dry or dried plant tissue feeder in the Phycitinae.

Acknowledgement

We thank Prof. T. Ishii, Laboratory of Pomology, Kyoto Prefectural University, for permitting the field survey at the peach orchard of the Experimental Farm, Shimogamo, Kyoto.

References

Cosse, A. A., J. J. Endris, J. G. Millar & T. C. Baker. 1994. Identification of volatile compounds from fungus-infected date fruit that stimulate upwing flight in female *Ectomyelois ceratoniae*. *Entomol. Exp. Appl.*, 72: 233–238.

Goater, B. 1986. British Pyralid Moths. A Guide to their Identification. 175 pp. Harley Books, London.

Gothilf, s. 1969. Natural enemies of the carob moth *Ectomyelois ceratoniae* (Zeller). *BioControl*, 14: 195-202.

Hasenfuss, I. 1960. Die Larvalsystematic der Zünsler (Pyralidae). Abhandlungen zur Larvalsystematic der Insekten, 5. 263 pp. Akademie-Verlag, Berlin.

Heinrich, C. 1956. American Moths of the Subfamily Phycitinae. 581 pp. United States National Museum Bulletin 207. Smithsonian Institution, Washington, D. C.,USA.

Inoue, H. 1982. Pyralidae. In: Inoue, H. *et al.* (ed.): Moths of Japan, 1: 307–404.

Nay, J. E. & T. M. Perring, 2006. Effect of fruit moisture content on mortality, development, and fitness of the carob moth (Lepidoptera: Pyralidae). *Environ. Entomol.*, 35: 237-244.

Roesler, R. & P. V. Küppers 1981. Die Phycitinae (Lepidoptera: Pyralidae) von Sumatra; taxonomy teil B, Okologie und Geobiology. *Beit. naturk. Forsch. SudwDtl.,* 4: 1–282.

Sonda, M. 1963. An interception of the locust bean moth, *Ectomyelois ceratoniae* (Zeller), on English walnuts from Italy. *Kontyû, Tokyo,* 31: 292–293.

Yamanaka, H. 2001. Notes on three unrecorded and two little-known species of the Phycitinae (Pyralidae) from Japan. *Japan Heterocerists' J.,* 215: 275–282. (in Japanese.)

Yoshiyasu, Y. 1986. Notes on two lepidopterous species attacking the galls of *Schlechtendalia chinensis* (Bell.) (Aphididae) on *Rhus javanica* L. *Tyô to Ga,* 37: 97–100. (in Japanese.)

Yoshiyasu, Y. 1991. A new species of *Assara* (Lepidoptera, Pyralidae) associated with the aphid gall. *Tyô to Ga*, 42: 261–269.