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A Taxonomic Study of the Genus *Eurema* Hübner, [1819] (Lepidoptera: Pieridae) in Thailand

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ABSTRACT.– The taxonomic study of the genus *Eurema* Hübner, [1819] from museum specimens over Thailand is reported. Seven hundred and one imagoes (butterflies) were examined, resulting in ten distinct species and some 15 species-subspecies being recorded. These were comprised of two species from the subgenus *Eurema* (*E. brigitta* and *E. laeta*) and eight species from the subgenus *Terias* (*E. ada, E. andersoni, E. sari, E. nicevillei, E. novapallida, E. blanda, E. simulatrix* and *E. hecabe*). A dichotomous key to the species of the genus in Thailand, based on the wing marking patterns with illustrations and descriptions of the male genitalia where this aids identification, is presented. The distribution of the genus in Thailand, and the taxonomic problems with wing marking variations of *E. hecabe hecabe* are discussed.

KEY WORDS: Taxonomy, *Eurema*, Thailand, Key to species

INTRODUCTION

Eurema Hübner, [1819], (Lepidoptera: Pieridae), butterflies are comparatively small butterflies with bright to pale lemon yellow wings which are bordered with black, especially on the upperside of both wings. The underside of the wings, which are usually paler in colour than the upperside, are marked with several black or faint brown markings.

The study of butterflies (Papilionoidea) in Thailand was first evaluated by Fabricius in 1770 (cited in Lekagul et al., 1977) who described several new species from Siam (Thailand), but *Eurema* were not included. The first report of *Eurema* (alias *Terias* Swainson, but *Eurema* has a few months priority over *Terias* (January, 1821)) species from Thailand, however, appeared in "The Butterflies of Siam" by E. J. Godfrey (1916), who reported five species from this genus; *E. venata* (reclassified as *E. laeta*), *E. laeta pseudolaeta*, *E. hecabe hecabe*, *E. blanda davidsoni* and *E. lacteola lacteola*. After Godfrey's works, eight more species of the genus were added; *E. tilaha*; (Pendlebury, 1923; reclassified as *E. nicevillei nicevillei* (Yata, 1992)), *E. sari sodalis*; (Godfrey, 1930), *E. pallida* (reclassified as *E. novapallida* (Yata, 1992)), *E. simulatrix inouei* and *E. andersoni*; (Shirôzu and Yata, 1973), *E. jordarni*; (Pinratana, 1983; now reclassified as *E. andersoni jordani* (Yata, 1991)), *E. novapallida* and *E. nicevillei*;

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(Yata, 1989), and followed recently by the addition of several subspecies within the genus (Ek-Amnuay, 2006). However, although the taxonomic study of *Eurema* in Thailand has been reported several times as outlined above, the exact number of species in the genus that are represented in Thailand remains unclear, especially at the subspecies level.

Moreover, to compound the issue, members of the genus *Eurema* within each sex show phenotypic variations in both body size and colour patterns (Braby, 2000; Jones, 1992; Pinratana, 1983; Yata, 1989), as is often found in other pierid butterflies. These variations may be caused by changes in developmental temperature and/or photoperiod of the juvenile stages, and also by other geographical related factors that presumably include clinal genetic differences (Jones, 1992; Yata, 1989). These variations lead to difficulties when using only the external wing pattern morphology for reliable identification, especially at the subspecies level. However, Yata (1989) revealed some correlation between the male or female genitalia characters with the external morphology characters and identification, at least at the species level. Combined, this makes it possible to separate almost the entire genus *Eurema* by using only external morphological characters, and thus potentially non-invasively, which is of significant use such as for museum pieces.

The purpose of this study was to clarify the exact number of species and, as far as possible, subspecies in the genus *Eurema* in Thailand and to develop a dichotomous key to these Thai *Eurema* species based mainly on the wing marking patterns with brief descriptions and illustrations of the male genital organ. In addition, the wing marking variations that occur in *Eurema hecabe hecabe* are evaluated and reported.

The shape and the number of processes on the valva structure of the male genitalia are important characters to determine the subgenus and species level of the genus (Yata, 1989). The following abbreviations (Shirôzu and Yata, 1973) are used to describe the valva processes, P1: a process near the middle of the ventral margin of costa–ampulla region; P2: a process beyond the middle of dorsal margin of costa–ampulla region; P3: an apical process of valve; P4: a process or processes at the basal portion or middle of harped; P5: a process arising from P4.

MATERIALS AND METHODS

Seven hundred and one specimens of *Eurema* butterflies, which are deposited in the indicated museums in Thailand, were examined. The abbreviations of the museums are as follows: APM, Museum of Bro. Amnuay Pinratana, Bangkok; CMB, Department of Biology, Faculty of Science, Chiangmai University, Chiangmai; CME, Department of Entomology, Faculty of Agriculture, Chiangmai University, Chiangmai; CUM, Chulalongkorn University Museum of Natural History, Bangkok; KKU, Department of Entomology, Faculty of Agriculture, Khon Kaen University Insect Collection, Khon Kaen; KUM, Insect museum, Department of Entomology Faculty of Agriculture, Kasetsart University, Bangkok; MJU, Department of Plant Protection, Faculty of Agricultural Production, Maejo University, Chiangmai; MUS, Faculty of Science, Mahasarakham University, Mahasarakham; MUT, Faculty of Technology, Mahasara-kham University, Mahasarakham; NPM, Department of National Park, Wildlife and Plant Conservation, Bangkok; PSU, Prince of

Songkla University Natural History Museum, Songkla; SPC, Mr. Suttisan Pimpasalee's private collection, Bangkok.

The key to the old world species of the genus *Eurema* (Yata, 1989) was used to identify all of the specimens. The male genital organ was studied when the external morphological characters could not be used to reliably identify the species. The organ was first prepared by boiling in 10 % (w/v) KOH solution for 10 minutes, before examination under a stereo microscope. The male genital organ description used here follows that of Klots (1956). The illustrations of the male genitalia in Yata's works were used to help confirm the likely species identification (Yata, 1989, 1991, 1992, 1994 and 1995). Forewing length was measured from the middle of the thorax to the apex of the forewing.

RESULTS

Ten species and twelve subspecies of the genus *Eurema* were found from specimens examined during the study.

Key to species of the genus *Eurema* Hübner, [1819] in Thailand

1a. Hindwing underside with submarginal spots in spaces 4 and 5 fused to form a streak……**subgenus *Eurema***…..**2**

b. Hindwing underside with submarginal spots in spaces 4 and 5 not fused…… ……..**subgenus *Terias***...…..**3**

2a. Forewing upperside with black distal border disappearing below vein 2; hindwing underside with submarginal spots represented by a parallel line; ovate sex patch present on base of forewing underside and hindwing upperside in male……...…***E. leata***

b. Forewing upperside with black distal border continuing to tornus; hindwing underside with submarginal spots not represented by a parallel line; male sex patch absent...……***E. brigitta***

3a. Forewing underside with 0 - 1 cell spot ……...…….……**4**

b. Forewing underside with 2 - 3 cell spots ……..……**8**

4a. Forewing upperside with black basal border continuing to wing base……..……***E. nicevillei***

b. Forewing upperside with black basal border not continued to wing base …….**5**

5a. Hindwing upperside with a narrow black distal border reduced to spot-like vein dots.....…***E. novapallida***

b. Hindwing upperside with black distal border not reduced to spot-like vein dots ….....**6**

6a. Forewing underside with large, quadrate bright chocolate brown apical patch…….***E. sari***

b. Forewing underside without large, quadrate bright chocolate brown apical patch…….……..…**7**

7a. Forewing underside with a large cell spot distinctly 3-shaped; forewing upperside with black distal border more deeply excavated in space 3 than in space 2; hindwing distal margin evenly rounded..……***E. andersoni***

b. Forewing underside with a cell spot represent by a minute spot or absent; forewing upperside with black distal border more deeply excavated in space 3 than in space 2; hindwing distal margin angulated at space 3…….…. ……..…….***E. hecabe***

8a. Female forewing length less than 18 mm, male sex-brand very short, spindle-shaped, ending far from origin of vein 2 ..……...……***E. ada***

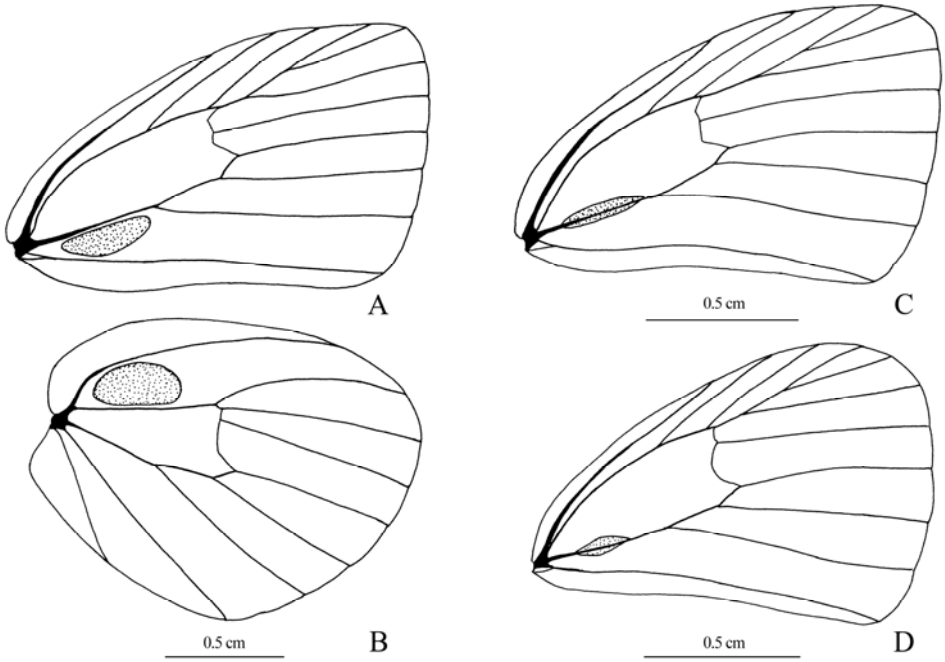

FIGURE 1. Wing venation and sex–brand of some *Eurema* species in Thailand. **A**, forewing underside; **B**, hindwing upperside of *E. laeta*; **C**, forewing underside of *E. hecabe*; **D**, forewing underside of *E. ada*.

b. Female forewing length larger than 18 mm, sex–brand elongate, extending to or ending before origin of vein 2…..…**9**

9a. Forewing underside with 3 cell spots…. ……..…***E. blanda***

b. Forewing underside with 2 cell spots…. …….……...**10**

10a. Forewing underside with distal cell spot larger, and distinctly zigzag–shaped; hindwing distal margin evenly rounded ..…….……***E. simulatrix***

b. Forewing underside with distal cell spot normal in size not distinctly zigzag–shaped; hindwing distal margin angulated at space 3…..……...***E. hecabe***

Genus *Eurema* Hübner, [1819]

Diagnosis: Forewing apex not produced. Hindwing humeral vein absent or much reduced, vein 7 from origin of vein 6 or slightly before it. Ground colour is yellow but varies from pale to bright yellow. Upperside of both wings usually with black distal border, but sometimes reduced to vein-dot in hindwing. Underside of both wings has several black or brown markings. Male genital organ with inner surface of valva are represented by several processes.

Subgenus *Eurema* Hübner, [1819]

Diagnosis: Forewing underside without cell spot, discocellular spot represented by small and faint spots. Hindwing underside with a series of submarginal spots fused and forms a streak in space 4 and 5. Male has no narrow and elongate sex-brand on the underside of forewing. Male genital organ with P1 of valva well developed and P4 represented by a simple process.

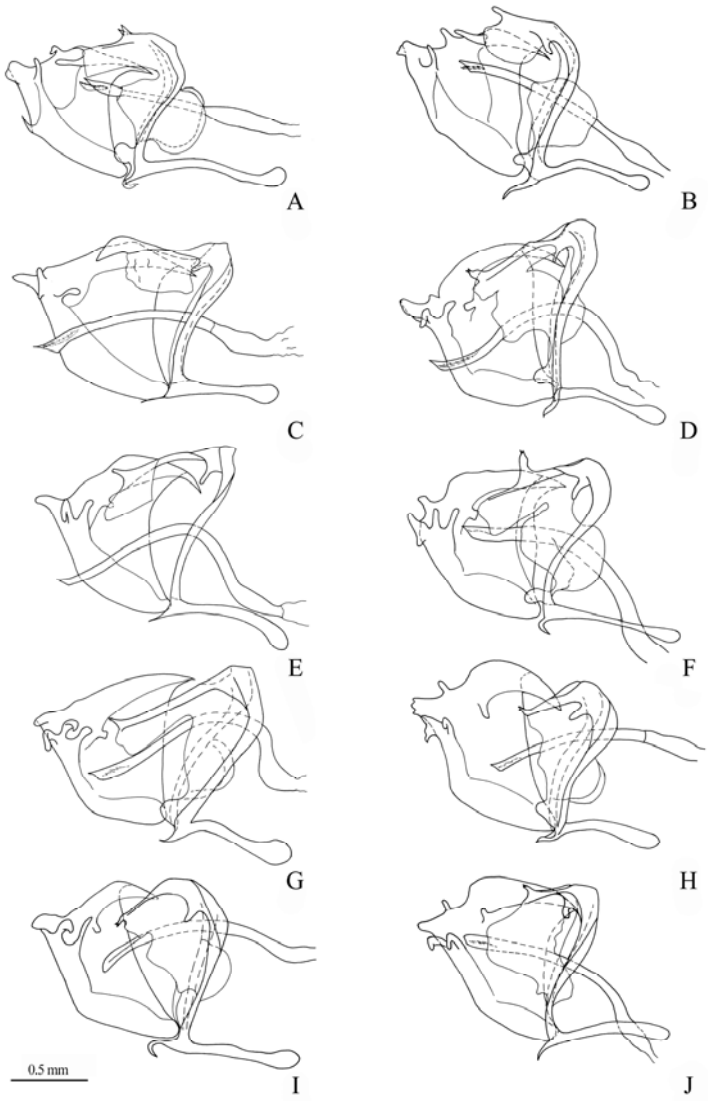

FIGURE 2. Male genitalia of the genus *Eurema,* lateral view with right valva removed: **A**, *E. brigitta*; **B**, *E. laeta*; **C**, *E. ada*; **D**, *E. andersoni*; **E**, *E. sari*; **F**, *E. nicevillei*; **G**, *E. novapallida*; **H**, *E. blanda*; **I**, *E. simulatrix*; **J**, *E. hecabe* (**C** after Yata (1991), and **E** after Yata (1992)).

***Eurema brigitta hainana* (Moore, 1878)**
(Fig 3A♂, B♂, C♀)

Diagnosis: ♂♀. Both wings fairly elongate, narrowed toward apex, hindwing distal margin round. *Upperside*: ground colour yellow to bright yellow, with black dusted at basal part of both wings. Forewing; black distal borders broad with its inner edge almost uniform and not deeply excavated in spaces 2 and 3, sometimes interrupted in space 1b+c. Hindwing; black distal border broad slightly narrower into tornus. *Underside*: male without sex-brand, most markings faint with

weakly black dusted. Hindwing disco-cellular marking represented by a black bar, sometimes divided into an upper and a lower spots.

Forewing length: ♀ 14.6 – 21.8 mm (n = 24 avg = 18.5 mm), ♂ 13.1 - 21.7 mm (n = 41, avg = 19.0 mm)

Male genitalia: (Fig. 2A) Tegumen somewhat broad; uncus short and strongly bifurcate at the apex; saccus nearly as long as height of vinculum; valva with P1 longer than the other processes extending posteroventrally, P2 long and curved ventrally, P3 very broad, flat, and much larger than the other processes, with its apex irregularly end, P4 represented by a single process with a short process at posteroventral corner of harped; phallus long and slender in shape.

This subspecies is distributed from the north to the central and some parts of the north-east of Thailand, also in Indo-China, South China, Hainan to Taiwan and southern Japan as a migrant (Yata, 1989).

Ek-Amnuay (2006) reported *E. brigitta senna*, the other Thai subspecies from Yala province. This subspecies has weaker black dusted on both upper and under sides of the wings than in *E. brigitta hainana*.

Eurema laeta pseudolaeta (Moore, 1906)

(Fig 3D♂, E♀)

Diagnosis: ♂♀. Forewing more or less point at apex, hindwing distal margin somewhat angulated at vein 3. *Upperside*: Ground colour is yellow, paler in female. Forewing black distal border broad with its inner margin edge concaved in spaces 2 and 3, sometimes disappeared or interrupted below vein 2. Hindwing black distal border very narrow, broader in spaces 6 and 7. Male has oval sex-patch at base of space 7 on hindwing upperside and base of space 1b + c on forewing underside (Fig. 1A) *Underside*: Ground colour reddish brown. Forewing with discocellular spots very faint reduced to only upper spot. Hindwing with sub-marginal spots of spaces 1b+c, 4 to 6 arranged in a parallel line.

Forewing length: ♀ 19.3 – 21.9 mm (n = 8 avg = 20.4 mm), ♂ 17.6 - 21.5 mm (n = 14, avg = 19.9 mm)

Male genitalia: (Fig. 2B) Tegumen somewhat narrow, not concaved dorso-medially; uncus short with apex bluntly ended, not bifurcate; saccus as long as half of the vinculum; valva with P1 longer than the other processes, extending postero-ventrally, P2 long and slender, P3 broad, with its apex irregularly ended and usually pointed, P4 represented by a single process. Phallus moderately long and slightly arched dorsally.

This subspecies is distributed in the north and the upper part of central Thailand, and is also found in the southern parts of Burma (= Myanmar) and Vietnam (Yata, 1989).

Subgenus *Terias* Swainson, 1758

Diagnosis: Forewing underside with one to three cell spots, discocellular represents by a ring–shaped spot. Hindwing underside with a series of submarginal spots in spaces 1a to 8, arranged in an irregular zigzag–line, faint in some species. Male usually with a narrow and elongate sex-brand situated along anterior cubital vein. Male genital organ with P4 of valva bifurcated.

Eurema ada iona (Talbot, 1939)

(Fig. 3F♂, G♀)

Diagnosis: ♂♀. This species is comparatively small in size (forewing length less than 21.0 mm). Ground colour is greenish yellow. *Upperside*: Black distal

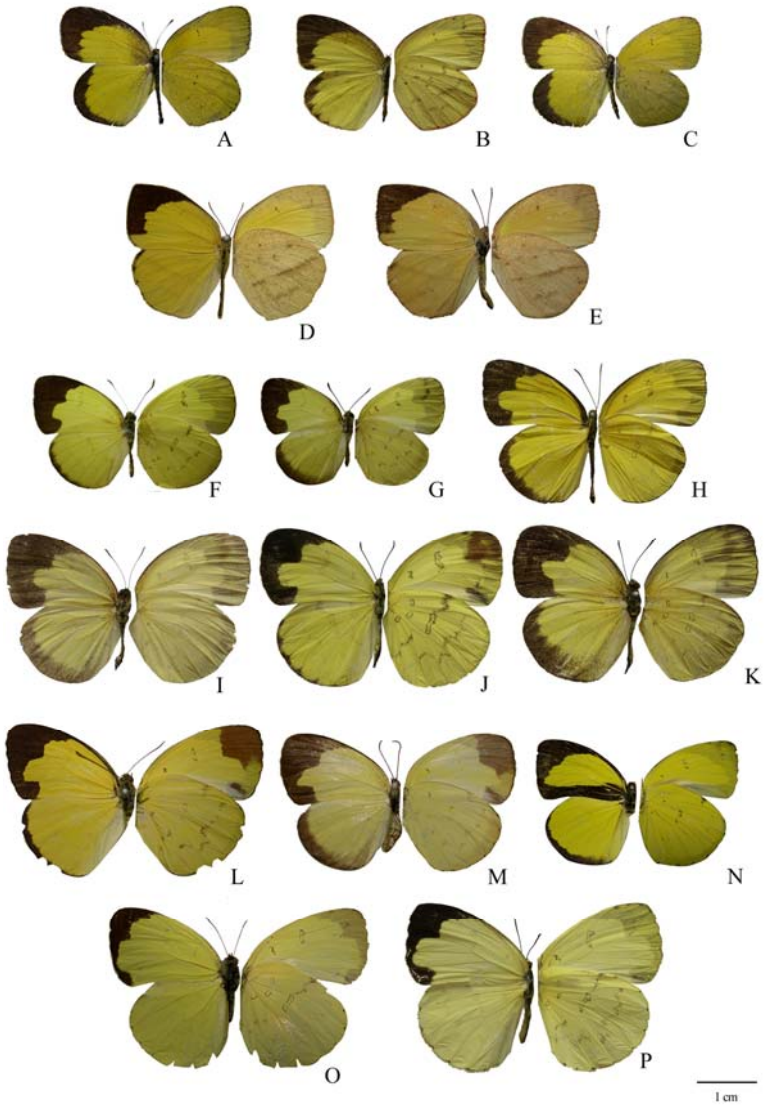

FIGURE 3. The genus *Eurema* in Thailand, figures show the upperside (left) and underside (right) of the butterflies wing. A ♂, B ♂, C ♀ *Eurema brigitta hainana* (Moore, 1878); D ♂, E ♀ *Eurema laeta pseudolaeta* (Moore, 1906); F ♂, G ♀ *Eurema ada iona* (Talbot, 1939); H ♂, I ♀ *Eurema andersoni andersoni* (Moore, 1886); J ♂, K ♀ *Eurema andersoni sadanobui* Shirôzu &Yata, 1982; L ♂, M ♀ *Eurema sari sodalis* (Moore, 1886); N ♂ *Eurema nicevillei nicevillei* (Butler, 1898); O. ♂, P. ♀ *Eurema novapallida* Yata, 1992.

border on forewing almost equally excavated in spaces 2 and 3 or more deeply in space 3 than 2. Hindwing black distal border generally broad, usually broader in female. *Underside*: Most markings are more developed. Forewing has two spots in discoidal cell; subapical patch sometimes present as faint streak. Sex- brand very

short, spindle shaped, ending far from origin of vein 2 (Fig. 1C).

Forewing length: ♀ 16.8 mm (n = 1), ♂ 16.6 - 18.3 mm (n = 2, avg = 17.5 mm)

Male genitalia: Not examined, but Yata (1991) described it as follows (Fig. 2C). Tegumen somewhat narrow; uncus long, slightly arched dorsally, bifurcated at the apex; saccus shorter than vinculum; valva with P1 weakly produced or absent, P2 absent, P3 almost triangular, producing upwards, P4 represented by two processes which are similar to each other in length and shape; phallus long, very slender and strongly arched dorsally.

This subspecies is distributed in some parts of the south of Thailand, and is also found in the Malay Peninsula (Yata, 1991).

Yata (1991) described *Eurema ada indosinica* using the holotype from Doi Inthanon, Chiang Mai, North Thailand. Ek-Amnuay (2006) reported this subspecies from Doi Inthanon, Chiang Dao, Omkoi, Umpang. This subspecies is similar to *Eurema ada iona* but has a narrower black distal border of the forewing and hindwing, especially in the female.

Eurema andersoni andersoni (Moore, 1886)

(Fig. 3H♂, I♀)

Diagnosis: ♂♀ Ground colour lemon yellow, paler in female. *Upperside*: forewing black distal border broad and more deeply excavated in space 3 than in space 2. Hindwing black distal border broad with its inner edge defined, usually zigzag-shaped. *Underside*: forewing with a 3-shaped spot in discoidal cell, sex-brand long and narrow.

Forewing length: ♀ 17.0 - 19.0 mm (n = 2, avg = 18.0), ♂ 16.5 - 20.2 mm (n = 4, avg = 19.0 mm)

Male genitalia: (Fig. 2D) Tegumen narrow, triangular in dorsal aspect, concaved dorsomedially; saccus as long as a half of vinculum height; uncus moderately long, arched dorsally, with apex weakly bifurcate. Valva with P1 weakly sclerotized, much shorter than P4, P2 weak process, P3 broad and triangular, with a point apex, P4 represented by two processes, distal one of which longer than proximal one and strongly arch dorsally. Phallus very long, slender and strongly arched dorsally.

This subspecies is distributed in the southern part of Thailand below the Isthmus of Kra to the Malay Peninsula and is also found in the southern part of Burma (= Myanmar) and Sumatra (Yata, 1991).

Eurema andersoni sadanobui Shirôzu & Yata, 1982

(Fig. 3J♂, K♀)

This subspecies is distinguishable from subspecies *andersoni* by the following combination characters.

Diagnosis: ♂♀. *Upperside*: ground colour somewhat darker. Forewing black distal border and hindwing black distal border sometimes broader with its inner margin more diffused. Scattered black scales on hindwing continued along vein 1 from tornus to basal part of wing.

Forewing length: ♀ 15.6 - 21.9 mm (n = 15, avg = 17.5 mm), ♂ 18.0 - 23.0 mm (n = 23, avg = 20.0 mm)

This subspecies is distributed in the north and the central parts of Thailand and also in the southern parts of Vietnam across Cambodia to Assam (Yata, 1991).

The other subspecies of *E. andersoni* that occurred in Thailand is *E. andersoni jordani*. This subspecies was described as a subspecies of *E. andersoni* by Corbet and Pendlebury (1932) and raised to specific rank by Corbet (1936). In 1939, Talbot sank

it to the subspecies again (Yata, 1991). It is somewhat similar to the subspecies *E. andersoni sadanobui*, but the black distal border on the forewing upperside is sometimes broader and narrowly extends towards the base for a half of basal margin and the hindwing black distal border is much broader. There is heavy black dusting occurs on the basal part of both wings. This subspecies occurs in the northern part of Thailand, especially at high elevations such as at Doi Phu Kha, Nan province (Ek-Amnuay, 2006).

***Eurema sari sodalis* (Moore, 1886)**
(Fig. 3L♂, M♀)

Diagnosis: ♂♀. *Upperside*: lemon yellow in ground colour. Forewing black distal border broad, more deeply excavated in space 2 than in space 3. Hindwing black distal border broad with its inner margin modulated zigzag–shaped, broader in female. *Underside*: apical patch on forewing large, quadrate and dark brown in colour, a spot in discoidal cell present, sex–brand in male long and narrow.

Forewing length: ♀ 18.3 mm (n = 1), ♂ 19.0 - 23.2 mm (n = 2, avg = 21.1 mm)

Male genitalia: Not examined, but Yata (1992) described it as follows (Fig. 2E). Tegumen narrow triangular in dorsal aspect, concaved dorsomedially; saccus as long as 0.7-0.8 of vinculum height; uncus moderately long, arched dorsally, with apex weakly bifurcate. Valva with P1 weakly sclerotized, much shorter than P4, P2 absent, P3 broad and triangular, with a point apex, P4 represented by two processes, distal one of which is longer than proximal one and strongly arched dorsally. Phallus very long, slender and strongly arched dorsally.

This subspecies is distributed from the lower central to the south of Thailand, and is also distributed from the Indo–China to Sundaland (Yata, 1992).

***Eurema nicevillei nicevillei* (Butler, 1898)**
(Fig. 3N♂)

Diagnosis: ♂. *Upperside*: Ground colour lemon yellow. Forewing black basal border, always well developed along the tornus to wing base with its inner margin almost uniform, having yellow veins in basal portion. Hindwing black distal costal broad, slightly broadened toward tornus. *Underside*: forewing with a spot in discoidal cell. Hindwing with a series of faint submarginal spots in spaces 1a to 8, arranged in a curved line parallel to wing margin. ♀ not examined.

Forewing length: ♂ 11.5 - 24.4 mm (n = 4, avg = 23.3 mm)

Male genitalia: (Fig. 2F) Tegumen narrow, triangular in dorsal aspect, somewhat concaved dorsomedially; saccus as long as a vinculum height; uncus moderately long, extending downwards, with apex strongly bifurcate. Valva with P1 weakly sclerotized, shorter than P4, P2 absent, P3 slender, P4 represented by two processes, P5 represented by flattened process with its apex distinctly incised. Phallus long, slender and strongly arched dorsally.

This subspecies is distributed in the south and some parts of the east of Thailand (Ko Chang, Trat province) and also occurs in South Burma (= Myanmar), the Malay Peninsula, Borneo and Sumatra (Yata, 1992).

This species has been treated as *E. tilaha* but was raised to specific rank because the female and male genitalia as well as wing markings are different (Yata, 1992).

***Eurema novapallida* Yata, 1992**
(Fig. 3O♂, P♀)

Diagnosis: ♂♀. *Upperside*: Ground colour greenish yellow in male and paler in female. Forewing black distal border more deeply excuvated in space 2 than in space 3; Hindwing black distal costal very narrow, usually reduced to from a small black dot at apex of each vein. *Underside*: Two spots present in discoidal cell on forewing which basal one reduce to a small faint spot, sex–brand short and narrow.

Forewing length: ♀ 22.6 mm (n = 1), ♂ 20.9 - 21.8 mm (n = 3, avg = 21.7 mm)

Male genitalia: (Fig. 2G) Tegumen narrow, triangular in dorsal aspect, somewhat concaved dorsomedially; saccus as long as a vinculum height; uncus very long, extending downwards, with apex strongly bifurcate. Valva with P1 weakly sclerotized, shorter than P4, P2 absent, P3 slender, P4 represented by two processes which are the same in length and shape, P5 almost same in length and shape of each process of P4. Phallus long, slenders and strongly arched dorsally.

Eurema novapallida is distributed in the upper central to the north of Thailand, and is also found in the Indo-China (Yata, 1992).

Shirôzu and Yata (1973) originally described this species from South Vietnam as *E. pallida*. However, the name was a junior homonym of *E. agave pallida* Chavannes (1850). Therefore, Yata (1992) proposed its new name as *E. novapallida*.

***Eurema blanda silhetana* (Wallace, 1867)**
(Fig. 4A♂, B♀)

Diagnosis: ♂♀. *Upperside*: ground colour lemon yellow, paler in female. Forewing black distal border more deeply excavated in space 2 than in space 3. Hindwing black distal border broad especially in female but sometimes narrower or reduced to form a small black vein–dot. *Underside*: forewing apical streak or patch marking sometime present, three cell spots present on forewing which a basal one sometimes barely traceable. Sex–brand long and narrow, ending slightly before the origin of vein 2.

Forewing length: ♀ 18.1 - 25.9 mm (n = 26, avg = 22.8 mm), ♂ 18.4 - 25.4 mm (n = 73, avg = 22.9 mm)

Male genitalia: (Fig. 2H) Tegumen broad, triangular in dorsal aspect, somewhat concaved dorsomedially; saccus short and thick; uncus moderately long, extending somewhat downwards, with apex bifurcate. Valva with P1 shorter than P4, P2 long and slender, P3 broad and irregularly serrate, P4 represented by two processes, distal one very large with its outer margin irregular serrate. Phallus moderately long, slender and somewhat strongly arched dorsally.

This subspecies is distributed from the north to the central and some parts of the north–east of Thailand, and also in the Indo-China to the North India (Yata, 1994).

***Eurema simulatrix sarinoides* (Fruhstorfer, 1910)**
(Fig. 4C♂, D♂)

Diagnosis: ♂♀. Distal margin of hindwing evenly rounded. *Upperside*: lemon yellow in ground colour. Black distal border more deeply excavated in space 2 than in space 3. Hindwing black distal border broad. *Underside*: forewing has two cell spots, the distal one is larger with prominent zigzag–shape. Apical patch present, sometimes reduced to a dark brown streak or absent. Sex-band brown, long and narrow, ending slightly before the origin of vein 2.

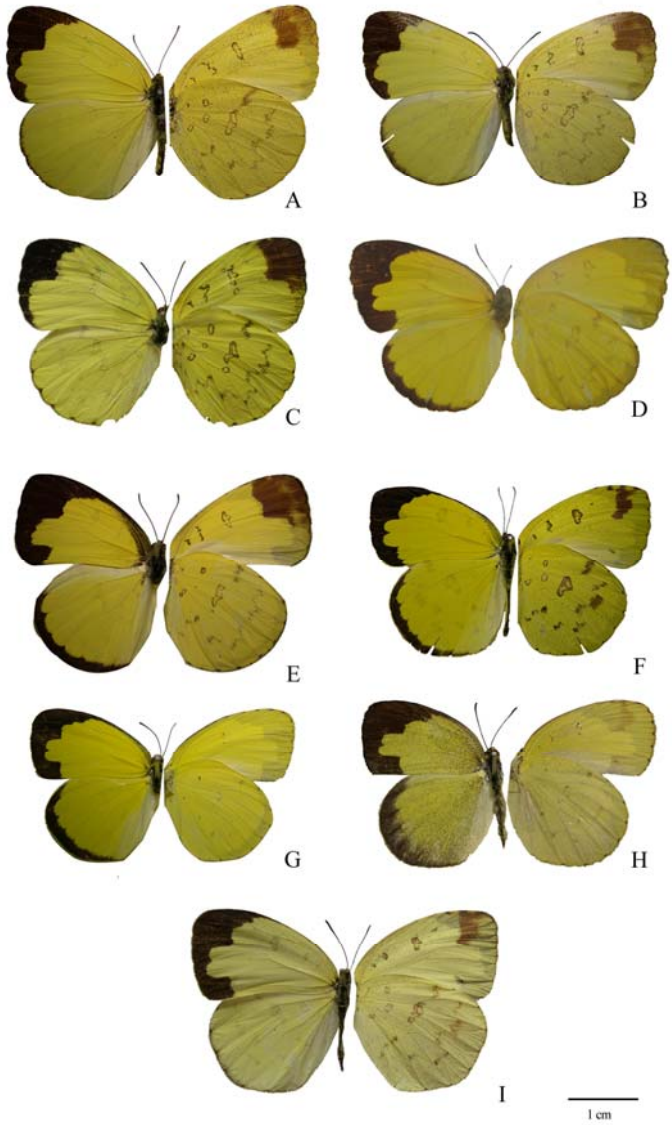

FIGURE 4. The genus *Eurema* in Thailand (cont.), figures show the upperside (left) and underside (right) of the butterflies wing. A. ♂, B. ♀ *Eurema blanda silhetana* (Wallace, 1867); C. ♂, D. ♂ *Eurema simulatrix sarinoides* (Fruhstorfer, 1910); E. ♂ *Eurema simulatrix tecmessa* (de Nicéville, 1895); F. ♂, G. ♂, H. ♀, I. ♀ *Eurema hecabe hecabe* (Linnaeus, 1758).

Forewing length: ♀ 21.4 - 26.5 mm (n = 3, avg = 22.7 mm) ♂ 18.8 - 24.5 mm (n = 20, avg = 21.9 mm)

Male genitalia: (Fig. 2I) Tegumen broad, triangular in dorsal aspect, somewhat concaved dorsomedially; saccus moderately long; uncus usually short, extending somewhat downwards, with apex bifurcate. Valva with P1 and P2 weakly sclerotized, P3 broad with point apex, P4 represented by two processes, distal one of which is larger than the proximal one and sickle–shaped.

Phallus is moderately long, slender and arched dorsally.

This subspecies occurs in the north-east, central and north of Thailand, and also in South Vietnam, Cambodia across Burma (= Myanmar) to Sikkim (Yata, 1994).

E. simulatrix inouei, named by Shirôzu and Yata (1973) (type locality from South Vietnam), was characterized by the absence of the brown apical streak on forewing underside. While the north subspecies, *sarinoides,* has a strongly dark brown subapical patch. Yata (1994) separated them into two subspecies using the presence or absence of this patch. However, from this study, we found both forms from within the same locality (Chanthaburi province). In addition to personal communication with Mr. Yutaka Inayoshi, he had an opportunity to examine some specimens obtained near the type locality of the *inouei*. These were quite variable and some specimens show the same pattern as *sarinoides*. From this we, therefore, suggest subspecies *inouei* should be included as one of the variations of the subspecies *sarinoides*. However, more specimens including type specimens need to be examined and molecular identification is needed to confirm our hypothesis.

Eurema simulatrix tecmessa **(de Nicéville, 1895)**

(Fig. 4M♂)

This subspecies is distinguishable from the subspecies *sarinoides* by the following combination of characters.

Diagnosis: ♂ *Upperside*: Ground colour usually bright yellow, black distal border broader and broaden toward a basal portion of wing with its inner margin diffused. *Underside*: most marking generally clear, subapical patch more strongly developed. ♀ not examined.

Forewing length: ♂ 22.0 - 24.6 mm (n = 2, avg = 23.3 mm)

E. simulatrix tecmesa is distributed in the south of Thailand, also from the Malay Penisula to Borneo, Sumatra and Java (Yata, 1994).

Eurema hecabe hecabe **(Linnaeus, 1758)**

(Fig. 4F♂, G♂, H♀, I♀)

Diagnosis: ♂♀ distal margin of hindwing is angulated at space 3 sometimes rounded in female. *Upperside*: ground colour bright yellow, paler in female and sometimes presented as milky white. Black dust present basally of both wings sometimes heavily developed in female. Forewing black distal border more deeply excavated in space 2 than in space 3. *Underside*: somewhat black dusted, two cell spots are present, but sometimes the basal one is reduced or both of them completely disappeared. Sex-brand light grey, long and broad, usually ending a point or slightly near the origin of vein 2 (Fig. 1C).

Forewing length: female 13.1 - 26.4 mm (n = 183, avg = 21.6) male 16.0 - 26.6 mm (n = 249, avg = 21.5 mm)

Male genitalia: (Fig. 2J) Tegumen broad, triangular in dorsal aspect, somewhat concaved dorsomedially; saccus moderately long; uncus usually short, with apex strongly bifurcate. Valva with P1 somewhat broad and flapped, P2 long and slender, P3 broad and triangular with point apex, P4 represented by two processes similar to each other. Phallus is moderately long, slender and arched dorsally.

Eurema hecabe hecabe is widely distributed in Thailand, and also from Japan across China, Indo-China, India, Sundaland, Lesser Sundas and New Guinea to Australia (Yata, 1995).

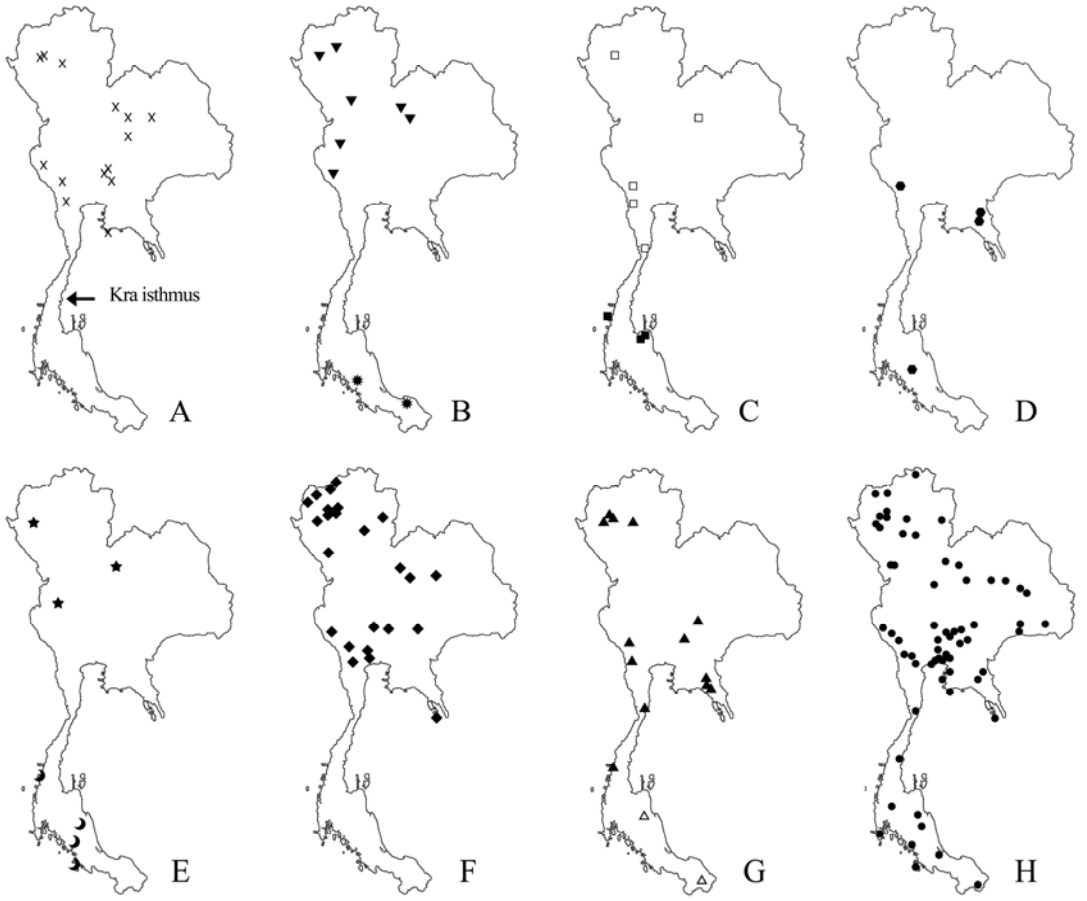

FIGURE 5. Distribution maps of the genus *Eurema* in Thailand: **A**, *E. brigitta hainana* (×); **B**, *E. laeta pseudolaeta* (▼), *E. ada iona* (✷); **C**, *E. andersoni andersoni* (□), *E. andersoni sadanobui* (■); **D**, *E. sari sodalist* (●); **E**, *E. nicevillei nicevillei* (☽), *E. novapallida* (★); **F**, *E. blanda silhetana* (◆); **G**, *E. simulatrix sarinoides* (▲), *E. simulatrix tecmessa* (△); **H**, *E. hecabe hecabe* (●).

DISCUSSION

The main external morphological characters used for identification at the species level of the genus *Eurema* are the black distal margin on the upperside, and black marking on underside of both wings and the male's sex - brand. Nevertheless, in dealing with a genus that has many species, especially when its members are very similar as well as subject to significant intra-species variation, identification should clearly not be placed on only one or a few characters, but rather as many characters as possible should be used.

Thailand is situated within two major biogeographical regions, the Indochinese region in the North and the Sundaic region in the South, separated by the Kra isthmus as a distinct boundary, where a considerable number of Indochinese and Malaysian fauna species reach their Southern and Northern limits (Office of Environmental Policy and Planning, 2000), respectively. From this study, the distribution of the genus *Eurema* in Thailand are divided into three distinct groups; a) the northern group distributed

from the north to the centre of Thailand (Kra isthmus) which consists of *E. blanda*, *E. brigitta*, *E. novapaliida* and *E. laeta*; b) the southern group which occurs below the Kra isthmus to the south of Thailand and consists of *E. nicevilli* and *E. sari*; c) the last group which is a widely distributed group recorded from the north to the south of Thailand and includes *E. ada*, *E. andersoni*, *E. simulatrix* and *E. hecabe*. Notice however that within group C above that, *E. ada*, *E. andersoni*, *E. simulatrix* have subspecies that are differently present between the north and the south and separated by the area of Kra isthmus (Fig. 5).

Because *E. hecabe* is the most widely distributed species amongst *Eurema* members and has highly variable wing markings, they are often misidentified. (Ek-Amnuay et al., 2007). However, any form of the species examined from this study showed the distinct characters of the species, the distal margin of the hindwing is angulated at the space 3. Combined with male genitalia investigation, we confirmed that more than 10 variant forms are all *E. hecabe hecabe*. The only variation of male genitalia noticed from the series examined was that some specimens have a thicker spine on the valva process than others.

From this study, and that of Corbet and Pendlebury (1932), we conclude that the variations of *E. hecabe hecabe* are as follows: a) indication of a basal black border on the upperside of the forewing where none is present normally; b) ground color of female wing upperside varies from yellow to milky white; c) the female is heavily black dusted on wing upperside; d) apical streak on forewing underside well developed (Fig. 6C) to completely disappeared (Fig. 6A); e) wing underside marking permanently black spots (Figs. 6B, C) to very faint brown spots (Fig. 6A); f) discoidal cell spots represented by one or two cell spots on the forewing underside or completely disappeared. These variations may be affected by changes in environmental factors during larvae development, such as temperature, photoperiod or food plant quality (Braby, 2000; Jones, 1992; Pinratana, 1983; Yata, 1989).

Although, ten species and twelve subspecies of the genus *Eurema* were found in Thailand during this study, some reported butterflies were not found. With the exception of junior synonymic names and misidentification cases, the other valid taxa reported from Thailand were; *E. brigitta rubella*; (Ek-Amnuay, 2006), *E. blanda blanda*; (Ek-Amnuay, 2006), *E. blanda davidsoni*; (Godfrey, 1916, 1930), *E. lacteola lacteola*; (Godfrey, 1916, 1930, Pinratana, 1983 and Ek-Amnuay, 2006); *E. simulatrix grandis* and *E. simulatrix littorea*; (Ek-Amnuay, 2006). All knowledge including recent surveys suggest these butterflies are unknown from Thailand and should be deleted from Thailand's fauna list as reasoned below.

Eurema brigitta rubella, illustrated by Ek-Amnuay (2006), should be identified as subspecies *hainana*. We found specimens obtained from the same locality as the subspecies *hainana* and we are aware of only the one variation of this subspecies. The exact distribution of *E. brigitta rubella* is West China, Burma (= Myanmar), Nepal to India and Srilanka (Yata, 1989).

For *E. blanda davidsoni*, this subspecies is restricted to South India and has not reached Thailand (Yata, 1994). For *E. blanda blanda*, according to the distribution of this subspecies *blanda* reported by Yata (1994), we think the *E. blanda blanda* reported in Ek-Amnuay (2006) should be identified as the subspecies *silhetana*.

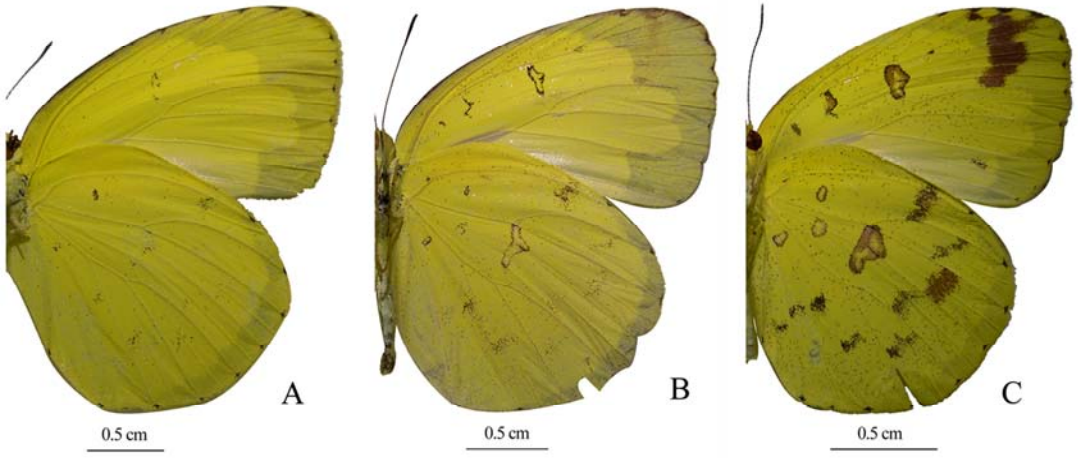

FIGURE 6. The forewing underside of male *E. hecabe hecabe* showing the wing marking variations: **A**, wing marking represented by very faint brown markings, discoidal cell spot reduce to a tiny brown scale which nearly disappearing, apical streak completely disappeared; **B**, wing marking fined, two discoidal cell spots presented, apical streak very faint; **C** permanently wing marking represented by smudgy black spots, apical streak present, dust scale presented over the wing (A: CUM 110 from Saraburi, 20.viii.2006; **B**: CUM 169 and **C**: CUM 164 from Chiangmai 26.xii.2006).

Eurema simulatrix grandis is confined to Khasi hills (the mountain in Assam, the northern state of India) in its distribution range (Yata, 1994). Therefore the illustrations of Ek-Amnuay (2006) (plate 59) and the male *E. simulatrix grandis* should be identified as *E. simulatrix sarinoides*. Likewise, the subspecies *E. simulatrix littorea* is found only in Langkawi Island in northwest Malaysia (Yata, 1994).

Whilst *E. lacteola lacteola* occurs in the Malay Peninsula, Borneo and Sumatra (Yata, 1992), and may have reached the southern-most part of Thailand in the Malay Peninsula region, to our knowledge this species is still unknown in Thailand (Ek-Amnuay et al., 2007).

In conclusion the members of the genus *Eurema* in Thailand consist of ten distinct species and fifteen species-subspecies, as summarized as a check–list below.

Checklist of the genus *Eurema* Hübner, [1819] in Thailand

Genus *Eurema* Hübner, [1819]

Subgenus *Eurema* Hübner, [1819]

Eurema brigitta hainana (Moore, 1878)

Eurema brigitta senna (C. & R. Felder, 1865)

Eurema laeta pseudolaeta (Moore, 1906)

Subgenus *Terias* Swainson, 1758

Eurema ada iona (Talbot, 1939)

Eurema ada indosinica Yata, 1991

Eurema andersoni andersoni (Moore, 1886)

Eurema andersoni sadanobui Shirôzu & Yata, 1982

Eurema andersoni jordani Corbet & Pendlebury, 1932

Eurema sari sodalis (Moore, 1886)

Eurema nicevillei nicevillei (Butler, 1898)

Eurema novapallida Yata, 1992

Eurema blanda silhetana (Wallace, 1867)

Eurema simulatrix sarinoides (Fruhstorfer, 1910)

Eurema simulatrix tecmessa (de Nicéville, 1895)

Eurema hecabe hecabe (Linnaeus, 1758)

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APPENDIX

Specimens examined

Eurema brigitta hainana: **Chaing Mai**: 1♀ 7.viii.1974 [CMB]; Doi Pui, 1♀ 10.vi.1979 [KUE]; Hauy Hong Krai, 1♂ 26.xii.2006 [CUM]; Maesaikhom, 1♂ 12.xii.1991 [NPM]; **Tak**: Sam Ngao, Huay Yao 1♂ 7 ix 2007 [CUM]; **Phetchabun**: Nam Nao, 1♀ 3.x.1996, 1♂ 3.xii.1996, 1♂ 6.i.1997 [NPM]; **Chaiyaphum**: Phu Khiao, 1♂ 8.i.1998, 1♂ 22.i.1998, 1♀1♂ 9.v.1998, 1♀ 14.v.1998, 1♂ 11.v.1998, 7♀6♂ 10.vi.1998, 3♂ 13.vi.1998, 1♂ 8.vii.1998, 1♂ 15.vii.1998, 7♂ 25.vii.1998, 4♀3♂ 27.vii.1998 [NPM]; **Khon Kaen:** 1♀ 11.ix.1982, 1♂ 24.viii.1983, 1♂ 4.ix.1991 [KKU]; **Saraburi:** Kaeng Koi, 1♂ 20.viii.2002, 1♀ 27.iii.2006, 1♂ 14.vi.2006, 3♀ 20.viii.2006, 2♂ 20.viii.2006, 1♀ 14 vii 2007 [CUM]; Pue Kae, 1♂ 25.i.1973 [KUE]; **Nakhon Nayok**: 1♂ 14.v.1963 [KUE]; **Kanchanaburi**: 1♂ 15.xi.1987 [NPM]; Thong Pha Phum, 1♂ 25.vi.2006 [CUM]; **Ratchaburi**: Banpong, 1♂ 22.vii.2002 [CUM]; **No label**, 2♀[CUM].

Eurema laeta pseudolaeta: **Chiang Mai**: Hauy Hong Krai, 1♀ 12.xi.1995 [NPM]; Doi Inthanon, 1♂ 18.ix.2004; **Sukhothai**: Ram Kham Hang National Park, 1♂ 7.iv.1991 [NPM]; **Phetchabun**: Nam Nao, 2♀ 3.xii.1996, 1♀1♂ 6.i.1997 [NPM]; **Chaiyaphum**: Phu Khiao, 1♂ 10.vi.1988, 1♂ 12.i.1998, 1♀ 22.i.1998, 1♂ 9.v.1998 1♀ 13.vi.1998, 1♂ 6.vii.1998, 1♀3♂ 26.vii.1998, 1♂ 27.x.1998, 1♂ 12.ii.1999 [NPM]; **Kanchanaburi**: Thong Pha Phum, 1♂ 24.vi.2006 [CUM]; **Uthai Thani**: Huai Kha Khaeng, 1♀ 5.i.1997 [NPM]; No label, 1♂ 18.ix.2004 [CUM].

Eurema ada iona: **Trang**: Khao Shong, 1♀1♂ 19.x.1980 [APM]; **Pattani**: Sai khew, 1♂ 14.xi.1995 [APM].

Eurema andersoni andersoni: **Ranong**: Ko Ra, 1♀1♂ 11.ii.2005 [SPC]; **Nakhon Si Thammarat**: Khanom, Khao Krod Cave, 3♂ 27 viii 2007 [CUM]; Khao Sai 1♀ 27 viii 2007 [CUM].

Eurema andersoni sadanobui: **Chiang Mai**: Huay Hong Krai, 1♂ 26.xii 2006 [CUM]; Chiang Dao, 1♂ 8 xi 2007, 1♀3♂ 6 ii 2008 [CUM]; **Ratchaburi:** Suan Phueng 3♀7♂ 25 x 2007 [CUM]; **Chaiyaphum**: Phu Khiao, 1♂ 21.i.1988, 2♂ 3.viii.1988, 3♀ 6.v.1998, 1♀ 3.viii.1998 [NPM]; **Kanchanaburi**: 1♂ 11.x.1998 [NPM]; **Prachuap Khiri Khan**: 1♂ 6.viii.1998 [CUM]; **No label:** 1♂ 21.i.1980, 1♀ 21.i.1998, 3♂ 3.vii.1988, 1♀ 8.vii.1998, 1♀ 28.vii.1998, 1♀ 3.viii.1998, 1♀ 22.i.1999, 1♂ 23.i.2000, 1♂ 19.viii.2000, 1♀ 24.i.2001, 1♀ 25.i.2002, [NPM].

Eurema sari sodalis: **Chanthaburi**: 1♂ 14.iii.1979 [KUE]; **Kanchanaburi**: 1♂ 11.x.1988 [NPM]; **Trang:**, Na Bin Lang, 1♀ 5.vii.2001 [PSU].

***Eurema nicevillei nicevillei*: Trang**: 1♂ 3.v.1980 [KUE]; Ao Son, 1♂ 1.x.1981 [PSU]; **Ranong**: Ko Ra 1♂ 11.ii.2005 [SPC]; **Nakhon Si Thamarat**: Namtok Yong, 1♂ 19.xi.1999 [NPM].

***Eurema novapallida*: Chiang Mai**: 1♀ 9 xi 2007; Chom Thong 1♂ 5 ii 2008 [CUM]; **Phetchabun:** Nam Nao, 1♂ 6.i.1997 [NPM]; **Uthai Thani**: Huai Kha Khaeng, 1♂ 3.i.1999 [NPM].

***Eurema blanda silhetana*: Chiang Mai**: 1♀ 18.viii.1972, 1♂ 21.viii.1972 [CMB],

1♂ 8.xii.1972 [CME], 1♂ 27.viii.1973, 1♂ 13.viii.1974 1♀ 1.x.1977 [CMB], 1♀ 13.i.2003 [CME], 1♂ 26.xi.2005, 1♂ 28.xii.2005 [MJU]; Doi Pui, 1♂ 23.i.1980 [KUE]; Doi Suthep, 1♂ 20.viii.2005 [MJU]; Huay Hong Krai, 3♀ 26.xii 2006, 1♂ 13.viii.2006, 1♂ 14.viii.2006, 5♂ 26.xii.2006 [CUM]; Maejo, 1♂ 2.vi.2000, 1♂ 18.xi.2005, 1♂ 5.xii.2005, 1♂ 8.xii.2005 [MJU]; Hauy Jo, 1♂ 15.xi.2002, 1♂ 2.xi.2005, 1♂ 25.xii.2005 [MJU]; San sai, 1♂ 12.vii.2005, 1♂ 18.xi.2005, 1♂ 26.xi.2005, 1♂ 13.xii.2005, 1♂ 31.xii.2005 [MJU]; Maehophra, 1♂ 4.x.1991 [NPM]; Maeheak, 1♂ 27.vi.1998 [CME]; Chom Thong, 2♂ 5 ii 2008 [CUM] ; **Chiang Rai**: Chiang Dao, 1♂ 18.v.1999, 1♂ 19.v.1999 [NPM]; **Mae Hong Son**: 2♀ 9.xii.1999 [NPM]; Pang Ma Pa, 1♂ 16.vii.1998, 1♂ 3.xii.1999, 1♂ 8.xii.1999, 1♀1♂ 9.xii.1999 [NPM]; **Tak**: Sam Ngao, Huay Yao 1♀ 3♂ 7 ix 2007 [CUM]; **Nan**: Na Noi, 1♀ 13 x 2007 [CUM]; **Phrae**: Pae Muang Pae, 1♂ 11.v.1999 [MPM]; **Singburi**: 1♂ 12.vi.2006 [CUM]; **Bangkok**: Bang Khen, 1♂ 1.ix.1964 [KUE]; **Kanchanaburi**: 1♂ 15.xi.1987, 1♂ 11.x.1988 [NPM]; Thong Pha Phum, 1♀ 12.xi.1986, 3♀4♂ 12.xi.1988 [NPM]; **Ratchaburi**: 1♂ vi.1985 [NPM]; **Nakhon Pathom**: 1♀ 19.i.1988 [NPM]; **Phetchabun**: Nam Nao, 1♀ 3.xii.1996, 2♂ 3.xii.1996, 1♂ 6.i.1997 [NPM]; **Chaiyaphum:** Phu Khiao, 1♀ iii.1998, 1♂ 28.vii.1998 [NPM]; **Nakhon Ratchasima**: 1♂ 13.ix.2001 [NPM]; Sakaeratch, 1♂ 3.i.1997, 1♀ 9.i.1997, 1♂ 10.i.1997 [NPM]; **Saraburi**: 1♂ 31.viii.2006 [CUM]; **Khon Kaen**: 1♀ 18.i.1990, 1♂ 25.xii.1989, 1♂ 9.viii.2001 [KKU]; **Trat**: Ko Kood, 1♂ 1.xii.2006 [SPC]; Son 1♂ 9.vii.1999 [NPM]; **No label**, 1♂ 21.i.1998, 4♀9♂ 3.xii.1999, 1♂ 4.xii.1999 [NPM], 2♀.

Eurema simulatrix sarinoides **Chiang Mai**: 1♀ 18.viii.1984, 1♂ 1.ix.1984 [CMB]; San Sai, 1♂ 25.i.2003 [MJU]; Chiang Dao 1♂ 6 ii 2008 [CUM] ; **Lampang**: Chae Son, 1♂ [NPM]; **Kanchanaburi**:1♂ 11.x.1988, 2♂ 13.x.1988 [NPM]; **Ratchaburi**: Suan Phueng 1♂ 25 x 2007 [CUM];**Nakhon Nayok**: 1♀1♂ 20.xi.1963 [KUE]; **Chanthaburi**, 2♂ 14.iii.1979 [KUE], 2♂ 1987 [NPM]; Phliu Waterfall, 2♂ 23.iv.1963 [KUE]; Krong Kaw Waterfall, 1♂ 19.vi.1985, 1♂ 23.ii.1988 [NPM]; Khoa Soi Dao, 1♂ 3.ii.1993 [NPM]; **Nakhon Ratchasima**: 1♂ 9.vi.2001 [KUE] **Prachuap Khiri Khan**: Kui Buri, 1♂ 11.vi.2000 [NPM]; **Ranong**: 1♀ 16.iii.1990 [CUM].

Eurema simulatrix tecmessa**: Nakhon Si Thammarat:** Khao Luang, 1♂ 3.v.2001 [NPM]; **Narathiwat:** Hala-bala, 1♂ 24.ix.2003 [KUE].

Eurema hecabe hecabe**: Chiang Rai:** Mae Chan, 1♂ 10.ix, 1♂ 12.ix.1981 [CMB]; **Chiang Mai:** 1♂ 2.x.1971, 1♀ 10.ix.1972, 1♂ 15.vii.1974, 1♂ 18.ix.1974, 1♀ 6.x.1977 [CMB], 1♂ 4.ii.1984 [CME], 1♀ 10.vii.1984 [CMB], 1♂ 29.vi.1987[KKU], 1♂ 4.ix.1987 [CME], 1♀ 8.v.1988, 1♀ 7.ix.1988, [CMB], 1♀ 20.xii.1990 [CME], 1♀ 18.vi.2001 [MJU], 1♀ 14.viii.2005 [CUM], 1♂ 19.viii.2005, 1♂ 28.xi.2005 [MJU]; Doi Inthanon, 1♂ 18.ix.2004 [KUE]; Doi Suthep, 1♀ 6.vii.1974, 1♂ 5.viii.1975, 1♀ 15.viii.1977, 1♀ 12.viii.1982 [CMB]; Maeheak, 1♂ 4.v.2000 [CUM]; San Kamphaeng, 1♂ 25.vi.2003 [CME], Maejo, 1♀ 18.vii.1983 [CME], 26.xii.2004, 1♂ 23.xi.2005, 1♂ 3.xii.2005, 1♂ 25.xii.2005 [MJU], 1♂ 26.xii.2006 [CUM]; San Sai, 1♂ 21.xii.2005, 1♂ 5.i.2006, 1♂ 9.ii.2006 [MJU]; Hauy Hong Krai, 1♂ 30.xi.1995, 1♂ 2.xii.1995 [NPM], 7♀10♂ 26.xii.2006

[CUM]; Maehophra, 1♂ 4.x.1991 [NPM]; Chiang Dao, 1♂ 18.v.1999 [NPM]; Mae Jam, 1♂ 15.v.1999 [NPM]; Doi Ang Khang, 1♀ 8 xi 2007 [CUM]; **Lampang**: 1♀ 9.viii.1998 [CUM], 1♂ 4.xii.1990 [CME]; Maesaikhom, 3♂ 12.vii.1991 [NPM]; Chae Son, 2♂ iii.1993 [NPM]; **Nan:** Sri Nan, 2♂ 26.viii.1999 [NPM]; **Phrae:** 1♀ 12.vi.2006 [CUM]; TAK, 1♂ 18.viii.1999, 1♂ 18.x.1999 [NPM], 1♂ 24.xi.2003 [KUE]; **Pichit**: 2♂ 3.xii.2006 [CUM]; **Singburi:** 1♀ 10.vii.1999, 3♀ 25.xii.2006 [CUM]; **Ayutthya:** 1♂ 3.ix.1999 [CUM]; **Bangkok:** 1♀ xii.1961, 1♂ 10.xii.1967, 1♀ 6.ii.1969, 1♀ xi.1962, 1♀ ix.1971, 1♀ 2.x.1971, 2♂ 3.i.1972, 1♀ 12.ii.1972, 1♀ 25.ii.1972, 1♀ 9.ix.1973, 1♀ 11.vii.1980, 1♀ x.1989, 1♀ 2.ix.1997, 1♀ 15.vi.1999, 1♀ 6.viii.2000 [CUM]; Nong Khaem, 1♂ 9.ix.1986 [CUM]; Pra Khanong, 1♀ 15.viii.1985 [CUM]; Bang Sue, 1♂ 2.vii.1966 [CUM]; Bang Khen, 1♀ 25.i.1964, 1♀ 30.vi.1964, 1♂ 17.vii.1964, 1♀ 3.ix.1964, 1♀ 10.ix.1964, 1♂ 18.ix.1964, 1♂ 4.vii.1965, 1♂ 8.vii.1965, 1♂ 15.ix.1965, 1♀ 22.ix.1964, 1♂ 1.viii.1965, 1♂ 27.viii.1965, 1♀ 30.ix.1965, 1♀1♂ 10.x.1965, 1♂ 2.iv.1968, 1♂ 23.ix.2004, 1♀ 10.viii.2006 [KUE]; Thon Buri, 1♂ 28.ix.1960, 1♀7♂ 17.iii.1963 [CUM]; Min Buri 1♀ 8.viii.1995 [CUM], 1♂ 30.viii.1991 [NPM]; **Samut Prakan:** 3♂ 2.ix.2006 [CUM]; **Pathum Thani:** 1♀ 10.vii.1964, 1♂ vii.1964 [KUE]; **Nakhon Pathom:** 4♀8♂ 19.i.1988 [NPM]; Sam Parn, 1♀ 20.x.1971 [CUM]; Kampaeng Saen, 1♂ 23.xii.1986 [NPM]; **Ratchaburi:** 1♂ vi.1986, 1♀2♂ 5.vi.1986, 1♀ 17.vi.1988 [NPM], 1♀ 12.vi [CUM]; Tham Kang Kaw, 1♂ 7.ii.1999, 2♂ 12.vii.1999 [NPM]; Moir Tawan, 1♀ 17.v.1999 [NPM]; **Uthaithani:** Huai Kha Khaeng, 1♂ 22.ix.1999 [NPM]; **Kanchanaburi:** 1♂ 20.ii.1972 [CUM], 1♂ 11.x.1988 [NPM], 1♂ 19.vii.2000 [CUM]; Si Sawat 1♂ 5.v.2005 [KUE]; Muang Sung Ga Si, 1♂ 10.vii.1999 [NPM]; Thong Pha Phum, 1♂ 8.ix.2000, 3♀ 21.iv.2006, 10♀3♂ 24.vi.2006 [CUM]; Arawan National Park, 1♀ 20.vii.2000 [NPM]; **Nakhon Nayok:** 1♀ 14.v.1962, 2♂ 14.v.1963 [KUE], 1♀ 21.xi.1971 [CUM]; Kho Yai, 1♀ 22.ix.1965 [KUE]; Klong Sasan, 1♂ 18.x.1997 [NPM]; **Phitsanulok:** Thung Salang Laung, 1♂ 21.iv.1965 [CUM]; **Phetchabun:** Nam Nao, 1♂ 3.xii.1996, 1♂ 8.xii.1996, 4♀2♂ 6.i.1997 [NPM]; Phu Khiao, 1♀1♂ 21.i.1998, 1♀1♂ 22.i.1998, 1♂ 26.i.1998, 1♂ 4.v.1998, 1♂ 5.v.1998, 1♂ 15.vii.1998, 2♂ 27.vii.1998, 1♂ 25.vii.1998, 1♂ 26.ix.1998, 2♀ 3.xii.1998, 1♀ 2.vii.1999, 1♀14.vii.1999, 5♀3♂ 2.xii.1999, 1♀ 8.xii.1999, 1♀ 14.xii.1999, 1♂ 27.i.2005 [NPM]; **Saraburi:** 1♂ 14.iv.1995 [CME], 1♂ 9.vii.2000 [CUM], 1♀ 6.viii.2005 [KUE]; Pue Kae, 1♀ 30.viii.1960 [CUM], 1♀ 2.ix.1964, 1♂ 10.vii.1965, 1♀ 7.viii.1965 [KUE], 1♂ 4.i.1968, 1♀ 14.vii.1970, 1♂ 17.viii.1996 [CUM]; Muak lek, 1♂ 6.iii.1963, 1♀ 15.xii.1968 [KUE]; Khaeng Khoi, 4♀6♂ 14.i.2006, 2♂ 27.iii.2006, 2♀5♂ 20.viii.2006, 2♀3♂ 10.xii.2006 [CUM]; **Chanthaburi:** 5♀ 12.i.1986, 1♀2♂ 19.ix.1988, 2♂ x.1988, 2♂ 12.i.1993, 2♂ 20.xii.1995 [NPM]; Khoa Soi Dao, 1♂ 3.iii.1993[NPM]; Trat: Ko Kood, 1♀1♂ 1.xii.2006 [SPC]; **Nakhon Ratchasima:** 1♀1♂ 4.viii.1989 [CUM], 2♂ 13.ix.2001 [NPM]; Pak Chong, 1♂ 19.vi.1963 [KUE]; Hew Suvat, 1♂ 23.ix.1987 [NPM]; **Surin:** 3♀ 24.xi.2000, 1♀ 24.i.2002, 1♂ 20.viii.2002, 1♀ 30.viii.2002, 3♀ 24.x.2002, 2♂ 24.xi.2002[CUM]; Prasat, 1♀1♂ 20.x.2006 [CUM]; **Khon Kaen:** 1♂ 28.vii.1976, 1♂ 2.ix.1976, 1♂ 4.xi.1976 [KKU], 1♀ 5.ix.1976 [CMB], 1♀ 10.vii.1979, 1♂ 9.ii.1980, 1♂ 2.i.1984, 1♂ 23.viii.1986, 1♀ 28.ix.1986, 1♂ 12.ii.1987, 1♂ 1.xi.1987, 1♂ 17.vii.1988, 1♂ 24.vii.1988, 1♂ 17.viii.1988, 1♀ 26.xi.1988, 1♂ 27.xi.1989, 1♂ 10.xii.1989, 1♂ 25.xii.1989, 1♂ 6.i.1990, 1♂ 18.ii.1990, 1♀ 10.ix.1991, 1♂ 15.ix.1991, 1♀ 20.vi.1991,

1♀ 27.vi.1991, 1♀ 28.viii.1991, 1♂ 2.ix.1992, 1♂ 2.vii.1993, 1♀ 24.vii.1993, 1♂ 1.viii.1993, 1♀ 13.ix.1993, 1♂ 17.ix.1993, 1♂ 20.ix.1993, 1♂ 27.xi.1993, 1♂ 28.xi1993, 1♂ 25.xii.1993, 1♂ 10.xi.1994, 1♂ 11.xi.1994, 1♂ 17.xi.1994, 1♂ 15.xii.1994, 1♂ 28.i.1995, 1♂ 16.vii.1997, 1♀ 5.ix.1997, 1♀ 8.xi.1997, 1♀ 15.xi.1997, 1♀ 6.xii.1997, 1♀ 15.xii.1997, 1♀ 20.xii.1997, 1♂ 8.i.1998, 1♂ 23.i.1998, 1♀ 17.vii.1998, 1♂ 18.vii.1998, 1♂ 11.viii.1998, 1♂ 20.viii.1998, 1♀ 8.ix.1999, 1♀ 14.ix.1999, 1♀ 21.viii.1999, 1♀ 28.viii.1999, 1♂ 29.i.2000, 1♂ 1.viii.2001, 1♂ 26.viii.2001 [KKU], 1♀ 8.viii.2002 [MUS], 1♂ 9.vii.2003, 1♂ viii.2003, 1♀ 15.viii.2003, 1♀ 22.viii.2003, 1♂ 10.vi.2006 [KKU]; **Si Sa Ket:** 1♀ 18.ix.1988 [KKU]; **Roi Et:** 1♂ 12.vii.2003 [KKU]; Mancha Khiri 1♂ ix [KUE]; **Maha Sarakham:** 1♀ 10.viii.2002 [MUS], 1♀ 24.vii.2003 [KKU], 1♂ 20.ii.2000, 1♂ 14.i.2002, 1♂ 26.i.2002 [MUT], 1♂ 14.i.2002 [MUS]; **Chon Buri:** 1♀ 9.vii.1989, 2♀ 23.viii.1997 [CUM]; Ko Sichang, 1♂ 9.ix.2006, 2♂ 10.ix.2006 [CUM]; Ko Samaesarn, 1♀ 27.v.1998 [CUM]; **Prachuap Khiri Khan:** 1♀ 18.vii.1963 [KUE]; Son, 1♀ 9.xii.1999 [NPM]; **Chumphon:** 1♀2♂ 19.v.2006 [CUM]; **Phuket:** 1♂ 21.viii.1999 [NPM]; **Surat Thani:** Ratchchaprapa Dam, 2♀3♂, Ban Na San, 1♂ 15.x.1999 [NPM]; 15.x.1999 [NPM]; **Nakhon Si Thammarat:** Khao Luang, 1♂ 3.v.2001 [NPM]; **Songkla:** 1♂ 24.vi.2005 [PSU]; Hadyai, 1♀ 7.vii.1977, 1♀ 6.x.1992, 1♂ 28.vi.1992 [PSU]; Ton Ngachang, 1♂ 12.x.1999, 1♂ 29.x.1999, 1♂ 31.x.1999 [NPM]; **Satun:** Ta Lu Tao, 1♂ 8.xii.1981, 1♀ 27.iii.1982, 1♂ 8.iv.1982 [PSU]; **Narathiwat:** Hala-bala, 1♀ 29.xi.1999 [NPM]; **No label:** 10♀11♂, 1♀ 22.vii.1995, 1♂ 13.viii.1996, 2♂ 16.i.1997, 1♂ 19.viii.1997, 1♀ 19xii.1997, 1♂ 3.vii.1980, 1♀1♂ 21.i.1998, 1♀ 22.i.1998, 1♀ 8.vii.1998.