

Article

ECOLOGY, BIOLOGY, AND CONSERVATION STATUS OF OLD WORLD BUTTERFLY-MOTHS GENUS *Tetragonus* Geyer (LEPIDOPTERA: CALLIDULIDAE).

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The Old World butterfly-moth genus *Tetragonus* Geyer has only two species; *Tetragonus catamitus* Geyer and *Tetragonus lycaenoides* Felder. Both are tropical, the former ranges the Oriental tropics, whilst the latter is restricted to the Malay Peninsula and adjoining islands. *Tetragonus* remarkably host on fern species. *T. catamitus* seems adapted to secondary habitats where its host, favourably *Drynaria* species are available. Scattered information were reviewed with addition of new distribution records and field observations. The life history of *T. catamitus* is described with photographs. Knowledge gaps and conservation status are discussed.

Keywords: *Tetragonus catamitus*, *Tetragonus lycaenoides*, fern moths, lowland forests.

Geotags: Asian tropics, India, Sri Lanka, Pokhara - Nepal (28.2060, 83.9500) and Timor (-9.1075, 125.0180), Myanmar, Laos, Vietnam, Cambodia, Thailand, Malay Peninsula, Borneo, Indonesia, Philippines, South China

INTRODUCTION

As the common name implies, old world butterfly-moths, *Tetragonus*, are day-flying moths, which can be easily mistaken for butterflies. *Tetragonus* look similar to Lycaenidae butterflies. Early collectors sometimes placed them with butterflies (Moore, 1877), and when seen, amateurs sometimes record them as ‘unidentified butterfly’. Even in the earliest description, *Tetragonus* was placed as a genus of butterfly by Geyer but later Kirby placed this genus in Callidulidae (Hemming, 1967). Genus

Tetragonus belong to subfamily Callidulinae, family Callidulidae of superfamily Calliduloidea. Calliduloidea is a monophyletic superfamily having only family Callidulidae which has three subfamilies; Callidulinae, Griveaudiinae and Pterothysaninae. All the three subfamilies together have only eight genera with about sixty valid species. Subfamily Callidulinae alone has five genera (Yen & Wu, 2009). Moore (1877) described family Callidulidae using *Callidula* Hübner as Type genus. Callidulidae has three subfamilies, Callidulinae with five genera:

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Tetragonus, *Comella* Pagenstecker, *Pterodecta* Butler, *Callidula* Hübner and *Cleis* Guérin-Méneville; Griveaudiinae with genus *Griveaudia* Viette; Pterothysaninae with *Helicomitra* Butler and *Pterothysanus* Walker. Genus *Tetragonus* has two species, *Tetragonus catamitus* Geyer and *Tetragonus lycaenoides* Felder (Holloway, 1998). Kobes (1990) recognized three subspecies of *Tetragonus catamitus*, but Holloway (1998) treated all of them as junior synonyms of the nominotypical subspecies, showing there is great variation in size and colouration (Figure 1 02). Proper identification and study of the ecology and biology of uncommon species like *Tetragonus*, which also are special in systematics and evolution is very important. There are

comprehensive reviews of the family Callidulidae by Minet (1991), Holloway (1998), Kristensen & Skalski (1998) and recently by Yen & Wu, (2009). But the biology and ecology of species of Callidulidae are poorly known.

In this article I gather available information of genus *Tetragonus*, its ecology and biology to assess conservation status. Information is based on published literature, author's observations, personal communications to author and records shared over social networks, blogs and web groups. This article reports recent field records of the species and notes on their life histories, further discusses knowledge gaps and conservation status. Nomenclature is based on Holloway (1998).

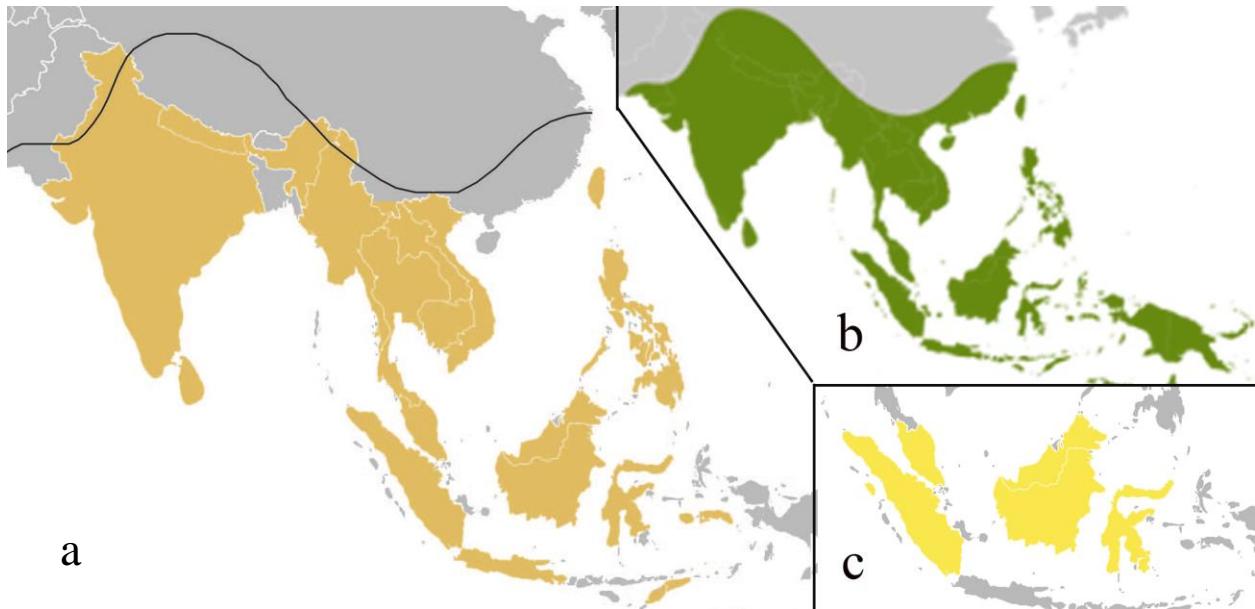


Figure 01. (Not to a scale) **a.** Range of *Tetragonus catamitus* with confirmed records. **b.** Range of genus *Drynaria* in Asia (Wikimedia Commons). **c.** Distribution of *Tetragonus lycaenoides*.

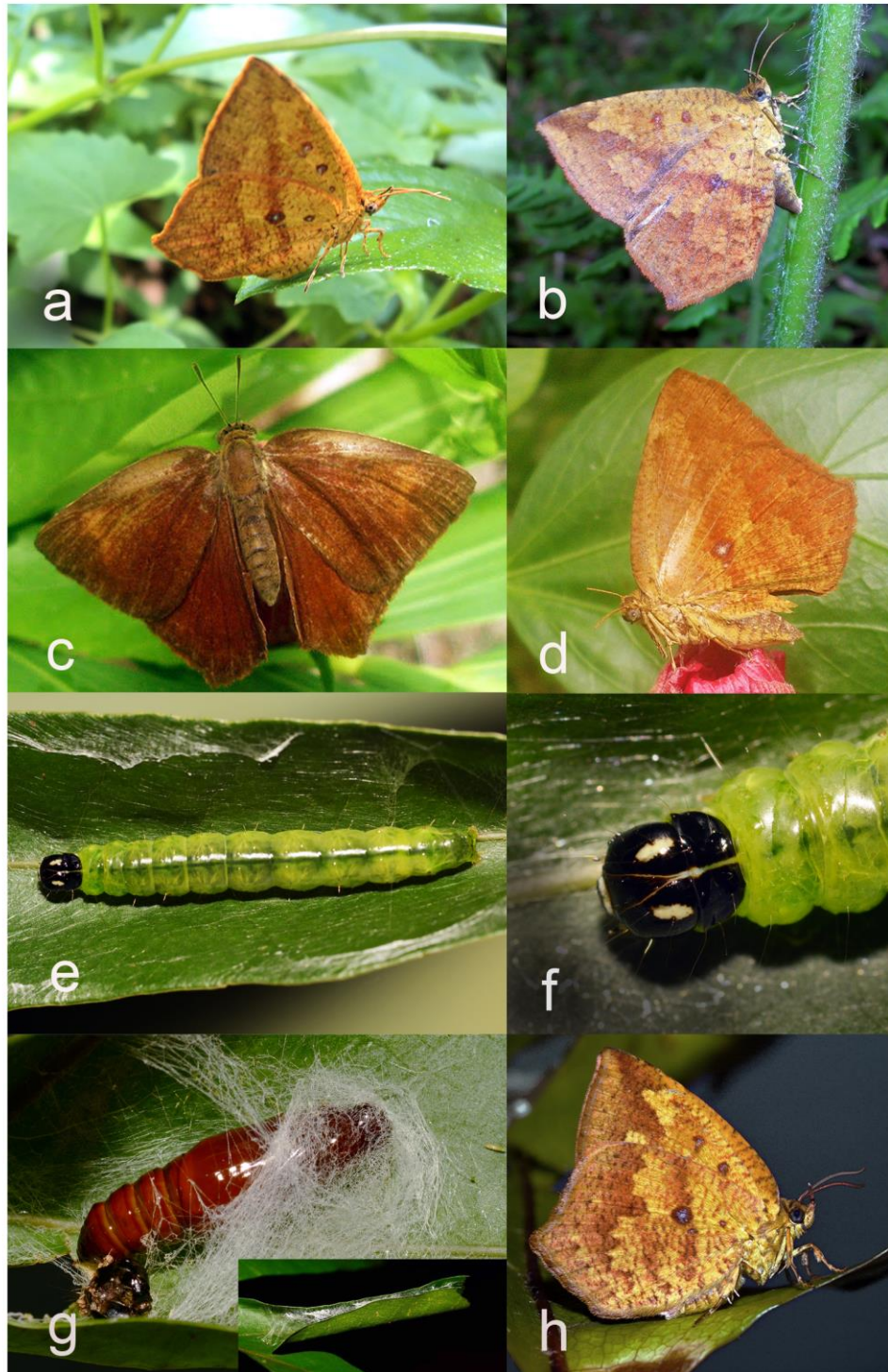


Figure 02. *Tetragonus catamitus*; **a.** From a home garden in Sri Lanka. **b.** Female laying eggs on *Pteridium* strand, one of its host plants. **c&d.** From Philippines. **e&f.** Final instar larvae on *Drynaria* leaves **g.** Cocoon and Cocoon case **h.** Imago of *Tetragonus catamitus*.



Figure 03. *Tetragonus lycaenoides* from Malaysia.

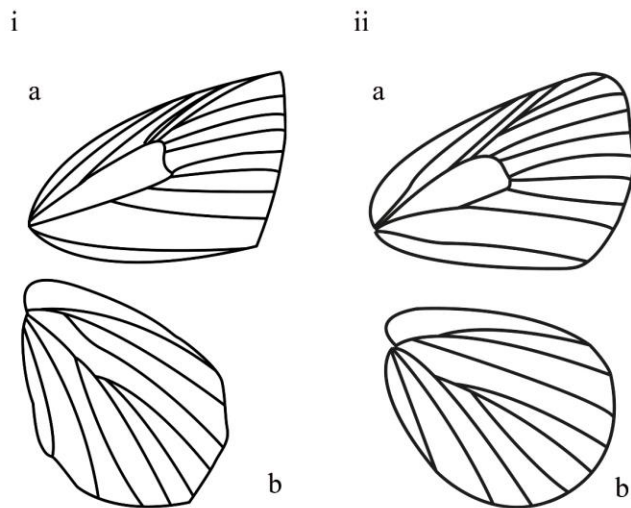


Figure 04. i. *Tetragonus catamitus* (after Hampson, 1892) **a.** Forewing **b.** Hind wing **ii.** *Tetragonus lycaenoides* (after Minet, 1998) **a.** Forewing **b.** Hind wing.

Box 01: Identification and summary of adult moths

A. *Tetragonus catamitus* Geyer

Tetragonus Catamitus, Geyer, *Zutrage Exot. Schmett.* pt. iv. p. 17, figure. 653-4 (1832). | *Cleosiris Catamita*, Boisduval, *Spec. Gen. Lep. i. pi.* 23, figure. 3; Doubleday & Westwood. *Gen. D. Lepi.* 77, f. 9. | *Tetragonus catamitus* Geyer, 1832, *Zuträge Samml. exot. Schmett.*, 4:17. | *Cleosiris fasciata* Moore, 1883, *Proc. zool. Soc. Lond.*, 1883: 15. | *Tetragonus catamitus simaluricus* Kobes, 1990: 106.

Adult: Forewing length 18–19 mm (Yen & Wu, 2009); Brownish-ferruginous ground colour: forewing with an indistinct yellowish-ferruginous wavy subapical fascia: hindwing uniformly coloured. Underside ferruginous-yellow, numerously covered with slender red confluent strigae, which, across the wings, forms a slight fascia from apex of forewing to middle of the abdominal margin of the hindwing, and a less defined similar outer fascia; three small dark-brown ocellated spots within each cell, the spots centred with a silver white spot; postmedial line irregular (Figure 02 and Figure 04.i). Wingspan 35 – 38 mm (Moore, 1880)

Geographical range: Sri Lanka, India, Andaman and Nicobar Islands, Nepal, Myanmar, Laos, Vietnam, Cambodia, Thailand, Malay Peninsula, Singapore, Borneo, Indonesia, Philippines, Hong Kong, Taiwan

B. *Tetragonus lycaenoides* Felder

Agonis lycaenoides Felder, 1874, *Reiseöst. Fregatte Novara (Zool.)*, 2: p1. 107. | *Tetragonus lycaenoides* Felder; Kobes, 1990: 107.

Adult: Abdomen dorsally brown, ventrally yellow, overall yellowish-ferruginous same as *Tetragonus catamitus*, but smaller with rounded wings, especially, the hind wings. On the bottom of the cell of forewing three spots with white or grey nuclei are located. The discocellular spot is figure-of-eight (8) shaped. Also on the hindwing, is a discocellular figure-of-eight shaped spot; towards the base another small spot with white core. For the rest, the wings are yellowish brown with two irregular median transverse lines, a very clear post-medial, strongly serrated line and a sub-marginal series of angular spots (Figure 03 and Figure 04.ii). Wingspan 35 – 38 mm (Eecke, 1926).

Geographical range: Sulawesi, Borneo, Peninsular Malaysia, Sumatra, Nias (Figure 01.c) (Eecke, 1926; Holloway, 1998).

BIOLOGY AND ECOLOGY

Tetragonus catemitus Geyer (Box 1. A)

Eggs are very flat, scale-like (Holloway 1998 after Bell & Barlow). Eggs are laid on the underside of fronds or the young stalk of the host plant (Figure 02.b). On 04th August 2013 a caterpillar that was in last instar larvae of *Tetragonus catemitus* was collected in Kumarakom, Kottayam District, Kerala, India which was reared on *Drynaria* species, (Figure 02) (Pers.com. Manoj Pankajakshannair). Larvae pupated on 9th August and adult emerged on 15th of August.

Larvae started feeding from the tip of the pinna and seems they have strong mandibles, helping to eat the central veins. The head and first thoracic segment of the larvae are black and they have well-developed, chitinous, shiny, black prothoracic shields, which are separated by a median green line. The same line splits in two at the base of the head carapace and extends towards the forehead forming a 'V' shaped mark. Larvae have grass green, translucent bodies. The head of the observed specimen had two symmetrical pale-whitish triangular patches besides the 'V' shape marking. The head and prothoracic shield on the first thoracic bore several whitish, translucent bristles of various sizes. Each segment has a single pair of whitish, translucent bristles; in segments from A1 to A8. The tracheal system and the digestive tract is dorsally visible through the translucent body. The last abdominal segment has a pair of rear-pointing protrusions. Body segments are very obvious, compressed at the beginning and the end of each segment, whilst the middle is swollen (Figure 02.e).

The pupa is a medium sized cocoon of an elongated narrow ovate shape, chocolate brown in colour; with a prominent head, which is thickest in the middle, a parallel-sided

abdomen forms a cone at the last four segments. The cremaster is a circular flat cap, with short central process. Cocoon is enclosed in a folded leaf of the host plant protected and stabilised within the leaf case by whitish silk that is used to fold the leaf (Figure 02.e-g).

Since the larvae of *Tetragonus catemitus* feed on ferns, the name Fern moth is also used. Holloway (1998) also mentions that it hosts on genus *Drynaria* probably referring to early work, because *Tetragonus catemitus* has not been recorded during their work in Borneo. Holloway (1998) further mentioned *Tetragonus catemitus* in Hong Kong hosts on *Pteridium* (a Dennstaedtiaceae fern commonly known as Bracken) citing an unpublished IIE report. Kendrick (2010) doubts this, though *Pteridium* is present in Hong Kong, as it is not a common plant, the actual host of *Tetragonus catemitus* in Hong Kong is possibly a similar looking fern. In Taiwan, this species has been reared from *Pteridium aquilinum* (Yen & Wu, 2009). HOSTS database (Robinson *et al.*, 2010) also mentions *Pteridium aquilinum* as host plant of *Tetragonus catemitus* (*Cleosiris catemitus* synonym), probably referring to later records from Taiwan. Therefore the report of *Tetragonus catemitus* hosting *Pteridium* species in Hong Kong should be true, whilst there is a high possibility of a common host plant from the genus *Drynaria*. Species such as *Drynaria fortune* occurs in Hong Kong and commonly used in Chinese traditional medicine (Ou Ming *et al.*, 1989; Wong *et al.*, 2013). It seems the distribution of *Tetragonus catemitus* follows its host plant range (Figure 02.b)

Tetragonus catemitus generally distributed in the Oriental region (Holloway, 1998); it has been recorded in Sri Lanka, North and South west India, Andaman and Nicobar Islands, Nepal, Myanmar, Laos, Vietnam, Cambodia, Thailand, Malay Peninsula,

Singapore, Borneo, Indonesia, Philippines, Hong Kong, Taiwan (Yen & Wu, 2009) (Figure 01. a). Its northern and southern limits of distribution are not known; Indian records are mainly from Southern regions, but *Tetragonus catemitus* has been recorded from as far north as Pokhara, Nepal (28.2060, 83.9500) and as south as Timor (-9.1075, 125.0180) (Niwakagamania *et al.* 2003-2013). It has been recorded in the Philippines (Beccaloni *et al.*, 2003) with a recent record from Capiz, Panay Island (Pers. Com. Shekai D. Alaban, 2014). There is a very recent record from Pu'er, Yunnan in Southern Mainland China (John Horstman at <https://www.flickr.com/photos/itchydogimages/18793665839>). Therefore the range should be tropical Asia, and it should occur in Bangladesh, Bhutan, Brunei southeast Pakistan and most of South China (see the possible northern limit line on Figure 01.a).

There are several recent records of *Tetragonus catemitus* in Sri Lanka from, Kandy (Gannoruwa, Peradeniya), Kegalle, Colombo (Kesbewa), Galle and Matara (Kiralakele) and Puttalama districts, all are in the mid hills to coast of the wet zone except Puttalama, which is in the dry zone of Sri Lanka. In Hong Kong *Tetragonus catemitus* is found in secondary forest, plantation woodlands, and scrublands up to 550m elevation (Kendrick, 2010). Both in Taiwan (Yen & Wu, 2009) and Borneo (Holloway, 1998), *Tetragonus catemitus* is distributed in lowland forests. It also flies in evergreen forests of India (Pers.com. Peter Smetacek). The habitat of *Tetragonus catemitus* therefore consists of the lowlands of seasonal or tropical Asian forests where the host fern species grow. It has also been recorded in home gardens in Sri Lanka (pers. observation) and urban parks in Singapore (Quek, 2010) with similar habitats.

The phenology of adults has been observed in Hong Kong and it flies from February to October, and is abundant from May

to August with a peak in July (Kendrick, 2010). Though the species is known as day flying, often crepuscular, active at dawn and dusk or active when the sky is overcast with cloud cover. It is also known to be attracted to light traps supporting the idea of crepuscular behaviour (Kendrick, 2010; Yen & Wu, 2009). It flies close to the ground, with slow flight that often covers only short distances (Kendrick, 2010). *Tetragonus catemitus* feeds on floral nectar, and is also known to be attracted to prawn bait (Holloway, 2013).

***Tetragonus lycaenoides* Felder (Box 1. B)**

Tetragonus lycaenoides ranges in Sulawesi, Borneo, Peninsular Malaysia, Sumatra, Nias (Figure 03.c). Known to host on ferns but no detailed information of early stages is available. Its limited distribution is perhaps due to a specific fern species it hosts on. It is common in Malaysia, can be found in shady forest or undergrowth especially near streams and damp areas (Gosh *pers.com*) probably because this is the habitat of its host plant where it flies during daytime from morning until late afternoon. In Borneo it has been recorded from lowland (Holloway, 1988).

RESEARCH AND CONSERVATION

Its intermediate taxonomic position and behaviour among moths and butterflies together with dependency on primitive plants (ferns) as host make *Tetragonus*, in general butterfly-moths obviously specific and important taxa in ecosystems with a special position in evolution. Protecting such taxa should get high priority to conserve the evolutionary potential of organisms and their specific ecosystem services.

Knowledge gaps of ecology and distribution of this species need to be filled in order to come to a clear idea of its conservation status. It should be recorded from possibly

distributed territories; northern and western limits in India, northern limit in South China, gap territories including the political boundaries of Bangladesh, Bhutan, and Brunei to include in checklists and conservation plans.

Tetragonus catemitus seems distributed in wet lowland forests, most of which are highly disturbed and populated areas. It is a good news that it can survive in secondary and human dominated habitats such as home gardens and urban parks. As a general practice of Lepidoptera conservation, urban planners and park developers can use native nectar and host plants in gardening, roadside planting etc. Especially many *Drynaria* species have a very ornamental appearance and uses. Such availability of host plants can be a reason, apart from higher number of enthusiasts, for frequent records from populated and urbanised Singapore, Hong Kong and Taiwan.

Any threat to the host plant is a threat to *Tetragonus catemitus*. It is likely that genus *Drynaria* is the preferred host whilst some *Pteridium* species are also hosts. Most *Pteridium* species are widely distributed and are weeds (Page, 1976). Many species of *Drynaria*, for example *Drynaria roosii* and *Drynaria quercifolia* have wide use in traditional medicine in Asia (Ou Ming, *et al.*, 1989), further showing rising interest in modern medicine inventions (Jung, 2007) but no records that *Drynaria* is cultivated for this industry and most of this exploitation happens in rainforest or adjoining secondary forests (Mazumder *et al.*, 2011). Many other faunal species also associate with *Drynaria* strands. Efforts to cultivate widely using *Drynaria* species will be effective in conservation.

It seems *Tetragonus lycaenoides* is limited to lowland wet evergreen forests in Malaysian Peninsula and several nearby islands. Since such forests in this region are disappearing rapidly (Brookfield & Byron, 1990; Jomo *et al.*,

2004) it is a clear threat to *Tetragonus lycaenoides*. Unlike *Tetragonus catemitus*, *Tetragonus lycaenoides* is not known to survive in disturbed or degraded habitats though it is considered common (Pers. Com. Goh, 2013). More information on the distribution and life history of both the species of *Tetragonus* is needed for conservation plans.

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Ecology, biology, and conservation status of *Tetragonus*

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