

A new family (Hesperiidae) for the butterfly fauna of the State of Kuwait

Mohammad A.J. Marafi & Sylvain Cuvelier

Abstract. For the first time, two species of the Hesperiidae family are recorded from the State of Kuwait. The observations of *Gegenes nostradamus* (Fabricius, 1793) and *Pelopidas mathias* (Fabricius, 1798) started in 2021. The habitats are discussed, dorsal and ventral pictures of both genders of *G. nostradamus* and *P. mathias* are included. For identification the genitalia of both genders were examined, and the photographs of their preparations are presented. While the male and female genitalia of *G. nostradamus* were described in detail, this was not the case for *P. mathias*. Images of the male and female genitalia of collected specimens of *P. mathias* are compared with detailed drawings of *Pelopidas thrax* (Hübner, [1821]). The discovery of two new species for the State of Kuwait increases the total number of butterfly species to 25.

ملخص

لأول مرة يتم تسجيل نوعين لعائلة الفراشات النطاطة من دولة الكويت. بدأ تدوين الملاحظات في عام 2021 لـ *Gegenes nostradamus* (فابريكوس، 1793) و *Pelopidas mathias* (فابريكوس، 1798). تمت مناقشة الموائل وتضمن الصور الظهرية والبطنية لجنسين النوعين *G. nostradamus* و *P. mathias*. للحصول على تصنيف قاطع، جرى فحص الأعضاء التناسلية لكلا النوعين وتم عرضهما. بينما جرى بالتفصيل وصف الأعضاء التناسلية للذكر وأنثى *G. nostradamus*، لم يكن هو الحال بالنسبة لـ *P. mathias*. جرت مقارنة صور الأعضاء التناسلية للعينات التي تم تجميعها للذكر وأنثى *P. mathias* مع رسومات تفصيلية لـ *Pelopidas thrax* (هوبنر، [1821]). إكتشاف نوعين جديدين لدولة الكويت يرفع العدد الإجمالي للفراشات إلى 25 نوعاً.

Samenvatting. Voor het eerst zijn er twee soorten Hesperiidae gevonden in de staat Koeweit. De waarnemingen van *Gegenes nostradamus* (Fabricius, 1793) en *Pelopidas mathias* (Fabricius, 1798) begonnen in 2021. De biotopen worden besproken, foto's van dorsale en ventrale zijde van beide geslachten van *G. nostradamus* en *P. mathias* zijn opgenomen. Voor sluitende determinaties werden de mannelijke en vrouwelijke genitalia geprepareerd en hier voorgesteld. Hoewel de genitalia van beide geslachten van *G. nostradamus* in detail zijn beschreven, is dit niet het geval voor *P. mathias*. De figuren van de mannelijke en vrouwelijke genitalia van de verzamelde *P. mathias* worden vergeleken met gedetailleerde tekeningen van *Pelopidas thrax* (Hübner, [1821]). De ontdekking van twee nieuwe soorten voor de staat Koeweit brengt het totale aantal dagvlindersoorten op 25.

Résumé. Pour la première fois, deux espèces de la famille des Hesperiidae sont signalées pour l'Etat du Koweït. Les observations de *Gegenes nostradamus* (Fabricius, 1793) et *Pelopidas mathias* (Fabricius, 1798) ont débuté en 2021. Les habitats sont discutés, des photographies dorsales et ventrales des deux sexes de *G. nostradamus* et *P. mathias* sont incluses. Pour les identifications, les organes génitaux mâles et femelles ont été examinés et les photographies de leurs préparations sont présentées. Alors que les organes génitaux des deux sexes de *G. nostradamus* ont été décrits en détail, ce n'est pas le cas pour *P. mathias*. Les images des organes génitaux mâles et femelles des spécimens collectés de *P. mathias* sont comparées aux dessins détaillés de *Pelopidas thrax* (Hübner, [1821]). La découverte de deux nouvelles espèces pour l'Etat du Koweït porte le nombre total d'espèces de papillons à 25.

Key words: Kuwait — Faunistics — Papilionoidea — Hesperiidae — *Gegenes nostradamus* — *Pelopidas mathias* — Comparative morphology — Male and female genitalia.

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Introduction

Kuwait overlooks the Arabian Gulf and is situated between Iraq to the west and north, and Saudi Arabia to the west and south (Fig. 1). The total surface area of the country is 17,818 km², all of which is desert (Asem & Roy 2010). The country has a coastline 500 km in length facing Kuwait Bay to the north of Kuwait City and the Arabian Gulf (Persian Gulf) to the east. The environment of Kuwait can typically be described as hot, harsh, and hyper-arid (Alahmad *et al.* 2022). The climate of Kuwait is generally considered hot, regardless of the country's four distinct seasons. It has been described by Irlapati (2017) as having elements similar to the European climate despite being hotter and drier. Summers in Kuwait are long and hot (35–48°C), exceptionally dry, windy, sometimes dusty, typically cloudless, and extremely humid especially towards the end of the season. Autumns (20–30°C) can be dusty, sporadically cloudy and often accompanied by

thunderstorms nearing the start of the rainy season in late October and early November. Winters (8–15°C, sometimes below zero) are short, sunny, cool and dry especially at night-time, occasionally foggy, sometimes dusty, and wet from time to time with rainfall varying from one day to several days. Springs (20–40°C) can be sunny, occasionally cloudy, with scattered showers and thunderstorms accompanied by sporadic dust storms, which usually happen toward the end of the season.

The country is also prone to climate change, regularly experiencing extreme weather conditions, with temperatures occasionally exceeding 50°C in the summer months (Alahmad *et al.* 2022). Asem & Roy (2010) addressed the consequences of climatic change and its effect on the local biodiversity and discussed taking appropriate measures to reduce the impact of climate change. Rises in seawater temperature, dust storms, drought, unpredictable flooding (which can cause runoff) and sand encroachment are major factors of climate change of great concern to the country (Asem & Roy



Fig. 1. Map of the Arabian Peninsula (AE: United Arab Emirates; BH: Bahrain; KW: Kuwait; OM: Oman; QA: Qatar; SA: Saudi Arabia; YE: Yemen). © Fatima AlQallaf.



Fig. 2. Grazing camels, off-road driving, and permanent camps in the desert of Sulaibiya Agricultural Area. Sulaibiya farms are situated behind the tree line, 3.ii.2023. © Mohammad A.J. Marafi.

2010). In addition, Kuwait’s natural habitats and ultimately their biodiversity are under anthropogenic stresses which include desert camping, the encroachment of new conurbations, and overgrazing by livestock (Asem & Roy 2010) (Fig. 2). Off-road driving can also have a detrimental effect on habitats, randomly killing different species of fauna, including desert dwelling insects (Mahgoub 2007).

The country is reputedly rich in biodiversity despite its small land mass (Amr 2021). This richness is distributed across marine and terrestrial fauna alike; however, it should be noted that some orders are represented by only a few species, as is the case for butterflies. This undoubtedly is a direct consequence of the constraints on the natural environment faced by Kuwait, such as drought

and vegetation type which undeniably allow for a low diversity of native butterflies. However, in the case of the introduced butterfly species, their hostplants appear to have been introduced with their inception (Pope & Nithyanandan 2014; Marafi & Asadalla 2023).

In the early stages of entomological research, carried out by several specialists, attention was directed towards the cataloguing of the country’s limited fauna. Brown (1970) documented the earliest fieldwork of the native butterfly species. More extensive research was undertaken by Al-Houty (1989), who also prepared a checklist of the insect fauna of Kuwait (Al-Houty 1997) in which sixteen butterflies from four families (Papilionidae, Pieridae, Lycaenidae, Nymphalidae) were attributed. Al-Houty (2011) later updated this list adding five more

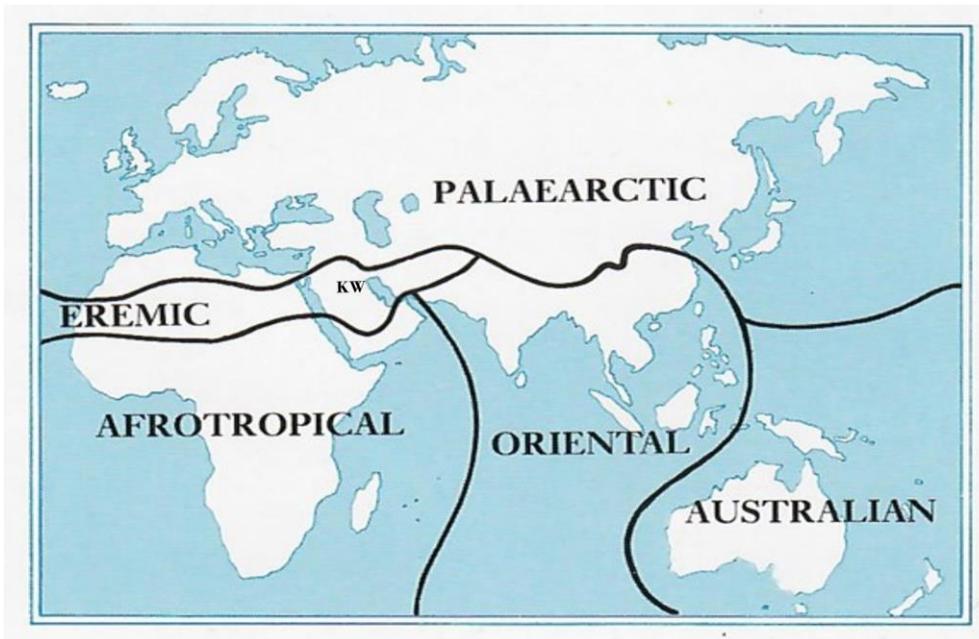


Fig. 3. Kuwait (KW) situated in the Eremic biogeographical zone. © Larsen 1984.

species to the Nymphalidae and Pieridae families. In addition, Pope & Nithyanandan (2014) added one Lycaenid species, while Marafi & Asadalla (2023) added a new Pierid species. Collectively, to date, a total of 23 butterfly species has been recorded from the State of Kuwait (S1). The number of butterfly species reported from the Arabian Peninsula totals 148 (Cowan & Cowan 2019) which, according to Pittaway (1985), is comprised of species from the Palearctic, Oriental, Ethiopian biogeographical zones, all of which converge within the peninsula, whereas a few species are found in the Eremic zone (Fig. 3). To date, five butterfly families (Papilionidae, Pieridae, Lycaenidae, Nymphalidae, and Hesperidae)

have been reported from the Arabian Peninsula (Larsen 1984).

Skippers (Hesperiidae) have a worldwide distribution, absent in Antarctica (Cock 2010). Notably in Arabia, the family is represented by three subfamilies: Coeliadinae (Giant Skippers), Pyrginae (Spread-winged Skippers) and Hesperinae (Grass Skippers) (Larsen 1984) (S2). Based solely on external characters, many Hesperinae are difficult to identify, but most differ markedly in their genital morphology. Up until the year 2021, no Skipper species had been recorded in Kuwait. But fieldwork in the central region of the country, which commenced in 2018, unearthed the discovery of two Hesperiid species.

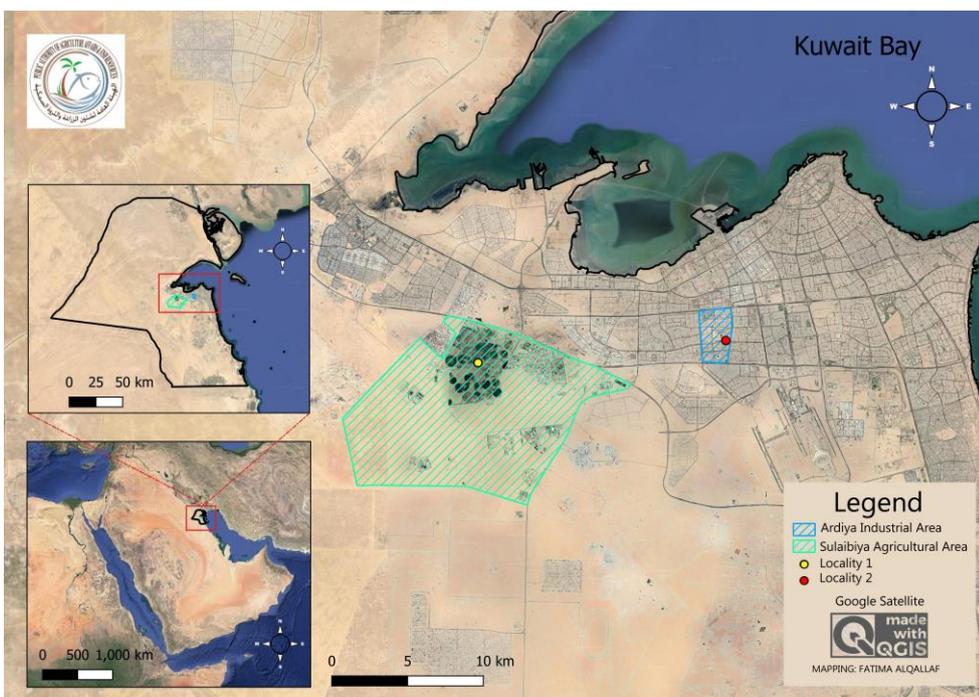


Fig. 4. Study sites with occurrences of Hesperidae in Kuwait; Locality 1 (yellow dot) in Sulaibiya Agricultural Area (green lines); Locality 2 in NPCC-AN (red dot) in Ardiya Industrial Area (blue lines). © Fatima AlQallaf.



Fig. 5a. North side of NPCC-AN, 15.i.2023.

Fig. 5b. Inside the NPCC-AN premises (Locality 2), 28.vii.2022.

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Methods

Two localities in Central Kuwait, twenty-one kilometers apart from one another, were regularly visited from October 2021 to January 2023 (Fig. 4). The localities are comprised of native flora and agricultural crops, forming ideal habitats for the local insect fauna, particularly Lepidoptera.

Locality 1: Sulaibiya Agricultural Area (137.712 km²) (Fig. 4) is primarily comprised of government-subsidised, privately operated fodder and dairy farms established in ≈1960-61 through the Department of Public Works at the time (Abdulaziz Alateeqi, a dairy farm owner, pers. comm.). In 1978, the farms were supervised by the Ministry of Public Works (Ministry of Public Works 2021), while in 1983 all agricultural activities were transferred to the Public Authority of Agriculture Affairs and Fish Resources (PAAFR 2023). Some farms have nurseries involved in the production of plant species used in various landscaping projects. In addition, Asian and African farm workers habitually grow crops such as eggplants, tomatoes, cucurbits, radishes, and herbs, among others for personal consumption. It is worth mentioning that parts of the area are uncultivated desert, yet campers and camel caravans do inhabit some areas (Fig. 2).

Locality 2: Native Plants Conservation Center, Ardiya Nursery (NPCC-AN) established in 2008 with an approximate total area of 60,000 m² is situated in the Ardiya Industrial Area. To the east and south, the nursery overlooks urban settlements, and uncultivated land to its northern and western boundaries (Figs 4, 5). The nursery is managed by the Department of Restoration of Terrestrial and Marine Ecosystems (DRTME), PAAFR. The main objective of the nursery is the production of native plants intended to be used in restoration projects of Kuwait's desert ecosystems administered by DRTME. The nursery encompasses several greenhouses, shade houses, and fields growing various annual and perennial species of

native flora, some of which are grasses, ornamental plants, and fruit trees. It also houses offices, an herbarium, a seed technology laboratory, and an entomology laboratory among other facilities.

The coordinates of the studied localities and sites are given in S3.

Specimens were collected from locality 1 – Site 1 between October 2021 and December 2022 using a hand-held butterfly net. They were freezer-killed, pinned, and spread (with wings displayed) on setting boards, and then labelled and preserved in the collection of Mohammad A.J. Marafi at the Entomology Laboratory, Native Plants Conservation Center at Ardiya Nursery (EL-NPCC-AN), PAAFR, Farwaniyah Governorate, Kuwait City. Abdomens of seven specimens were placed in a KOH solution for genitalia clearing. An Olympus SZ61 stereomicroscope equipped with an Olympus camera was used for the examination and imaging of the genitalia through cellSens Entry 3.1.1 software (Build 21264). Photos of the genitalia, achieved using focus stacking, were processed using Zerene Stacker software. The identification of the material was based on several publications (Coutsis & Olivier 1993; Coutsis 2012; de Jong & Coutsis 2017; Evans 1937; Jakšić 1998; Kolev & Shtinkov 2016). John Coutsis kindly provided detailed drawings (Figs 19, 20) of the male and female genitalia of *Pelopidas thrax* (Hübner, [1821]) which were compared with the prepared genitalia of the collected *Pelopidas* specimens.

Results and Discussion

Gegenes nostradamus (Fabricius, 1793) (Fig. 6)

Material examined: Kuwait: Jahra Governorate: Sulaibiya Agricultural Area (29.26651 N 47.75510 E) 17 m a.s.l, 1♂, 2.ix.2022; 1♂ 1♀, 9.ix.2022; 1♂, 16.ix.2022; 1♂, 7.x.2022, M.A.J. Marafi leg.



Fig. 6. Left: *Gegenes nostradamus* ♂ upper- and underside, 7.x.2022, Locality 1: Site 1; right *Gegenes nostradamus* ♀ upper- and underside, 9.ix.2022. Locality 1: Site 1. Collector and © Mohammad A.J. Marafi.

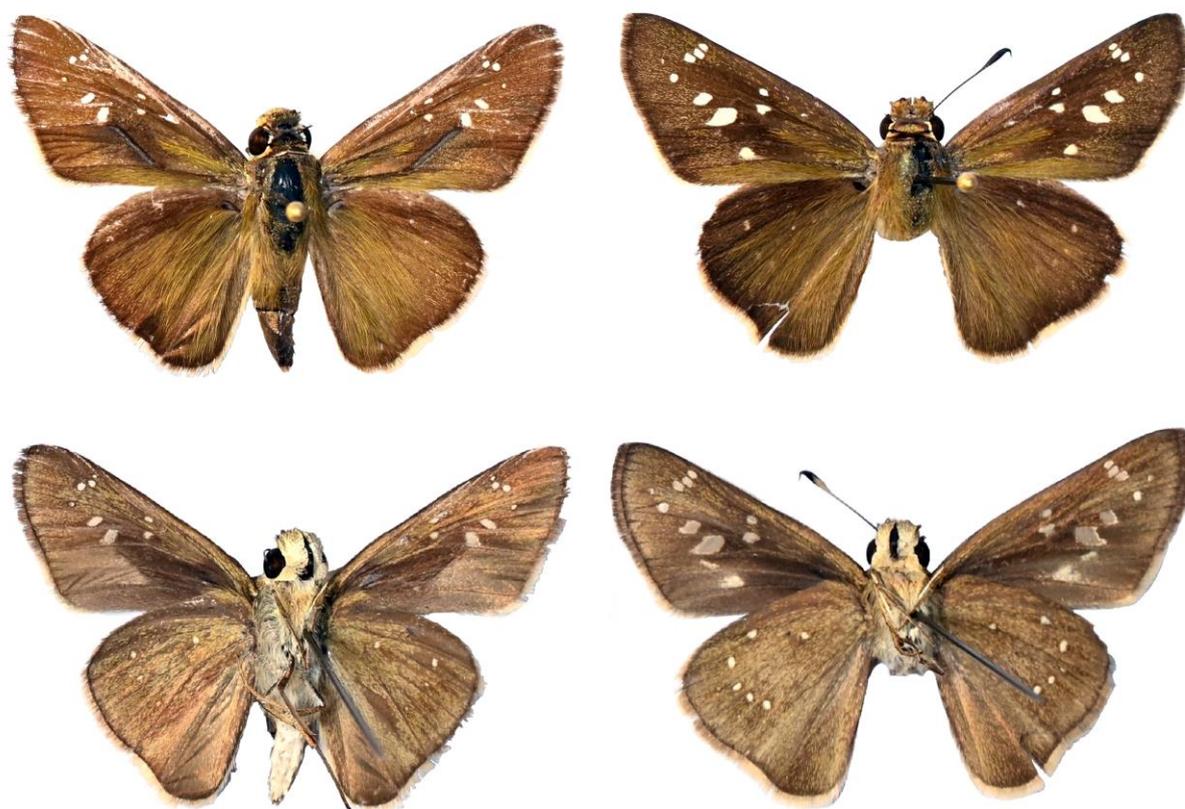


Fig. 7. Left: *Pelopidas mathias* ♂ upper- and underside, 22.x.2022, Locality 1: Site 1; right *Pelopidas mathias* ♀ upper- and underside, 16.xii.2022. Locality 1: Site 1. Collector and © Mohammad A.J. Marafi.

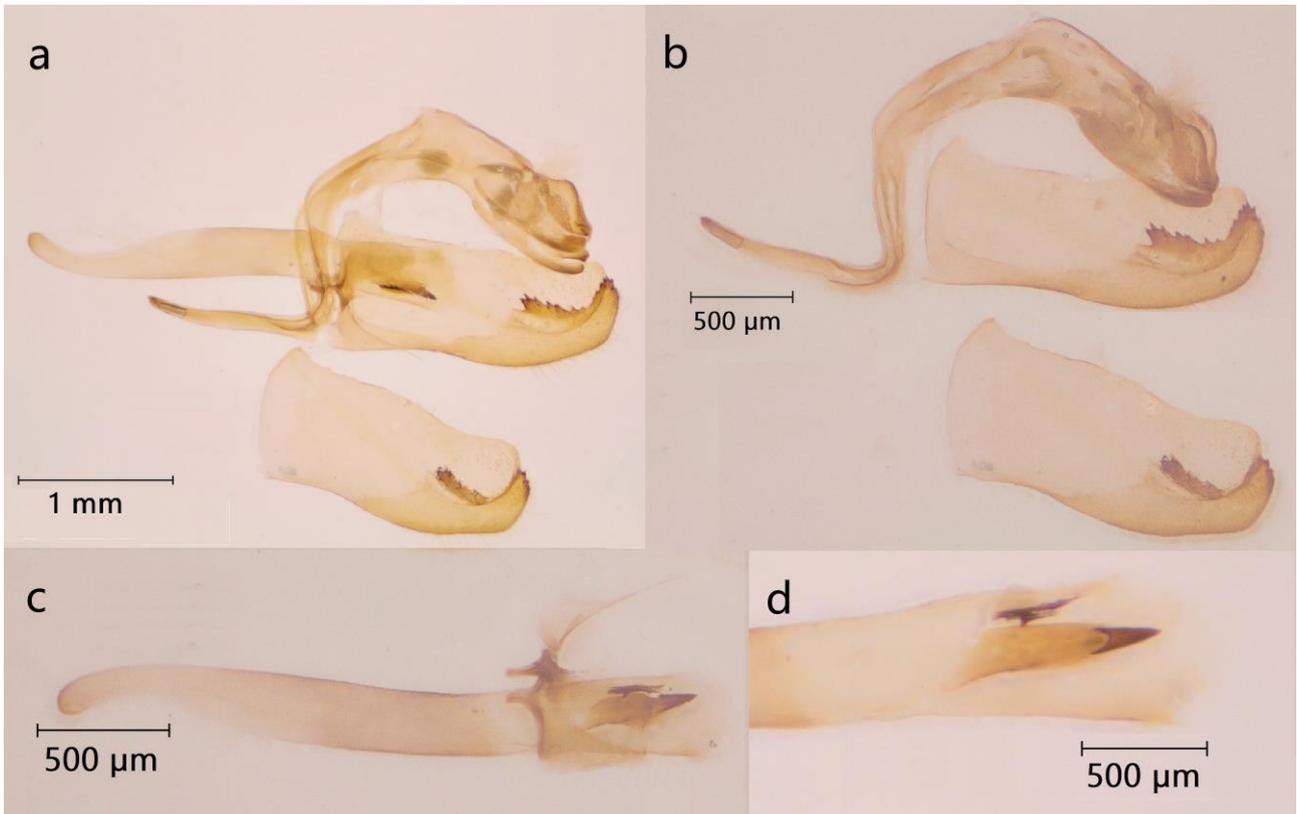


Fig. 8a. Lateral view of the male genitalia of *Gegenes nostradamus* (left valve removed). 8b. Lateral view (aedeagus and valves removed). 8c. Aedeagus. 8d. Distal end of the aedeagus. © Genit. prep.: Mohammad A.J. Marafi, Imaging: Sylvain Cuvelier.

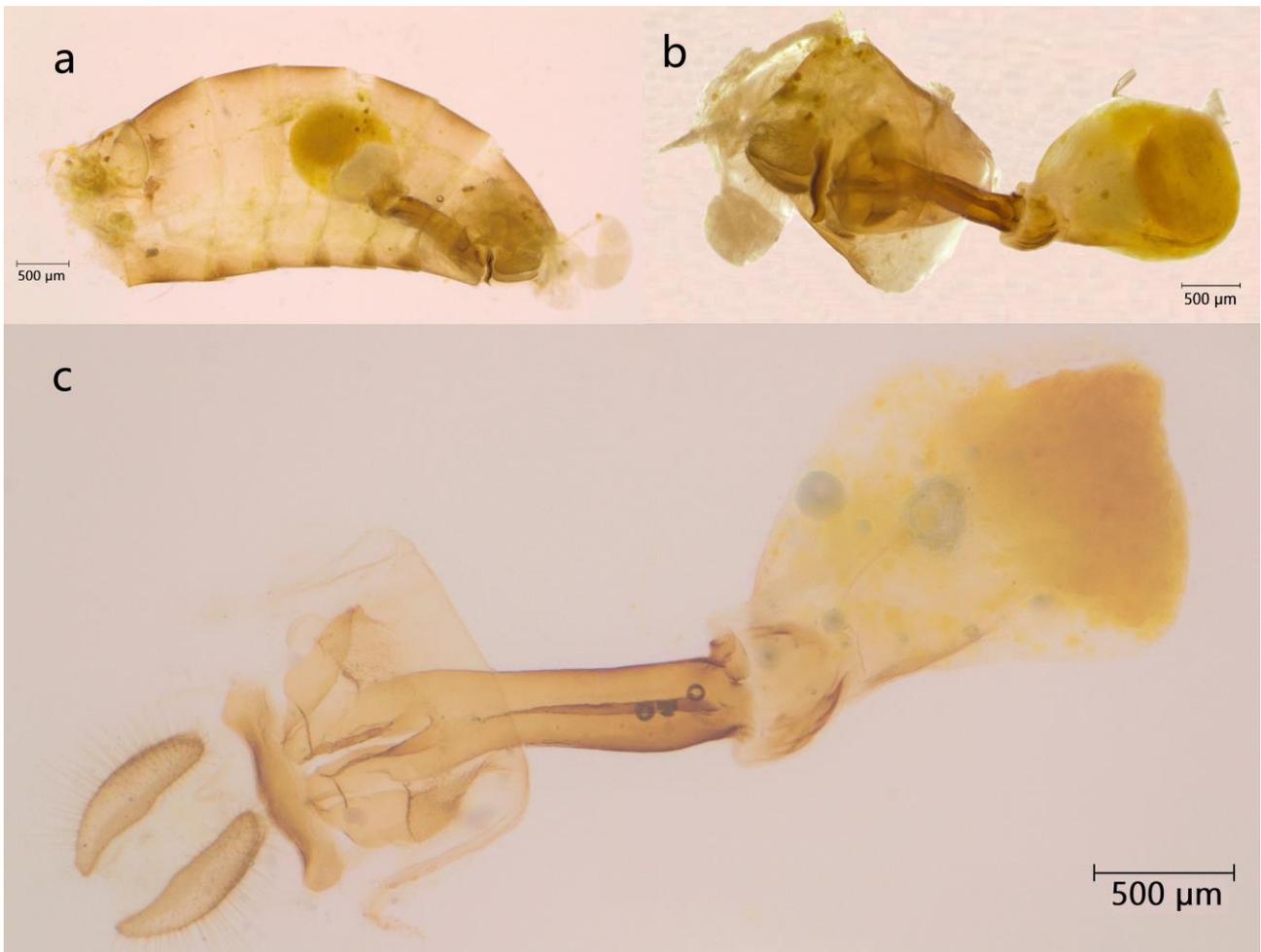


Fig. 9a. Lateral view of the female genitalia of *Gegenes nostradamus* inside the abdomen. 9b. Heavily sclerotized ductus bursae distended at the base. 9c. Sterigma and ductus bursae. © Genit. prep.: Mohammad A.J. Marafi, Imaging: Sylvain Cuvelier.

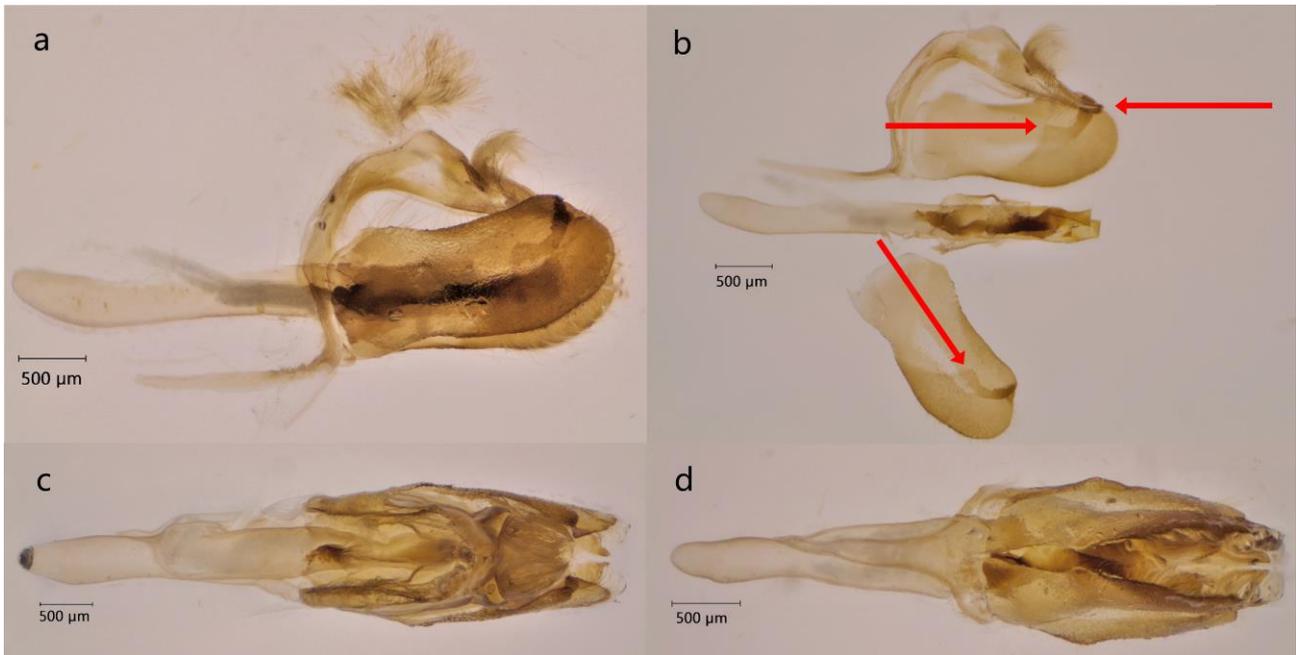


Fig. 10a. Lateral view of the male genitalia of *Pelopidas mathias* with diagnostic features. 10b. Lateral view (left valve and aedeagus removed). 10c. Dorsal view. 10d. Ventral view. © Genit. prep.: Mohammad A.J. Marafi, Imaging: Sylvain Couvelier.



Fig. 11a. Lateral view of the female genitalia of *Pelopidas mathias*. 11b. Lateral view sterigma and proximal part ductus bursae. © Genit. prep.: Mohammad A.J. Marafi, Imaging: Sylvain Couvelier.

Genitalia ♂ (Fig. 8 a, b, c, d). The saccus is as long as the vertical length of the vinculum. The cucullus projects beyond the tip of the valva and is more sclerotized on its basal and distal sides with an evenly dentated upperside. The aedeagus vesica has two cornuti of uneven proportions.

Genitalia ♀ (Fig. 9 a, b, c). The lamella postvaginalis is long. The ductus bursae is heavily sclerotized, expanding over the corpus bursae. The corpus bursae is ovaloid.

***Pelopidas mathias* (Fabricius, 1798) (Fig. 7)**

Material examined: Kuwait: Jahra Governorate: Sulaibiya Agricultural Area (29.26651 N 47.75510 E) 17 m a.s.l, 1♂, 22.x.2021; 1♂, 27.x.2022; 1♀, 16.xii.2022, M.A.J. Marafi leg.

Genitalia ♂ (Fig. 10 a, b, c, d). The ends of the uncus are connivent. The basal side of the cucullus is not crescent-shaped. With *P. thrax* (Fig. 19), the uncus ending is curved and the basal side of the cucullus is crescent-shaped (Fig. 19).

Genitalia ♀ (Fig. 11 a, b). The ductus bursae is long and narrow (ratio length/width=5). The papilla analis is elongated with rounded ends. Similarly, the corpus bursae is rounded (ratio length/width=1.7). Compared to *P. thrax* (Fig. 20), the papilla analis is virtually square. The ductus bursae is short and wide (ratio length/width=2.5). The corpus bursae is elongated (ratio length/width=2.15).

On 07.x.2021, during a midmorning visit to the Sulaibiya Agricultural Area (Locality 1 – Site 1) (Figs 4, 12), a dull-coloured, rapid-flying butterfly was observed in a plot of cultivated cucurbit (Cucurbitaceae) outside the premises of a fodder farm. A photograph was taken on 15.x.2021 (Fig. 13a) and the first specimen was collected on 22.x.2021. During the following visits, a total of eight specimens, both males and females of *Gegenes* and *Pelopidas*, were collected (Fig. 14). Two additional specimens were also observed but not collected at Site 2 (Fig. 13b) and at Site 3 (Figs 17, 18b) which are approximately 1 km west of Site 1 (S3). Yet a couple more observations confirming a wider distribution range for



Fig. 12. Locality 1: Site 1 in Sulaibiya Agricultural Area, 29.x.2021.

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Fig. 13a. *Pelopidas mathias* on a cucurbit flower, Locality 1: Site 1, 15.x.2021.

Fig. 13b. *Pelopidas* sp. resting on *Malva parviflora* (Malvaceae), Locality 1: Site 2, 30.xii.2022.

Fig. 13c. *Pelopidas* sp. in Locality 2, 28.xi.2022.

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Skippers (not collected) within Kuwait were documented in Locality 2 (NPCC-AN) (Fig. 4, 5) at 21 km east of Locality 1 (S3). The first observation at the site, made on 05.v.2022, was of an unidentified Hesperiid seen feeding on *Ocimum basilicum* L. (Lamiaceae), a specimen of which was photographed on 28.xi.2022, confirming the presence of a *Pelopidas* species in Kuwait (Fig. 13c). According to field observations, Locality 1 might be a main breeding ground for HesperIIDae in the country with 26 observations, compared to two documented observations at Locality 2 as shown in Fig. 14. It is worth mentioning that Locality 1 was regularly visited from 2018 prior to the first encounter in 2021, while Locality 2 was the study area of the first author since 2009. There were no sightings of HesperIIDae before 2021 in either locality.

We can predict with certainty the phenological trend of the aforementioned HesperIIDae in Kuwait from October 2021 until April 2023. No specimens were recorded in February, March, June, and August. At present, the main flight time for Skipper species is during autumn, with twelve records in September and seven in October (Fig. 15). This might be linked to more favourable climatic conditions and presumably an abundance of

flowering vegetation in the autumn. During the morning of 09.ix.2022 (Locality 1 – Site 1), in excess of seven newly emerged *Gegenes* and *Pelopidas* were observed foraging gregariously a *Mentha* species (Lamiaceae) imbibing nectar from its inflorescences (Fig. 16). The butterflies were skittish and difficult to photograph.

Based on accounts from the Middle East, East Africa, and India, Larsen (1984) groups migrant butterflies recorded in Arabia into three categories: regular, moderate, and weak. According to T. Larsen, both *P. mathias* and *G. nostradamus* are weak migrants. This leads us to speculate that both species may have arrived in Kuwait via human transportation, especially in the knowledge that residents of Kuwait customarily import plant species for personal or commercial use. This suggests that these plants may have contained larvae or eggs, or both.

As Kuwait inevitably becomes more and more urbanised, the Sulaibiya Agricultural Area and NPCC-AN will undoubtedly increase the number of manmade habitats suitable for the expansion of local entomofauna. Hence, finding previously unrecorded butterfly species is anticipated in these isolated parts of the country since

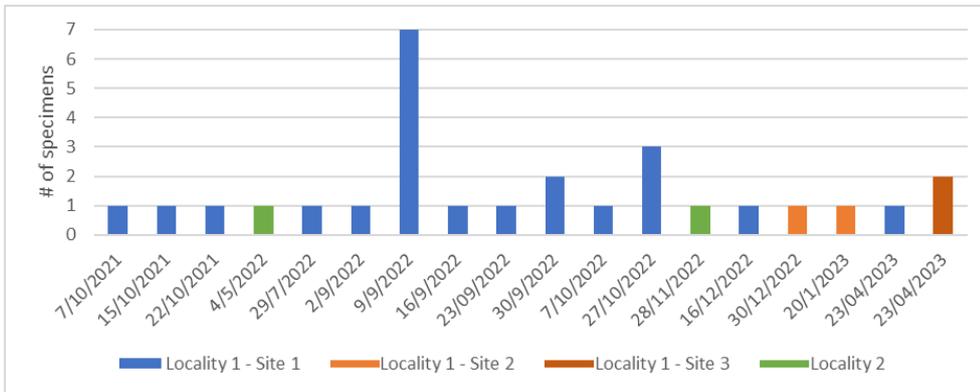


Fig. 14. Occurrences of Hesperidae since the first sighting on 07.x.2021.

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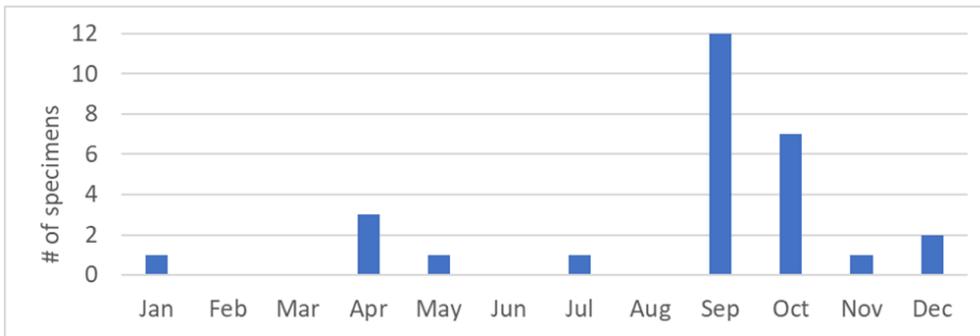


Fig. 15. Phenogram x.2021–iv.2023 of the Hesperidae in Kuwait.

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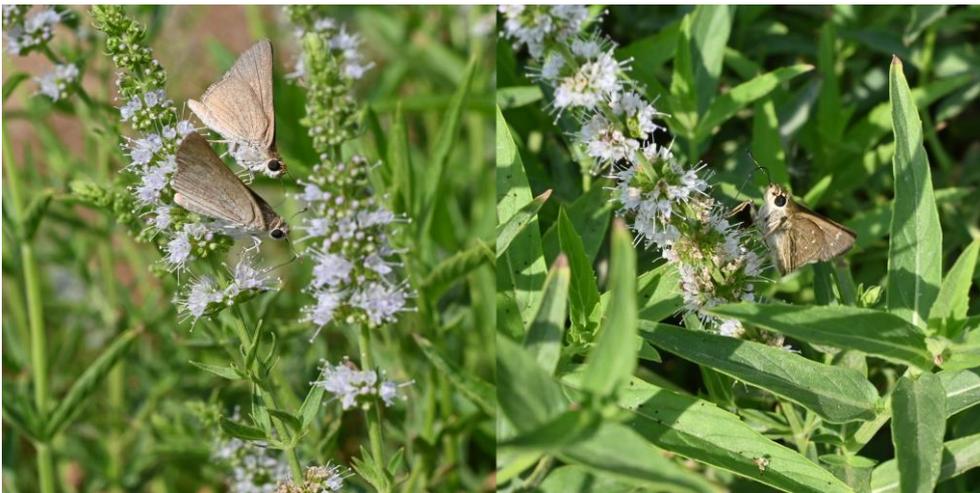


Fig. 16. *Gegenes nostradamus* (left) on *Mentha* sp. on 9.ix.2022.

Pelopidas mathias (right) foraging on *Mentha* sp. on 9.ix.2022.

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Fig. 17. *Gegenes nostradamus* basking on a rock 23.iv.2023, Locality 1: Site 3.

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Fig 18a. A field of cultivated *Panicum antidotale* in a farm at the Sulaihiya Agricultural Area (Locality 1: Site 3) on 23.iv.2023. © Mohammad A.J. Marafi.

Fig. 18b. Sideview of the habitat where *Gegenes nostradamus* was found on 23.iv.2023. © Mohammad A.J. Marafi.

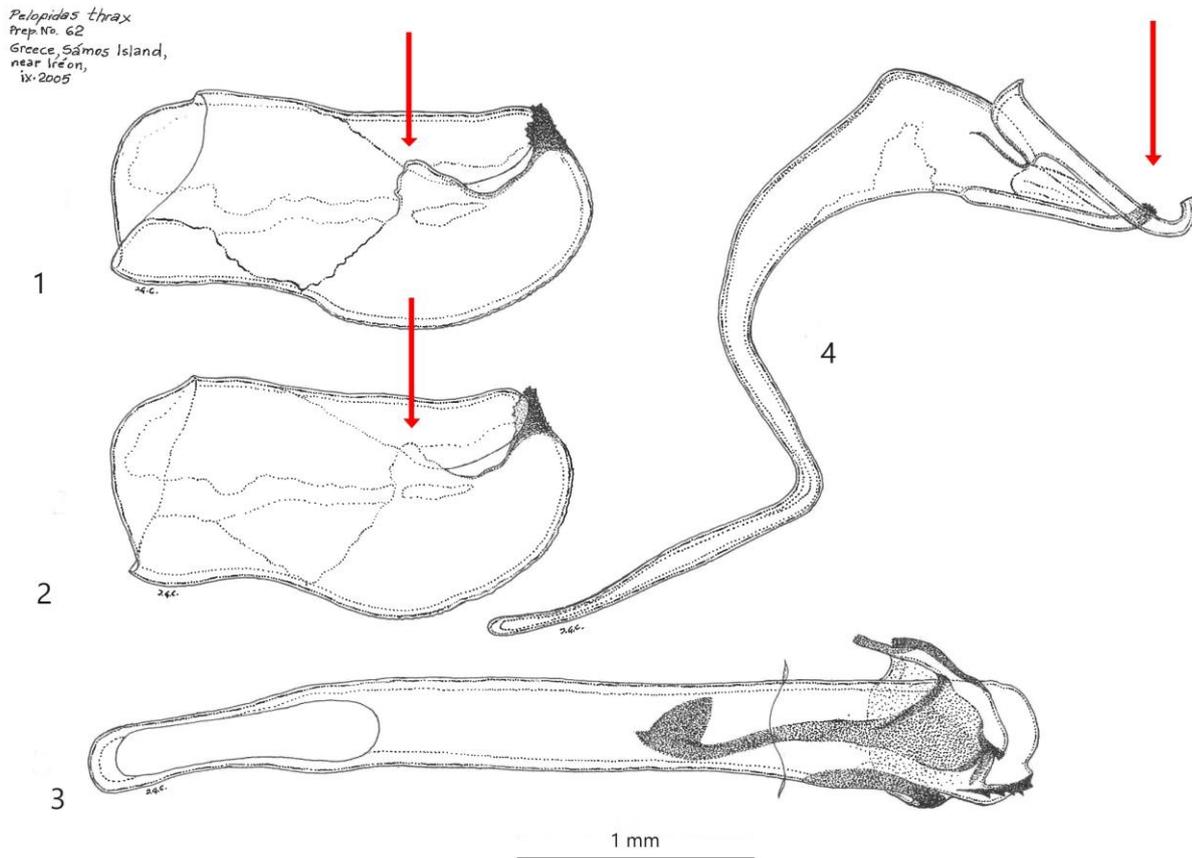


Fig. 19. Male genitalia of *Pelopidas thrax*. 1, 2. Internal and external view of valva with crescent-shaped cucullus. 3. Aedeagus. 4. Curved uncus. © John Coutsis.

Greece, Sámos Island,
near Iréon, 27.ix.2003
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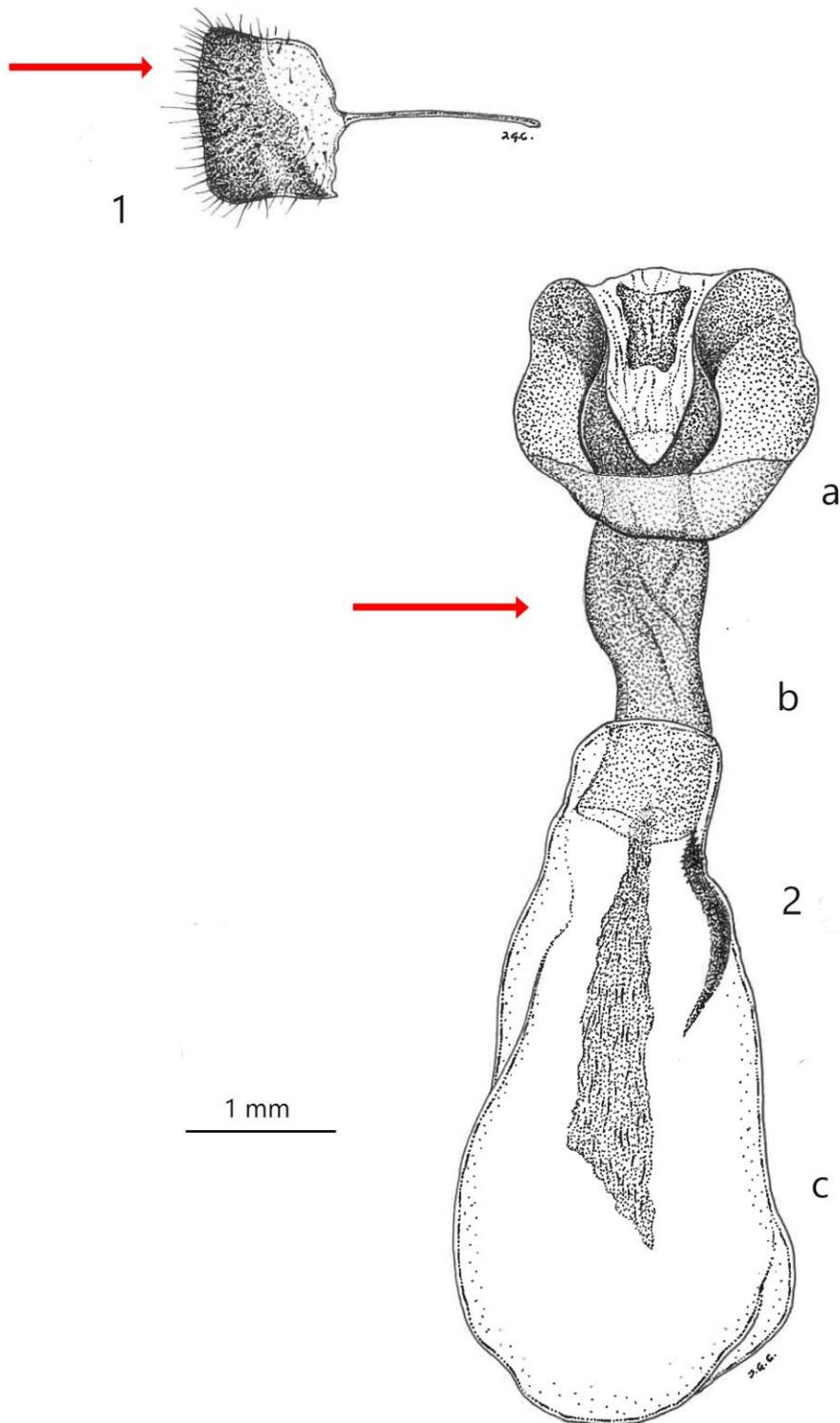


Fig. 20. Female genitalia of *Pelopidas thrax*. 1. Rectangular, almost square papilla analis. 2a. Sterigma. 2b. Short ductus bursae. 2c. Elongated corpus bursae. © John Coutsis.

agricultural activities and the continuous importation of plant species, for example, can promote the introduction of new Lepidoptera species in the Sulaibiya Agricultural Area. The propagation and maintenance of a variety of native flora within the premises of NPCC-AN are the main activities carried out at the facility and the sustenance of which onsite creates a sanctuary that attracts butterflies year-round. However, it remains a question how the aforementioned species arrived in Kuwait, particularly as migration is ruled out (based on the categorization of migrant butterflies provided by T. Larsen).

The hostplants of *P. mathias* include various grass species (Poaceae) such as rice, millet, and wheat (Larsen & Larsen 1980). Feulner *et al.* (2021) list an extensive record of larval food plants consisting of Asteraceae (3) and Poaceae (17) distributed across Angola, India, Saudi Arabia, SE Asia, and Zimbabwe and in terms of Old World and Palaeotropical and Afrotropical regions. Out of the seventeen grasses, seven species occur in Kuwait and precisely in its central region.

Two species occur naturally and are also used in landscaping plans across the country (*Cynodon dactylon* (L.) Pers. and *Panicum* spp.) (Poaceae) while five species are cultivated in the farms of the Sulaibiya Agricultural Area (*Avena sativa* L., *Hordeum vulgare* L., *Saccharum officinarum* L., *Triticum* spp. (wheat), and *Zea mays* L.). Sugarcane (*S. officinarum*), however, is a species which is sparsely found in the farms of Sulaibiya Agricultural Area and has never been observed at NPCC-AN, but it is likely to occur in nearby domestic gardens.

Likewise, *G. nostradamus* larvae depend on Poaceae species, and Larsen (1990) reports grasses in the *Aeluropus* and *Panicum* genera as hostplants. Both genera have representatives in Kuwait. *Aeluropus lagopoides* (L.) Thwaites is a native grass species occurring sparsely in the vicinity where *G. nostradamus* has been collected and more extensive patches of the grass inhabit the wetlands located further north of Sulaibiya. The genus *Panicum* is

represented by several native (*P. turgidum* Forssk.) and introduced grass species including *P. antidotale* Retz., a candidate hostplant, that is commonly cultivated in the farms within the Sulaibiya Agricultural Area (Fig. 18a, b).

Conclusions

The current findings emphasise the importance of both the Sulaibiya Agricultural Area and NPCC-AN as epicentres for non-indigenous butterflies in a country whose natural environment is considered unfavourable for butterflies. However, apart from the native species, introduced species seem to adapt well in conditions where their hostplant can proliferate. The larval foodplants utilised by *G. nostradamus* and *P. mathias* in these areas remain uncertain. Future studies are needed to establish the range of hostplants that these naturalized Skippers depend on. Further research is essential to investigate the distribution of the species in the Abdali and Wafra Agricultural areas, in the northern and southern regions respectively, and the possibility of finding additional Hesperidae species. Continuous plant trade will more than likely lead to the introduction of new species, while further fieldwork is essential to expand the present knowledge.

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Supplementary table 1. Total of 25 butterfly species recorded from Kuwait.

Pieridae	Vernacular name
<i>Anaphaeis aurota</i> (Fabricius, 1793)	Pioneer White
<i>Pieris rapae</i> (Linnaeus, 1758)	Small White Butterfly
<i>Colias croceus</i> (Geofroy, 1785)	Clouded Yellow
<i>Colias erate marnoana</i> Rogenhofer, 1883	Eastern pale clouded
<i>Colias electo</i> (Linnaeus, 1763)	African Clouded Yellow
<i>Colotis fausta</i> (Oliver, 1804)	Salmon Arab
<i>Colotis phisadia</i> (Godart 1819)	Blue-spotted Arab
<i>Euchloe belemia</i> (Esper, [1800])	Green-striped White
<i>Pontia glauconome</i> Klug, 1829	Desert White
<i>Gonepteryx rhamni</i> (Linnaeus, 1758)	Common Brimstone
Nymphalidae	Vernacular name
<i>Danaus chrysippus</i> (Linnaeus, 1758)	Plain Tiger
<i>Hypolimnas misippus</i> (Linnaeus, 1764)	Danaid Eggfly
<i>Junonia orithya</i> (Linnaeus, 1758)	Blue Pansy
<i>Melanitis leda</i> Linnaeus, 1758	Common Evening Brown
<i>Vanessa atalanta</i> (Linnaeus, 1758)	Red Admiral
<i>Vanessa cardui</i> (Linnaeus, 1758)	Painted Lady
Lycaenidae	Vernacular name
<i>Brephidium exilis</i> (Boisduval, 1852)	Western Pygmy Blue
<i>Lampides boeticus</i> (Linnaeus, 1767)	Long-tailed Blue
<i>Tarucus balkanica</i> (Freyer, [1844])	Little Tiger Blue
<i>Tarucus rosacea</i> (Austaut, 1885)	Mediterranean Pierrot
<i>Zizeeria karsandra</i> (Moore, 1865)	Dark Grass Blue
Papilionidae	Vernacular name
<i>Papilio demodocus</i> Esper, 1798	Citrus Swallowtail
<i>Papilio demoleus</i> Linnaeus, 1758	Lime Swallowtail
Hesperidae	Vernacular name
<i>Gegenes nostrodamus</i> (Fabricius, 1793)	Light Pygmy Skipper
<i>Pelopidas mathias</i> (Fabricius, 1798)	The Dark Small-branded Swift

Supplementary table 2. Hesperidae species recorded from the Arabian Peninsula.

Hesperidae	Vernacular name
Coeliadinae (giant skippers)	
<i>Coeliades anchises</i> (Gerstaecker, 1871)	One-pip Policeman
Pyrginae (spread-winged and grizzled skippers)	
<i>Carchardus alcaeae</i> (Esper, [1780])	Mallow Skipper
<i>Gomalia elma</i> (Trimen, 1862)	Green-marbled Skipper
<i>Sarangesa phidyle</i> (Walker, 1870)	Orange Flat
<i>Spialia colotes</i> (Druce, 1875)	Bushveld Sandman
<i>Spialia diomus</i> (Hopffer, 1855)	Common Sandman
<i>Spialia doris</i> (Walker, 1870)	Aden Skipper
<i>Spialia mafa</i> (Trimen, 1870)	Mafa Sandman
<i>Spialia mangana</i> (Rebel, 1899)	Arabian Grizzled Skipper
<i>Spialia spio</i> (Linnaeus, 1764)	Mountain Sandman
<i>Spialia zebra</i> (Butler, 1888)	Zebra Grizzled Skipper
Hesperinae (grass skippers)	
<i>Baoris fatuellus</i> (Hopffer, 1855)	Foolish Swift
<i>Borbo borbonica</i> (Boisduval, 1833)	Olive Haired Swift
<i>Borbo gemella</i> (Mabille, 1884)	Twin Swift
<i>Pelopidas mathias</i> (Fabricius, 1798)	Dark Small-branded Swift
<i>Pelopidas thrax</i> (Hübner, [1821])	Pale Small-branded Swift
<i>Gegenes hottentota</i> (Latreille, 1827)	Latreille's Skipper
<i>Gegenes nostrodamus</i> (Fabricius, 1793)	Light Pygmy Skipper
<i>Gegenes pumilio</i> (Hoffmannsegg, 1804)	Pigmy Skipper
Tagiadinae	
<i>Caprona pillaana</i> (Wallengren, 1857)	Ragged Skipper

Supplementary table 3. GPS coordinates of collection and occurrence sites in two localities in the central region of Kuwait.

Locality 1	Lat.	Lon.
Sulaibiya Agricultural Area – Site 1	29.26651	47.75510
Sulaibiya Agricultural Area – Site 2	29.26476	47.74587
Sulaibiya Agricultural Area – Site 3	29.26430	47.74231
Locality 2	Lat.	Lon.
NPCC-AN	29.28149	47.92541

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