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# *Papilio demoleus* Linnaeus (Lepidoptera: Papilionidae), a new host in Cyprus for *Pteromalus puparum* (Linnaeus) (Hymenoptera: Pteromalidae)

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ABSTRACT

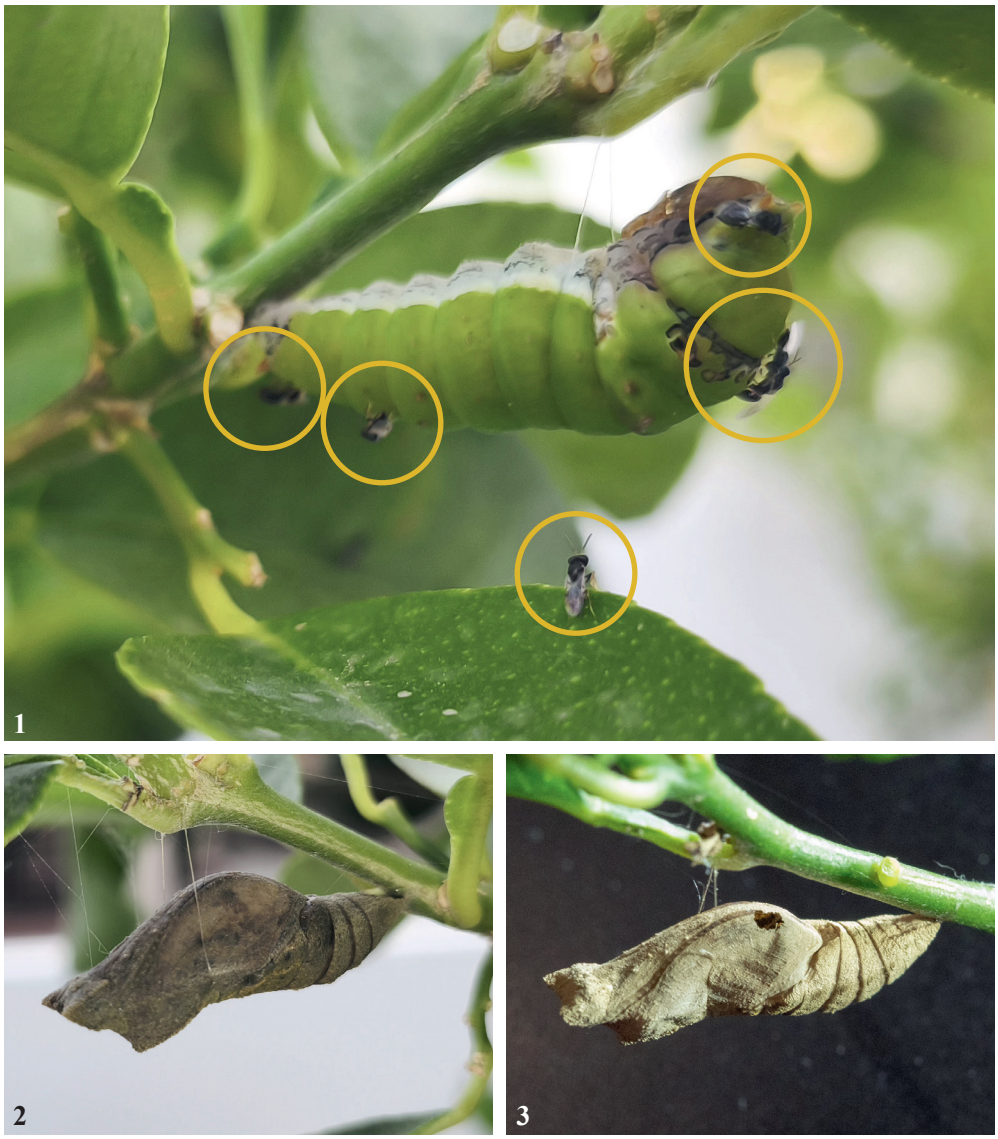
Although *Pteromalus puparum* is widely recognized within much of its range as a pupal endoparasitoid of (among others) *Papilio demoleus*, this has not previously been reported from Cyprus. Here we document the first such record from the island and report on the presence of very large numbers (299) of *P. puparum* within a single pupa of *P. demoleus*, most likely resulting from oviposition by several, if not all, seven wasps seen to be attending the larva at the pre-pupal stage. High quality photos of *P. puparum* from a different study (in the Netherlands) are presented as an aid to recognition of the species. We also report on an unusually cryptic pupal coloration of *P. demoleus*, resulting from pupation taking place on soil, the pupa having been formed without attachment to any substrate. A perfect female *P. demoleus* emerged successfully.

Keywords: Lepidoptera, Papilionidae, *Papilio demoleus*, Hymenoptera, Pteromalidae, *Pteromalus puparum*, endoparasitoid, Cyprus

## INTRODUCTION

The traditional family, to which *Pteromalus puparum* (Linnaeus, 1758) belongs is huge: there are 4257 extant species (Gibson *et al*. 2021). Cosmopolitan *P. puparum* is widely recognized as a pupa-specific, gregarious endoparasitoid of a range of butterfly species, which includes *Papilio demoleus* (Linnaeus 1758), *e.g*., in Iran (Lotfalizadeh & Gharali 2008) and India (Sarada *et al*. 2014). To date there have been no published records of such parasitism from Cyprus. This endoparasitoid idiobont from the superfamily Chalcidoidea has been known in Cyprus since at least 1930 (Georghiou 1977: p. 187), when it was recovered from a pupa of *Vanessa cardui* (Linnaeus, 1758). *Pteromalus puparum* has a wide host repertoire, strongly focussed on pupae of Papilionidae, Pieridae and Nymphalidae (Shaw, Stefanescu & van Nouhuys 2009). Records from other lepidopteran families, *e.g*., Hesperiidae and Lycaenidae, exist but require confirmation. Old records from non-Lepidoptera are particularly doubtful. Pteromalidae and even the genus *Pteromalus* are large and complex groups parasitizing a wide span of host orders (Kumar, Ray & Agnihoteri 2023); there have been considerable identification problems, especially prior to Graham (1969). *Pteromalus puparum* is native to Europe and is common in the UK (Graham 1969; Askew & Shaw 1997). Indeed, accidental introduction of *P. puparum*

by various means, including the importation of infested pupae, is a constant threat for butterfly houses around the world. At the Stratford Butterfly House, the UKs largest of its kind, newly arrived pupae are isolated, and staff members are trained to identify and remove affected pupae before parasitoids reach full development (Richard Lamb, pers. comm. to EJ).




*Photos*: Charis Panagiotou

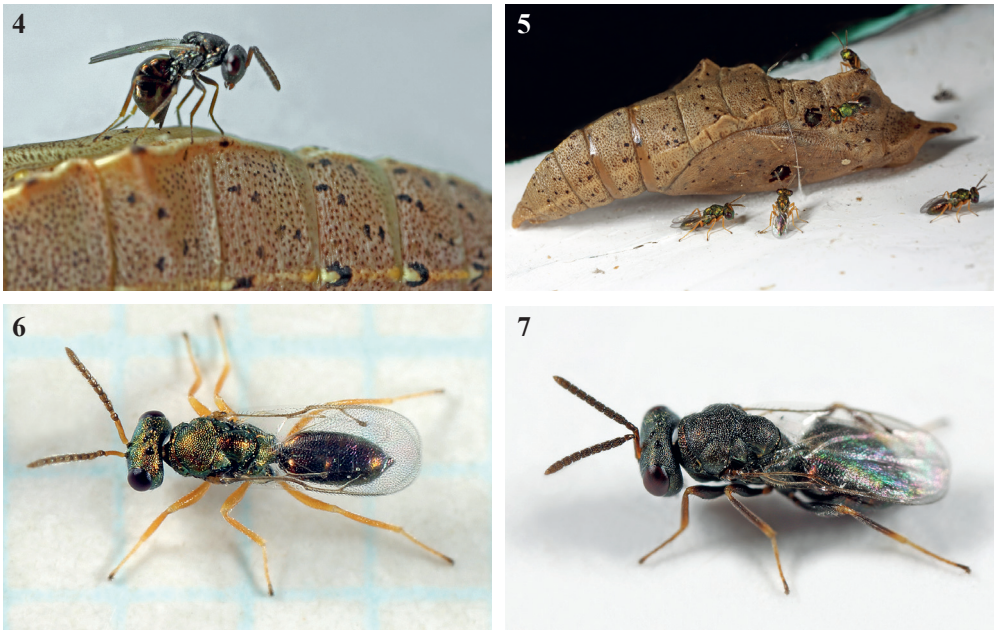
Figs 1–3. — 1, Pre-pupa of *Papilio demoleus* highlighting six (two within the larger circle) of the seven attending female *Pteromalus puparum*, Dali, Nicosia, 20 May 2025; 2, Parasitized and now discoloured pupa of *Papilio demoleus*, Dali, Nicosia, 29 May 2025; 3, A second parasitized pupa of *Papilio demoleus*, showing a single hole through which an entire brood of *P. puparum* had exited, Dali, Nicosia, 24 June 2025

## *PAPILIO DEMOLEUS*: A PRIMARY HOST OF *PTEROMALUS PUPARUM*

The first recorded observation of *P. puparum* parasitizing *P. demoleus* appears to have been that by Ramzan & Singh (1978) who reported on their findings in India. In our study reported here, at least seven presumed *P. puparum* females were seen to attend the pre-pupal stage of *P. demoleus* on 20 May 2025 (six of which are shown in Fig. 1); from which it can safely be assumed that several, possibly all, subsequently oviposited. By the following day, the larva had pupated; the pupa was initially green in colour, resembling that of the host substrate, *Citrus* x *aurantiifolia* (F) (lime). However, as anticipated, the pupal colour soon darkened (Fig. 2), confirming attack by the parasitoid wasps.

The infested butterfly pupa was sent to the first author, where it arrived on 3 June. The abdomen was found to have become separated from the rest of the pupal body, the natural contents of which had been consumed to be replaced by parasitoid pupae. About 20% of the parasitoid pupae, judging from the partial lighter colour, were showing the cream colour of having recently pupated (see Ramzan & Singh 1978 who referred to 'cream coloured pupae' recovered from an *opened*, parasitized *P. demoleus* pupa). The parasitoid pupae subsequently darkened to a dark brown colour.

The *P. demoleus* pupa was kept in a plastic box (140mm × 80mm × 70mm) at normal UK room temperatures (*ca* 15–18°C) and well away from direct sunlight. The first adult parasitoids emerged on 5 June (just 15 days after oviposition into the pupa on 21 May) and, over a period of two days, 297 adult wasps were recovered,




*Photos*: Albert de Wilde

Figs 4–7 — 4, *Pteromalus puparum* ovipositing into a freshly pupated *Pieris brassicae* (Linnaeus, 1758), the Netherlands, 15 September 2016; 5, *Pteromalus puparum* ♂ awaiting the emergence of ♀♀ wasps from the *Pieris brassicae* pupa, the Netherlands, 29 September 2016; 6, *Pteromalus puparum* ♂, the Netherlands, 18 September 2016; 7, *Pteromalus puparum* ♀, the Netherlands, 30 September 2016.

with a further two dead pupae found within the papilionid pupa. Specimens were sent for determination to MRS, who confirmed their identity as *P. puparum*. Adult body length varied from *ca* 1.75–2.75mm, the females generally a little larger than males but size was probably heavily influenced by available food in a highly competitive environment. Ten adult specimens (five ♂♂, five ♀♀) have since been deposited in the National Museums of Scotland.

## REARING OF A SECOND *P. DEMOLEUS* LARVA

On 26 May 2025, at the same small host tree in the Panagiotou Cyprus garden another *P. demoleus* larva, which had recently progressed into its final instar, was seen



*Photos*: Charis Panagiotou

Figs 8–9. — 8, Highly cryptic pupa of *Papilio demoleus* formed on soil, Dali, Nicosia, 4 June 2025; 9, Perfectly formed female *P. demoleus*, Dali, Nicosia, 17 June 2025.

to be attended by a single pteromalid wasp. The larva was transferred indoors (the attending wasp excluded) and reared on cut twigs of *C*. x *aurantiifolia*. Development into the pupal stage was not straightforward, however, as the larva, appearing not to find a suitable pupation site on the provided twigs, became restless before eventually settling on the bare soil into which the potted twigs had been inserted. On 4 June, it pupated in this position, without silk pad (into which the cremaster could attach) and girdle. As discussed in John *et al*. (2025), substrate colour and texture are among factors influencing pupal coloration in *P*. *demoleus*. The colour adopted by the pupa in question so strongly matched the colour of the soil substrate that the appearance suggested that it was already dead (Fig. 8). Surprisingly, however, without either assistance or the pupa having any form of attachment to assist eclosion, a perfect female (Fig. 9) successfully emerged on 17 June and several days later than would normally be expected (perhaps because the pupa had been kept in an air-conditioned room). The butterfly was released a few hours later. We report this because of the unusual pupation site and the highly unusual appearance of the pupa, quite unlike that of the normal brown form.

## HOST LOCATION BY CERTAIN *PTEROMALUS* SPECIES

Female *P. puparum* oviposit into the fresh cuticle of recently pupated butterflies, habitually selecting their host in advance of pupation (Fig. 1) to facilitate timely oviposition while the host's pupal cuticle is still soft (Shaw, Stefanescu & van Nouhuys 2009). In relation to the attendance of *P. puparum* on another target species (larvae of *P*. *brassicae*), Huigens & Fatouros (2013) applied the description of 'phoresy' (hitch-hiking): 'Only one pupal parasitoid, *Pteromalus puparum*, has been observed to hitch a ride on late-instar caterpillars of cabbage white butterflies [*P*. *brassicae* is illustrated] to eventually parasitize fresh pupae…'. It appears, from experiments with the related *Pteromalus apum* (Retzius, 1783) and oviposition into Melitaeinae (Nymphalidae) pupae (Shaw 2002) that larval hosts in the penultimate instar aroused interest (but not oviposition) from the female parasitoids while in proecdysis, but attractiveness declined after their moult. Only the final, prepupal, moult elicited attack. While any attractiveness of hosts in earlier instar apolysis has not been investigated in *P. puparum*, it seems likely that for this species, too, allomones related to the host's ecdysal events will be the principal attractant for the parasitoid.

Numerous authors have written on the use of various parasitoids, including *P*. *puparum*, as biological control agents. In Iran, Razmi, Karimpour & Safaralizadeh (2011) reporting on the use of *P*. *puparum* as a control agent for *P*. *brassicae*, found that 48 percent of recovered parasitoids from host pupae of *P*. *brassicae* collected in the wild were pteromalid.

## CONCLUDING REMARKS

In contrast to the rapid increase in population numbers of *P*. *demoleus* since the first reports of its arrival in Cyprus in 2021, there was growing evidence of a noticeable reduction in 2025. By the end of June 2025, 66 records of verified observations had been received, compared with 96 for the same period in 2024. Early reports (March/April 2025) mirrored those for 2024, after which numbers showed a substantial fall. In John *et al*. (2025) it was acknowledged that citizen science reports on social media

posts, for example, may be adversely influenced by familiarity, *i.e.*, having once had the eye-catching swallowtail identified, further interest among some will have waned. Yet, the decline observed in 2025 was also witnessed by those with more experience of the species and who have been noting its presence over the three full years since its appearance in the autumn of 2021 (see John *et al*. 2025 for details, in which predation is also discussed). Although 'One swallow does not a summer make', this report of the presence of as many as seven *P. puparum* awaiting an opportunity to oviposit into the targeted papilionid, and the evidence that the wasp was attracted to all three larvae present on the small host tree, provides food for thought about the implications for *P. demoleus* in Cyprus. To an unknown extent the parasitoid is likely to have targeted *P. demoleus* soon after its arrival in Cyprus, but, perhaps in concert with an unusually cold winter (2024–2025), a possible resurgence in the wasp population (if the example of attack reported here is replicated widely), will have contributed to some degree to the fall in reports in 2025. However, further observations are needed to test this hypothesis.

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