

## Discovery of the genus *Venanides* Mason 1981 (Hymenoptera: Braconidae, Microgastrinae) in Europe, with description of a new species parasitizing *Carcina quercana* (Fabricius) (Lepidoptera: Peleopodidae)

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### Abstract

The small Microgastrinae genus *Venanides* is recorded from Europe (Netherlands, Germany and Czech Republic) for the first time, where one species, *Venanides carcinae* sp. nov., described here, proves to be a regular solitary parasitoid of *Carcina quercana*. Outline notes on its biology, phenology and abundance are given.

**Keywords:** Biology, phenology, Netherlands, Germany, Czech Republic, *Quercus*, *Fagus*, *Venanides carcinae*.

### Introduction

Microgastrinae is a huge subfamily of relatively small parasitoid wasps in the family Braconidae, numbering almost 3000 described species and believed to be entirely associated with Lepidoptera, parasitizing all but the most basal lineages (Fernández-Triana *et al.*, in press). Currently 81 microgastrine genera are recognised, some of which are extremely speciose and familiar to many entomologists. Although distributed in all the main zoogeographical regions of the world, the rather distinctive genus *Venanides* Mason contains only about a dozen described species (although several more species, currently undescribed, have been recognised in collections (Fernández-Triana *et al.*, in press) and specimens are rather infrequently collected. The genus has been found in the Palaearctic region (North Iran; Abdoli *et al.*, in prep.) and also the Arabian peninsula (Fernández-Triana & van Achterberg, 2017) but this largely tropical and subtropical genus has hitherto not been recorded from Europe. Although rearing records are very few, both solitary and gregarious species of *Venanides* are known.

A series of 11 females and 12 males of a species of *Venanides*, labelled as reared in 2013 and 2014 as a solitary parasitoid of the small peleopodid moth *Carcina quercana* (Fabricius) was found among a range of reared Microgastrinae from the Czech Republic being determined by me at the request of Drs Stefan Schmidt and Martin Sigut, resulting from a wider project comparing tropical and temperate faunas (see Acknowledgements) focussed on tree canopies. The material had been barcoded as part of the German Barcode of Life project (see Acknowledgements) prior to being identified. It seemed to represent an undescribed species but most specimens were in poor condition and seemed also to have faded, probably as a result of DNA extraction, so before formally describing the species I decided to try to rear fresher material, which I was able to do in visits to the Netherlands in 2018 and 2019 (in the latter year also to Germany).



**Fig. 1.** Cocoon of *Venanides carcinae* sp. nov. in *Carcina quercana* web with still living host (on leaf underside).



**Fig. 2.** *Venanides carcinae* sp. nov., abnormally pale female paratype (Netherlands), habitus.

The purpose of this paper is to report *Venanides* as a new genus for Europe, to describe a new species which may be widespread in Europe, and to record some aspects of its biology and phenology.

### Material and Methods

The biological outline given below is based on observations and material collected from *Quercus robur* and *Fagus sylvatica* in four periods of fieldwork undertaken in the Netherlands (Gelderland): in Hoge Veluwe National Park, on the three occasions 29.vii.2018, 14–17.vii.2019 and 30.vii–3.viii.2019; and in the period 21–24.ix.2018 at Otterlo and also in Herikhuizerveld Nature Reserve, Veluezoom National Park on 21.ix.2018. An additional brief search on *Fagus sylvatica* in Germany, Saxony-Anhalt, Steirnerne on 22.vii.2019 yielded a host larva with fresh cocoon. The formal description of the new species is based both on this material and on the specimens collected in the Czech Republic (see listed paratypes, and Acknowledgements).

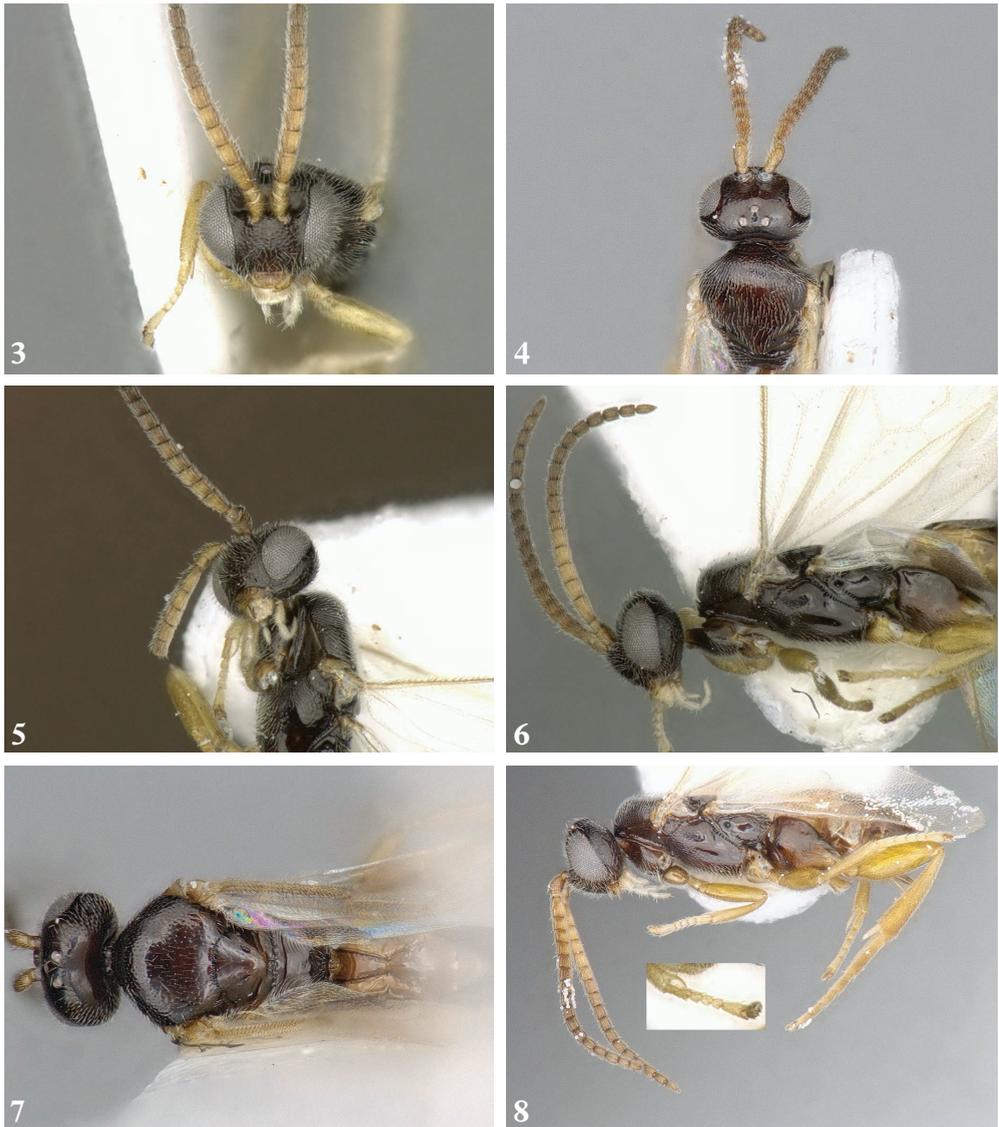
The larva of the host, *Carcina quercana*, is usually to be found most abundantly on the underside of *Quercus* or *Fagus* leaves, though it can be found feeding on a variety of other deciduous trees (including *Carpinus betulus* and *Acer campestre*, see listed paratypes). It overwinters as a small larva, and in its post-hibernation feeding stages the larva constructs an elongate thinly translucent web on a part of the leaf underside, forming a finely-spun and almost smooth sheet under the slightly arched leaf surface on which it rests upside down. It easily leaves its retreat, and usually constructs a series of such structures, changing leaves, and eventually it pupates in the last one with adult emergence following soon after.

Actively feeding *Carcina quercana* larvae collected from *Fagus sylvatica* and *Quercus robur* were transferred, still under their webs and with additional picked clean leaves of the plant on which they were found, to closed clear 14 × 8 × 6 cm plastic boxes lined with several sheets of absorbent tissue (lavatory paper). Larvae were examined daily and any with a parasitoid cocoon (Fig. 1) were removed, the web cut around so as to leave host larva and parasitoid cocoon *in situ*, and transferred to 7.5 × 2.5 cm clear glass corked tubes to await parasitoid emergence.

Photography was mostly done via an Apple iPhone 10 (Figs 1, 18–21, 23), or in some cases down an arm of a Wild M5A binocular microscope with ×20 eyepieces using a Canon PowerShot 110 (Figs 15, 16, 22). Stacked photos were done on a Keyence VHX-1000 Digital Microscope, using a lens with a range of ×13–130° (Figs 3–14), or a Leica M205 C / Canon EOS7D Mark 2 with Leica extension tube 10447436 1.6× and Helicon Focus 6.8.0 (Figs 2, 17).

The Czech material was subjected to DNA barcoding and the data are accessible (<https://doi.org/10.5883/DS-VENANEUR>) in BOLD as a single citable dataset. The data include collecting locality, geographic coordinates, elevation, collector, one or more digital images, identifier and voucher depository. Sequences data can be obtained through BOLD, and they include a detailed LIMS report, primer information and access to trace files.

**Depositories.** CNC = Canadian National Collection of Insects, Ottawa; NHM = Natural History Museum, London; NMS = National Museums of Scotland, Edinburgh; ZSM = Zoologisches Staatssammlungen, Munich.



**Figs 3–8.** *Venanides carcinae* sp. nov., female paratypes (Czech Republic). 3, head, facial. 4, head, dorsal. 5, head, plane of malar space. 6, head and mesosoma, lateral. 7, mesonotum. 8, habitus, lateral, including legs with fore tarsus inset.

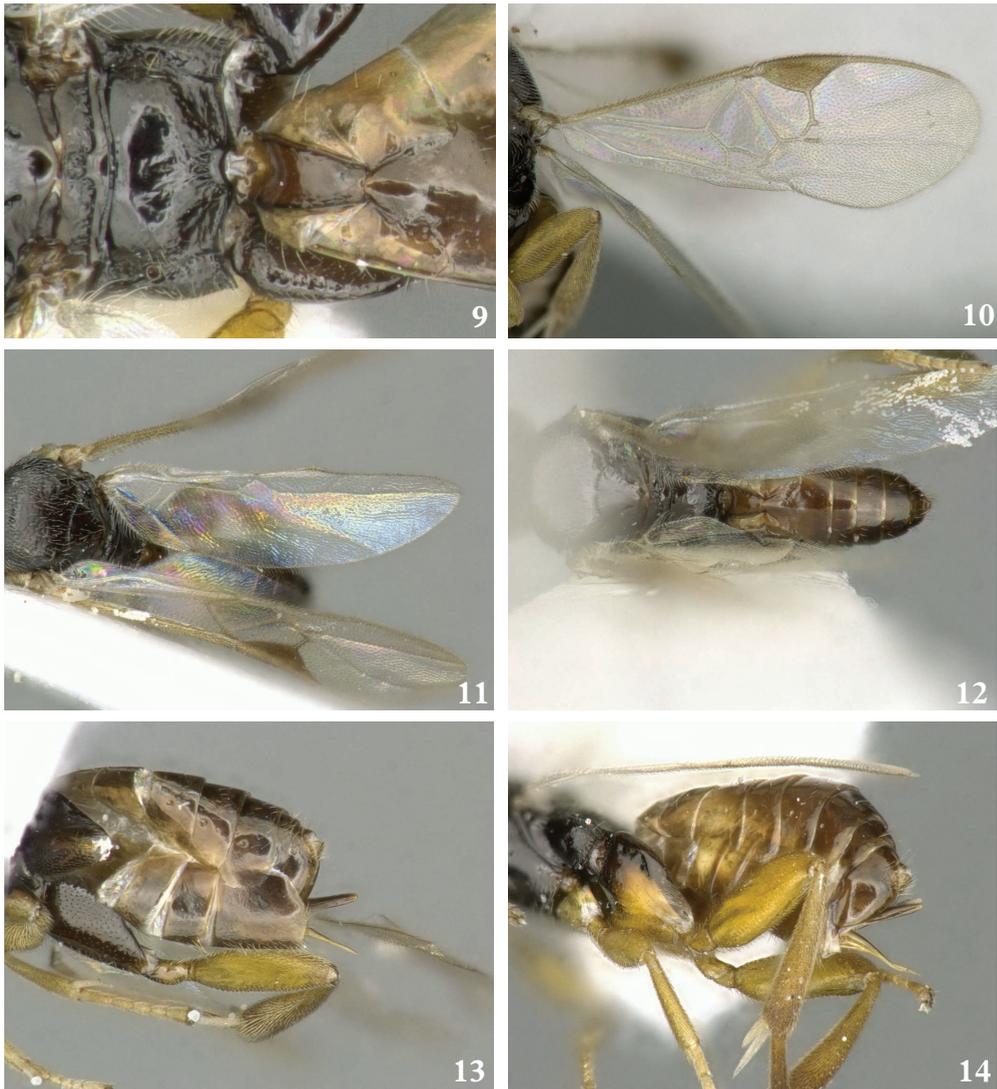
## Results

### Description of new species

#### *Venanides carcinae* sp. nov. (Figs 2–17)

##### MATERIAL EXAMINED

Holotype ♀ (NMS) 'NETHERLANDS: Gelderland, Hoge Veluwe N[ational] P[ark], ex *Carcina quercana*, *Quercus robur*, 29.7.2018, coc. 11.8.18, em. 24.8.2018 M. R. Shaw'. Paratypes (15 ♀, 16 ♂): 1 ♀ (NHM), as holotype but coll. as cocoon 3.viii.2019, em.



**Figs 9–14.** *Venanides carcinae* sp. nov., female paratypes (Czech Republic). **9**, metanotum and propodeum, dorsal with basal metasoma tergites partly out of plane. **10**, fore wing. **11**, hind wing. **12**, metasoma, dorsal. **13**, metasoma, lateral. **14**, metasoma, lateral, showing base of ovipositor.

6.ix.2019; 1 ♀ (CNC), as holotype but *Fagus sylvatica*, coll. as cocoon 29.vii.2019, em. 4.viii.2019; 1 ♀ (NMS), as preceding but coll. 15–17.vii.2019, cocoon 23.vii.2019, em. 29.vii.2019; 2 ♂ (NMS), as preceding but coll. as cocoon, em. 24.vii. 2019 and 25.vii.2019; 1 ♀ (NMS), as preceding but host larva + cocoon coll. 29.vii.2019 [1 ♀ em. 4.viii.2019, now in CNC], a second cocoon formed 23.viii.2019, em. 4.ix.2019 [host died 6.ix.2019]; 1 ♂ (NMS) Netherlands, Rheden, Veluwezoom National Park, Herikhuiszerveld Nature Reserve, *Carcina quercana* on *Quercus robur*, cocoon coll. 21.ix.2018, em. 12.x.2018, M.R. Shaw & J. Voogd; 1 ♂ (NMS) GERMANY: Sachsen-Anhalt, Steinerne, *Carcina quercana* on *Fagus sylvatica*, coll as cocoon 23.vii.2019, em. 29.vii.2019, M.R. Shaw; 8 ♀, 10 ♂ (NMS, ZSM)

CZECH REPUBLIC: South Moravia, Mikulcice, 48.808°N, 17.094°E, 196 m ex *Carcina quercana* on *Carpinus betulus* (9), *Quercus robur* (8) and *Acer campestre* (1), collection dates 24.v–13.vi.2013, M. Volf (eruption [cocoon] and emergence dates not recorded); 3 ♀, 2 ♂ (NMS, ZSM) Czech Republic, South Moravia, obora Soutok, Lanzhot, 48.69°N, 16.945°E, 165 m ex *Carcina quercana* on *Acer campestre* (3) and *Quercus robur* (2), collection dates 16.v–15.vii.2013 and 14.viii.2014, P. Drozd (eruption [cocoon] and emergence dates not recorded).

**Diagnosis.** With the generic characters given by Mason (1981), except that the vannal lobe of the hind wing has distinct but sparse short setae in its straight distal part, and the spine on the fifth tarsomere of the fore leg is relatively weak. In Nixon's (1965) key to his '*Apanteles congoensis*-group', which contains the African, Oriental and Australasian species of what was subsequently recognised as *Venanides* by Mason (1981), the new species would run near to [*V.*] *pyrogrammae* (Nixon) from New Guinea, but differs by having a concave posterior margin of the basal field of T2 (*inter alia*). It differs from the gregarious *V. xeste* Mason, the type species of *Venanides* described from specimens ranging from Canada to Brazil, in having the basal field usually much better defined and anyway having stronger sculpture (*inter alia*). The described species geographically closest to Europe are from the Arabian peninsula; the new species would run to *V. flavus* Fernández-Triana and van Achterberg in the key given by Fernández-Triana & van Achterberg (2017) but differs in having the basal field much less transverse (*inter alia*). Habitus: Figs 2, 8.

### Description

**Holotype** ♀. Length of body 2.3 mm, of fore wing 2.2 mm.

Head (Figs 3–6) in facial view 1.4 times as wide as high, face plus clypeus 1.15 times as wide as high, clypeus short and scarcely differentiated from face, labrum exposed, face scarcely shiny and rather strongly rugose with coarse punctate element, temple less strongly so and matt; head in dorsal view 1.55 times as wide as long, strongly roundly narrowed behind eyes, eye as long as temple, distance between eye and a lateral ocellus 2.7 times diameter of posterior ocellus, distance between posterior ocelli 1.4 times (up to 2 times in some paratypes) diameter of posterior ocellus, anterior ocellus rather small 0.7 times diameter of posterior ocellus, ocelli in rather high triangle, imaginary tangent to posterior ocelli not cutting anterior ocellus, vertex mostly smooth and shining with weak setiferous punctures; malar space about 0.8 times as long as base of mandible, subocular sulcus distinct; antenna short, 2.6 times width of head and about 0.6 times as long as fore wing, stout (sub)basally, attenuating apically, 4th segment 1.2 times (square in some paratypes), 14th 1.3 times (1.2–1.5 in paratypes) and 17th 1.4 times (1.2 in some paratypes) as long as wide.

Mesosoma (Figs 7–11) 1.2 times wider than head and dorsoventrally depressed, 2.0 times as long as high, 1.6 times as long as wide; mesoscutum anteriorly strongly sloping and matt with dense minute setiferous punctures, but the dorsal posterior part flat, shining, with the setiferous punctures weakening and becoming more sparse posteriorly, prescutellar groove narrow but distinctly foveolate; scutellum shining, impunctate with sparse setae, its phragma (often) slightly exposed by narrowness of metanotum; mesopleuron dorsally, ventrally and anteriorly with small close punctures, posteriorly smooth and shining, precoxal area impressed but not sculptured; propodeum mostly smooth and shining, with weak rugae radiating from nucha. Fore wing with metacarp about 5 times (somewhat more in some paratypes) its distance from apex of marginal cell; vein r rather long, 0.9 times as long as depth of pterostigma, angled at junction with vein 2-SR where stub of vein 3-SR is indicated in holotype (but absent in some paratypes). Hind wing with usually distinct but short and weak fringe of setae on straight part of vannal lobe. Legs stout; hind leg flattened, with coxa smooth on outer face but dorsal surface distinctly punctate, femur 2.5 times as long as wide, tibia evenly widening from a narrow base and 4.5 times as long as wide at apex, inner spur much longer than outer and more than three quarters as long as first tarsomere; fore leg with first four tarsomeres short (1st 2.2 times, 2nd



15



16



17

**Figs 15–17.** *Venamides carcinae* sp. nov., paratypes (Netherlands). 15, 16, females, metasoma, dorsal, showing variation in sculpture of tergite 2. 17, male, habitus.

1.2 times as long as wide) 5th tarsomere (without claw) about as long as the preceding three and with a preapical curved spine but no emargination beneath it.

Metasoma (Figs 12–16) narrow and laterally compressed, in dead specimens about 3.2 times as long as wide, all tergites shiny; T1 1.8 times as long as wide anteriorly, almost evenly narrowed to posterior where about 0.4 times as wide as anteriorly, smooth but with weak rugosity narrowly at sides posteriorly; T2 with large triangular (but posteriorly concave and posterior margin obscure centrally) median field, usually defined (but compare Figs 15 and 16) by straight lateral sulci diverging at about 65° to fall short of sides posteriorly, smooth and raised as a longitudinal ridge centrally but with rugae and a few fine punctures laterally; remaining tergites smooth, and all tergites with a few sparse setae at sides; hypopygium fully sclerotized, truncate, angled at 90° or a little more, the apparently completely smooth ovipositor sheath scarcely projecting in holotype but quite strongly protruding in some paratypes, especially from the Czech Republic [presumed partly artefactual due to means of preservation], ovipositor narrow in apical half but very broad basally.

*Colour.* Black; palpi mostly whitish; mandible, basal half of antenna especially ventrally (dorsally wholly dark in holotype), legs except coxa basally more or less orange but hind leg with femur and tibia apically very slightly and coxa, trochanter and tarsus mostly brown. Pterostigma brown with paler posterior periphery; proximal venation partly yellowish.

Male (Fig. 17). Differs strongly: altogether less shiny and more roughened than female, also lacking its flattened build. Antenna longer than body, about as long as fore wing, broad basally and strongly attenuating apically, 17th segment about 3.5 times as long as wide and all flagellomeres with distinct false divisions. Mesosoma scarcely 1.6 times as long as high; wings ample, rather milky white; legs slenderer than female, fore leg unmodified (tarsi not shortened, 1st tarsomere 3.3 times and 2nd 1.8 times as long as wide, 2nd–4th tarsomeres about 1.4 times 5th without claw), hind femur about 2.9 times as long as wide and both femur and tibia apically quite strongly darkened. Metasomal tergites similar to female.

**Variation.** There is a surprising amount of variation in various characters such as the extent of setosity (e.g. of scutellum), size of ocelli, shape of antennal segments, development of the stub of vein 3-SR in the fore wing, extent of a fringe of setae on the straight part of the vannal lobe (virtually absent in some paratypes), and angle of divergence of the lateral sulci defining the median field of T2 (from about 60° to 75°); in this last respect the sulci are sometimes lost among enhanced rugosity extending over most of the tergite (compare Figs 15 and 16). The colour is also very variable: Fig. 2 shows an unusually pale example (hind coxa entirely and antenna basally orange) but in most examples the antenna is much darker and the hind coxa may be completely black (e.g. Fig. 13).

**Note.** The paratypes from Czech Republic (Figs 3–14) had all been stored in ethanol and then undergone a procedure to extract DNA from the whole specimen. They are mostly somewhat faded to a lighter (brown) colour, and many have the ovipositor sheath + ovipositor apparently [artefactually] more extended than the female specimens (e.g. Fig. 2) from the Netherlands and Germany that had all been allowed to die of starvation. But as the host is the same in all cases (known for all the Czech specimens) it is clear that all specimens seen belong to the same species.

### Biology and phenology

Observations in the Netherlands suggested at first sight (but see below) that *Carcina quercana* may be at least partly plurivoltine, as well-grown larvae could be found in July (frequently) and also in September (though perhaps more sparingly). The paratypes of *V. carciniae* from the Czech Republic mostly resulted from host larvae collected in late May and early June in tree canopies which,



**Figs 18–22.** 18, 19, *Carcina quercana*, pre-hibernation larva in spinning. 20–22, *Carcina quercana* larva that supported two *Venanides carcinae* sp. nov. successively (host's web removed). 20, after emergence of the first parasitoid adult the second cocoon appeared (23.viii.2019). 21, host still alive (4.ix.2019) after emergence of the second parasitoid adult. 22, host after its death (6.ix.2019), showing exit wounds on 8th and 3rd segments (by respectively the first and second parasitoid larvae).

although parasitoid eruption and emergence dates are unrecorded, also suggests a very long season for the host larvae, indicative of plurivoltinism. Both cohorts from the Netherlands were parasitized by *V. carcinae*, with adult parasitoid emergence peaks in late July–early August and September–October. By late September in 2018 first instar host larvae were quite abundant on both *Quercus* and *Fagus*, under minute webbed tunnels alongside the leaf midrib (Figs 18, 19). At this time (24.ix.2018) a female *V. carcina* was seen searching, but it could not be captured; from a cocoon collected on 21.ix.2018 a male *V. carcinae* emerged on 12.x.2018 suggesting adult activity perhaps extending into leaf fall. Unfortunately it was not possible to overwinter the young *C. quercana* larvae collected, which grew to about 4–5 mm in length during the autumn, but it is clear that the parasitoid would overwinter in the host larva and its plurivoltinism seems beyond doubt (whether or not the host is plurivoltine, see below).

From four half grown *C. quercana* larvae collected on *Quercus* on 29.vii.2018 only one *V. carcinae* resulted, the other three becoming adult moths. Two of these fed up relatively quickly and produced moths in August, but from the third, which fed very slowly and did not pupate until September, a moth resulted on 6.x.2018. This tardiness dents the supposition that the host is partly plurivoltine, but of course does not prove otherwise. In the period 21–24.ix.2018, in addition to two emerged *V. carcinae* cocoons in fresh-looking *C. quercana* webs, one living *V. carcinae* cocoon with still living host was found from which a male emerged on 12.x.2018. In the 14–17.vii.2019 collections (almost exclusively from *Fagus*, as this plant had suffered far less leaf damage than *Quercus* and was consequently easier to search) two predated larvae were found but otherwise the total of nine living half-grown or older larvae collected (one already with a cocoon, Fig. 1) all produced *V. carcinae* with adult emergence in July or the first few days of August, and one smaller larva produced the solitary microgastrine braconid *Dolichogenidea candidata* (Haliday) considerably later on. While the larva of *V. carcinae* is a haemolymph feeder and egresses from the penultimate or final instar host (both observed, and usually in the neighbourhood of the spiracle in the seventh or eighth segment) to spin its cocoon alongside but not quite touching the still-living host (Fig. 1), *D. candidata* consumes almost the entire host, which is usually killed at a smaller size than those from which *V. carcinae* erupt. Although the similarly solitary white cocoons are to be found in the host's web in both cases, the largely consumed remains of the host parasitized by *D. candidata* are minute and shrivelled, and often absent from the web, while in *V. carcinae* the host is always, at least initially, present and quiescent though potentially active alongside the parasitoid cocoon, and indeed usually remains there and lives until well after the adult parasitoid has emerged (though it never resumes feeding).

A quick opportunistic search on *Fagus* in Germany (Sachsen-Anhalt, Steinerne) on 22.vii.2019 produced one predated *C. quercana* larva and one with a cocoon of *V. carcinae* already being spun in the web. As the main objective was simply to explore the possibility of a wide distribution of the parasitoid no further searching in the area was conducted.

However, in view of the evidently extreme pressure that *V. carcinae* appeared to be exerting on the host, on our return to the Hoge Veluwe National Park I again searched, chiefly on *Fagus* (rather unsuccessfully) but also on *Quercus*, in the period 30.vii–3.viii.2019, finding one *V. carcinae* cocoon with host larva, and three much smaller *C. quercana* larvae, of which one appeared to be already dying

from an unknown cause when collected and two produced *D. candidata* at a later date. The *V. carcinae* cocoon produced a female on 4.viii.2019 and, as is usual, the host continued to live though remaining quiescent and, surprisingly, another cocoon appeared alongside it on 23.viii.2019 (Fig. 20) from which a further female of *V. carcinae* emerged on 4.ix.2019 with the host still alive (Fig. 21). The second larva had egressed from the third segment, and the host finally died on 6.ix.2019 (Fig. 22). Had the second female been a male it would not have been easy to rule out the possibility that the first female to emerge had immediately parasitized the host larva in captivity, but because it was a female and the species is evidently not thelytokous (see listed paratypes) it is clear that the second female arose from an egg inserted in the wild, probably but not certainly after the first parasitoid larva had erupted.

On the last day (3.viii.2019) before leaving the Hoge Veluwe National Park a high density of *C. quercana* larval workings was encountered on growth sprouting from near the bases of mature *Quercus robur*, and also on low *Fagus sylvatica* growing nearby. In the Hoge Veluwe National Park such growth was virtually confined to trees near the highly disturbed entrances, as in other places any low sprays around the trunks of mature oaks was heavily browsed. Near the Hoenderloo entrance to the Park 26 *C. quercana* webs with *V. carcinae* cocoons were quickly found. One was unemerged (as detailed above), and two had already



Fig. 23. Collage of predated cocoons of *Venanides carcinae* sp.nov. (not all to same scale).

successfully emerged (clear from the detached cap of the cocoon, characteristic of microgastrine as opposed to secondary parasitoid emergence), but each of the remaining 23 cocoons had been predated (presumably along with the host larva, which was absent in each case) as evidenced by the torn web and the ravaged parasitoid cocoon with strikingly consistent appearance (Fig. 23), strongly indicating either bird or perhaps more likely vespid predation. Other incidences of (host) predation, noted above, seemed not to be by birds or vespids but rather by sucking invertebrates, as initially limp corpses remained.

### Discussion

It seems highly unlikely that such a distinctive and easily seen parasitoid of a common and frequently encountered host is a long-established and overlooked resident in Europe; rather it seems likely to be a relatively recent colonist, though evidently long enough ago for it to have become widespread. If this is the case there seems to be no clue to its origin. In 2019, when not one of the *C. quercana* encountered was destined for adulthood (and pupae or pupal remains of the moth were not seen), *V. carcinae* seemed to be inflicting very high levels of mortality. As this seemed less severe in the same areas in 2018 it is possible that *V. carcinae* had relatively recently arrived in the Veluwe area, and it will be interesting to see whether the abundance of *Carcina quercana* will be depressed there in years to come. The clear plurivoltinism of the parasitoid may be an additional threat, as the rather slow-growing host seems to be only partially (or possibly not at all) plurivoltine. It is interesting that while the Czech specimens resulted from sampling tree canopies (M. Sigut, pers. comm), by far the highest density found in the Veluwe area of the Netherlands was on very low growth. The evidently high incidence of cocoon predation at least in that situation might suggest that predation could substantially check *V. carcinae* populations, although birds or vespids may not necessarily focus their search so easily in the canopy where the density is lower.

*Venanides carcinae* should be regarded as an obligatorily solitary parasitoid, despite the rearing of two individuals in succession from the same host recorded here. That was probably a freak event, and in the wild the odds are surely that the host would have been scavenged long before the second parasitoid larva erupted. But, even if it does occasionally happen in the wild, it is not gregariousness in the generally accepted meaning.

The sexual dimorphism is pronounced and the flattened and robust build of the female, typical of all *Venanides* (Mason, 1981), would appear to be an adaptation allowing it to enter the web of the host, at least in the summer generation when it apparently parasitizes moderately well-grown hosts. For its overwintering generation, it may parasitize the young host in its small and much more compact silken tube (Figs 18, 19) in the same way, or possibly from an external position for which its moderately protruding ovipositor with smooth and essentially unadorned sheath would then be adaptive. It would be of interest to know whether the larval hosts of other *Venanides* species live in ways broadly similar to *Carcina quercana*, which in the meantime seems to be a reasonable prediction.

### Acknowledgements

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