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A NEW SPECIES OF ALLIPHIS (MESOSTIGMATA : EVIPHIDIDAE) FROM BRITAIN

BY J. E. CHRISTIE*

NEW EVIPHIDIDAE POECILANDRIF INTERBREEDING

SUMMARY: Alliphis necrophilus n. sp. is described from British burying beetles and mole corpses. The larva, protonymph, deutonymph, male and female are figured. The male is dimorphic. A. necrophilus does not interbreed with Alliphis halleri.

NEW EVIPHIDIDAE POECILANDRIF KREUZUNG


INTRODUCTION

The genus Alliphis was proposed by HALBERT (1923), the type species being Alliphis halleri (G. & R. Can.). HALBERT (1923) recorded males and females of the type species from "the decayed roots of henbane and under the bark of cut pine logs" in Ireland. KARG (1963), in a review of the genus, noted Alliphis spp. were found in rotting organic substrates in top soil and also on coprophilous beetles, particularly the Scarabaeidae. OUDEMANS (1905) described a species, Alliphis siculus. KARG (1971) stated that all stages of this species use Geotrupes spp. as phoretic hosts. COSTA (1963) figured and redescribed the male, female and deutonymph of A. halleri, which he collected from Copris hispanus (L.) in Israel. He commented that on the basis of literature alone, he was unable to separate A. halleri and A. siculus. SAMSINÁK and DANIEL (1978) noted that A. halleri is the most numerous member of the genus, having been recorded on Geotrupes stercorarius (L.) in Central Europe, on C. hispanus in Israel and on Geotrupes laevistriatus Motschulsky in Japan. They compared specimens named by KARG as A. siculus with material from G. stercorarius and compost and, finding no differences, considered A. siculus to be synonymous with A. halleri.

In Britain, HYATT (1959) recorded A. halleri from G. stercorarius. EVANS et al. (1961) recorded it from this beetle as well as from a wide range of soils. SARDAR (1980) carried out an extensive study of A. halleri, including laboratory studies on its biology and food consumption.

During a study of mites associated with British burying beetles (CHRISTIE, 1981), a new species of Alliphis was found. Females and males occurred in the prothoracic spiracles of four species of

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Nicrophorus: Nicrophorus humator (Gleditsch), Nicrophorus investigator Zetterstedt, Nicrophorus vespillo (Linnaeus) and Nicrophorus vespilloides Herbst. Males and females were collected from mole (Talpa europaea (L.)) corpses. Immature stages were bred in laboratory cultures. This paper describes the new species and compares it with A. halleri, which were collected from Geotrupes stercorosus (Scriba) and G. stercorarius. An experiment to determine whether the new species can interbreed with A. halleri is also described.

MATERIALS AND METHODS

Alliphis necrophilus was collected from Nicrophorus spp. in Dunbartonshire, West Yorkshire and West Sussex and from mole corpses in West Yorkshire. Of the four species of burying beetles collected, N. vespilloides was the most numerous. The proportion of individual N. vespilloides on which this mite was found ranged from 14% in West Sussex to 50% in Dunbartonshire (CHRISTIE, 1981). Alliphis halleri was collected from Geotrupes spp. in Dunbartonshire and Perthshire.

Living material of A. necrophilus and A. halleri was cultured in the same way. Stock cultures were maintained in 27 x 54 mm plastic, tubular specimen bottles, volume 30 ml, with plaster-charcoal bases. The base was prepared in the same proportions as USHER and STONEMAN (1977). The tubes were covered with "self cling clear foodwrap" (P. W. MURPHY pers. comm.). Observations on individual or pairs of mites were carried out in small glass tubes, 6 x 25 mm. One end was closed with a piece of cotton fabric (glued on) and the other with plasticine. These tubes could be readily examined under a low power stereoscopic microscope, illuminated with a fibre-optic cold light source. They were kept in a container at 100% RH.

KARG (1971) stated that A. siculus is a specialised nematode feeder. SARDAR (1980) found that A. halleri fed readily on Nematospiroides dubius (Baylis), Pelodera strongyloides (Schneider) and Globodera rostochiensis (Woll.). In the present study, Alliphis spp. thrived on a diet of the nematode Panagrellus sp. This nematode is readily cultured on porridge oats cooked in milk, in glass dishes. It multiplies rapidly and migrates up the sides of the dish. It may be collected with a fine brush and fed directly to the mites. It remains alive for days in the humid cultures. Panagrellus sp. cultures require subculturing every 3-4 weeks.

Preparations of mites were cleared in 60% lactic acid on a warm plate for a few days depending on their degree of sclerotization. Permanent mounts were made in de Faure's medium (EVANS et al., 1961). The figures of the larva and protonymph were prepared from temporary mounts in lactic acid. The deutonymph, male and female were figured from permanent mounts. The figures were drawn onto graph paper with the aid of a graticule in the eyepiece of the microscope.

The morphological nomenclature used in the descriptions is taken from EVANS and TILL (1979) and HYATT (1980).

FAMILY EVIPHIDIDAE BERLESE, 1913

Alliphis necrophilus n. sp.

larva: The dorsum is covered by two shields, the podonotal, measuring 172 μm long and 166 μm wide, and the opisthonotal shield measuring 56 μm long and 146 μm wide. The former shield bears 9 pairs of simple setae, 12-36 μm in length, while the latter shield bears five pairs of setae (fig. 1A). There are a further 3 pairs of setae on the posterior membrane with the same shape as those at the posterior end of the opisthonotal shield.

The tritosternum has a narrow base and pilose laciniae. The intercoxal region bears 3 pairs of
setae, but there is no clear indication of a sternal shield. The anal shield is present but weakly sclerotized, bearing paired paranal setae and a longer (32 \( \mu \text{m} \)) postanal seta. The opisthogaster bears 5 pairs of setae, 4 of which are simple. Three pairs measure 12 \( \mu \text{m} \) and the fourth 30 \( \mu \text{m} \). The fifth pair is shaped like those on the posterior dorsal membrane (fig. 1C).

The tectum (fig. 1D) is short and stout with a tapering base. On the gnathosoma (fig. 1B), only the anterior hypostomatic and the external posterior hypostomatic setae are present. On the chelicera (fig. 1E) the pilus dentilis is situated in the distal half of the fixed digit.

**Protonymph**: The dorsum is covered by two shields, the podonotal shield measuring 220 \( \mu \text{m} \) by 196 \( \mu \text{m} \), and the opisthonal shield measuring 128 \( \mu \text{m} \) by 45 \( \mu \text{m} \). The podonotal shield bears 9 pairs of simple setae. The vertical setae are on the membrane at the anterior end of the shield. There are a further 4 pairs of setae on the membrane at the side of the shield. The opisthonal shield bears 10 pairs of simple setae. All the dorsal setae are short measuring 8-16 \( \mu \text{m} \). Both shields are reticulate (fig. 2A).

The tritosternum has a narrow base with pilose laciniae (fig. 2D). The intercoxal region bears 4 pairs of setae, sternal setae 1-111 on the scarcely discernible sternal shield and setae V between coxae IV. The anal shield is present with the paired paranal setae being approximately equal in length to the postanal seta (20 \( \mu \text{m} \)). The opisthogastric region bears a further 5 pairs of setae. A pair of stigmata and short peritremes are present.

The tectum (fig. 2C) has a broad base with a
Fig. 2 A-E: *Alliphis necrophilus* n.Lsp., protonymph.
A) dorsum ; B) chelicera ; C) tectum ; D) venter ; E) venter of gnathosoma. (Scale A and D 1 unit = 40 μm ; B, C and E 1 unit = 16 μm).
single, short, serrated process. The gnathosoma is shown in figure 2E and the chelicera in figure 2B.

- **DEUTERONYMPH**: This stage is again only weakly sclerotized. The dorsum is covered entirely by the dorsal shield, measuring 408 µm long and 246 µm wide (fig. 3C). It bears 30 pairs of setae, 8-20 µm. It is finely reticulate.

The tritosternum (fig. 3A) has a narrow base with pilose laciniae. The sternal shield, though present, is weakly sclerotized. It extends to the posterior margin of coxae IV and bears sternal setae I-IV. Endopodal shields are situated between coxae II and III and III and IV. The anal shield is 80 µm wide and 60 µm long. The opisthogastric membrane bears eleven pairs of setae. The peritreme extends posteriorly to the anterior margin of coxae IV.

The tectum (fig. 3D) has a broad base with gradually tapering, serrated sides leading to a single, serrated process. On the gnathosoma (fig. 3B), the internal posterior hypostomatic setae are equal in length to the anterior hypostomatic setae. The palpcoxal setae are longer than the external posterior hypostomatic setae.

- **MALE**: Two morphologically different types of male are found. Type I has short dorsal setae at the posterior end of the dorsal shield and a small anal shield, while type II has long dorsal setae at the posterior end of the dorsal shield and an enlarged anal shield. Type II was found only in laboratory cultures while type I was found on beetles, mole corpses and in laboratory cultures. Some males show an intermediate condition between the two forms.

In the type I male, the oval dorsal shield covers most of the dorsum, it is 344-496 µm long and 232-304 µm wide. The size shows considerable variation, those reared in laboratory culture were the largest, those from mole corpses were intermediate and those from *Nicrophorus* beetles were smallest. The dorsal shield bears 30 pairs of setae. In morphological type I, these are fairly uniform in length (8-36 µm) (fig. 4A). The vertical setae are lancet shaped and the dorsal shield is reticulate.

The tritosternum has a short base with pilose laciniae. The sternogenital is 144-216 µm long and 80-96 µm wide at the anterior margin. It bears five pairs of setae and is ornamented particularly at the posterior end (fig. 5C). The anal shield is 72-100 µm wide and 64-88 µm long in type I (fig. 4D). The opisthogastric membrane bears ten pairs of setae, measuring 20-24 µm. The peritreme extends posteriorly to the anterior margin of coxae IV. The shape and width of the peritrematal shield is shown in figure 5D.

The tectum (fig. 4C) has a broad base with gradually tapering, serrated sides leading to a single, serrated process, similar to that of the deuteronymph. The gnathosoma is shown in figure 5B. Figure 4B shows the spermatodactyl on the movable digit of the chelicera. It has a short stalk and a terminal process, which may be fanned out as in figure 4B, or folded as in figure 4E. The latter shape is more usual in microscopical preparations.

The femurs of leg II and IV bear spurs in most individuals (fig. 4F and G). On femur IV this may be well developed or it may remain a simple seta or a stout seta. The spur on femur II was present in all specimens examined.

The males of type II differ from type I with respect to the length of the posterior dorsal setae, which may reach 60 µm in length in type II (Fig. 5A). The anal shield may be 120 µm wide and 112 µm long and frequently has an irregular pattern of sclerotization (fig. 5C). The setae on the opisthogastric membrane reach 64 µm in length and may be situated on the anal shield.

- **FEMALE**: The oval dorsal shield covers the whole dorsum, it is 416-552 µm long and 288-376 µm wide. As in the male, their sizes show considerable variation depending on whether they were reared in laboratory cultures or collected from beetles or mole corpses. The dorsal shield is reticulate and bears 30 pairs of setae, 12-32 µm long (fig. 6A). The vertical setae are lancet shaped.

The tritosternum has a broad base with pilose laciniae (fig. 6D). The sternal shield is 104-124 µm long and 96-120 µm wide, at the anterior margin. The ratio of length to width is 1.05.
Fig. 3 A-D: *Alliphis necrophilus* n sp., deuteronymph.
A) venter; B) venter of gnathosoma; C) dorsum; D) tectum. (Scale A and C 1 unit = 40 μm; B and D 1 unit = 16 μm).
Fig. 4 A-G: *Alliphis necrophilus* n. sp., male.

A) dorsum of type I; B) chelicera; C) tectum; D) venter of type I; E) spermatodactyl; F) femur of leg IV; G) femur of leg II.

(Scale A and D 1 unit = 40 \( \mu \text{m} \); B, C, E, F and G 1 unit = 16 \( \mu \text{m} \)).
Fig. 5 A-D : *Alliphis necrophiles* n. sp., male.
A) dorsum of type II ; B) venter of gnathosoma ; C) venter of type II ; D) peritrematal shield. (Scale A, C and D 1 unit = 40 μm ; B 1 unit = 16 μm).
It bears three pairs of setae. The metasternal setae are inserted on small metasternal shields. The endopodal plates are fused with the sternal shield. The genital shield has rounded posterior margins, though the overall shape is variable. In large individuals, it appears more rectangular. A pair of setae are marginal or just off the edge of the shield. The anal shield is 76-112 μm wide and 64-96 μm long. The opisthogastric membrane bears 10 pairs of setae. The peritreme extends posteriorly to the anterior margin of coxae IV. The sculpturing and width of the peritrematal shield is shown in figure 6F.

The tectum is similar to that of the deuteronymph and male, it has a broad base with gradually tapering, serrated sides leading to a single, serrated process. The gnathosoma is shown in figure 6B and a chelicera in figure 6E.

Material: Holotype — 1 ♀ ex Nicrophorus vespilloides Herbst, Near Balloch, Dunbartonshire, Scotland (NS 456831), 3 September 1978; many ♀♀ and ♂♂ paratypes ex Nicrophorus spp. from Dunbartonshire (NS 456831), West Yorkshire (SE 415352) and West Sussex (SU 810237); 5 ♂♂ and 21 ♀♀ from mole corpses from West Yorkshire (SE 425405); numerous LL, PNN, DNN, ♂♂ and ♀♀ from laboratory cultures.

The holotype and paratypes will be deposited in the British Museum (Natural History), London.

Cross-breeding A. halleri and A. necrophilus

Living material for this experiment was obtained from stock cultures of each species. The experiment was conducted in glass tubes at 15°C, 100 % RH. Five replicates of three treatments were set up. In the first treatment one female A. necrophilus was placed in a tube with one male A. halleri. In the second treatment, one female A. halleri was placed in a tube with one male A. necrophilus. In the third treatment, tubes contained one male and one female A. necrophilus. All the females used in the experiment were reared singly and were therefore virgins.

The mites were fed every 2-3 days. After 14 days four of the five replicates in treatment 3 contained immature stages. None were observed in treatment 1 or 2, although a few, unviable eggs were laid. This had previously been observed in virgin females. On day 14, the males in treatment 1 and 2 were exchanged, so that treatment 1 then contained A. necrophilus and treatment 2 A. halleri. After a further 7 days, three tubes of A. halleri contained immature stages, and in the remaining two tubes one of the pair had died. Four of the tubes of A. necrophilus contained immature stages.

The inability of A. halleri to cross-breed with A. necrophilus confirms that their separation into two species is indeed valid.

DISCUSSION

Specimens of A. halleri were compared with COSTA'S (1963) figures. (These specimens are figured in CHRISTIE, 1981). They compare favourably in most respects, though the present specimens are larger and the shape of the spermatodactyl differs. The size difference may be due to the regime under which they bred. Marked size difference was found in A. necrophilus probably for this reason. The shape of the spermatodactyl may indicate specific differences. COSTA (1963) describes it as being short and terminating in a disc-like structure. The fork-shape observed in the present specimens corresponds well with KARG'S (1971) description and figure of A. siculus. This was to be expected as A. siculus is a synonym of A. halleri.

Although A. halleri would not interbreed with A. necrophilus demonstrating that they are both valid species, morphologically they are very similar. Due to the variation in size of A. necrophilus, the two species may not be separated on the basis of the size of any one dimension. Measurements of several dimensions of the two species are given in table 1 for males and table 2 for
FIG. 6 A-F: *Alliphis necrophilus* n. sp., female.

A) dorsum; B) venter of gnathosoma; C) tectum; D) venter; E) chelicera; F) peritrematal shield. (Scale A, D and F 1 unit = 40 μm; B, C and E 1 unit = 16 μm).
The ratio of length to width of the anal shield reveals that *A. necrophilus* is longer and narrower than *A. halleri*.

In addition to differences in dimensions, there are also differences between the two species with respect to the shape of some morphological structures. Karg (1971) figures the larva of *A. siculus*. This differs from *A. necrophilus* in the shape of the opisthonotal shield. In *A. necrophilus* the shield covers a greater part of the posterior dorsal region. Karg (1971) figures all the setae as simple whereas in *A. necrophilus* three distinct shapes were observed. Karg (1971) also figures the protonymph where there are no obvious differences between the two species.

The deuteronymph of *A. halleri* is more sclerotized than that of *A. necrophilus*. This corresponds well with their respective phoretic behaviour. *A. halleri* deuteronymphs are frequently found on Geotrupes spp. (Hyatt 1959 and personal observation), and therefore require to be more robust whereas *A. necrophilus* is very rarely phoretic at this stage, (1 in 596 individuals). The sternal shield of *A. halleri* is broader than *A. necrophilus*. In *A. halleri*, the internal posterior hypostomatic setae are longer than the anterior hypostomatic setae, while in *A. necrophilus* they are approximately equal. The shape of the tegument of the deuteronymph as well as the male and female differs in the two species. In *A. halleri*, the base is square while in *A. necrophilus*, it is gradually sloping toward the single process.

The male of *A. necrophilus* usually has a spur present on femur IV and always on femur II, but these are absent in *A. halleri*. The shape of both the spermatodactyl and corniculi are different. The peritrematal shield is broader in *A. halleri*.

The females are very similar. A slight difference was found in the width of the peritrematal shield, *A. halleri* being broader than *A. necrophilus*.

**ACKNOWLEDGEMENTS**

I wish to thank Mr. K. H. Hyatt (British Museum (Natural History)) and Professor G. O. Evans (University College, Dublin) for examining the specimens. I gratefully acknowledge the advice and support of my

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**TABLE 1. Measurements of male Alliphis spp., μ ± SE**

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th><em>A. halleri</em></th>
<th><em>A. necrophilus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal shield length</td>
<td>387.6 ± 3</td>
<td>366.5 ± 3 389.4 ± 14</td>
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<tr>
<td>Dorsal shield width</td>
<td>251.7 ± 3</td>
<td>238.3 ± 2 217.2 ± 2</td>
</tr>
<tr>
<td>Sternal shield length</td>
<td>176.2 ± 3</td>
<td>170.2 ± 2 169.8 ± 8</td>
</tr>
<tr>
<td>Sternal shield width</td>
<td>88.2 ± 2</td>
<td>90.1 ± 1 81.1 ± 1</td>
</tr>
<tr>
<td>Anal shield length</td>
<td>63.3 ± 3</td>
<td>69.2 ± 2 76.2 ± 2</td>
</tr>
<tr>
<td>Anal shield width</td>
<td>75.3 ± 3</td>
<td>79.4 ± 2 86.3 ± 3</td>
</tr>
<tr>
<td>Gnathosoma width</td>
<td>75.2 ± 2</td>
<td>76.2 ± 2 78.2 ± 2</td>
</tr>
</tbody>
</table>

* type I and II combined.

**TABLE 2. Measurements of female Alliphis spp., μ ± SE**

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th><em>A. halleri</em></th>
<th><em>A. necrophilus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal shield length</td>
<td>470.0 ± 6</td>
<td>430.6 ± 6 470.7 ± 7</td>
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<tr>
<td>Dorsal shield width</td>
<td>304.3 ± 3</td>
<td>299.2 ± 2 320.5 ± 5</td>
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<tr>
<td>Sternal shield length</td>
<td>112.1 ± 3</td>
<td>110.2 ± 2 110.0 ± 1</td>
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<tr>
<td>Sternal shield width</td>
<td>94.2 ± 1</td>
<td>101.2 ± 2 106.1 ± 2</td>
</tr>
<tr>
<td>Anal shield length</td>
<td>75.3 ± 3</td>
<td>73.4 ± 2 87.2 ± 2</td>
</tr>
<tr>
<td>Anal shield width</td>
<td>91.0 ± 1</td>
<td>81.2 ± 2 94.2 ± 2</td>
</tr>
<tr>
<td>Gnathosoma width</td>
<td>86.2 ± 2</td>
<td>83.2 ± 2 92.2 ± 1</td>
</tr>
<tr>
<td>Genital shield width</td>
<td>54.1 ± 1</td>
<td>53.1 ± 1 58.2 ± 2</td>
</tr>
</tbody>
</table>

* type I and II combined.
supervisors Dr. R. A. BAKER and Dr. B. SHORROCKS. The work was funded by a Science Research Council studentship.

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Paru en octobre 1983.