**Hericia sanukiensis**, a new species of Algophagidae (Astigmata) inhabiting sap flux in Japan

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Abstract

A new species, *Hericia sanukiensis*, is described and illustrated from adults, phoretic deutonymphs and non-phoretic deutonymphs collected from sap flux on oak trees (*Quercus acutissima* Carruth.) in Takamatsu City, Kagawa Prefecture, Japan. Deutonymphs are phoretic on the sap flux inhabiting beetle *Librodor japonicus* (Coleoptera, Nitidulidae).

Key words: Acari, Algophagidae, Hericia, sap flux, Librodor japonicus, Japan

Introduction

Robin (1868) described *Glycyphagus hericius*, an inhabitant of sap flux on English elm (*Ulmus minor* Mill., formerly *U. campestris* L.) in France. Canestrini (1888) recognized the species was not in the genus *Glycyphagus* and established the genus *Hericia* to accommodate it. However Canestrini (1888) also changed the specific name from *hericius* to *robinii*, a mistake that has since been corrected and the species is now known as *H. hericia*. To date, three additional species of *Hericia* have been described: *H. georgei* Michael 1903 from the sap of an English black poplar (*Populus nigra* L.), *H. fermentationis* Vitzthum 1931 from strongly fermenting, sour, milk-white liquid in a cut-off bamboo stump in Sumatra, and *H. paradoxa* Türk and Türk 1957 from a deutonymph found in birch rot in Germany. The present paper describes a fifth species collected from sap flux on sawtooth oak (*Quercus acutissima* Carruth) (Fagaceae), in Kagawa Prefecture, Japan.

Materials and methods

Bark and wood were collected from sap flux on sawtooth oak trees (*Quercus acutissima*), brought back to the laboratory, and examined for mites under a dissecting microscope. Specimens were cleared in a mixture of Lactophenol and Nesbitt’s solution and mounted in Hoyer’s medium on microscope slides (Krantz 1978; Evans 1992). Measurements were taken on ten individuals of each stage and are given in micrometers (µm) in the following order: holotype, mean and range (in parentheses). Relative position of setae and other structures are as in figures. Nomenclature for idosomal setae follows Griffiths *et al.* (1990) and for leg setae Grandjean (1939).

For observation of characters under the scanning electron microscope (SEM), specimens were dehydrated in ethyl alcohol, dried using the critical point procedure, individually affixed to stubs using double-sided sticky tape, and coated with gold-palladium in a sputter coater. Microscopy was performed on an AMR 1200.
FIGURES 1–4. *Hericia sanukiensis*, sp. n., female—1. chelicera, lateral view, 2. gnathosoma, ventral view, 3. dorsum, 4. venter. Scale bar: 400 µm (Figs. 1, 2), 200 µm (Figs. 3, 4).
**Hericia sanukiensis** sp. nov.

Material examined

**Holotype:** Male collected from sap flux on *Quercus acutissima* at Sogawa-Higashimachi, Takamatsu City, Kagawa Prefecture, Japan, 25 June 2003, by K. Hayashi. Deposited in the Natural Resources Inventory Center, National Institute for Agro-Environmental Sciences, Tsukuba, Japan (NIAES).


**Description**

**Female** (Figs. 1–8, 9, 11, 13)

Body broadly ovoid; length 738 (650–830); width just posterior to coxae II 482 (420–560). Gnathosoma with chelate chelicerae (Fig. 1) with digits thin and with few well developed teeth, cheliceral seta short and spine-like; subcapitulum (Fig. 2) bearing a pair of filiform subcapitular setae ventrally. Each palpal tibia bears a filiform dorsal seta, and each palpal tarsus a filiform dorsal seta, a subapical solenidion, and a basal rounded eupathidium; ventral palpal seta absent.

**Dorsum** (Fig. 3)—Cuticle lightly sclerotised, bearing striations (Fig. 11). Prodorsal sclerite with a reticulate pattern (Fig. 13), over twice as long as wide, extending to a level between trochanters I and II. A pair of small unsclerotised areas representing the vestigial alveoli of setae ve occur on lateral margins of prodorsal sclerite. Grandjean’s organs and supracoxal setae absent. Axillary organs originate dorsally between legs I and II, extending laterally between legs and ventrally onto coxae. Opisthontal gland openings (gla) located between setae d1 and d2. Cupules located as follows: ia slightly posterior seta cp, im on lateral margin and slightly anterior seta e1, and ip between setae h1 and h2. Dorsum bearing 14 pairs of filiform setae: vi 94 (88–112); si 108 (92–118); se 128 (112–138); c1 26 (20–35); c2 106 (98–112); cp 129 (112–142); d1 111 (105–118); e1 85 (70–100); e2 138 (125–145); f2 88 (75–108); h1 126 (110–150); h2 188 (175–200) and h3 208 (198–220).

**Venter** (Fig. 4)—Cuticle lightly sclerotised. Anterior coxal apodemes I directed posteromedially, joining at midline to form a Y-shaped sternum. Anterior coxal apodemes II directed posteromedially; anterior coxal apodemes III and IV directed anteromedially; posterior apodemes III directed anterio- posteromedially and joining anterior apodemes IV. Epigynial apode small, located anterior to oviparous. Genital papillae vestigial. Cupule ih between seta ps3 and ps4. Anus ventroterminal. Bursa copulatrix (ba) a short tube slightly posterior anus. Venter bearing 9 pairs of filiform setae: c1 129 (120–142); la 61 (50–82); 3a 16 (12–18); 3b 39 (32–48); 4a 29 (25–32); g 8 (3–12); ps 16 (8–22) and ps2 21 (15–32). Anus ventroterminal. Bursa copulatrix (ba) a short tube slightly posterior anus. Venter bearing 9 pairs of filiform setae: c1 129 (120–142); la 61 (50–82); 3a 16 (12–18); 3b 39 (32–48); 4a 29 (25–32); g 8 (3–12); ps 16 (8–22) and ps2 21 (15–32). Anus ventroterminal. Bursa copulatrix (ba) a short tube slightly posterior anus. Venter bearing 9 pairs of filiform setae: c1 129 (120–142); la 61 (50–82); 3a 16 (12–18); 3b 39 (32–48); 4a 29 (25–32); g 8 (3–12); ps 16 (8–22) and ps2 21 (15–32). Anus ventroterminal. Bursa copulatrix (ba) a short tube slightly posterior anus. Venter bearing 9 pairs of filiform setae: c1 129 (120–142); la 61 (50–82); 3a 16 (12–18); 3b 39 (32–48); 4a 29 (25–32); g 8 (3–12); ps 16 (8–22) and ps2 21 (15–32). Anus ventroterminal. Bursa copulatrix (ba) a short tube slightly posterior anus. Venter bearing 9 pairs of filiform setae: c1 129 (120–142); la 61 (50–82); 3a 16 (12–18); 3b 39 (32–48); 4a 29 (25–32); g 8 (3–12); ps 16 (8–22) and ps2 21 (15–32). Anus ventroterminal. Bursa copulatrix (ba) a short tube slightly posterior anus. Venter bearing 9 pairs of filiform setae: c1 129 (120–142); la 61 (50–82); 3a 16 (12–18); 3b 39 (32–48); 4a 29 (25–32); g 8 (3–12); ps 16 (8–22) and ps2 21 (15–32) and ps3 100 (75–112).

**Legs** (Figs. 5–8)—Legs heavily sclerotised; lengths (measured from base of femur to tip of tarsus); mean, followed by range and mean percentage of idiosomal length in parentheses: I 286 (258–315, 39%); II 322 (291–349, 44%); III 370 (343–406, 50%); IV 388 (357–428, 53%). Tarsal lengths: I 85 (70–100); II 106 (91–113); III 150 (136–166); IV 166 (153–185). Trochanteral setation 1-1-1-0; setae pR I–II thin, filiform, sR III thick, robustly filiform. Femoral setation 1-1-0-1; setae vF I–II and wF IV thin, filiform. Genual setation 2-2-1-0; setae eG and mG I–II and nG III stout spines. Tibial setation 2-2-1-1; setae hT and gT I–II and kT III–IV stout spines. Tarsal setation 9-7-8; tarsae I and II with setae la, wa, ra, s and e stout spines, proral setae (p and q) short spines, seta d long, filiform, and seta f short, filiform; tarsus III setae w, s and e stout spines, proral setae (p and...
4) short spines, seta \(d\) long, filiform, and seta \(f\) short, filiform; tarsus IV similar to tarsus III but with the addition of seta \(r\), a stout spine. Solenidia (I to IV): tarsi 3-1-0-0, tibiae 1-1-1-1, genua 2-1-1-0; solenidia \(\sigma\) of genua I–II originating 1/3 of way from apical end and approximately midway on genua III; solenidion \(\sigma'\) 2/3 length of \(\sigma\), tibiae I–IV with solenidion \(\phi\) originating approximately 1/3 of way from apical end; tarsus I with solenidion \(\omega_1\) originating near segment base, solenidion \(\omega_2\) approximately 1/4 of way from basal end, and \(\omega_3\) apical. Tarsus II with \(\omega\) originating near segment base. Tarsus I with spinelike famulus \(\epsilon\) adjacent to solenidion \(\omega_1\). Pretarsi with membranous ambulacra and slender, curved claws; condylophores absent.

FIGURES 5–8. *Hericia sanukiensis*, sp. n. female—5. leg I, 6. leg II, 7. leg III, 8. leg IV. Scale bar = 100 \(\mu\)m

*Male* (Figs. 10, 14–21)

Body broadly oval, but tapering more both anteriorly and posteriorly than female; shallow cleft at posterior margin; length 640, 633 (540–710); width just posterior to coxae II 500, 503 (430–580).
Axillary organs and gnathosoma similar in appearance to female, but gnathosoma and chelicerae smaller relative to idiosomal size.


**Dorsum** (Fig. 16)—Dorsum lightly sclerotized and with cuticular ornamentation on perimeter; three small patches of irregular cuticle forming a triangle on each side between setae \( s_i \) and \( c_1 \). Prodorsal sclerite with a reticulate pattern (Fig. 14), extending to level of trochanters I; anterior of prodorsum expanded and flared (Figs. 14, 15). Opisthontal gland openings (\( gla \)) located anterior
to seta e₂. Cupules located as follows: ia slightly posterior seta c₂, im between setae d₁ and h₁, and ip between setae f₂ and h₂. Dorsum bearing 18 pairs of filiform setae: vi 108, 111 (88–138); si 122, 128 (108–155); se 125, 138 (122–162); c₁ 58, 58 (45–88); c₂ 200, 220 (185–275); c₃ 235, 246 (218–272); cp 178, 205 (178–245); d₁ 135, 164 (130–198); d₂ 192, 214 (192–268); e₁ 250, 229 (188–270); e₂ 258, 236 (198–275); f₂ 92, 137 (92–188); h₁ 233, 243 (215–275); h₂ 290, 271 (242–290); h₃ 265, 274 (262–302); ps₁ 25, 34 (25–58); ps₂ 15, 19 (15–28) and ps₃ 288, 290 (238–325).


Venter (Fig. 17)—Cuticle lightly sclerotised. Anterior coxal apodemes I and II directed posteromedially; apodemes I joining at midline to form a Y-shaped sternum that extends posteriorly and joins with apodemes II. Coxae IV located ventrad and mesiad coxae III, with the result that legs IV are positioned below legs III. Anterior coxal apodemes III directed anteriomedially and joining
medially to form a bridge. Anterior apodemes IV directed anteriomedially and joining anterior apodemes III. Aedeagus located between coxal fields IV. A narrow sclerite containing setae g just anterior to adeagus. Cupule ih on idiosomal margin laterad and midway anus. Anus ventroterminal. Venter bearing five pairs of filiform setae: Ia 82, 86 (68–125); 3a 102, 97 (70–120); 4a 70, 74 (55–100); 3b 52, 46 (30–58) and g 18, 21 (18–32).


Legs (Figs. 18–21)—Leg lengths, measured from base of femur to tip of tarsus (holotype, mean followed by range and mean percentage of idiosomal length): I 485, 469 (381–551, 74%); II 528, 513 (415–611, 81%); III 542, 544 (475–632, 86%) and IV 440, 438 (387–492, 70%). Tarsal lengths: I 134, 120 (91–140); II 177, 173 (128–202); III 189, 193 (166–217) and IV 104, 105 (91–112). Legs
of male more robust than those of female, and with total lengths as well as tarsal lengths significantly longer. In addition, leg IV with tibia and tarsus broader and flatter, tarsus concave ventrally, ambulacrum reduced to a fleshy pad, and claw absent or vestigial. Although setae and solenidia of legs II and III are similar to those of female, they differ on legs I and IV. Tarsus I with setae la and ra filiform rather than spines, and solenidion ω2 located apically near seta f. Tarsus IV with setae f, q and s broadly expanded to form thin, membrane-like flaps, setae e and w filiform rather than spines, and seta d apical rather than basal.

Phoretic deutonymph (Figs. 12, 24–29)

Body shape variable, elliptical to broadly ovoid; length 338 (282–365); width at sejugal furrow 250 (205–278). Gnathosoma with well developed subcapitulum and palps (Fig. 22); subcapitulum somewhat rounded in shape, bearing a pair of filiform subcapitular setae ventrally. Palpal remnants reduced, each bearing a palpal solenidion apically and a filiform palpal seta laterally.

Dorsum (Fig. 24) — Dorsum largely covered by reticulate-sculptured (Fig. 12) propodosomal and hysterosomal sclerites that are separated by a well developed sejugal furrow. Apex of propodosomal sclerite with a pair of un sclerotised areas representing vestigial alveoli of setae ve. Propodosoma with three pairs of filiform setae: vi 16 (14–18) at apex; si 16 (14–18) located on scerite and se 17 (13–20) located anterior to sclerite. Hysterosomal sclerite wraps around lateral margin of idiosoma, joining ventral sclerite, and bearing 10 pairs of hairlike setae: c1 10 (7–13); c2 11 (10–12); cp 27 (20–31); d1 9 (6–11); d2 11 (8–17); e1 9 (7–10); e2 33 (18–43); f 31 (21–38); h1 8 (6–10) and h2 10 (7–15). Opisthosomal gland openings located laterally between setae d1 and e2. Cupules ia mesiad and slightly anterior setae c2, cupules im mesiad setae e2 and cupules ip slightly anterior to setae f2.

Venter (Fig. 25) — Anterior apodemes of coxal fields I fused to form Y-shaped sternum; anterior apodemes of coxal fields II curved posteriorly and medially. Posterior apodemes of coxal fields II join anterior apodemes III. Anterior apodemes of coxal fields III fused with each other and with anterior apodemes of coxal fields IV; posterior apodemes III fused with anterior apodemes IV and also with base of anterior apodemes III, coxal fields III completely enclosed. Posterior medial apodeme well developed, extending from anterior apodemes IV to genital opening. Setae c, filiform, 17 (14–21), positioned between legs II and III. Setae h2 18 (15–20), positioned on posterior margin of idiosoma. Setae of coxal fields I (Ja), III (Jb) and IV (Jd) absent, their positions represented by vestigial alveoli. Setae 3a usually absent, their position represented by vestigial alveoli at junction of apodemes IV and median apodeme (occasionally present as short, filiform setate). Genital opening between coxae IV; setae g 11 (9–13) filiform, flanking genital opening. Genital papillae short, two segmented, rounded apically. Cupules ih slightly anterior setae h2. Attachment organ well developed (Fig. 23). Anterior suckers (ad), with spokes radiating from center. Median suckers larger, consisting of a marginal ring surrounding an inner core containing paired vestigial alveoli (ad1,2). Pair of small refractile spots (vestigial alveoli of ps, ) anteriolateral to median suckers. Setae ps1 conoid and situated posteriolateral to median suckers; Setae ps2, conoid and situated contiguously, posterior to median suckers.

Legs (Figs. 26–29) — Legs heavily sclerotised, elongate, all segments free. Trochanteral setation 1-1-1-0; setae pr I–II and sr III thin, filiform. Femoral setation 1-1-0-1; setae vF I–II and wF IV thin, filiform. Genual setation 2-2-0-0; setae cG and mG I–II stout spines. Tibial setation 2-2-1-1; setae hT and gT I–II and kT III–IV stout spines. Tarsal setation 8-8-7-8; tarsae I and II with setae f, wa,q and p stout spines, setae la and ra filiform, setae e elongate, foliate apically, and seta d long, filiform. Tarsus III with setae w, s, q, f and e elongate spines, seta p short spine and seta d filiform and very long. Tarsus IV similar to tarsus III, but with the addition of seta r, an elongate spine. Solenidia (I–IV): tarsus 3-1-0-0, tibiae 1-1-1-1 and genua 1-1-0-0. Spineline famulus ε on tarsus I.
Pretarsi of legs I–II consist of short, membranous ambulacula whereas those of legs III–IV consist of elongate membranous ambulacula, all with hooked empodial claws; condylophores not observed.

Non-phoretic deutonymph (Figs. 30–37)

Body broadly ovoid; length 354 (318–392); width at sejugal furrow 262 (220–280). Not significantly different in length ($p = 0.192$, $df = 18$; $t = 1.357$) or width ($p = 0.211$, $df = 18$, $t = 1.296$) to phoretic deutonymph. Gnathosoma (Fig. 30) similar to phoretic deutonymph, except palps and palpal solenidia shorter.

Dorsum (Fig. 32)—Similar in cuticular sculpturing, gland and cupule placement, and setation to phoretic deutonymph. Setal lengths: $vi$ 18 (13–21); $si$ 28 (20–33); $se$ 21 (13–26); $c_1$ 9 (5–14); $c_2$ 14 (10–17); $cp$ 32 (23–43); $d_1$ 9 (5–12); $d_2$ 11 (5–16); $e_1$ 8 (4–13); $e_2$ 38 (32–45); $f_2$ 36 (28–50); $h_1$ 9 (4–15); $h_2$ 12 (5–15) and $h_3$ 16 (10–18).

Venter (Fig. 33)—Idiosoma similar in appearance to phoretic deutonymph. Setal lengths: $c_1$ 16 (10–21); $g$ 9 (8–10). Attachment organ greatly modified and devoid of suckers; no longer functional as a sucker plate (Fig. 31). Anterior suckers ($ad_1$) reduced to vestigial alveoli, and median suckers reduced to the paired vestigial alveoli of setae $ad_{1,2}$. Setae $ps_2$ and $ps_1$ filiform rather than conoidal.

Legs (Fig. 34–37)—Chaetotaxy and soleniotaxy similar to that of phoretic deutonymph, however legs shorter. In addition, pretarsae of legs III–IV short rather than elongate.
Etymology

The species is named after the locality where the types were collected. Sanuki is the old name for Kagawa Prefecture, and people there still love the old name.

Remarks

The most straightforward character to separate *H. sanukiensis* from *H. hericia* and *H. fermentationis* occurs in males. *Hericia sanukiensis* males have three small patches of irregular cuticle forming a triangle on each side between setae *si* and *c₁*, whereas *H. hericia* and *H. fermentationis* males have greater than nine on each side irregularly distributed between setae *si* and...
Türk and Türk (1957) described *H. paradoxa* from a single deutonymph but were uncertain as to taxonomic placement since the sucker plate was reduced and the pretarsi short. Fashing (1991) demonstrated that species of *Hericia* have two types of deutonymphs, one phoretic and one non-phoretic. The non-phoretic morph has lost most of the attributes associated with dispersal, and the specimen used to describe *H. paradoxa* is obviously a non-phoretic morph. Unfortunately Türk and Türk’s description is poor, the type unavailable, and the non-phoretic deutonymphs of European *Hericia* are not described and associated with adults. *Hericia sanukiensis* appears to be most closely related to *H. georgei* (Michael), and the possibility exists that future research will find *H. sanukiensis* to be a junior synonym of *H. georgei*. Published morphological descriptions as well as illustrations of *H. georgei* are poor and incomplete, and cannot be used to separate *H. sanukiensis* from *H. georgei*.

Michael (1903) described *H. georgei* from specimens collected by C. F. George under the bark of a black poplar tree where sap flux was oozing from a wound made by *Cossus cossus* L. (Lepidoptera: Cossidae). The description is poor and incomplete due to what Michael referred to as poorly preserved specimens which were poorly mounted in the wrong slide mounting medium. Repeated searches in England for additional specimens of *H. georgei* by Michael as well as others were fruitless, and the four slide-mounted specimens used by Michael for his description are no longer in existence. Vitzthum (1931), based on Michael’s description, considered *H. georgei* to be a junior synonym of *H. hericia*. Although he later examined specimens of *H. georgei* from Stockholm, Sweden, he did not recognize them as such and deposited them in his private collection as *H. fermentationis*, a species he had previously described from Sumatra (Türk and Türk 1953). Türk and Türk (1953), as part of their revision of middle European “tyroglyphid” mites, examined Vitzthum’s material but also failed to recognize the specimens of *H. georgei* as being different from *H. fermentationis*. Samši ák (1972) examined the Vitzthum collection (currently housed in Zoologische Sammlung des Bayerischen Staates, Munich) and established a neotype male for *H. georgei* (ZSBS V 3075). Although Samši ák titled his paper “Redescription of *H. georgei* Michael, 1903 (Acarina, Tyroglyphidae) phoretic on Lepidoptera”, in reality the paper briefly lists five deutonympal characters and three male characters that can be used to distinguish between *H. georgei* and *H. fermentationis*. Samši ák provides the average idiosomal lengths of *H. georgei* deutonymphs and males as 380 µm and 580 µm respectively, but does not provide a range for the specimens examined. Although average idiosomal lengths for phoretic deutonymphs of *H. sanukiensis* are smaller (338 µm) and those for males larger (633 µm), the range of measurements in both cases (282–365 and 540–710 respectively) encompass Samši ák’s means for *H. georgei*. Attempts to borrow the Vitzthum material (including neotype V 3075) from Zoologische Sammlung des Bayerischen Staates, Munich, were not successful. The neotype as well as other specimens were borrowed on August 8, 2000, and repeated requests by the museum for their return have been unanswered by the borrower.

Without specimens of *H. georgei* for comparison, the most compelling reason to treat *H. sanukiensis* as a new species is biological rather than morphological; deutonymphs of the two species disperse on quite different insect hosts. Deutonymphs of *H. georgei* are phoretic on lepidopterans, and have been collected from all six *Catocala* moth species native to Finland (Samši ák 1972). A constant infestation rate was found regardless of locality, with 7 to 15% of the moths harboring mites. Deutonymphs were also collected from the following butterflies and moths in Finland: *Nymphalis antiopa* L., *Polygonya c-album* L., *Vanessa atalanta* L., *Apatele psi* L., *Europis occulta* L., and *Scoliopleryz libatrix* L. (Samši ák (1972).) *Catocala* species collected from the district of Leningrad displayed similar infestation rates, and *H. georgei* deutonymphs were also recovered from *Catocala* species in France and southern Russia (Samši ák 1972). In contrast, an examination of 250 *Catocula* specimens from Japan revealed no mites (Samši ák 1972), and Japanese researchers
studying the biology of *H. sanukiensis* are certain that deutonymphs have never been collected from *Cossus cossus orientalis* Gaede (T. Ichikawa, Y. Yasui and K. Hayashi, pers. comm.). To date deutonymphs of *H. sanukiensis* have been collected only from the sap flux inhabiting beetle *Librodor japonicus* (Motschulsky) (Coleoptera, Nitidulidae).

If future research does synonymize *H. sanukiensis*, the present paper will then serve as a much needed redescription of *H. georgei*.

Acknowledgements

We would like to express our gratitude to Dr. Gisela Fashing for her translations of German publications, and to Dr. Stefan Friedrich, Zoologische Sammlung des Bayrischen Staates, Munich, for his attempts to recall the Vitzthum specimens of *H. georgei*. We also thank Drs. T. Ichikawa and Y. Yasui, and Mr. K. Hayashi of Kagawa University for providing the specimens on which this description is based, and for providing information concerning the biology of *H. sanukiensis*.

References


Accepted by Zhi-Qiang Zhang: 30 Nov. 2006
Published on 20 Dec. 2006