A New Genus and Two New Species of Chigger Mites (Acari, Trombiculidae) Collected from Amphibious Sea Snakes of Japan

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Abstract One new genus and two new species of chigger mites are described and illustrated from amphibious sea snakes of the Nansei Islands in Japan. Ancoracarus gen. nov. is created for the unique species Ancoracarus hayashii sp. nov., collected from a Japanese sea krait Laticauda semifasciata (Reinwardt, 1837). This mite is characterized by having a palpal setal formula of BN/NNB/6B; more than 7 genualae on each of genu I, II, and III; 2, 2, and 1 tibiala on each of tibia I, II, and III; no mastisetae on legs; elongated tarsala I; unique anchor-like post-humeral setae in the central portion of the dorsal idiosoma; scutum roughly pentagonal with filamentous sensillae that are trifurcate; and anteromedian seta base on the line of the anterolateral seta bases. A. hayashii sp. nov. is also parasitic on the other Japanese sea kraits, L. laticaudata (Linnaeus, 1758) and L. colubrina (Schneider, 1799). Schoutedenichia masunagai sp. nov., found only on L. laticaudata, differs from the previously known species of the genus Schoutedenichia Jadin and Vercammen-Grandjean, 1954 by the shape and size of the scutum, form of sensillae and combination of characters mentioned in the diagnosis. Our description of a new species of Schoutedenichia increases the total number of species in this genus to 3 (S. atollensis, S. nagasakiensis and S. masunagai sp. nov.) in Japan and 10 in Asia.

Key words: Trombiculidae, chigger, new genus, Ancoracarus hayashii sp. nov., Schoutedenichia masunagai sp. nov., sea snake.

Introduction

Hayashi and Masunaga (2001) reported the results of intensive surveys of ectoparasites on amphibious sea snakes in the Ryukyu Islands in southern Japan. We had an opportunity to study the slide specimens of the many chiggers they collected. Among their samples, there were two previously undescribed species. One species had morphologically unique characteristics, including having many genualae on each of genu I, II and III and anchor-like post-humeral dorsal idiosomal setae, with the exception of the marginal setae. Hence, the study of this unique specimen led us to propose the new genus Ancoracarus.

Another rare and previously undescribed species belonged to the genus Schoutedenichia Jadin and Vercammen-Grandjean, 1954 in accordance with the classification of Vercammen-Grandjean, 1968. Subsequently, we investigated ectoparasitic chigger mites from more than 100 laticaudid sea snakes isolated from the Nansei Islands of Japan during the period 2007–2011. The chiggers collected were mounted in gum chloral solution and identified under a photomicroscope. We obtained specimens of the above two new species from the same sea snake host species listed in the collection records of Hayashi and Masun-
Fig. 1. Three Japanese sea kraits (unique hosts) and two new chigger species parasitic under their scales. A, *Laticauda laticaudata*, resting on the shore bed in a seashore cave in Ishigakijima Island; B, *L. colubrina*; C, *L. semifasciata*; D, living *Ancoracarus hayashii* sp. nov. (red in color) parasitic under the scale of *L. semifasciata*; E, living *Schoutedenichia masunagai* sp. nov. (white in color) parasitic under the scale of *L. laticaudata*. F–H: characteristic setae of *A. hayashii* sp. nov.; F, dorsal view of genuala I, having 10 genualae and long microgenuala (arrow) (holotype); G, dorsal medial setae of first post-humeral setal row (note anchor-like setules); H, ventral preanal setae, having stout and differentiated setules along their entire length.
Abbreviations and terminology are those used by Goff et al. (1982), with some modifications: anterolateral seta (AL); anteromedian seta (AM); distance from anterolateral setal base to postero- lateral setal base on one side (AP); distance from sensillary bases to extreme anterior margin (ASB); anterior width of scutum (AW); branched seta (B); postanal seta or caudal seta (CS); dorsal idiosomal seta (DS); dorsal setal formula (DSF); coxal setation formula (fCx); palpal setal formula (fPp); scutal formula (fSC); ventral setation formula (fV); humeral seta (H, HS); leg index (IP); nude seta (N); total number of idiosomal setae, excluding coxal setae (NDV); posterolateral seta (PL); distance from sensillary bases to extreme posterior margin (PSB); parasubterminala (pST); posterior width of scutum (PW); length of sensilla (S); distance between sensillary bases (SB); scutal depth (SD): SD = ASB + PSB; synthetic identification formula (SIF); sternal seta (StS); and true ventral seta or preanal seta (VS).

All measurements were obtained in micrometers, with those for the holotype followed in parentheses by the mean and extremes of the type series (holotype & 9 paratypes) in each new species. All specimens collected from sea snakes in the present study were insufficiently engorged larvae.

The specimens used for descriptions of the two new species are deposited in the collection of the Department of Zoology, National Museum of Nature and Science, Tokyo, Japan.

Results

Family Trombiculidae
Ancoracarus Takahashi, Misumi and Takahashi, gen. nov.
[Japanese name: Ikaritsutsugamushi-zoku]

Type species: Ancoracarus hayashii Takahashi, Misumi and Takahashi, sp. nov.

Diagnosis. Trombiculinae larvae with 7-segmented legs; palpal setation BN/NNB/6B; galeal N; 3 claws trifurcate, each of same length, arising from the distal end of the palpal tibia.

Cheliceral blade with dorsal and ventral rows of small teeth; 9–11 genualae I and long microgenualae, 7 genualae II, 7 genualae III; subterminala, parasubterminala, and pretarsala I; microtarsala, stout and elongate tarsala I; tarsala II and microtarsala; no tarsala III; no mastisetae on legs; scutum punctate, roughly pentagonal with anterior margin concaved deeply twice and peculiarly pronounced anterolateral shoulders, posterior margin deeply convex with 5 setae barbs; filamentous sensillae with trifurcate; eyes 2/2, on ocular plate. Unique anchor-like post-humeral dorsal idiosomal setae except for the marginal setae.

Etymology. The specific epithets are a combination of Latin words, ancora (anchor) and acaurus (mite), and refers to the morphologically unique anchor-like post-humeral setae in the central portion of the dorsal idiosoma.

Remarks. Vercammen-Grandjean (1960b) published an abbreviated pictorial key to the more than 100 genera and subgenera of the largest subfamily Trombiculinae in the world. Subsequently, Vercammen-Grandjean (1968) also published an illustrated key and a synopsis for 80 genera and subgenera of chigger mites of the Far East. Nadchatram and Dohany (1974) keyed 50 genera and subgenera of Southeast Asian chiggers.

Among genera belonging to the Trombiculinae having palpal tarsus 6B, palpobital claw trifurcate, scutum punctate, roughly pentagonal with pronounced anterolateral shoulders and posterior angle, Ancoracarus gen. nov. is similar to the genus Eltonella Audy, 1956 (Vercammen-Grandjean, 1960b, 1965, 1968). However, Ancoracarus may be easily separated from Eltonella in having approximately 10, 7, and 7 genualae on each of genu I, II, and III (2 or 3, 1, 1 in all known Eltonella), and unique anchor-like post-humeral setae in the central portion of the dorsal idiosoma (normally ciliated in Eltonella).
Ancoracarus hayashii Takahashi, Misumi and Takahashi, sp. nov.

[Japanese name: Hayashi-ikaritsutsugamushi]

Trombiculidae sp. t: Hayashi and Masunaga, 2001: 6, 7, fig. 2.

Diagnosis of larva. SIF’ 6B-B-3-(8–10) 771.0000; fPp’ BN/NNB/6B; fCx’ 1.1.1; IP = 1227 (1166, 1124–1227); pST = N; fSC = AM > PL > AL; 10–14 humeral setae; 122–142 dorsal setae (122 in holotype) arranged in irregular rows; IV = 130–148 (134 in holotype); NDV’ 250–280 (256 in holotype).

claw stout, 3 pronged, each of same length, 11 long.

Scutum: Shape roughly pentagonal, sparsely punctate; slightly wider than long, PW/SD ratio 1.2 (1.2, 1.1–1.3) with anterior margin concaved deeply twice and peculiarly pronounced anterolateral shoulders; lateral margins slanting outwards with slightly concavity, posterior margin convex, degree of convexity more marked medially between sensillary bases; posterior corners somewhat extended; width of scutum greatest at PL corners; AL seta situated on inner side of lateral margin, and on the half of ASB. PL seta on extended respective corners. AM seta situated on sub-anterior margin, on the half of ASB. AM base in line with AL seta bases; relative length of the scutal setae, AM > PL > AL; AL, AM, and PL setae barbed with stout and short setules, resembling humeral setae in appearance, but not anchor-like post-humeral setae; The sensillary bases are surrounded by upheaval of an elliptical form, and each base round with several small ridges. Sensillarly bases not so widely separated from each other, and slightly below portion in line with PL seta bases; tip of filamentous sensilla with trifurcate, proximal shaft finely nude; large punctations distinctly distributed on scutum, except around AM base. Scutal measurements: AW, 68 (63, 58–68); PW, 117 (115, 113–117); SB, 35 (33, 32–35); ASB, 68 (63, 60–68); PSB, 31 (32, 31–33); AP, 33 (34, 33–35); AM, 73 (72, 72–73); AL, 43 (42, 40–43); PL, 56 (55, 54–56); S, 102 (97, 93–102).

Idiosomal setae: 5–7 pairs HS, measuring 53 on average (55, 47–58); DS with well developed barbs; number of DS varies from 120–142 (122 in holotype), arranged in irregular rows; post-humeral and dorsal idiosomal setae in central portion peculiarly anchor-like, unique for the genus, while humeral and dorsal marginal setae are usually covered with a moderate number of thick, short setules for almost their entire length, similar to scutal setae. Length of dorsal setae as follows: medial seta of first post-humeral row 54 (59, 54–62); dorsal medial seta in central position 45 (46, 45–47); posterodorsal medial seta 44 (47, 44–48); dorsal terminal seta 45 (47, 45–49); two pairs of StS usually recognized, but one pair of sternal setae observed in several specimens, and posterior sternal setae undistinguishable from preanal setae. StS 2–2 [anterior 44 (44, 43–44), posterior 41 (41, 40–41)], covered with a moderate number of stout and differentiated setules on their entire length; 72–86 preanal setae and 56–66 postanal setae (72 and 58 setae in holotype, respectively) similar in nature to StS but shorter; length of medial seta in first preanal setal row 35 (34, 33–35); medial seta in first postanal setal row 30 (31, 30–32), different in nature from dorsal marginal setae, but shorter; total number of idiosomal setae, excluding coxal setae, 252–284 (256 in holotype).

Leg: IP = 1227 (mean 1166, range 1124–1227). All 7-segmented, terminating in a pair of claws and a slender claw-like empodium. Onychotriches lacking. Conspicuous small punctations on coxae and free leg segments. No modified leg segments.

Leg I: 413 (414, 410–419) long; tarsus + pretarsus 104 (106, 105–107) long by 23 (23, 22–23) wide; coxa with 1 B; trochanter 1B; basifemur 1B; telofemur 4B and one nude seta 36 (36, 33–37); genu 4B, 9–11 genualae, 28 on average (28, 26–30), long microgenuala 8 (7, 6–8); tibia 8B, 2 tibialae [proximal tibialae 36 (33, 31–36), distal tibiae 33 (33, 33–34)], slightly long microtibialae 5 (5, 4–5); tarsus 23B, stout and elongate tarsala 52 (50, 48–54) located on proximal 1/4 of segment, microtarsala 3 (3, 3), a nude subterminala 28 (26, 25–28), a short parasubterminala 15 (14, 13–15), a short pretarsala 15 (14, 13–15).


Leg III: 431 (404, 386–434) long; tarsus +
pretarsus 108 (110, 108–111) long by 21 (20, 20–21) wide; coxa 1B situated on the anterior margin; trochanter 1B; basifemur 2B; telofemur 3B; genu 2B, 7 genualae 30 on average (29, 28–30); tibia 6B, stout and blunt tibiala 38 (35, 35–40), no microtibiala; tarsus 16B.

Etymology. This species is named in honor of Associate Professor Fumio Hayashi, Department of Biological Sciences, Tokyo Metropolitan University, in recognition of his substantial contribution to our knowledge of the ectoparasites of amphibious sea snakes in Japan.

Family Trombiculidae

Genus Schoutedenichia Jadin and Vercammen-Grandjean, 1954

Schoutedenichia masunagai Takahashi, Misumi and Takahashi, sp. nov.

[Japanese name: Masunaga-tamatsutsugamushi] (Fig. 3)

Trombiculidae sp. b: Hayashi and Masunaga, 2001: 6, 7, fig. 2.

Notes. Jadin and Vercammen-Grandjean (1954) created the genus Schoutedenichia with S. fullerii Jadin and Vercammen-Grandjean, 1954 as the type specimen. Vercammen-Grandjean (1958) revised the genus and listed 41 species and subspecies. The chiggers of this genus are predominantly African with many records (Goff, 1983; Taufflieb, 1960, 1961, 1966; Vercammen-Grandjean, 1960a, 1963, 1964a, b; Vercammen-Grandjean and Yang, 1963, 1964; Vercammen-Grandjean and Watkins, 1965). However, several species in this genus have been recorded from non-African locations, including Southeast Asia (Audy, 1956; Domrow, 1962; Mitchell and Nadchatram, 1966; Mo et al., 1959; Schluger et al., 1960; Upham and Nadchatram, 1968; Wharton and Hardcastle, 1946; Womersley, 1952), Australia (Domrow and Lester, 1985), Europe, and Russia (Kudryashova, 1998; Stekolnikov and Daniel, 2012). In Japan, Neoschoengastia atollensis Wharton and Hardcastle, 1946 initially collected from wild birds at Okinawa, southern Japan, had been transferred into the genus Schoutedenichia (Vercammen-Grandjean, 1960b). Subsequently, Suzuki (1982) reported unfed S. nagasakiensis larvae collected from soil samples at Unzen, Nagasaki Prefecture. S. masunagai sp. nov. is the third species of this genus from Japan.

Diagnosis of larva. SIF = 4B-B(N)-3-2110.0000; fPp = B/B/NNB/4B; fCx = 1.1.1.; IP = 715 (731, 715–757); pST = N; fSC = PL > AL > AM; DSF = 2H, 8–10, 6–8, 8, 8, 6, 4, 2, 2H, 8, 4–5, 10, 2, 6–8, 6, 2–4, 4, 2; 2H, 8, 6, 8, 2, 8, 6, 4, 2; DS = 44–54; fV = 59–68; NDV = 107–114.


Fig. 3. *Schoutedenichia masunagai* sp. nov., insufficiently engorged larva. A and B, ventral and dorsal aspects of larva; C and D, ventral and dorsal aspects of gnathosoma; E, coxa III; F, scutum and eyes on ocular plate; G, H, and I, legs I, II, and III; J, details of setae (abbreviations: HS, humeral seta; DS, dorsal medial seta of first post-humeral row; StS, anterior sternal seta; VS, ventral medial seta of first post-ster nal row). The length of the scale bar for each structure is in micrometers.
Takahashi.

Description of larva. Live insufficiently engorged larvae, white in color.

Idiosoma: Body longer than wide, measuring 415 (475, 404–606) long by 293 (352, 268–494) wide. One pair of eyes on the ocular plate, located by scutum at level of sensillary bases; diameter of eyes 7 (6, 4–7).

Gnathosoma: Gnathosomal base moderately punctated, 57 (59, 57–61) wide at level of the bases of a pair of branched setae; posterior margin of cheliceral bases rounded, 36 (36, 35–40) long by 19 (18, 17–23) wide; cheliceral blade 21 (19, 17–22) long by 4 (4, 4–5) wide, with one longer subapical dorsal tooth and one short ventral tooth (tricuspid cap). Galeal seta mainly nude, sometimes one branch (holotype). IP = B/B/NNB/4B; palpal claw stout, 13 (13, 11–14) long, 3 pronged, with axial prong 7 (7, 7–8), 2 accessory prongs of unequal length and shorter than axial prong.

Scutum: Shape trapezoidal, large punctations distinctly distributed except around AM base and sensillary bases; wider than long, PW/SD ratio 1.7 (1.7, 1.7–1.9) with shallowly sinuous anterior margin and two slightly convex anterior corners; lateral margins slanting outwards with slightly concavity, posterior margin slightly concave, degree of concavity more marked medially, between sensillary bases; posterior corners somewhat extended; width of scutum greatest at PL corners. AL and PL setae in respective corners, AM seta submarginal and PL setae situated on extended PL margins. AM base slightly below portion in line with AL seta bases; AL, AM, and PL setae barbed with stout and short setules, resembling dorsal setae in appearance; Sensillary bases round and widely separated, anterior margins of sensillary bases with midline of lateral margins.

PL > AL > AM; sensillae lanceolate and covered with many long bristles, proximal shaft finely nude; an “eye-lid” ridge on anterior margins of sensillary bases. Other scutal setae with a moderate number of short, thick setules for almost their entire length. Scutal measurements: AW, 50 (51, 49–53); PW, 74 (77, 74–83); SB, 33 (32, 29–36); ASB, 27 (28, 27–29); PSB, 17 (17, 16–17); AP, 43 (43, 42–43); AM, 21 (19, 18–21); AL, 39 (37, 35–39); PL, 47 (44, 42–47); S, 47 (48, 47–49).

Idiosomal setae: One pair HS, measuring 47 (47, 46–47); DS with well-developed barbs; number of DS varied from 44–54 as follows: DSF = 2H, 8–10, 6–8, 8, 6, 4, 2; 2H, 8, 4–5, 10, 2, 6–8, 6, 2–4, 4, 2; 2H, 8, 6, 8, 2, 8, 6, 4, 4, 2; DS in holotype arranged 2, 8, 8, 8, 8, 4, 4, 2; dorsal setae covered with a moderate number of thick and short setules for almost their entire length. HS and DS similar to scutal setae. Length of dorsal setae as follows: medial seta of first post-humeral row 36 (33, 30–36); dorsal medial seta in central position 36 (35, 34–36); posterodorsal medial seta 34 (35, 33–37); dorsal terminal seta 38 (38, 34–41); StS 2–2 [anterior 39 (38, 36–39), posterior 28 (29, 28–31)], covered with a moderate number of short setules on the surface of their entire length, more pliant than preanal setae: 24–36 VS (36 in holotype) similar in nature to StS but shorter; length of medial seta in first preanal setal row 20 (21, 20–23); 32–36 CS (32 in holotype) similar in nature to DS but shorter and more slender; length of medial seta in first postanal row 34 (35, 34–36). Total number of idiosomal setae, excluding coxal setae 107–114 (114 in holotype).


Leg I: 250 (260, 250–273) long; tarsus + pretarsus 61 (66, 61–70) long by 18 (18, 17–18) wide; coxa 1B; trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 2 genualae [dorsal genuala 21 (19, 18–21), distal genuala 21 (20, 19–21)], microgenuala 2 (3, 2–3); tibia 8B, 2 tibialae [proximal tibiala 23 (23, 22–23), distal tibiala 15 (17, 15–19)], microtibiala 3 (3, 3–4); tarsus 20B, tarsala stout and blunt 32 (31, 31–32), microtarsala immediately proximal to base of tar-

Leg II: 218 (220, 216–227) long; tarsus + pretarsus 51 (50, 46–54) long by 15 (16, 15–17) wide; coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala 14 (14, 14–15); tibia 6B, 2 tibialae [proximal tibiala 18 (16, 15–18), distal tibiala 15]; tarsus 15B, tarsala stout and blunt 19 (19, 18–20), microtarsala 2 (3, 2–3), a short pretarsala 11 (12, 11–12).

Leg III: 247 (250, 246–257) long; tarsus + pretarsus 63 (63, 60–67) long by 14 (14, 13–14) wide; coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala 17 (18, 17–18); tibia 6B (tibiala absent); tarsus 15B.

**Etymology.** It is a pleasure to name the new species for Dr. Gen Masunaga, who not only collected chiggers from sea kraits that hosted this new species, but contributed much to our knowledge of the ecology of sea snakes in Japan.

**Remarks.** Although this new species is closely related to *S. centralkwangtunga* (Mo, Chen, Ho and Li, 1959), *S. trisetosa* Upham and Nadchatram, 1968 and *S. shalleri* Mitchell and Nadchatram, 1966, this species is separated from these species by the shape and size of the scutum, the form of the sensillae and the combination of characters mentioned in the diagnosis.


**Discussion**

**Association with ectoparasites and unique hosts — sea snakes**

There are 70 species of sea snakes in the world, found in 4 of the 15 living families of snakes. Two of the four families include venomous sea snakes, the Laticaudidae (4 species) and the Hydrophiidae (53 species), some species of which have venom toxicity more than 10 times that of the most lethal terrestrial elapid snake venom, making them among the most potentially dangerous of all animals (Broad et al., 1979; Pickwell, 1994; Tamiya, 1975). These two families are closely related to each other and to the terrestrial cobras of the family Elapidae (Heatwole, 1999). However, the systematics of sea snakes has been variously classified at the familial and subfamilial level, and there is no universal agreement on the scheme to be used (Heatwole and Cogger, 1993). Following the review by Heatwole (1999), new species and re-classified species were added. Thus, eight species are currently recognized in the genus *Laticauda*: *L. semifasciata* (Reinwardt, 1837); *L. laticaudata* (Linnaeus, 1758); *L. colubrina* (Schneider, 1799); *L. frontalis* (De Vis, 1905); *L. shistorhyynchus* (Guenther, 1874); *L. guineai* Heatwole, Busack et Cogger, 2005; *L. saintgironsi* Cogger et Heatwole, 2006; and *L. crockery* Slevin, 1934. These laticaudids are restricted to the tropical waters of the western Pacific and eastern Indian oceans (Heatwole and Guinea, 1993; Heatwole, 1999).

Laticaudids, such as the amphibious sea snakes (sea kraits), that live on land and water, have been reported to have evolved a marine mode of life independent of true sea snakes, or Hydrophiidae, which never leave the water (Cogger and Zweifel, 1998; Keogh, 1998). The common name of the sea krait comes from the resemblance of these snakes to land kraits, ringed terrestrial Asian venomous snakes of the genus *Bungarus*, family Elapidae. Sea kraits have developed flattened paddle-like tails, enabling them to swim rapidly, but have retained a cylin-
drical body shape similar to their terrestrial relatives. They also have enlarged specialized ventral scales for crawling on land, unlike Hydrophiidae species, which have belly scales that are either greatly reduced in size or absent (Easton, 2003). Ecological data suggest that the Laticaudidae evolutionarily departed from an elapid stem much later than other Hydrophiidae. This would explain their parasitic association with two tick species, *Amblyomma nitidum* Hirst and Hirst, 1910 and *Aponomma fimbriatum* (Koch, 1844), which are lacking in other Hydrophiidae (Easton, 2003; Hayashi and Masunaga, 2001; Takahashi *et al.*, 2012a). *Amblyomma* is the only genus of acarine ectoparasites hosted by *Laticauda*, and the latter genus, *Aponomma*, is generally host specific to terrestrial snakes and varanid lizards (Wilson, 1970, 1975; Sonenshine, 1991).

Vercammen-Grandjean (1972) described a new species of chigger, *Eutrombicula poppi*, from *Laticauda* sp. It is well known that several representatives of the genus *Eutrombicula* parasitize terrestrial snakes. One of the species described here for the first time, *Ancoracarus hayashii* sp. nov., infests laticaudid snakes, but not other members of Hydrophiidae, and it provides further evidence for the later divergence of this genus of snakes than that of the true sea snakes (Hydrophiidae).

The new genus *Ancoracarus* is closely related to the genus *Eltonella* Audy, 1956, and many species of *Eltonella* are recorded from various terrestrial snakes (Vercammen-Grandjean, 1965). Further, Japanese laticaudid snakes have been found to have infestations of their trachea and longitudinal lung by 4 species of chigger mites (*Vatacarus ipoides* Southcott, 1957, *V. kunzi* Nadchatram and Radovsky, 1971, *Iguanacarus alexfaini* Nadchatram, 1980 and *Iguanacarus* sp.) (Takahashi *et al.*, 2012b), that are highly specific to laticaudid snakes. These chiggers are maggot-like endoparasites unlike the typical shape of ectoparasitic chiggers, lacking in other Hydrophiidae snakes (Nadchatram and Radovsky, 1971; Nadchatram, 2006; Takahashi *et al.*, 2012b).

**Timing of the infestation of chigger larvae on the sea snakes**

Of the 70 species of marine snakes in the world, ecto- and endoparasitic chiggers are recorded only in laticaudid species (Hayashi and Masunaga, 2001; Nadchatram, 2006; Takahashi *et al.*, 2012b). True sea snakes (family Hydrophiidae) are completely adapted to a marine way of life. They are livebearers and never come onto land, either voluntarily or to breed (Heatwole and Cogger, 1993). Thus, they have no opportunity to be infested with unfed terrestrial chiggers. In contrast, sea kraits (family Laticaudidae) are oviparous, and gather in shore-based aggregations to breed or to rest. They lay their eggs in rock crevices and/or on cave beds. It is during this period that the life histories of the ecto- and endoparasitic chiggers and sea kraits appear to overlap; the sea kraits are often infested with unfed terrestrial larval chiggers. Therefore, all chiggers that were found under the scales are considered insufficiently engorged larvae.

**Host relationships between chiggers and sea kraits**

Hayashi and Masunaga (2001) examined a total of 147 individuals of sea kraits, consisting of *L. semifasciata* (27), *L. laticaudata* (99) and *L. colubrina* (21), and 77 individuals of true sea snakes, consisting of *Emydocephalus ijimae* Stejneger, 1898 (58), *Hydrophis melanochephalus* Gray, 1849 (11) and *H. ornatus* Mittleman, 1947 (8), collected from Ishigakijima Island and Irromotejima Island in the Nansei Islands of Japan. Ectoparasitic chiggers, especially *A. hayashii* sp. nov. and *S. masunagai* sp. nov. described here were collected only from the laticaudid sea snakes, and not from the true sea snakes. Subsequently, we also investigated ectoparasitic chigger mites from more than 100 laticaudid sea snakes collected from several of the Nansei Islands during 2007–2011. The above two new species were obtained from the same hosts listed by Hayashi and Masunaga (2001) (unpublished data).

*Ancoracarus hayashii* sp. nov. was collected...
from all three species of Japanese sea kraits (Laticaudidae) \((L.\ laticaudata, L.\ colubrina\ and\ L.\ semifasciata)\). However, \(S.\ masunagai\ sp.\ nov.\) was collected only from \(L.\ laticaudata\). Hayashi and Masunaga (2001) did not find either of these species on any of the 77 true sea snakes (Hydrophiidae) that they examined. Therefore, \(A.\ hayashii\ sp.\ nov.\) is considered to be restricted to parasitizing the genus \(Laticauda\), but is not host species specific. Eight sea krait species are currently recognized in the world (Heatwole and Guinea, 1993; Heatwole, 1999; Takahashi et al., 2012b). It is possible that \(A.\ hayashii\ sp.\ nov.\) is parasitic on the remaining five sea krait species.

Almost all known species of \(Schoutedenichia\) parasitize either mammals (Prosimiens to Ron-geurs) or birds and have a wide host range (Vercammen-Grandjean, 1958, 1968). The present study is the first record of a species of \(Schoutedenichia\) parasitic on a reptile, and it was found on only one species, \(L.\ laticaudata\). Thus, \(S.\ masunagai\ sp.\ nov.\) is considered to have close host specificity to \(L.\ laticaudata\).

Expansion of chigger distribution

Three laticaudid sea snakes (\(L.\ semifasciata, L.\ laticaudata\ and \(L.\ colubrina\)) are found in Japan, mainly around the Ryukyu Archipelago. The habitats of these species overlap, and they are non-territorial. If different species of laticau- did sea snakes interacted in a spawning ground or other place, unfed larval chiggers parasitizing one snake could expand its hosts domain and dis- tribution leading to further opportunities for diffusion. Indeed, on Iriomotejima Island, all three species are often found on coral reefs and sometimes two species use the same rock crevice to rest or digest a meal. Notably, 20–30 \(L.\ semifas- ciata\) and almost the same number of \(L.\ laticau- data\) gather within a single cave from June to August (Takahashi et al., 2012b). As mentioned above, \(A.\ hayashii\ sp.\ nov.\) was collected from all Japanese sea krait species and from all localities (Iriomotejima Island, Ishigakijima Island and Kodakarajima Island).

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