A revision of Japanese spiders of the genus *Dolomedes* (Araneae: Pisauridae) with its phylogeny based on mt-DNA

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**Abstract** — Japanese spiders of the genus *Dolomedes* are revised and its phylogeny is inferred by mt-DNA. *Dolomedes japonicus* Bösenberg & Strand 1906 and *D. angustivirgatus* Kishida 1936 are removed from the synonymy. *Dolomedes fimbriatoides* Bösenberg & Strand 1906 and *D. hinoi* Kayashima 1952 are newly synonymized with *D. sulfureus* L. Koch 1878, and *D. stellatus* Kishida 1936 is synonymized with *D. japonicus*. Two new species, *D. fontus* and *D. silvicola* are described. Relative leg length and proportion of male palpal tibia are considered as good keys to indentify *Dolomedes* spiders, whose genital organs closely resemble one another. *Dolomedes sulfureus* and *D. silvicola*, often found on vegetation, have much longer legs and male palpal tibia than their relatives that inhabit near water and run on water surface or hide under water when disturbed. Molecular phylogenetic analysis using mt-COI revealed the following; (((raptor, yawatai), japonica), orion), (((angustivirgatus, sulfureus), fontus), (silvicola, saganus)), horishanus).

**Key words** — new species, *Dolomedes fontus*, *Dolomedes silvicola*, new synonymy, leg length, COI, phylogeny

After Koch (1878) described *Dolomedes sulfureus*, twenty species of *Dolomedes* were described from Japan. Of these, nine were synonymized with other species, and one was treated as nomen dubium (Table 1). Thus, ten species have been known as Japanese *Dolomedes* spiders. After examining many specimens from various localities in Japan, we recognized eleven species of the genus *Dolomedes*; nine of them are known species and two are new to science. Furthermore, we verified the previous synonymization by examining the original descriptions and the type specimens. As a result, eight species are reconfirmed to be junior synonyms, two are removed from synonymy, and five are newly synonymized with other species. To verify the validity of species group recognized by morphological resemblance, *raptor*, *sulfureus*, *sagatus*, and *horishanus*-group, molecular phylogeny of these spiders was analyzed using the partial sequence of mitochondrial cytochrome oxidase subunit I (mt-COI) gene.

All the specimens examined in this study were collected by Akio Tanikawa unless otherwise noted. The type specimens designated in this paper are deposited in the collection of the department of zoology, National Museum of Nature and Science, Tokyo. Nucleotide sequence data analyzed in this paper are available in the DDBJ/EMBL/GenBank databases.

The abbreviation used in this paper are as follows: ZMH, Zoologisches Institut und Zoologisches Museum der Universität Hamburg; MOA, median ocular area; NSMT, National Museum of Nature and Science, Tokyo; SMS, Staatliches Museum für Naturkunde Stuttgart; SMF, Forschungsinstitut und Naturmuseum Senckenberg, Fürnankurt am Main.

**Taxonomy**

Family Pisauridae

Genus *Dolomedes*

*Dolomedes japonicus* Bösenberg & Strand 1906
[Japanese name: Kikume-hashiri-gumo]

Figs. 1–6

*Dolomedes japonicus* Bösenberg & Strand 1906, p. 313, pl. 13, fig. 312. [syntypes from Saga, Japan, preserved in SMF (1446), examined]; Kishida 1936, p. 124.

*Dolomedes stellatus* Kishida 1936, p. 121, fig. 1 [type specimen from Honshu, Japan, lost]; Paik 1978, p. 371, text-fig. 168, pl. 5, fig. 101, pl. 30, fig. 101; Hu 1984, p. 259, fig. 272; Song, Zhu & Chen 1999, p.347, figs. 203_A, B; Namkung 2002, p. 347, fig. 21_2. NEW SYNONYMY

**Type series.** Syntypes, 1♂1juv., Saga, Japan (SMF 4846).

*Other specimens examined.* All the specimens were collected at Orikisawa, Kimitsu-shi, Chiba Pref. 1♀, 17–VII–2005 (NSMT-Ar 7776); 2♀1♂, 8–IV–2006 (2♀, NSMT-Ar 7777, 7778; 1♂, NSMT-Ar 7779); 2♀1♂, 25–IV–2006 (2♀, NSMT-Ar 7780, 7781; 1♂, NSMT-Ar 7782; these spiders
were collected as juveniles and became adults after rearing); 1♂, 30 IV–2006 (NSMT-Ar 7783).

Description. Coloration and markings. Female and male as shown in Figs. 1–2. Carapace dark brown with bright colored markings; longitudinal midline and radial lines diagnostic. Dorsum of abdomen dark brown with light colored markings; black cardiac pattern conspicuous.

Measurements. Based on 1♀♂1♂ from Chiba Pref. (NSMT-Ar 7777, 7783), measurements in parentheses indicate the range among specimens examined. Body 27.06 (17.96–27.06), d 16.21 (14.38–17.84) long. Carapace 13.00 (8.70–13.00), d 8.08 (6.54–9.80) long; d 11.50 (7.70–11.50), d 7.42 (5.77–8.80) wide. Length of legs [male/female; tarsus + metatarsus + tibia + patella + femur = total]: I, 5.25 + 9.63 + 10.88 + 5.88 + 11.88 = 43.52/5.70 + 8.90 + 8.70 + 4.00 + 8.90 = 36.20; II, 5.63 + 9.75 + 10.63 + 6.13 + 12.00 = 44.14/5.20 + 8.40 + 8.40 + 9.30 = 35.30; III, 5.13 + 9.50 + 10.13 + 5.50 + 11.50 = 41.76/4.30 + 7.80 + 8.70 + 3.50 + 8.60 = 32.90; IV, 5.88 + 12.38 + 12.00 + 5.63 + 13.19 = 49.08/5.40 + 10.00 + 8.90 + 3.80 + 9.70 = 37.80. Abdomen 14.37 (10.13–14.37), d 8.00 (7.58–9.00) long; d 9.33 (6.13–9.33), d 5.33 (5.33–5.50) wide.

Female and male. Carapace longer than wide [length/width 1.13 (1.13–1.18), d 1.09 (1.09–1.13)], MOA almost as long as wide [length/width 1.03 (0.92–1.03), d 0.96 (0.92–0.96)]; Wider behind than front [anterior width/posterior width 0.68 (0.66–0.70), d 0.67 (0.58–0.67)]. Fang furrow of chelica with 3 promarginal and 4 retromarginal teeth. Labium almost as long as wide [length/width 1.01 (0.94–1.01), d 1.00 (0.96–1.01)]. Sternum almost as long as wide [length/width 1.00 (0.93–1.00), d 0.98 (0.98–1.01)]. Length of leg I/length of carapace 3.35 (3.26–3.43), d 4.48 (4.12–4.48). Male palp (Figs. 5–6): shapes and arrangement of sclerites as for the *fimbriatus*-group style (Carico 1973). Abdomen longer than wide [length/width 1.54 (1.51–1.65), d 1.50 (1.42–1.64)]. Female genitalia (Figs. 3–4): shape of epigynum *fimbriatus*-group style (Carico 1973), m-shaped sclerotized part diagnostic (Fig. 3, arrow).

Remarks. *Dolomedes japonicus* is related to *D. raptor*, but it can be easily distinguished from the latter even by the coloration and markings. The radial light colored marking on the carapace of *D. japonicus* is the most diagnostic feature (Figs. 1–2). Such marking is never seen in *raptor* (Fig. 9). As for epigynum, m-shaped sclerotized part is seen only in *japonicus* (Fig. 3, arrow; Fig. 7). The relative length of male palpal tibia is much longer in *japonicus* than in *raptor* (Figs. 5–6, 10–11). The shape of male palpal tibial apophysis is also different from other (Figs. 6, 11).

Notes. *Dolomedes japonicus* Bösenberg & Strand 1906 was synonymized with *D. sulfureus* Koch 1878 by Yaginuma (1986). We examined the syntypes of *D. japonicus* and revealed that they cannot be identified as *D. sulfureus*. On the other hand, the spiders identified as *D. stellatus* Kishida 1936 by the previous authors (see the synonym list above) are identical with them. Consequently, we removed *D. japonicus* from the synonymy of *D. sulfureus* and newly synonymize *D. stellatus* with *D. japonicus*.

Distribution. Japan (Honsyu and Kyushu), China, Korea.

*Dolomedes raptor* Bösenberg & Strand 1906
[Japanese name: Aoguro-hashir-gumo]

Figs. 7–11

* Dolomedes raptor* Bösenberg & Strand 1906, p. 309, pl. 8, fig. 119, pl. 13, fig. 342 [syntypes from Saga, Japan, preserved in SMF, not examined]; Yaginuma 1960, p. 80, text-fig. 73, pl. 37, fig. 208; Paik 1978, p. 370, text-fig. 167, pl. 30, fig. 100; Yaginuma 1986, p. 172, text-fig. 95, pl. 46, fig. 3; Chikuni 1989, p. 107, fig. 5; Namkung 2002, p. 348, fig. 21_3; Tanikawa 2003, p. 38, figs. 14–15; Zhang, Zhu & Song 2004, p. 373, figs. 29–34, 188–193.
Figs. 1–11. 1–6, Dolomedes japonicus (famele: NSMT-Ar 7777, male: NSMT-Ar 7783) — 1, female; 2, male; 3, epigynum; 4, internal genitalia; 5, male palp, ventral view; 6, same, lateral view. 7–11, Dolomedes raptor — 7, epigynum; 8, internal genitalia; 9, female; 10, male palp, ventral view; 11, same, lateral view. (Scales: 1, 2, 9, 10 mm; others, 0.5 mm)


Remarks. Dolomedes raptor resembles D. yawatai and D. orion. As for the discriminating point among these species, see Tanikawa (2003). Dolomedes raptor can be easily distinguished from D. japonicus as mentioned in the remarks of the latter species.


Dolomedes yawatai Ono 2002

[Dishigaki-auguro-hashiri-gumo]


Remarks. As for the discriminating point among D. raptor, yawatai, and orion, see Tanikawa (2003).

Distribution. Japan (Dishigakijima Is., Iriomotejima Is. and Yonagunijima Is.)

Dolomedes orion Tanikawa 2003

[Japanese name: Ō-hashiri-gumo]

Dolomedes orion Tanikawa 2003, p. 35, figs. 1–11 [female holotype from Okinawajima Is., Japan, preserved in NSMT (Ar 5306), examined].


Remarks. As for the discriminating point among D. raptor, yawatai, and orion, see Tanikawa 2003.


Dolomedes fontus new species

[Japanese name: Baba-hashiri-gumo]

(Figs. 12–13, 19–22, 31–33)

Type series. All of the following specimens were collected by Y. G. Baba. Holotype ♀, Ōtada, Ōtaki-machi, Isumi-gun, Chiba Pref., 30–IV–2004 (NSMT-Ar 7784). Paratypes. Tsutsumori, Ōtaki-machi, Isumi-gun, Chiba Pref., 1♂, 5–V–2003 (NSMT-Ar 7785); 4♀4♂, 5–V–2003 (3♀, NSMT-Ar 7786, 7787, 7788; 4♂, 7789, 7790, 7791, 7792; collected as eggs, became adults after rearing); 1♂, 30–IV–2006 (NSMT-Ar 7793; collected as a juvenile, became adult after rearing).

Description. Coloration and markings. Female and male (Figs. 12–13). Dark brown, lateral part and cardiac pattern whitish, with several pairs of small white spots on dorsum of abdomen.


Female and male. Carapace longer than wide [length/width ♀1.23 (1.17–1.23), ♀1.19 (1.15–1.19)]. MOA almost as long as wide [length/width ♀0.93–1.04], ♀1.02 (1.02–1.07)]; Wider than the front [anterior width/posterior width ♀0.67 (0.67–0.71), ♀0.68 (0.67–0.70)]. Fang furrow of chelicera with 3 (2–3) promarginal and 4 (3–4) retromarginal teeth. Labium slightly wider than long [length/width ♀0.95 (0.85–0.95), ♀0.96 (0.86–0.96)]. Sternum slightly wider than long [length/width ♀0.96 (0.89–0.96), ♀0.90 (0.90–0.97)]. Length of leg I/length of carapace ♀2.73 (2.73–2.92), ♀3.35 (3.34–3.47). Male palp (Figs. 19–22): shapes and arrangement of sclerites as for the fimbriatus-group style (Carico 1973). Abdomen longer than wide [length/width ♀1.52 (1.38–1.57), ♀1.74 (1.43–1.74)]. Female genitalia (Figs. 31–33): shape of epigynum fimbriatus-group style (Carico 1973).

Remarks. Dolomedes fontus resembles D. angustivirgatus and D. sulfuriferus. Even in a general appearance, fontus can be distinguished from the latter species (Figs. 12–18). Although much color variation is found in sulfuriferus (Fig. 16–18), the coloration like fontus is not found. Dolomedes fontus can be separated from the latter species by the relative length of the first leg and the male palpal tibia as shown in Table 2 and Figs. 19–30, 40. The first leg and male palpal tibia of fontus (Figs. 19–22, 40) are conspicuously shorter than those of angustivirgatus (Figs. 23–26, 40) and sulfuriferus (Figs. 27–30, 40). Dolomedes fontus and angustivirgatus, whose legs are relatively short, inhabit wetlands such as paddy fields. When disturbed, they often run on water surface (Fig. 14). In contrast, sulfuriferus, whose legs are long, inhabits among vegetation (Figs. 16–17) and do not run on water surface when disturbed.

Distribution. Japan (Honshu, known only from central part of Bōsō Peninsula).

Etymology. The specific name derived from its habitat,
wetland. Fontus is the god of wells and springs in Roman mythology.
Table 2. The ratio of the length of leg I to carapace width and the ratio of the length of male palpal tibia to its width in *Dolomedes fontus*, *angustivirgatus* and *sulfureus*.

<table>
<thead>
<tr>
<th>species</th>
<th>leg I</th>
<th>male palpal tibia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>female</td>
<td>male</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>range</td>
</tr>
<tr>
<td><em>fontus</em></td>
<td>6</td>
<td>3.29–3.45</td>
</tr>
<tr>
<td><em>angustivirgatus</em></td>
<td>22</td>
<td>3.79–4.40</td>
</tr>
<tr>
<td><em>sulfureus</em></td>
<td>56</td>
<td>4.30–5.09</td>
</tr>
</tbody>
</table>

ANOVA p<0.01 (log-transformed value); Stell-Dwass method multiple comparison p<0.01

cf. Fig. 40.


*Dolomedes angustivirgatus* Kishida 1936  
[Sujiboso-hashiri-gumo]  
Figs. 14–15, 23–26, 34–36

*Dolomedes hercules*: Bösenberg & Strand 1906 p. 310, pl. 13, fig. 361 [in part, one specimen from “yamato” preserved in ZMH, examined; female holotype in SMS was destroyed during World War II]. [Misidentification.]

*Dolomedes angustivirgatus* Kishida 1936, p. 123, pl. 13, fig. 3 [type specimen, lost]; Paik 1978, p. 367, pl. 29, fig. 98, text-figs. 165_1–3; Hu 1984, p. 254, figs. 266_1–2.

*Dolomedes sulfureus*: Namkung 2002, p. 346, fig. 21_1 [in part, only upper left figure, nec Koch 1878, misidentification].


Description. Coloration and markings. Female and male (Figs. 14–15). Dark brown, with a longitudinal white lateral band. Abdomen with several pairs of small white spots on dorsum.

Measurements. Based on 1♀ 1♂ from Chiba Pref., Japan (NSMT-Ar 7794, 7797), measurements in parentheses indicate the range among specimens examined. Body 18.76 (12.63–19.83), 1♂ 19.05 (12.50–16.96) long. Carapace 8.33 (5.82–8.70), 1♀ 7.46 (5.87–7.92) long; 6.75 (4.76–8.50), 6.23 (5.00–6.67) wide. Length of legs [male/female; tarsus + metatarsus + tibia + patella + femur = total]: I, 3.45 6.67 4.00 + 7.90 = 27.55, 3.45 + 6.70 = 14.00 + 8.30 = 30.75; II, 4.30 + 6.65 + 7.75 + 8.80 + 9.70 = 33.20, 4.30 + 6.65 + 3.90 + 8.25 = 29.25; III, 3.80 + 6.35 + 7.10 + 4.30 + 9.00 = 30.55, 3.20 + 5.50 + 6.50 + 3.20 + 7.20 = 24.70; IV, 4.80 + 9.40 + 9.80 + 4.60 + 10.90 = 39.50, 4.40 + 7.80 + 7.60 + 3.65 + 8.60 = 32.05. Abdomen 9.75 (7.50–12.13), 9.77 (6.60–9.00) long; 5.13 (3.25–7.00), 4.17 (3.40–4.60) wide.

Female and male. Carapace longer than wide [length/ width 1.23 (1.02–1.23), 1♂ 1.20 (1.15–1.20)]. MOA wider than long [length/width 0.90 (0.86–0.91), 0.93 (0.90–0.93)]; wider behind front [anterior width/posterior width 0.64 (0.59–0.64), 0.60 (0.59–0.63)]. Fang furrow of chelicera with 3 (2–3) promarginal and 4 retromarginal teeth. Labium almost as long as wide [length/width 0.90 (0.89–1.00), 0.91 (0.91–1.02)]. Sternum almost as long as wide [length/width 1.00 (0.94–1.01), 1♀ 1.04 (1.00–1.06)]. Length of leg I/length of carapace 3.31 (3.24–3.60), 3.41 (4.12–4.45). Male palp (Figs. 23–26): shapes and arrangement of sclerites as for the fimbriatus-group style (Carico 1973). Abdomen longer than wide [length/width 1.90 (1.71–2.31), 1.84 (1.84–2.09)]. Female genitalia (Figs. 34–36): shape of epignum fimbriatus-group style (Carico 1973).

Remarks. Dolomedes angustivirgatus closely resembles D. suffureus, but it can be separated from the latter by the following features. On dorsum of abdomen, angustivirgatus has several pairs of small white spots (Figs. 14–15), but suffureus does not have such white spots (Figs. 16–18). The first leg of angustivirgatus is shorter than that of suffureus (Table 2, Fig. 40). Male palpal tibia of angustivirgatus is shorter than that of suffureus (Table 2, Figs. 23–30). The difference in female epignum is difficult to recognize, but it is possible for skilled worker to discriminate (Figs. 34–35, 37–38).

Dolomedes angustivirgatus also resembles D. fontus, but can be separated from each other by the following features. The length of leg I and male palpal tibia are longer in angustivirgatus than in suffureus (Table 2, Figs. 19–26, 40). These two species can be scarcely distinguished from each other by general appearance (Figs. 12–15) and the shape of epignum (Figs. 31–32, 34–35).

Notes. Although Dolomedes angustivirgatus Kishida 1936 was synonymized with D. suffureus Koch 1878 by Yaginuma (1986), it can be separated from the latter as mentioned above. Consequently we remove it from the synonymy.

Distribution. Japan (Honshū, Shikoku, Kyushu), China, Korea.


Dolomedes suffureus L. Koch 1878, p.778 [juvenile holotype from Japan, preserved in Naturhistorisches Museum, Wien, not examined]; Bösenberg & Strand 1906, p.311, pl. 13, fig. 330; Saiito 1934, p.349, pl. 15, fig. 80; Kishida, 1936 p.118; Saiito 1939, p. 69, fig. 8; Saiito 1959, p. 45, pls. 3–4, figs. 21_a–c; Yaginuma 1960 p. 80, fig. 73_1–2; Paik 1978, p. 373, figs. 169_1–5; Hu 1984, p. 258, fig. 270–2; Yaginuma 1986, p. 170, pl. 46, fig. 1, text-fig. 95_1; Chikuni 1989, p. 107, fig. 6; Song, Zhu & Chen 1999 p. 347, figs. 203C, K. Namkung 2002, p. 346, figs. 21_1a–b [in part, except upper left fig.]; Zhang, Zhu & Song 2004, p. 378, figs. 55–61, 194–199.

Caripeta japonica Bösenberg & Strand 1906, p. 307, pl. 13, fig. 343 [juvenile holotype from Saga, Japan, preserved in SMF (4840), examined].

Dolomedes fimbriatoides Bösenberg & Strand 1906, p. 308, pl. 13, fig. 341; Saiito 1959, p. 46, figs. 23_a–c [juvenile holotype from Saga, Japan, preserved in SMF (4845), examined]. NEW SYNONMY

Dolomedes hercules Bösenberg & Strand 1906 p. 310, pl. 13, fig. 361 [in part, 3 specimens from “yamato”, “Setsu”, and “Kasugayama” preserved in ZMH, examined; female holotype in SMS was destroyed during World War II]; Saiito 1939, p. 67; Saiito 1959, p. 47, figs. 25_a–c; Yaginuma 1960, p. 80, fig.
Figs. 31–39. Female genital organ. 33, 36, 39, dorsal view; others, ventral view. — 31–33, Dolomedes fontus (31, paratype, NSMT-Ar 7788; 32–33, holotype, NSMT-Ar 7784). 34–36, Dolomedes angustivirgatus (34, NSMT-Ar 1634; 35–36, NSMT-Ar 1637). 37–39, Dolomedes sulfureus (37, NSMT-Ar 7806; 38–39, NSMT-Ar 1609). (Scales: 0.5 mm)

73_4; Paik 1978, p. 369, fig. 166.
Dolomedes oviger Dönitz & Strand, in Bösenberg & Strand 1906, p. 389, pl. 8, fig. 113 [type specimen depository unknown].
Dolomedes annulatus Kishida 1936, p. 121, pl. 13, fig. 7 [type specimen from Nagano, Japan, lost].
Dolomedes xanthum Saito 1939, p. 69, text-fig. 8.8, pl. 1, fig. 13 [male holotype from Iwate, Japan, preserved in NSMT, not examined]; Saito 1959, p. 46, figs. 22 a–d.

Dolomedes hinoi Kayashima 1952, p. 265, fig.1 [female holotype from Yamaguchi, Japan, presumably lost]. NEW SYNONYM

Dolomedes pallitarsis: Chikuni 1989, p. 107, Fig. 7 [in part, only male, nec Dönitz & Strand 1906, misidentification].


**Description.** Coloration and markings. This species has three malor color morphs: 1) light brown mottled with dark brown (Fig. 16), 2) uniformly brown (Fig. 17), and 3) dark brown with a pair of lateral white band (Fig. 18).

Measurements. Based on 1♀ from Chiba Pref. (NSMT-Ar 7806) and 1♂ from Kanagawa Pref. (NSMT-Ar 7833), measurements in parentheses indicate the range among specimens examined. Body 1♀ 19.85 (12.38–26.06), 1♂ 16.75 (11.88–17.63) long. Carapace 1♀ 10.00 (5.53–12.25), 1♂ 8.30 (5.73–8.33) long; 1♀ 8.20 (4.59–9.88), 1♂ 6.60 (4.60–6.83) wide. Length of legs [male/female; tarsus + metatarsus + tibia + patella + femur = total]; 1♀, 5.13 + 8.50 + 9.75 + 5.06 + 10.63 = 39.07/6.60 + 9.10 + 8.90 + 4.15 + 9.10 = 37.85; II, 5.00 + 8.13 + 9.44 + 4.88 + 11.00 = 38.45/5.60 + 7.90 + 8.10 + 4.10 + 9.20 = 34.90; III, 4.13 + 7.31 + 8.00 + 4.31 + 9.88 = 33.63/4.30 + 6.80 + 6.55 + 3.40 + 8.00 = 29.05; IV, 5.25 + 11.13 + 11.25 + 4.75 + 12.38 = 44.76/5.60 + 9.60 + 8.80 + 3.85 + 9.80 = 37.65. Abdomen 1♀ 10.88 (6.92–15.56), 1♂ 8.80 (6.31–9.40) long; 1♀ 6.00 (3.00–7.36), 1♂ 3.90 (2.92–4.50) wide.

Female and male. Carapace longer than wide [length/width 1.22 (1.14–1.24), 1.26 (1.20–1.26)]. MOA wider than long [length/width 0.95 (0.86–0.95), 0.94 (0.90–0.95)]; Wider behind than front [anterior width/posterior width 0.62 (0.57–0.65), 0.65 (0.56–0.65)]. Fang furrow of chelicerae with 3 (2–3) promarginal and 4 (4–5) retro-marginal teeth. Labium almost as long as wide [length/width 1.00 (0.94–1.00), 1.04 (1.00–1.08)]. Sternum almost as long as wide [length/width 0.99 (0.91–0.99), 0.91 (0.98–1.01)]. Length of leg I/length of carapace 4.13 (3.61–4.04), 4.56 (4.56–5.37). Male palp (Figs. 27–30): shapes and arrangement of sclerites as for the *fimbriatus*-group style (Carico 1973). Abdomen longer than wide [length/width 1.81 (1.81–2.31), 2.26 (2.02–2.26)]. Female genitalia (Figs. 37–39): shape of epigynum *fimbriatus*-group style (Carico 1973).

**Remarks.** The present species resembles *D. fontus* and *D. angustivirgatus*. For the discrimination points among these species, see the remarks of the latter species.

**Notes.** Although the holotype of *Dolomedes fimbriatoide Bösenberg & Strand 1906* is a juvenile, we determined it as *D. sulfureus* Koch 1878 using the relative length of the first leg. Consequently, *D. fimbriatoide* is newly synonymised here with *D. sulfureus*.

Because we could not find the holotype of *D. hinoi
Kayashima 1952, we determined it as *D. sulfurus* by the relative length of the first leg calculated from the measurement in the original description, and newly synonymize it with *D. sulfurus*.

**Distribution.** Japan (Hokkaido, Honshu, Shikoku, Kyushu, and Yakushima Is.), China, Korea.

*Dolomedes saganus* Bösenberg & Strand 1906
[Japanese name: Sujibuto-hashiri-gumo]
(Figs. 41–42, 45–48, 53–54, 57–59)

*Dolomedes saganus* Bösenberg & Strand 1906, p. 312, pl. 13, fig. 328 (pl. 8, fig. 115 does not agree with syntypes) [syntypes 1♀15 juv. from Saga, Japan, preserved in SMF (4851, 4852) and 1♀1juv. from “Hiuga”, Japan, preserved in ZMH, examined]; Zhang, Zhu & Song 2004, p. 375, [in part, figs. 38, 40; figs. 39, 41–43, misidentification].

*Dolomedes pallitarsis* Dönitz & Strand, in Bösenberg & Strand 1906, p. 388, pl. 8, fig. 114 [type specimen depository unknown]; Yaginuma 1985, p. 124, figs. 4_A, C; Yaginuma 1986, p. 171, pl. 46, fig. 2, text-fig. 95_2; Chikuni 1989, p. 107, fig. 7 [in part, female, male misidentification]; Song, Zhu & Chen 1999, p. 347, figs. 13_D, 202_O–P, 203_H–I.

*Dolomedes insurgens* Chamberlin 1924, p. 25, pl. 6, fig. 41; Song, Zhu & Chen 1999, p. 347, figs. 203D–E.

**Type series.** Syntypes. 1♀3juv. (SMF 4851), 12juv. (SMF 4852), Saga, Japan and 1♀1juv. (ZMH), “Nishitake, Hiuga, Kiushu”, VII–1898.

**Other specimens examined.** CHIBA PREF.: 5♀5♂, Tsutsumori, Ōtaki-machi, Isumi-gun., 8–IV–2006 (3♀3♂, NSMT-Ar 7813, 7814, 7815, 7816, 7817, 7818, collected as juveniles, became adults after rearing); 1♂, Yokoze, Ōtakimachi, Isumi-gun, 8–IV–2006 (NSMT-Ar 7819); 3♀2♂, Hiratsuka, Kamogawa-shi, 8–IV–2006 (2♀1♂, NSMT-Ar 7820, 7821, 7822; collected as juvenile, became adults after rearing). KANAGAWA PREF.: Atsugi-shi, 1♀, 15–V–1984; 1♀, 6–VI–1993. HIROSHIMA PREF.: Haji Dam,

Figs. 41–44. 41–42, *Dolomedes saganus* — 41, female; 42, male. 43–44, *Dolomedes silvicola* — 43, female; 44, male, color variation, usually as in female. (Scales: 10 mm)

**Description.** Coloration and markings. Carapace dark green or brownish green, with a pair of longitudinal lateral white band. Abdomen also dark green or brownish green, with longitudinal lateral white band and several pairs of small white spots (Figs. 41-42).


Female and male. Carapace longer than wide [length/width ♀1.18 (1.14-1.18), ♂1.09 (1.09-1.14)]. MOA wider than long [length/width ♀0.91 (0.82-0.95), ♂0.88 (0.88-0.93)]; wider behind than front [anterior width/posterior width ♀0.71 (0.64-0.71), ♂0.68 (0.63-0.69)]. Fang furrow of chelicera with 3 promarginal and 4 retromarginal teeth. Labium slightly wider than long [length/width ♀0.92 (0.77-0.94), ♂0.88 (0.82-0.91)]. Sternum almost as long as wide [length/width ♀0.99 (0.89-0.99), ♂0.94 (0.94-1.00)]. Length of leg I/length of carapace ♀3.29 (3.04-3.44), ♂3.83 (3.83-4.41). Male palp (Fig. 45-48, 53-54): shapes and arrange-

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**Figs. 45-56.** Male palp; odd numbers from 45 to 51, ventral view; even numbers from 46 to 52 and 53-56, lateral view. — 45-48, *Dolomedes saganus* (45-46, 53, NSMT-Ar 7819; 47-48, 54, NSMT-Ar 7816). 49-52, *Dolomedes silvicola* (paratypes; 49-50, 55, NSMT-Ar 7827; 51-52, 56, NSMT-Ar 7832). (Scales: 45-52, 1 mm; 53-56, 0.5 mm)

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ment of sclerites as for the *fimbriatus*-group style (Carico 1973). Abdomen longer than wide [length/width 1.79 (1.66–1.79), $\delta$ 1.87 (1.59–1.87)]. Female genitalia (Figs. 57–59): shape of epigynum *fimbriatus*-group style (Carico 1973).

Remarks. *Dolomedes saganus* resembles *D. silvicola*. For the discriminating points, see the remarks of *silvicola*.

Notes. The status of *Dolomedes saganus* Bösenberg & Strand 1906 is much controversial. Although the figure of epigynum in the original description of *saganus* (Bösenberg & Strand 1906, pl. 13, fig. 328) agrees with those of two females in syntypes, but the figure of the general appearance (Bösenberg & Strand 1906, pl. 8, fig. 115) does not agree with any of the syntypes. Furthermore, the original description notes the presence of white spots on dorsum of abdomen, whereas the figure lacks white spots. Meanwhile the original figure of *Dolomedes pallitarsis* Dönitz & Strand, in Bösenberg & Strand 1906 (pl. 8, fig. 114), whose type specimen was lost, agrees with the syntypes of *saganus* and the description of white spots on abdomen. In addition, the original figure of *saganus* resembles the type specimen of *Dolomedes fimbriatoides* Bösenberg & Strand 1906. Thus there must have been some mistakes when these figures were arranged and numbered. This caused many misidentifications by many authors. The spiders identified as *saganus* by many previous authors do not agree with the syntypes of *saganus*, but the spiders previously identified as *pallitarsis* are identical with them. Zhang, Zhu & Song (2004) considered *Dolomedes pallitarsis* as a junior synonym of *Dolomedes saganus*. Although their decision itself is correct, their *saganus* includes real *saganus* (Figs. 39, 40) and so called *saganus* (Figs. 39, 41–43). The latter species is described as a new species below.

**Distribution.** Japan (Hokkaido, Honshu, Shikoku, Kyushu), China.

*Dolomedes silvicola* new species

[Japanese name: Suijika-hashiri-gumo]

(Figs. 43–44, 49–52, 55–56, 60–62)

*Dolomedes saganus*: Yaginuma 1960, p. 81, pl. 38, fig. 209, text-fig. 74.1; Yaginuma 1986, p. 172, pl. 46, fig. 4, text-fig. 95.4; Chikuni 1989, p. 106, fig. 4; Zhang, Zhu & Song 2004, p. 375 (in part, figs. 39, 41–43). [ nec Bösenberg & Strand 1906, misidentification]


Other specimens examined. HOKKAI:O 2♀, Kanayama Dam, Minami-furano-chō, Sorachi-gun, 30–VIII–1985. CHIBA PREF.: same locality as holotype 1♀, 27–

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**Figs. 57–62.** Female genital organ; 57, 58, 60, 61, ventral view; 59, 62, dorsal view. — 57–59, *Dolomedes saganus* (57, NSMT-Ar. 7813; 58–59, NSMT-Ar. 7820). 60–62, *Dolomedes silvicola* (60, holotype, NSMT-Ar 7824; 61–62, paratype, NSMT-Ar 7825). (Scales: 0.5 mm)
A revision of Japanese spiders of the genus Dolomedes

Description. Coloration and markings. Female and male. Carapace and abdomen dark green or brownish green, with a pair of longitudinal lateral white band (Fig. 43). Variation: rarely with light colored radial line on carapace and several transverse lines on abdomen (Fig. 44).


Female and male. Carapace longer than wide [length/width ♀1.18 (1.18-1.26), ♂1.18 (1.13-1.24)]. MOA wider than long [length/width ♀0.91 (0.87-0.92), ♂0.90 (0.90-0.92)]; wider behind than front [anterior width/posterior width ♀0.63 (0.59-0.64), ♂0.64 (0.60-0.64)]. Fang furrow of chelicera with 3 (2-3) promarginal and 4 retromarginal teeth. Labium, ♀slightly wider than long, ♂almost as wide as long [length/width ♀0.93 (0.83-0.93), ♂1.02 (0.92-1.02)]. Sternum almost as long as wide [length/width ♀0.98 (0.97-1.03), ♂1.03 (1.03-1.07)]. Length of leg I/length of carapace ♀4.05 (3.83-4.39), ♂5.22 (5.04-5.76). Male palp (Figs. 49-52, 55-56): shapes and arrangement of sclerites as for the fimbriatus-group style (Carico 1973). Abdomen longer than wide [length/width ♀1.91 (1.54-1.91), ♂1.98 (1.98-2.19)]. Female genitalia (Figs. 60-62): shape of epigynum fimbriatus-group style (Carico 1973).

Remarks. The present new species, Dolomedes silvicola, resembles D. saganus, but can be separated from the latter by the following features. Dolomedes saganus has several pairs of small white spots on dorsum of abdomen (Figs. 41-42), but silvicola does not (Figs. 43-44). Legs and male palpal tibia of saganus are shorter than silvicola (Table 3, Fig. 63). Male palpal patella anteriorly has several strong bristles in saganus (Figs. 45-48, arrows), but not in silvicola.

Table 3. The ratio of the length of leg I to carapace width and the ratio of the length of male palpal tibia to its width in Dolomedes saganus and silvicola.

<table>
<thead>
<tr>
<th>species</th>
<th>leg I</th>
<th>male palpal tibia</th>
</tr>
</thead>
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<tr>
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<td>mean±SD</td>
</tr>
<tr>
<td></td>
<td>range</td>
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</tr>
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<td>12</td>
<td>19.83-28.90</td>
</tr>
<tr>
<td>silvicola</td>
<td>11</td>
<td>18.83-27.79</td>
</tr>
</tbody>
</table>

Fig. 63. Relationship between the carapace width and the leg I length of Dolomedes silvicola (●) and D. saganus (○). ANCOVA p<0.01, for both female and male.

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Tibial apophysis of male palp is rather flattened in *saganus* (Figs. 53–54), but more acute in *silvicola* (Figs. 55–56). Reddish membranous part is seen at the posterior part of epigonum in *silvicola* (Figs. 60–61, arrow), but not in *saganus* (Figs. 57–58).

**Notes.** As mentioned in the notes of *saganus*, the taxonomic treatment of *saganus* and *silvicola* has been much controversial.

**Distribution.** Japan (Hokkaido, Honshu, Shikoku, Kyushu, Yakushima Is.), China.

**Etymology.** The specific name derived from its habitat.

* Dolomedes horishanus Kishida 1936
  [Japanese name: Herijiro-hashiri-gumo]


Remarks. This species can be easily distinguished from the other Japanese *Dolomedes* species by the general appearance.

**Notes.** In the previous paper (Tanikawa 2003), Tanikawa considered *Dolomedes mizhoanus* Kishida 1936 as a color variation of *horishanus* and treated it as a junior synonym of the latter species. While Zhang, Zhu and Song (2004) removed *mizhoanus* from the synonymy. Judging from the figures of *mizhoanus* in their paper, these two species can be separated by the shape of epigonum and the length of male palpal tibia (cf. Tanikawa 2003, figs. 24, 25; Zhang, Zhu & Song 2004, figs. 19, 22).

* Dolomedes zatsun Tanikawa 2003
  [Japanese name: Sasaki-hashiri-gumo]

**Remarks.** This species can be easily separated from the other Japanese *Dolomedes* spiders by the general appearance (Tanikawa 2003).

**Notes.** No additional specimen has been available even from the type locality.

**Phylogeny**

**Taxon analysed.** All of the Japanese species, except for *Dolomedes zatsun*, were analysed. The sampling data and accession number of DDBJ/EMBL/GenBank are shown in appendix. *Hygropropoda higenaga* (Kishida 1936) was used as an out-group.

DNA extraction, polymerase chain reaction and sequencing. Specimens were preserved in 99.5% ethanol, and genomic DNA was extracted from muscle of legs using DNeasy Blood & Tissue kit (Qiagen, Inc.). The mitochondrial cytochrome oxidase I (mt-COI) partial sequence were

![Fig. 64. 50% majority rule consensus tree topologies obtained from Bayesian inference. Posterior probabilities are shown just after nodes. Numbers in parentheses correspond to the specimen numbers in appendix. Scale: 0.02 substitution/site.](image-url)
amplified using the primer combination LCO1-1498: 5'--GTT CAA CAA ATC ATA AAG ATA TTG G-3' with HCO1-2198: 5’-TAA ACT TCA GGG TGA CCA AAA AAT CA-3' (Folmer et al. 1994). The reactants were initially denatured for 2 min at 95°C, proceeded with 40 cycles of 30 sec at 95°C, 30 sec at 47°C, 60 sec at 72°C and then the final extension at 72°C for 5 min. PCR products were purified using the ExoSAP-IT (GE Healthcare BioSciences, Co. Ltd.). The purified PCR products were sequenced using the BigDye terminator cycle sequencing kit and analysed on ABI 3100 automated DNA sequencer (Applied Biosystems, Foster City, CA). Chromatograms were checked by eye. Sequence alignments were done by Clustal W program (Thompson et al. 1994) in BioEdit version 7.0.5.3 (Hall 1999).

Data analyses. The perl script MODELSELECT written by Akihumi Tanabe (available at http://www.fifthdimension.jp/) and PAUP ver. 4.0b10 (Swofford 2002) were used to determine the appropriate model of DNA evolution by AIC, AICc, and BIC for Bayesian analyses. MrBays ver. 3.1.2 (Ronquist & Huelsenbeck 2003) was employed to infer the phylogeny. Four concurrent Markov Chain Monte Carlo (MCMC) chains were run for 1,000,000 generations, saving a tree every 100 generations. Topologies prior to In stabilization (“burn-in”) were discarded and posterior clade probabilities were computed from the remaining trees.

Results and discussion. We finally obtained 610 bp of mt-COI partial sequence from the specimens used. The best-fit model of sequence evolution determined by MODELSELECT was GTR+G. Bayesian inference resulted in a phylogenetic tree shown in Fig. 64. The combination of species in each clad agrees with the species group recognized by morphological resemblance. Dolomedes horishanus is a sister to all other species comprising two reciprocally monophyletic clades. The first clad (A in Fig. 64) is uniting D. raptor, yamatai, japonicus, and orison. In the clad A, orison is a sister to other three species, and the remaining three species seem to be unresolved trichotomy due to the weak support (pp=0.52). The second clad (B in Fig. 64) is uniting D. angustivirgatus, sutureus, fontus, silvicola, and pallitarsis. The clad B comprises two clades (C & D in Fig. 64). The clad C is uniting angustivirgatus, sutureus and fontus, and the clad D is uniting silvicola and saganus.

Although raptor and japonica in clad A are common in China, Korea and Japan mainland islands, yamatai and orison are endemic to Ryukyu Islands, southwest Japan. Judging from the topology of clad A and the present distribution area, we consider that the lineage leading to orison became isolated in Central Ryukyu (Fig. 65) from the common ancestor, and then speciation of yamatai occurred in Southern Ryukyu (Fig. 65). Similar phylogenetic relationships, i.e. the taxa in Southern Ryukyu are more closely related to those in Asian Continent rather than Central Ryukyu, are also known in other animals such as oriental pitvipers genus Trimenurus (Tu et al. 2000), lacertid lizard genus Tokydromus (Ota et al. 2002), or stag beetle genus Neolucanus (Hosoya & Araya 2006).

All of the Japanese Dolomedes spiders, except for sutureus and silvicola, inhabit wetlands or streams, where they run on water surface or hide under water when disturbed. In contrast, sutureus and silvicola are always found on vegetation and never run on water surface even when disturbed. There is a marked difference in leg length between sutureus, silvicola and other related species, fontus, angustivirgatus and saganus. The legs of sutureus and silvicola that never run on water are relatively longer than those of the other species (Figs. 40, 63). Phylogenetic analysis suggests that the characters of having long legs and inhabiting vegetations, evolved independently at two lineages leading to sutureus and silvicola.

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Fig. 65. Map showing the geographical localities of Northern, Central, and Southern Ryukyu.

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Gomi, Toho University, Dr. Masami Hasegawa, Toho University, Mr. Yusuke Ikeda, Osaka, Mr. Ryuta T. Nakajo, Toho University, Mr. Akira Shinkai, Tokyo, Mr. Shun R. Takagi, the University of Tokyo, Dr. Yoko Takematsu and Dr. Shuhei Tanaka, Yamaguchi University, Dr. Hozumi Tanaka, Sonoda Womens’ University, Dr. Nobuo Tsurusaki, Tottori University, Dr. Kentaro Uchiyama, the University of Tokyo, Ms. Inori Umemoto, Hokkaido University, Ms. Maki Kayashima, Tokyo, Dr. Yuya D. Watari, the University of Tokyo, Mr. Akihiko Yawata, Tokyo, Dr. Masanobu Yoshiho, the University of Tokyo, and Dr. Wolfgang Schawaller, Staatliches Museum für Naturkunde, Stuttgart, for their kind help or offering specimens used in this study.

References


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Appendix. Collection sites and DDBJ accession numbers of Dolomedes spiders used for DNA analyses and Hygropoda higenaga as an out-group. Specimens without accession numbers has same sequence with the specimen above.

<table>
<thead>
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<th>Collecting sites</th>
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<th>Accession No.</th>
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