Taxonomic revision of *Simulium konoi* Takahasi
(Diptera: Simuliidae) from Japan

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Abstract: Morphological characters of *Simulium konoi* (Takahasi) so far assigned
to the subgenus *Simulium* (*Nevermannia*) are revised based on female, male, pupal
and larval specimens collected from Tottori (type locality), Oita and Ibaraki, Japan. There
was no difference in most morphological characters among the different populations.
*Simulium konoi* is transferred to a Holarctic subgenus *Simulium* (*Boreosimulium*),
because it has a combination of the subgeneric key characters including arms of
furcasternum without any projection directing ventrally, slender male style tapered to
pointed apex, paramere with several hooks, and the larval antenna with 3–5 colorless
annular bands. This species is easily distinguished from all the 16 known species of
the subgenus *Boreosimulium* by the female cibarium with several oblique rows of
denticles, an autopomorphic character not found so far in other species of Simuliidae.

Key words: black fly, Simuliidae, *Simulium konoi*, Boreosimulium

*Simulium konoi* (Takahasi, 1950) is one of the three species unplaced to any of theive species groups of the subgenus *Simulium* (*Nevermannia*) Enderlein, according to
Crosskey and Howard (1997). This species is morphologically distinctive in having a
female cibarium furnished with ca. 80 denticles in several oblique rows, a character
not found so far in other species of Simuliidae. *Simulium konoi* is also found to be
very distant from all the three Asian species-groups (*vernun*, *feuerborni*, and *ruficorne*-species groups) of the subgenus
Nevermannia using phylogenetic analyses of nucleotide sequences of a subregion
of the mitochondrial 16S ribosomal RNA
gene (Otsuka et al., 2001). However, full
descriptions of all stages of *S. konoi* have
been never given since it was described
from a male specimen collected from Tottori Prefecture, western Japan (Takahasi,
1950). Although each stage has been par-
tially described under *Simulium* sp. J-9
(Bentinck, 1955) and *Simulium yamaya-
ense* (Ogata and Sasa, 1954), of which the
former was synonymized to *S. konoi* by
Takahasi (1971) and the latter by Uemoto
(1991). We describe the female, pupa and
mature larva and redescribe the male of
this species, based on adults (reared from
pupae), pupae and mature larvae collected
from Tottori Prefecture (type locality),
together with other specimens collected
from Oita and Ibaraki Prefectures (south-
western and central Japan, respectively),
and transfer *S. konoi* to the subgenus *Si-
mulium* (*Boreosimulium*), created by Rub-
tsov and Yankovsky (1982) and redefined
by Adler et al. (2004).
**Simulium (Boreosimulium) konoi** (Takahasi, 1950)

*Nevermannia konoi* Takahasi, 1950: 1556 (male and cocoon).


**Simulium (Eusimulium) konoi**: Ogata and Uemoto, 1971: 80 (illustration of larval cleft); Matsuo, 1975: 130–133 (notes and photographs of hairs of larval abdomen).

**Simulium (Gomphostilbia) konoi**: Uemoto, 1985: 330.


**Eusimulium yamayaense**: Orii, Uemoto and Onishi, 1969: 9 and 11 (illustrations of head spots and cleft of mature larva).


**Cnetha konoi**: Yankovsky, 2002: 305 (illustrations of female, male, pupa and larva).

[Note: The same species name *C. konoi* (Takahasi) was erroneously used by Ono (1979) for the different species, which was later named as *S. (N.) onoi* by Sato et al. (2004)]

**DESCRIPTION. Female.** Body length 2.3–3.1 mm. **Head.** As wide as thorax. Frons dark brown to brownish black, dull, densely covered with pale whitish-yellow scale-like recumbent hairs; frontal ratio 1.5–1.7 : 1.0 : 1.4–1.7; frons-head ratio 1.0 : 3.3–3.8. Fronto-ocular area (Fig. 1) well developed, directed laterally and slightly upwardly. Clypeus brownish black, densely covered with pale whitish recumbent hairs and several usual dark longer hairs on lower portion. Labrum 0.7–0.9 times as long as clypeus. Antenna (Fig. 2) composed of 2 + 9 segments, dark brown, except scape, pedicel and basal 1/2 of 1st flagellar segment pale yellow when viewed posteriorly (though scape, pedicel and 1st flagellar segment pale when viewed anteriorly); 9th flagellar segment somewhat elongate, 1.7–2.6 times as long as 8th one. Maxillary palp composed of 5 segments, light to medium brown, proportional lengths of 3rd, 4th and 5th segments 1.0 : 1.1–1.3 : 1.8–2.6; 3rd segment of moderate size; sensory vesicle (Fig. 3) elongate, 0.3 times as long as 3rd segment, with medium-sized opening. Lacinia with 9–11 inner and 12–19 outer teeth. Mandible with 27–31 inner and 12 outer teeth. Cibarium (Fig. 4) with well sclerotized posterior margin and several oblique rows of ca. 80 denticles on each side. **Thorax.** Scutum dark brown to brownish black, shiny when illuminated, densely covered with pale whitish-yellow scale-like recumbent hairs; scutellum light yellowish-brown, densely covered with whitish-yellow recumbent short hairs as well as whitish-yellow long upright hairs intermixed with several dark-brown long hairs. Postnotum dark brown, slightly shiny when illuminated, whitish-grey pruinose, bare. Pleural membrane bare. Katepisternum longer than deep, dark brown to brownish black, shiny and bare. Furcasternum (Fig. 5) with wide arms each lacking any projection directed downwards. **Legs.** Foreleg (Fig. 6): coxa and trochanter whitish yellow; femur whitish yellow with apical cap slightly to moderately darkened; tibia whitish yellow with apical cap brownish black; tibia densely covered with whitish fine hairs on most of outer surface; tarsus brownish black to black, with moderate
Figs. 1-12. Morphological characters of female of *Simulium (Boreosimulium) konoi*. 1, fronto-ocular area; 2, antenna; 3, 3rd segment of maxillary palp; 4, cibarium; 5, furcasternum; 6, foreleg; 7, midleg; 8, hind leg; 9, claw; 10, genitalia in situ (lateral view); 11 and 12, paraprocts and cerci (11, lateral view; 12, ventral view). Scales. 0.01 mm for Fig. 9; 0.02 mm for Figs. 4 and 10-12; 0.04 mm for Figs. 1 and 3; 0.1 mm for Figs. 2 and 5-8.
dorsal hair crest; basitarsus slightly dilated, 7.0–7.8 times as long as its greatest width. Midleg (Fig. 7): coxa light to medium brown (except posterior surface dark brown); trochanter dark yellow to light brown; femur whitish yellow with apical cap slightly to moderately darkened; tibia whitish yellow with apical cap brownish black; tibia moderately covered with white fine hairs on posterior and outer surfaces of basal 2/3; tarsus brownish-black to black. Hind leg (Fig. 8): coxa light to medium brown; trochanter whitish yellow; femur whitish yellow with apical cap medium to dark brown; tibia whitish yellow with apical cap brownish black, covered with white fine hairs on posterior and outer surface of basal 3/4; tarsus medium brown to brownish black with basal 1/2 of 2nd tarsal segment somewhat lighter; basitarsus slender, parallel-sided, 6.2–6.3 times as long as wide, and 0.7 and 0.6 times as wide as the greatest widths of tibia and femur, respectively; calcipala 0.8–1.0 times as long as wide, and 0.4 times as wide as the greatest width of basitarsus. Pedisulcus distinct. All tarsal claws (Fig. 9) each with large basal tooth 0.53 times as long as and 1.2 times as wide as claw. Wing. Length 2.3–2.5 mm; costa with dark spinules as well as dark hairs except longer hairs near base whitish yellow; subcosta fully haired on ventral surface; basal portion of radial vein fully haired; R₁ with spinules as well as hairs on dorsal surface; R₂ with hairs on ventral surface; hair tuft at base of radial vein whitish yellow. Abdomen. Basal scale light yellow to light yellowish-brown with fringe of pale whitish-yellow hairs. Dorsal surface of abdomen light to medium brown except segment 2 pale yellow to light yellowish-brown, moderately covered with short pale whitish-yellow hairs interspersed with dark hairs; all tergites not shiny except tergites 6–9 slightly shiny at certain angle of light. Ventral surface of 7th segment with well-developed sternal plate medially. Genitalia (Figs. 10–12). Sternite 8 bare medially, with 1–5 short setae and 10–19 long hairs on each side. Ovipositor valve nearly triangular, with round medioposterior corner, thin, membranous, densely covered with microsetae except round medioposterior corner and narrow portion along posterior margin bare, interspersed with 4–11 short setae; inner margin slightly sinuous, moderately sclerotized. Genital fork of usual inverted-Y form; arms rather wide, with a strong projection directed anterodorsally and a broad projection posteromedially. Paraproct moderately produced ventrally, with 13–19 long hairs on ventral and lateral surfaces, and with 5–11 seta on inside surface. Cercus rounded posteriorly, ca. 0.6 times as long as wide, when viewed laterally. Spermatheca ellipsoidal, 1.3–1.4 times as long as wide, well sclerotized (except small area near its juncture to duct unsclerotized) and with distinct reticulate surface pattern; internal setae appear to be absent; both accessory ducts slender, subequal in diameter to major one.

**Male.** Body length 2.5–2.7 mm. Head. Wider than thorax. Holoptic. Upper eye consisting of 20–22 vertical columns and 19–22 horizontal rows of large facets. Face brownish black. Clypeus brownish black, thinly grey pruinose, moderately covered with yellowish simple hairs, interspersed with several dark simple longer hairs on each side of lower portion. Antenna composed of 2+9 segments, brownish black except base of 1st flagellar segment pale yellow; 1st flagellar segment elongate, 1.7–1.8 times as long as 2nd one. Flagellar segment 9 elongate, 1.6–1.9 times as long as 8th one. Maxillary palp with 5 segments, brownish black, proportional lengths of 3rd, 4th and 5th segments 1.0:1.1–1.3:2.1–2.7; sensory vesicle (Fig. 13) ellipsoidal, 0.2–0.3 times as long as 3rd segment and with small opening. Thorax. Scutum brownish-black to black, shiny on shoulders and along lateral margins at certain angles of light, densely covered with golden-yellow scale-like recumbent hairs intermixed with several golden-yellow (a few appearing brown) long upright hairs on prescutellar area. Scutellum brown to brownish black, with golden-yellow long upright hairs, as well as concolored short hairs. Postnotum brownish black, grey or white pruinose, slightly shiny at certain angle of light, and bare. Pleural membrane, katepisternum and furcasternum as in female. Legs. Foreleg: coxa light brown; trochanter light to medium brown; femur medium brown with apical cap dark brown; tibia medium to dark brown and with a yellowish sheen on outer surface of basal 3/4 at certain angle of light; tarsus dark brown. Midleg: coxa dark brown; trochanter and femur medium brown with apical cap of femur dark brown; tibia light to medium brown with apical cap dark brown and with a yellowish sheen on outer surface of basal 2/5 at certain angle of...
light; tarsus dark brown. Hind leg: coxa dark brown; trochanter light brown; femur medium to dark brown with base somewhat paler and apical cap brownish black; tibia medium to dark brown with apical cap brownish black and with a yellowish sheen on outer surface of basal 1/2 at certain angle of light; tarsus medium to dark brown with basal 1/3 of 2nd segment somewhat paler; basitarsus (Fig. 14) slightly widened from base toward apical 2/5, then narrowed to apex, 4.5-4.9 times as long as its greatest width, and ca. 0.8 and 0.7-0.8 times as wide as the greatest widths of hind tibia and femur, respectively; calcipala 0.8 times as long as wide, and 0.3 times as wide as the greatest width of basitarsus. Pedisulcus distinct. **Wing.** Length 2.2 mm; other characters including haired subcosta as in female. **Abdomen.** Basal scale black, with fringe of dark long hairs. Dorsal surface of abdomen dark brown to brownish black, not shiny, covered with dark hairs. **Genitalia.** Coxite in ventral view (Fig. 15) 1.3-1.5 times as long as wide. Style (Figs. 15-18) 0.9-1.0 times as long as coxite, gently bent inward, with apical spine having median slit. Ventral plate in ventral view (Fig. 15) transverse, much shorter than wide, with posterior margin concave medially, and moderately covered with microsetae on ventral surface; basal arms of moderate length, somewhat wide basally, then slightly converging apically; ventral plate in lateral view (Fig. 19) only slightly produced ventrally near posterior margin; ventral plate in end view (Fig. 20) rounded ventrally,
and densely covered with microsetae on posterior surface. Parameres (Fig. 21) of moderate size, each with 8-15 distinct hooks and several indistinct ones close together near apex. Aedegal membrane (Fig. 22) moderately covered with microsetae. Dorsal plate (Fig. 23) well sclerotized. Median sclerite (Fig. 24) elongate, thin, plate-like. Abdominal segment 10 (Fig. 25) with 0-3 short setae on ventral surface and 6-10 short setae on lateral surface on each side. Cerci (Fig. 25) rounded, each encircled with 9-16 short setae.

**Pupa.** Body length 2.3-3.0 mm. **Head** (Fig. 26). Integument light to medium brown, bare except upper portion of face very sparsely covered with small tubercles; antennal sheath normal, bare; face with 1 pair of simple long trichomes with uncoiled apex, and frons with 3 pairs of simple medium-long trichomes with uncoiled apex; 3 frontal trichomes on each side arising close together, somewhat different in length from one another. **Thorax.** Integument light to medium brown, almost bare except posterior 1/2 of dorsal surface moderately covered with small corn-shaped tubercles, with 3 pairs of simple long trichomes with coiled or uncoiled apex dorsally, with 2 pairs of simple trichomes anterolaterally (1 long, 1 medium-long with coiled or uncoiled apex differing by individuals), with 1 pair of simple medium-long trichomes with uncoiled apex posterolaterally, and with 3 pairs of simple medium-long trichomes with uncoiled apex (1 pair much longer than the other 2) ventrolaterally. Gill (Fig. 27) composed of 4 pale yellowish-brown thread-like filaments, arranged in pairs; each pair with very short stalk arising from very short basal common stalk; all 4 filaments subequal in length (2.0-2.6 mm) and thickness to one another, gradually tapered toward apical tip, with annular ridges and furrows basally, and densely covered with minute tubercles. **Abdomen.** Dorsally, segments 1 and 2 almost light brown, and bare or sparsely covered with minute tubercles laterally in some pupae; segment 1 with 1 simple medium-long seta (rarely 2 or 3 minute setae also present) on each side; segment 2 with 1 simple medium-long seta and 4-6 short setae submedially on each side; segments 3 and 4 pale except narrow portion along anterior margin light brown, each with 4 hooks and 1 spinous seta submedially on each side; segments 5-8 almost pale except narrow portion along anterior margin light to medium brown; segment 9 entirely light to medium brown, each of segments 5-9 with spine-combs in transverse row, together with comb-like groups of minute spines on each side (spine-combs on segments 5 and 9 sometimes very few in number and smaller than those on segments 6-8); segment 9 with a pair of distinct simple terminal hooks (Fig. 28). Ventrally, segments 3 and 4 each with a few simple slender minute setae; segment 5 with a pair of bifid or trifid hooks submedially and a few simple short slender setae on each side; segments 6 and 7 each with a pair of bifid or trifid inner and simple outer hooks somewhat separated from each other and a few simple short slender setae on each side. Each side of segment 9 without grapnel-like hooklets. **Cocon.** (Figs. 29 and 30). Wall-pocket-shaped, pale to light brown, neatly and very compactly woven without open spaces in webs, not extending ventrolaterally; anterodorsal margin thickly woven and often with anterodorsal short bulge; 2.7-3.5 mm long by 1.0-1.2 mm wide.

**Mature larva.** Body length 4.7-5.5 mm. Body color somewhat variable: in 15 of 25 larvae (collected in Oita) examined, thoracic segment 1 and abdominal segments 1-4 each with light purplish-red or light-brown transverse band (though color intensity variable by individual larvae) and abdominal segments 5-9 entirely purplish-red; or body entirely grey with abdominal segments 5-9 light purplish-red in 5 larvae; or body entirely grey in 5 larvae. Abdomen equally narrow from 1st to 4th segments, abruptly swollen from 5th to 6th segments, then narrowed from 7th to 9th segments; greatest width between 6th and 7th segments. Cephalic apotome (Fig. 31) yellow, somewhat darkened near posterior margin; head spots medium to dark brown, well defined. Lateral surface of head capsule (Fig. 32) yellow except eye-spot region white; eyebrow medium to dark brown; 1 small and 2 large spots posterior to eye-spot region medium to dark brown; 1 small spot below eye-spot region usually light to medium brown (rarely faint and invisible). Ventral surface of head capsule yellow with 2 light to medium brown spots (1 elongate, 1 round) on each side of postgenal cleft; posterior margin heavily sclerotized as usual. Antenna (Fig. 33) much longer than stem of labral fan, with 3-5 colorless annular bands; proportional lengths of 1st, 2nd and 3rd segments 1.0 : 1.1-1.5 : 0.6-0.9. Labral
Figs. 26-40. Morphological characters of pupa and mature larva of Simulium (Boreosimulium) konoi. 26-30, pupa and 31-40, larva. 26, integument of frons (right half); 27, gill filaments (lateral view); 28, terminal hooks (end view); 29 and 30, cocoons (29, lateral view; 30, dorsal view); 31 and 32, head capsules (31, dorsal view; 32, lateral view); 33, antennae with colorless annular bands; 34, apical portion of mandible; 35, mandibular serrations of various shapes; 36, hypostomium; 37, head capsule showing postgenal cleft (ventral view); 38, dark setae on the dorsal surface of abdomen; 39, rectal organ; 40, anal sclerite. Scales. 0.02 mm for Figs. 28, 34-36 and 38; 0.04 mm for Figs. 26, 33, 39 and 40; 0.08 mm for Fig. 37; 0.1 mm for Figs. 27, 31 and 32; 1.0 mm for Figs. 29 and 30.
fan with 33–40 main rays. Mandible (Fig. 34) with comb-teeth of different lengths, 1st tooth thickest of all and as long as, or slightly longer than, 3rd one, and 2nd tooth shortest; mandibular serrations composed of 2 teeth (1 large and 1 small); angle formed by large tooth with the mandible on apical side variable form a little less to a little more than 90 degrees, as shown in Fig. 35; 1 or 2 supernumerary serrations present (additional serration often present in front of large tooth). Hypostomium (Fig. 36) with 9 apical teeth in row; median tooth sub-equal in length to each corner tooth, much longer than 3 intermediate teeth on each side; lateral margin with teeth; 4–7 hypostomal bristles per side, lying divergent from lateral margin. Postgenal cleft (Fig. 37) arrow-head-shaped, somewhat constricted basally, widest medially, then gradually tapered apically, deep, ca. 2.2 times as long as postgenial bridge. Cervical sclerites (Fig. 31) composed of 2 small rod-like pieces, not fused to occiput, widely separated medially from each other. Pharate pupal gill with 4 filaments arising near base. Thoracic cuticle very sparsely covered with simple minute dark setae dorsally. Abdominal cuticle sparsely covered with simple and bifid minute colorless or dark setae on segments 1–4, densely covered with dark setae of somewhat different sizes (usually bifid, tridid and quadrifid, rarely simple or branched into 5–7) on segments 5–8 (Fig. 38); each side of anal sclerite of last segment moderately covered with simple colorless setae. Rectal scales absent. Rectal organ (Fig. 39) compound, each of 3 lobes with 3–7 finger-like (or sometimes thumb-like) secondary lobules. Anal sclerite (Fig. 40) of usual X-form, with anterior arm 0.6–0.9 times as long as posterior ones, broadly sclerotized at base; accessory sclerite absent; 3–6 sensilla posterior to anal sclerite on each side. Last abdominal segment expanded ventrolaterally forming double bulges on each side, visible as a small ventral papilla or invisible when viewed from side, but ventral papilla clearly visible when viewed obliquely. Posterior cirplet with 60–72 rows of up to 11 or 12 (up to 15 in one larva from Tottori) hooklets per row.

SPECIMENS EXAMINED. 1 female and 1 male reared from pupae collected from the main channel of the Nagatani river (flowing width ca. 1 m, exposed to the sun, water temperature 11.0°C, altitude 44 m), ca. 500 m down from the Nagatani bridge on which the national road route-9 runs; 12 mature larvae collected from the Kotobiki stream (flowing width ca. 0.5 m, shaded, water temperature 9.0°C, altitude 56 m), one of the tributaries of the Nagatani river flowing under the Miya bridge near Kotobiki shrine, at Nagatani, Iwami, Tottori Prefecture, 9. IV. 2004, by M. Fukuda and H. Sato; 4 females and 4 males, all reared from pupae and 25 mature larvae collected from the Yamai river (flowing width ca. 4.0 m, shaded, water temperature 12.5°C, altitude ca. 610 m), flowing along the prefectoral road route-28, at Hitotsuya, Shinyabakei, Yabakei, Oita Prefecture, 14. IV. 2003, by H. Takaoka, M. Fukuda and H. Sato; 2 females and 2 males, all reared from pupae and 13 mature larvae collected from the Yamizo river (water temperature 12.0°C, altitude ca. 350 m), flowing along the road at the Isogami, Kaminomiya, Kuji, Ibaraki Prefecture, 10. V. 2000, by K. Saito and M. Takahashi.

BIOLOGICAL NOTES. The larvae and pupae of *S. konoi* were found to be attached to trailing grass leaves in streams with moderate or rapid flow. Associated species were *Prosimulium kiotoense*, *S. aokii*, *S. arakawa*, *S. bidetatum*, *S. japonicum*, *S. kamurameae*, *S. rufibasis*, *S. subcostatum*, *S. suzuki* and *S. uchidai* in Tottori; *S. aokii*, *S. bidetatum*, *S. japonicum*, *S. quinquestratum*, *S. rufibasis* and *S. uchidai* in Oita; *P. yezoense*, *S. bidetatum*, *S. japonicum*, *S. kamurameae* and *S. nikkoense* in Ibaraki.

*Simulium konoi* is assumed to be univoltine. The mature larvae and pupae of this species were found only in April and not found in the other months, although a few immature larvae were recognized in late March according to our yearly surveys carried out during 2003–2004 in Oita (data not shown). In Ibaraki, our preliminary investigations carried out during 2000–2001 show that many mature larvae
Table 1. The geographical distributions of Simulium konoi in Japan.

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<th>Species names used</th>
<th>Prefectures where S. konoi was recorded</th>
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<td>S. konoi</td>
<td>Hokkaido&lt;sup&gt;1&lt;/sup&gt;, Iwate&lt;sup&gt;2&lt;/sup&gt;, Yamagata&lt;sup&gt;3&lt;/sup&gt;, Miyagi&lt;sup&gt;3&lt;/sup&gt;, Ishikawa&lt;sup&gt;6&lt;/sup&gt;, Gifu&lt;sup&gt;6&lt;/sup&gt;, Gunma&lt;sup&gt;7&lt;/sup&gt;, Fukushima&lt;sup&gt;8&lt;/sup&gt;, Nagano&lt;sup&gt;10, 11&lt;/sup&gt;, Ibaraki&lt;sup&gt;12&lt;/sup&gt;, Chiba&lt;sup&gt;13&lt;/sup&gt;, Saitama&lt;sup&gt;14&lt;/sup&gt;, Osaka&lt;sup&gt;15&lt;/sup&gt;, Hyogo&lt;sup&gt;16&lt;/sup&gt;, Nara&lt;sup&gt;17&lt;/sup&gt;,&lt;sup&gt;18&lt;/sup&gt;, Aichi&lt;sup&gt;19&lt;/sup&gt;, Shiga&lt;sup&gt;20&lt;/sup&gt;, Hiroshima&lt;sup&gt;21, 22&lt;/sup&gt;, Okayama&lt;sup&gt;23&lt;/sup&gt;,&lt;sup&gt;24&lt;/sup&gt;, Shimane&lt;sup&gt;25, 26&lt;/sup&gt;, Tottori&lt;sup&gt;27, 28, 29, 30&lt;/sup&gt;, Kochi&lt;sup&gt;31&lt;/sup&gt;, Ehime&lt;sup&gt;32&lt;/sup&gt;, Tokushima&lt;sup&gt;33&lt;/sup&gt;, Kumamoto&lt;sup&gt;34&lt;/sup&gt;, Fukuoka&lt;sup&gt;35&lt;/sup&gt;, Oita&lt;sup&gt;36&lt;/sup&gt;</td>
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<td>S. yamayaense</td>
<td>Wakayama&lt;sup&gt;37&lt;/sup&gt;, Tottori&lt;sup&gt;38, 39, 40&lt;/sup&gt;, Nagano&lt;sup&gt;11&lt;/sup&gt;, Niigata&lt;sup&gt;29&lt;/sup&gt;, Aomori&lt;sup&gt;13&lt;/sup&gt;</td>
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<td>S. sp. J-9&lt;sup&gt;44&lt;/sup&gt;</td>
<td>Akita, Ishikawa, Kyoto, Mie, Saitama, Shiga, Shizuoka, Wakayama, Yamanashi</td>
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<sup>1</sup>Matsuo, 1975; <sup>2</sup>Saito et al., 1996c; <sup>3</sup>Kanayama and Saito, 1990b; <sup>4</sup>Saito et al., 1995; <sup>5</sup>Saito et al., 1983; <sup>6</sup>Saito et al., 1996b; <sup>7</sup>Saito and Kanayama, 1986; <sup>8</sup>Saito and Kanayama, 1987b; <sup>9</sup>Saito et al., 1990; <sup>10</sup>Saito and Kanayama, 1992a; <sup>11</sup>Saito and Kanayama, 2001; <sup>12</sup>Saito and Kanayama, 1987a; <sup>13</sup>Saito et al., 1985a; <sup>14</sup>Saito et al., 1985b; <sup>15</sup>Saito and Kanayama, 1988; <sup>16</sup>Saito et al., 1994; <sup>17</sup>Saito and Saito, 1987; <sup>18</sup>Saito et al., 1999a; <sup>19</sup>Kanayama and Saito, 1986; <sup>20</sup>Saito and Kanayama, 2002; <sup>21</sup>Kanayama and Saito, 1987; <sup>22</sup>Kanayama and Saito, 1994; <sup>23</sup>Saito et al., 1996a; <sup>24</sup>Kanayama and Saito, 1992; <sup>25</sup>Saito and Kanayama, 2002; <sup>26</sup>Saito et al., 1992b; <sup>27</sup>Kanayama and Saito, 1995; <sup>28</sup>Takahasi, 1971; <sup>29</sup>Saito et al., 1989; <sup>30</sup>Saito and Saito, 1990; <sup>31</sup>Kanayama and Saito, 1990a; <sup>32</sup>,<sup>33</sup>Saito, 1991; <sup>34</sup>Saito and Kanayama, 1997; <sup>35</sup>Kanayama and Saito, 2002; <sup>36</sup>Yamamoto et al. 1990; <sup>37</sup>Saito and Saito, 1984; <sup>38</sup>Okamoto, 1957; <sup>39</sup>Okamoto, 1958a; <sup>40</sup>Okamoto, 1958b; <sup>41</sup>Shogaki and Shimizu, 1956; <sup>42</sup>Okata and Sasa, 1954; <sup>43</sup>Okata and Sasa, 1954; <sup>44</sup>Bentinck, 1955.

and pupae were also collected in April and a few in May; a few immature larvae were collected in February and December (data not shown).

Simulium konoi seems to be an autogamous. No ovarian development was observed in all of the 12 females which were reared from pupae collected from Oita and kept alive with 30% sucrose solution under an air temperature of 21–22°C for three days.

It may be noteworthy that our preliminary phylogenetic analyses show no difference in the nucleotide sequences of a subregion of the mitochondrial 16S ribosomal RNA gene of S. konoi among the populations of Tottori, Oita, Tochigi (central Japan) and Ibaraki (unpublished data).

DISTRIBUTION. Japan (Hokkaido, Honshu, Kyushu and Shikoku) and Siberia. Table 1 shows prefectural distributions of S. konoi so far reported in Japan.

REMARKS. We revised the morphological characters of S. konoi based on female, male, pupal and larval specimens collected from Tottori, Oita and Ibaraki. There is no difference in most morphological characters among the three different populations. The most distinctive character of S. konoi is a female cibarium with several oblique rows of denticles (Fig. 4), as first illustrated by Bentinck (1955). This is an autapomorphic character not found so far in other species of Simulidae. Other remarkable characters (not mentioned before) include the male subcosta with hairs as in the female, the presence of hairs on the ventral and lateral surfaces of the male abdominal segment 10 (Fig. 25), larval antenna with 3–5 colorless bands (Fig. 33), a character often recognized in most species of the subgenus Simulium (Montisimulium), and larval abdomen densely covered with minute spinous setae (Fig. 38), as seen in certain species of the subgenus Simulium (Gomphostilbia).

It is clarified in our study that S. konoi can be more reasonably placed in the Holartic subgenus Boreosimulium, recently redefined by Adler et al. (2004), than in the subgenus Nevermannia. It is because S. konoi has a combination of the following diagnostic characters of the former subgenus: in female and male, basal portion of radius haired and arms of furcasternum without any projection directing ventrally; in female, each claw with a large basal tooth; in male, style slender, tapered...
to pointed apex, with 1 apical spine, paramere with several hooks; in the pupa, gill with 4 filaments; and in the larva, antenna with 3–5 colorless annular bands and ventral papillae present. This species is easily distinguished from all the 16 known species of the subgenus *Boreosimulium* by the female cibarium with several oblique rows of denticles (Fig. 4), and the larval abdominal segments 5–8 densely covered with dark branched setae dorsally.

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