New Spiders of the Families Tetragnathidae, Nephilidae and Clubionidae (Arachnida, Araneae) from Izu and Ogasawara Islands, Tokyo

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Abstract Three new spiders of the families Tetragnathidae, Nephilidae and Clubionidae (Arachnida, Araneae) from Hachijojima and Mikurajima Islands of the Izu Islands, and Chichijima Island of the Ogasawara Islands are described under the names, Leucauge nagashimai sp. nov. (Tetragnathidae), Nephila clavata caerulescens subsp. nov. (Nephilidae) and Clubiona oceanica sp. nov. (Clubionidae). Leucauge nagashimai resembles Chinese Leucauge bimaculata and liui, both described by Zhu, Song et Zhang (2003), but differs from the two species by the details of female genitalia, especially in the shape of spermatheca. Clubiona oceanica belongs to the species group of Clubiona hystrix defined by Deeleman-Reinhold (2001) and stands close to Clubiona maipai Jäger et Dankittipakul, 2010 from Thailand, Clubiona kuu Jäger et Dankittipakul, 2010 from Laos, Clubiona damirkovaci Deeleman-Reinhold, 2001 from Peninsular Malaysia and Clubiona hitchinsi Saaristo, 2002 from Seychelles Islands, but is distinguishable from these known species by the structure of female genitalia, especially the position of intromittent orifices and the condition of intromittent canals and in details of tibial apophysis and embolus of male palpal organ. Nephila clavata caerulescens is described for the populations of Nephila clavata on Hachijojima and Mikurajima Islands, which show a remarkable variation on the coloration of the body not mimic to the color pattern of vespid wasps.

Key words: Taxonomy, Araneae, Nephilidae, Tetragnathidae, Clubionidae, Izu Islands, Ogasawara Islands.

Introduction

Under a long-term project of the “Studies on the Origin of Biodiversity of the Sagami Sea, the Fossa Magna Element and the Izu-Ogasawara Island Arc” organized by the National Museum of Nature and Science, Tokyo, the present author continued inventory studies of spiders of these areas in the period from 2006 through 2010. At the same time, he was appointed a committee member of an assessment of threatened species (Red Data) of spiders of the Izu and Ogasawara Islands, Tokyo, which was provided by the Japan Wildlife Research Center, Tokyo, under commission of the Environment Bureau of the Tokyo Metropolitan Government in the years 2009 and 2010.

In the course of these projects the present author concentrated his efforts on field researches on Mikurajima and Hachijojima Islands of the Izu Islands, and Chichijima and Hahajima Islands of the Ogasawara Islands. Although some papers were published on the basis of results of the study during these projects (Ono, 2008, 2009, 2010, 2011), several spider specimens have been left undetermined. On the basis of a part of this unstudied material, three new and interesting spiders are described in the present paper.

The Izu Islands are composed of seven main islands and some smaller islands stretching to the south from the Bay of Tokyo and occupy a wide range between 32 and 35 degrees north latitude. Of these, Mikurajima Island (20.55 km² in size) and Hachijojima Island (62.52 km²) are situated...
in the southern part. All the islands of Izu are volcanic formed by Pleistocene activity, and their spider fauna seems to be poor in the total number of species (Ono, 2001). However, Mikurajima and Hachijo islands have developed evergreen broad-leaved forests well preserved and various aspects of arachnology are expected, for instance a phase of isolation.

From Mikurajima Island, 86 species were recorded (Ono, 2010), while 91 species were known from Hachijo Island (Sasaoka, 2010). A new subspecies of well-known *Nephila clavata* L. Koch, 1878, is reported, which shows a geographic variation presumably caused by the isolation in these islands.

On the other hand, the Ogasawara Islands (= the Bonin and Volcano Islands) are situated in a much southern area surrounded by the latitude between 23° and 28° N and the longitude between 141° and 143° E in the northwestern Pacific (see Ono, 2011, figs. 1–4). The islands have volcanic origin came into existence forty-eight million years ago and were uninhabited up to the 19th Century. Being more than 1,000 km apart from a land, such islands should perform a typical oceanic fauna composed of many endemics explosively evolved from small number of ancestral species. However, human activities after first immigration in 1830 influenced actually the nature of Ogasawara, and gave a serious damage on the spider fauna. Of 81 species known from the Ogasawara Islands, two thirds are regarded as artificial immigrants (Ono, 2011). Chichijima Island (24 km²) is the largest and administratively main island in Ogasawara, having a population of about 2,000. Two new species of the families Tetragnathidae and Clubionidae are herein described from this island, both of which seem to be endemic to the islands.

**Material and Methods**

The specimens used for this study were collected during research trips on Hachijo Island between 23rd and 26th November 2007 and between 6th and 8th March and between 7th and 11th November 2010 and on Chichijima Island between 18th and 30th May and between 19th and 24th October 2010 by the present author using sweeping and beating methods in the forest as well as collecting by hand, that is, two females of *Nephila clavata*, seven females, four males and four juveniles of a leucaugine species, and six females, four males and two juveniles of a clubionid species. Other than the above material, some specimens (17 immature females and 7 adult males) of *Nephila clavata* collected by Mr. M. Tanaka on Mikurajima Island on 3rd October 2009 were provided for this study. Comparative material was also used, which were selected from the specimens preserved in the Arachnid Collection of the National Museum of Nature and Science, Tokyo.

All the specimens were preserved in 76% or absolute ethanol on location, examined under Leica MZ16 stereomicroscope, and taxonomically studied at the Department of Zoology of the above museum. Some individuals were photographed while alive at the field to record natural coloration (Figs. 32–38). Body, legs and eyes were measured, and pro- and opisthosomata, chelicerae and details of female genitalia and male palpal organ of the specified specimens were illustrated. Thus, a new subspecies of *Nephila clavata* L. Koch, 1878 (Nephiidae), and two new species of the genera *Leucauge* White, 1841 (Tetragnathidae) and *Clubiona* Latreille, 1804 (Clubionidae) are recognized and described as follows.

The type specimens of the new species and subspecies are deposited in the Department of Zoology, National Museum of Nature and Science, Tokyo (NSMT).

Following abbreviations are used for the descriptions: AME, anterior median eye, ALE, anterior lateral eye, PME, posterior median eye and PLE, posterior lateral eye.
Descriptions of New Taxa

Family Tetragnathidae

Leucauge nagashimai sp. nov.

[Japanese name: Hime-shirokanegumo]

(Figs. 1–16, 36–38)

Diagnosis. This new species resembles some Chinese species as Leucauge bimaculata Zhu, Song et Zhang, 2003 from Yunnan and Leucauge liui Zhu, Song et Zhang, 2003 from Hainan Island in the structure of female genitalia, but is distinguishable from these species by the details of female genitalia, especially the shape of spermathecae (Figs. 10–11). The structure of male palpal organ of this new species is also peculiar (Figs. 3–6) and the horn-like dorsal apophysis on cymbium is absent. The opisthosoma of this new species is cylindrical and without posterior projection, while that of the other species is fusiform and the posterior end is more or less narrowed and expanded over the spinnerets.

Type specimens. Holotype: male and allotype: female from Mt. Yoakeyama, Chichijima Island, Ogasawara Islands, Tokyo, Japan, 28-V-2010, H. Ono leg. (NSMT-Ar 9451-9452); paratypes: one female from the same locality as for the holotype, 22-X-2010, one female from Omura, 1-IV-1974, Mt. Asahiyama, one female from Mt. Asahiyama, 26-V-2010, two males from Mt. Asahiyama, 20-21-X-2010, one female and one male, from Komagari, 22-X-2010, two females from forest near Maruyama Tunnel, 23-X-2010; all specimens from Chichijima Island and H. Ono leg. (NSMT-Ar 9453-9459).

Description (holotype and allotype). Measurements: Body length female 5.85 mm, male 3.15 mm; prosoma length female 2.15 mm, male 1.31 mm, width female 1.75 mm, male 1.05 mm; opisthosoma length female 3.55 mm, male 1.88 mm, width female 1.75 mm, male 0.98 mm; lengths of legs [total length (femur+patella+tibia+metatarsus+tarsus)]: female, I 13.50 mm (3.79+0.88+3.60+3.99+1.24), II 10.07 mm (2.87+0.83+2.51+2.85+1.01), III 5.26 mm (1.69+0.53+0.98+1.50+0.56), IV 8.69 mm (2.94+0.53+1.91+2.48+0.83), male, I 13.10 mm (3.39+0.64+3.56+4.31+1.20), II 9.01 mm (2.63+0.56+2.36+2.63+0.83), III 4.13 mm (1.35+0.36+0.83+1.06+0.53), IV 7.24 mm (2.40+0.47+1.58+2.06+0.73).

Prosoma: Carapace flat, longer than wide (length/width female 1.23, male 1.25), median furrow distinct. Eyes almost same in size, ALE and PME of female slightly larger, the anterior eye row slightly recurved and the posterior row straight in both the sexes, AME-AME≤AME-ALE (5:6 in female, 1:1 in male), PME-PME<ME-PLE (1:2 in female, 2:3 in male), median ocular area almost square (length/width 0.94 in female, 1.08 in male; anterior width/posterior width 0.88 in female, 1.00 in male), clypeus narrow. Chelicera of female with three strong teeth on the promargin of fang furrow and one large and four small teeth on retromargin (Fig. 8), that of the male with retromarginal teeth reduced (Fig. 2). Labium wider than long (length/width 0.60 in female, 0.66 in male), sternum longer than wide (length/width 1.11 in female, 1.09 in male), female palp without a long claw. Legs long and slender, with long spines on femora dorsally and laterally, patellae dorsally, tibia laterally and metatarsi dorsally; femora with a low of trichobothria [twelve pairs in female, ten pairs in male (Fig. 7)]; leg formula: I-II-IV-III.

Male palp (Figs. 3–6): Tibia short with long spines and trichobothria. Cymbium short and without dorsal apophysis, paracymbium simple digitiform with curved tip. Tegulum large and expanded, embolic division compactly set, with spiniform embolus.

Opisthosoma: Longer than wide (length/width 2.23 in female, 1.92 in male), cylindrical with the posterior end wide and not extending backwards over spinnerets as normal shape of Leucauge, which is narrowed and projecting.

Female genitalia (Figs. 9–11): Epigynum simple, having typical shape of the genus. Intromittent orifices situated in the anterior part, intromittent canals relatively short and not distinct, spermathecae glandularis and winding, separated in two parts and connected by a short canal, soft
bladder organ present.

Coloration and markings: Female (Fig. 36): carapace dull yellow margined with black and a longitudinal black stripe; chelicerae yellowish brown, maxillae brown, outer margin darker, labium brown and sternum blackish brown; palps

Figs. 1–7. *Leucauge nagashimai* Ono, sp. nov., male, holotype (NSMT-Ar 9451). — 1, Pro- and opisthosomata (appendages omitted), dorsal view; 2, chelicera, retrolateral view; 3, male palp, ventral view; 4, male palp, retrolateral view; 5, basal part of cymbium, dorsal view; 6, tip of male palpal organ, prolateral view; 7, femur of leg IV, prolateral view. [Scales for Fig. 1, 1 mm; for Figs. 2–6, 0.1 mm; for Fig. 7, 0.5 mm.]
yellowish brown, femora and patellae of legs
dlight greenish brown, other segments of legs
reddish brown. Opisthosoma whitish gray dorsal-
ly, with a pair of black lines and white, black and
silver spots, laterally and ventrally black, with a
pair of silver-gray longitudinal bands from epi-
gastric furrow to the spinnerets. Male (Fig. 1):
carapace yellow marginated with black; chelicer-
ae, maxillae, labium and sternum light yellowish
brown, palps and legs yellow, tibiae, metatarsi and
tarsi darker. Opisthosoma light pinkish yellow,
with a some pair of black spots, ventrally light
grayish brown without light colored band.

Variation. Body length of paratypes: Females
3.57–7.14 mm, males 2.73–3.36 mm. Markings
on opisthosoma are variable (Figs. 1, 36–38),
some individuals lack black lines and have only
two or three pairs of black spots in the posterior
part like in males (Fig. 1 and 38). One female
from Komagari has gold spots on the opisthosoma,
while most of females have silver ones. The
shape of epigynum is variable (Figs. 9, 12–16).

Distribution. Japan (at present known only
from Chichijima Island).

Etymology. This new species is dedicated to
Mr. Tadayoshi Nagashima, Chichijima Island,
Ogasawara.

Remarks. Spiders of this species were found in
dark places of forests and along a rivulet and at
the entrance of artificial caves like bomb shelters
in wartime. The webs of spiders are small with a
diameter of 15–30 cm and nearly vertical or
slightly leaning.

Family Nephilidae

_Nephila clavata caerulescens_ subsp. nov.
[Japanese name: Aoi-jorougumo]
(Figs. 17–23, 32–35)

_Diagnosis._ Nephila clavata L. Koch, 1878, is a
species distributed widely in East Asia from
India to Japan. Its phylogenetic position was
studied recently by Su _et al._ (2011) on the molec-
ular basis. In Japan, the species is widely distrib-
uted from Aomori Prefecture, Honshu, to the
Ryukyu Islands. In Izu Islands, the spider has
been recorded from Oshima, Shikinejima,
Kozushima, Miyakejima, Mikurajima, Hachijoji-
ma and Aogashima Islands (Ono, 2001, 2010).
However, spiders observed on Hachijojima and
Mikurajima Islands show a remarkable variation
of the coloration and markings of the opisthoso-
mal dorsum (Figs. 32 and 34). The back of
female is wholly blue with a distinct yellow bar
at the anterior part, while the individuals of the
nominal subspecies herewith designated,
_Nephila clavata clavata_, in the main islands of Japan have
a striped pattern in yellow and blue (Yaginuma,
1986, plate 35; Chikuni, 1989 and 2008, p.80;
Shinkai, 2006, p. 183). Resembling the warning
pattern of some vespid wasps, the coloration and
markings on the opisthosoma of the spider has a
important meaning in mimicry. Therefore, the
present author regarded the characteristics
remarkable.

_Type specimens._ Holotype: female, and allo-
type: male from Noboryou-touge, Hachijojima
Island, Izu Islands, Tokyo, Japan, H. Ono leg.
(NSMT-Ar 9481-9482); paratypes: one female
and one male, same data as for the holotype
(NSMT-Ar 9483-9484).

_Other specimens examined._ Seven males and
17 immature females from Sato Village, Mikuru-
jima Island, Izu Islands, Tokyo, Japan, 3-X-2009,
M. Tanaka leg.; two females and one egg sac,
near Sato, 50–100 m in elevation, Mikurajima
Island, 5-III-2010, H. Ono leg. (NSMT-Ar 9516-
9517).

_Comparative material._ Many females and
males of _Nephila clavata clavata_ from Japan, in
the Arachnid Collection of NSMT, data omitted.

_Description._ (holotype and allotype). Measure-
ments: Body length female 20.05 mm, male
7.00 mm; prosoma length female 6.82 mm, male
3.38 mm, width female 4.02 mm, male 2.06 mm;
opisthosoma length female 14.70 mm, male 4.35
mm, width female 7.23 mm, male 1.54 mm;
lengths of legs [total length (femur/patella/tibia/metatarsus/tarsus)]: female,
I 42.52 mm (12.39+2.41+10.19+14.38+3.15),
II 33.55 mm (9.66+2.10+7.56+11.66+2.57),
III 18.02 mm (5.46+1.58+3.15+5.88+1.95),
IV 31.25 mm (10.71+1.58+6.30+10.24+2.42), male,
I absent, II 21.09 mm (6.08+1.28+4.28+7.20+2.25),
III 9.71 mm (3.11+0.75+1.65+2.85+1.35),
IV 16.91 mm (5.48+1.01+3.22+5.55+1.65).

_Prosoma:_ Carapace flat, much longer than
wide (length/width female 1.70, male 1.64), me-
dian furrow present. Eyes almost same in size,
AME slightly larger than the others, both the eye
rows slightly recurved in both the sexes, AME-
AME wider than AME-ALE in female (1 : 2),
narrower in male (5 : 4), PME-PME < PME-PLE
(1 : 2 in female, 4 : 6 in male), median ocular area
almost square (length/width 1.00 in female, 1.11
in male; anterior width/posterior width 1.00 in
female, 1.11 in male), clypeus > AME-AME.
Chelicera of female with three strong teeth on the
promargin of fang furrow and five teeth on retro-
margin (Fig. 17), that of male with three promar-
ginal and four small retromarginal teeth (Fig.
21), fang very short. Labium triangular, longer
than wide (length/width 1.07 in female, 1.19 in
male), maxillae closer apically, sternum longer
than wide (length/width 1.20 in female, 1.25 in
male). Female palp without a small claw. Legs
long and slender, with spines on femora, patellae,
tibia and metatarsi, and each tibia with scopula;
leg formula: I-II-IV-III.
Male palp (Figs. 22–23): Tibia short with long spines and trichobothria. Cymbium small cup, paracymbium with a dorsal tooth. Tegulum large and expanded, embolic division long without apophysis, embolus tubular, curved apically. Opisthosoma: Longer than wide (length/idth 2.03 in female, 1.82 in male), oval with the posterior end wide and slightly extending backwards.
Female genitalia (Figs. 18–20): Epigynum small and strongly sclerotized, wider than long, without scape. Intromittent orifices situated along the posterior edge, intromittent canals thick tube and very short, spermathecae globular and hard, with long fertilization tubes.

Coloration and markings: Female (Fig. 32–34): carapace dull yellow marginated with black and a longitudinal black stripe; chelicerae yellowish brown, maxillae brown, outer margin darker, labium brown and sternum blackish brown; palps yellowish brown, femora and patellae of legs light greenish brown, other segments of legs reddish brown. Opisthosoma whitish gray dorsally, with a pair of black lines and white, black and silver spots, laterally and ventrally black, with a pair of silver-gray longitudinal bands from epigastric furrow to the spinnerets. Male: carapace yellow marginated with black; chelicerae, maxillae, labium and sternum light yellowish brown, palps and legs yellow, tibiae, metatarsi and tarsi darker. Opisthosoma light pinkish yellow, with some pair of black spots, ventrally light grayish brown without light colored band.

Variation. Body length of paratypes: Female 17.32 mm, male 6.62 mm.

Distribution. Japan (at present known only from Hachijo-jima and Mikurajima Islands).

Etymology. The subspecific epithet is Latin meaning bluish, derived from the coloration of abdominal dorsum of female.

Remarks. Although the population of Mikurajima Island shows a same pattern of abdomen as that of the Hachijo-jima Island, the present author used specimens from Hachijo-jima only as type material. This new subspecies has many characteristics common with the nominal subspecies, including female and male genital organs. However, because the female genitalia and the details of male palp of *Nephila clavata* were never examined and illustrated properly, the present author described those of this new subspecies fully as above.
Figs. 24–31. *Clubiona oceanica* Ono, sp. nov.: 24–27, female, holotype (NSMT-Ar 9427), 28–31, male, allotype (NSMT-Ar 9428). — 24, 29, chelicerae, retrolateral view; 25, epigynum, ventral view; 26, female genitalia, dorsal view; 27, female genitalia, posterior view; 28, pro- and opisthosomata (appendages omitted), dorsal view; 30, male palp, retrolateral view; 31, male palp, ventral view. [Scales: for Figs. 24–27, 29–31, 0.1 mm; for Fig. 28, 1 mm.]
Figs. 32–38. Coloration and markings of body of new spiders. — 32 (Upper, left), *Nephila clavata caerulescens* Ono, subsp. nov., female, holotype from Hachijojima Island (NSMT-Ar 9481), dorsal view; 33 (upper, right), same specimen, ventral view; 34 (middle, left), same specimen, lateral view; 35 (middle, right), same species, a female from Mikurajima Island (NSMT-Ar 9516), dorsal view; 36 (bottom, left), *Leucauge nagashimai* Ono, sp. nov., female, allotype from Mt. Yoakeyama, Chichijima Island (NSMT-Ar 9452), dorsal view; 37 (bottom, center), a female paratype from Mt. Yoakeyama (NSMT-Ar 9454), dorsal view; 38 (bottom, right), a female paratype from near Maruyama Tunnel (NSMT-Ar 9456), dorsal view. [Body lengths of spiders: 32–34, 20.05 mm; 35, 22.31 mm; 36, 5.85 mm; 37, 7.14 mm; 38, 4.67 mm.]
mm, width female 1.80 mm, male 1.32 mm; lengths of legs [total length (femur + patella + tibia + metatarsus + tarsus)]: female,
I 3.86 mm (1.18 + 0.63 + 0.90 + 0.70 + 0.45),
II 4.06 mm (1.29 + 0.64 + 0.90 + 0.75 + 0.48),
III 3.76 mm (1.17 + 0.60 + 0.68 + 0.90 + 0.41),
IV 5.58 mm (1.71 + 0.60 + 1.20 + 1.51 + 0.56), male,
I 4.40 mm (1.35 + 0.68 + 1.08 + 0.82 + 0.47),
II 5.10 mm (1.50 + 0.87 + 1.26 + 0.96 + 0.51),
III 4.27 mm (1.25 + 0.62 + 0.87 + 1.08 + 0.45),
IV 6.43 mm (1.82 + 0.84 + 1.37 + 1.81 + 0.59).

Prosoma: Carapace longer than wide (length/width 1.37 in female, 1.39 in male), with wide head and median furrow. Eyes almost same in size except for ALE larger than the others, ALE > AME = PLE = PME (10 : 9 : 9 : 9 in female and male), the anterior eye row slightly recurved and the posterior row procured in dorsal view, AME-AME > AME-ALE (2 : 1 in female and male), PME-PME > PME-PLE (8 : 5 in female, 5 : 3 in male), median ocular area wider than long (length/width 0.71 in female, 0.68 in male), wider behind than in front (anterior width/posterior width 0.71 in female, 0.68 in male), clypeus very narrow. Chelicera (Figs. 24 and 29) with four or five teeth on the promargin of fang furrow, two of which are larger, and three teeth on the retromargin, labium longer than wide (length/width 1.58 in female, 1.54 in male), sternum longer than wide (length/width 1.52 in female, 1.42 in male). Female palp furnished with a very small claw. Legs robust and hairy; leg formula: IV-II-I-III. Spination: Femora: I-IV dorsally 1-0-1-1, I-II prolaterally 0-0-0-1 (female) of 0-0-1-1 (male), III-IV pro- and retrolaterally each 0-0-0-1; patellae: I-IV dorsally 1-0-1 (weak); tibiae: I-IV dorsally 1-0-1 (weak), I-II ventrally 2-2, III-IV pro- and retrolaterally 1-1, III ventrally 1-1, IV ventrally 1-1-1ap; metatarsi: I-IV pro- and retrolaterally 1-1-2ap except for IV of male prolaterally 1-2-2ap, II ventrally 1-0, III ventrally 2-0-2ap, IV ventrally 2-1-2ap. A long, ventral spine on the basal part of metatarsus II is characteristic.

Male palp (Figs. 30–31): Tibia shorter than tarsus, furnished with a retrolateral apophysis with spiniform tip. Cymbium a long, oval cup, palpal organ simple with small digitiform, membranous tegular apophysis and short and curved embolus.

Opisthosoma: Oval, longer than wide (length/width 1.50 in female, 1.86 in male), narrower posteriorly furnished with short hairs. Spinnerets formed typically for the genus.

Female genitalia (Figs. 25–27): Epigynum wider than long, its posterior ledge sclerotized and forming a pair of guide pockets, inner organ visible through integument. Genital openings situated at the middle of epigynum near epigastric furrow, intromittent canal tubular and curved. Spermathecae globular and in two parts, the main globe situated in the anterior part, smaller than the attached globes, with small glands laterally and fertilization tubes between both globes.

Coloration and markings: Female and male (Fig. 28): carapace light yellowish brown, head darker, chelicerae light reddish brown, maxillae, labium and sternum light yellowish brown, palps and legs dark yellow, without any markings; opisthosoma light yellowish brown dorsally and ventrally, without any markings.

Variation. Body length of the paratypes: females 4.62–5.09 mm, males 4.62–4.80 mm. Color of the opisthosoma is variable in white and gray.

Distribution. Japan (at the present known only from Chichijima Island).

Etymology. The species epithet is Latin Oceanius.

Remarks. Spiders of this new species were found under the bark of trees. One female collected in May had an egg sac in her retreat.
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