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A revised and updated checklist of the parasites of eels (*Anguilla* spp.) (Anguilliformes: Anguillidae) in Japan (1915-2017)

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REVIEW

A revised and updated checklist of the parasites of eels (*Anguilla* spp.) (Anguilliformes: Anguillidae) in Japan (1915-2017)

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Abstract Information on the protistan and metazoan parasites of four species of eels (the Japanese eel *Anguilla japonica*, the giant mottled eel *Anguilla marmorata*, the European eel *Anguilla anguilla*, and the short-finned eel *Anguilla australis*) in Japan is summarized in the Parasite-Host and Host-Parasite lists, based on the literature published for 103 years between 1915 and 2017. This is a revised and updated version of the checklist published in 2007. *Anguilla japonica* and *A. marmorata* are native to Japan, whereas *A. anguilla* and *A. australis* are introduced species from Europe and Australia, respectively. The parasites, including 54 nominal species and those not identified to species level, are listed by higher taxa as follows: Sarcomastigophora (no. of nominal species: 0), Ciliophora (6), Microspora (1), Myxozoa (6), Trematoda (12), Monogenea (8), Cestoda (3), Nematoda (7), Acanthocephala (6), Hirudinida (3), Bivalvia (1), and Copepoda (1). For each parasite species listed, the following information is given: its currently recognized scientific name, any original combination, synonym(s), or other previous identification used for the parasite from Japanese eels; habitat (freshwater, brackish, or marine); site(s) of infection within or on the host; known geographical distribution in Japanese waters; and the published source of each locality record. Of the 54 nominal species of parasites listed, 50 are from *A. japonica*, six from *A. marmorata*, nine from *A. anguilla*, and one from *A. australis*. Five species, *viz.*, *Gyrodactylus anguillae*, *Gyrodactylus nipponensis*, *Pseudodactylogyrus mundayi* (Monogenea), *Bothriocephalus claviceps* (Cestoda), and *Raphidascaris acus* (Nematoda), have been regarded as introduced parasites from other countries, and the remaining 49 nominal species are indigenous parasites of Japan. Nine nominal species of marine and/or brackish-water origin, *viz.*, *Lecithochrium musculus*, *Proctotrematoides pisodontophidis*, *Tubulovesicula anguillae* (Trematoda), *Gyrodactylus nipponensis*, *Pseudodactylogyrus kamegaii* (Monogenea), *Nybelinia angullicola* (Cestoda), *Cucullanus filiformis*, *Heliconema anguillae* (Nematoda), and *Limnotrachelobdella okae* (Hirudinida), have been reported from *A. japonica*. Individiduals of *A. japonica* known as "sea eels" and "estuarine eels" inhabiting coastal marine and riverine brackish waters are considered to serve as hosts for those marine and/or brackish-water parasites.

Key words: *Anguilla anguilla*, *Anguilla australis*, *Anguilla japonica*, *Anguilla marmorata*, bibliography, checklist, eels, parasites

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INTRODUCTION

In 2007, *A checklist of the parasites of eels (*Anguilla *spp.) (Anguilliformes: Anguillidae) in Japan (1915-2007)* was published based on the literature published for 93 years between 1915 and 2007 (Nagasawa *et al.*, 2007). This checklist contained the information on both protistan and metazoan parasites reported from three species of freshwater eels (the Japanese eel *Anguilla japonica* Temminck and Schlegel; the giant mottled eel *Anguilla marmorata* Quoy and Gaimard; and the European eel *Anguilla anguilla* (Linnaeus)) in Japan, and 44 nominal species of parasites were listed by higher taxa as follows: Ciliophora (6), Microspora (1), Myxozoa (6), Trematoda (7), Monogenea (7), Cestoda (3), Nematoda (7), Acanthocephala (4), Hirudinida (2), and Copepoda (1). It also contained the information on unidentified species of Sarcomastigophora, Ciliophora, Microspora, Myxozoa, Trematoda, Monogenea, Cestoda, and Nematoda.

The checklist is revised and updated herein based on three sources of the literature: 1) the papers cited in the 2007 version; 2) those overlooked in the 2007 version (Nagao, 1956; Isobe, 1956, 1962; Irie, 1958; Egusa, 1958; Furukawa and Kobayashi, 1966; Ito, 1968; Horiuchi *et al.*, 1988; Nagasawa, 1991; Rahhou *et al.*, 2005; Shimazu and Araki, 2006; Shimazu, 2007); and 3) those published between the years 2008 and 2017 (Shimazu, 2008; Wielgross *et al.*, 2008; Fang *et al.*, 2008; Tanaka *et al.*, 2009; Shimazu *et al.*, 2011; Katahira *et al.*, 2011, 2012, 2016: Laetsch *et al.*, 2012; Nagasawa *et al.*, 2013; Shimazu, 2014a, 2014b, 2015, 2016a, 2016b; Katahira and Nagasawa, 2014, 2015; Nagasawa and Utsumi, 2015; Ogawa *et al*., 2015; Kan *et al.*, 2016; Nagasawa and Kan, 2017). In this revised checklist, we deal with the parasites reported from *A. japonica*, *A. marmorata*, *A. anguilla*, and the short-finned eel *Anguilla australis* Richardson. *Anguilla japonica* and *A. marmorata* are native to Japan, whereas *A. anguilla* and *A. australis* are introduced species from Europe and Australia, respectively. A total of 54 nominal species of parasites and those not identified to species level are listed herein, and the following 11 nominal species are newly included:

1. *Coitocaecum plagiorchis* Ozaki, 1926 (Trematoda) from *Anguilla japonica* (Shimazu *et al.*, 2011);
2. *Genarchopsis anguillae* Yamaguti, 1938 (Trematoda) from *Anguilla japonica* (Shimazu, 2015);
3. *Genarchopsis chubuensis* Shimazu, 2015 (Trematoda) from *Anguilla japonica* (Shimazu, 2015);
4. *Genarchopsis gigi* Yamaguti, 1938 (Trematoda) from *Anguilla japonica* (Shimazu, 2015);
5. *Isoparorchis eurytremus* (Kobayashi, 1915) (Trematoda) from *Anguilla japonica* (Nagasawa *et al.*, 2013);
6. *Palaeorchis diplorchis* (Yamaguti, 1936) (Trematoda) from *Anguilla japonica* (Shimazu *et al.*, 2011);
7. *Pseudodactylogyrus mundayi* Ogawa, Iwashita, Hayward and Kurashima, 2015 (Monogenea) from *Anguilla australis* (Ogawa *et al*., 2015);
8. *Acanthocephalus longiacanthus* Katahira and Nagasawa, 2014 (Acanthocephala) from *Anguilla marmorata* (Katahira and Nagasawa, 2014);
9. *Southwellina hispida* (Van Cleave, 1925) (Acanthocephala) from *Anguilla marmorata* (Katahira and Nagasawa, 2014; Nagasawa and Kan, 2017);
10. *Limnotrachelobdella okae* (Moore, 1924) (Hirudinida) from *Anguilla japonica* (Nagasawa and Utsumi, 2015); and
11. *Hyriopsis schlegeli* (Martens, 1861) (Mollusca) from *Anguilla japonica* (Furukawa and Kobayashi, 1966).

A new scientific name is adopted herein for each of the following species because their scientific name has currently been changed: *Pseudophyllodistomum macrobrachicola* (Yamaguti, 1934) (Trematoda), *Anguillicola crassus* Kuwahara, Niimi and Itagaki, 1974 (Nematoda), and *Heliconema anguillae* Yamaguti, 1935 (Nematoda). These species were reported as *Phyllodistomum anguilae*, *Anguillicoloides crassus*, and *Heliconema longissimum*, respectively, in the 2007 version. Moreover, *Genarchopis goppo* Ozaki, 1925 (Trematoda) listed in the 2007 version has been re-identified and separated by Shimazu (2015) into three species, itself, *Genarchopsis gigi* Yamaguti, 1939, and *Genarchopsis chubuensis* Shimazu, 2015, the latter two species of which are listed herein.

Like in Nagasawa *et al.* (2007), the information on the parasites reported from Japanese *Anguilla* spp. is assembled as Parasite-Host and Host-Parasite lists. In the **PARASITE-HOST LIST**, the parasites are arranged by higher taxa in the following order: Sarcomastigophora, Ciliophora, Microspora, Myxozoa, Trematoda, Monogenea, Cestoda, Nematoda, Acanthocephala, Hirudinida, Bivalvia, and Copepoda. Within each higher taxa, genera and species are listed alphabetically. For each species of parasite, the following information is provided:

1) The current **scientific name,** including author(s) and date(s), followed by any original combination, recognized synonym(s), or other identifications(s) that have been used in establishing records from *Anguilla* spp. in Japan.

2) The **habitat** in which the parasite was acquired and normally completes its life cycle is given as FW for fresh waters, B for brackish waters, and M for marine waters.

3) The **Site(s) of infection** of the parasite in or on its host. If the site was not given in the original record, the likely site was determined from other records and is enclosed in square brackets.

4) The **Distribution** of the parasite is indicated by prefecture (boundaries shown in Fig. 1), in geographical order from northeast to southwest in Japan.

5) The **Record(s)**. The authors responsible for the records are listed in chronological order. If a parasite has been reported more than once, the references are numbered, but not when there has been only one record of the parasite. Each reference is followed by the locality or localities given in two parts, first the prefecture and then the detailed collection locality or localities from which the parasite was reported. If no locality record was given, the geographical locality is shown by a dash (–). When all records are from the same prefecture, only the detailed collection locality or localities are listed.

6) Under **Remarks**, explanatory comments are given on systematics, nomenclature, useful references, and notes on specific items such as tentative parasite identifications in the original reports.

In the **HOST-PARASITE LIST**, *Anguilla japonica* is first listed, followed by *A. marmorata*, *A. anguilla*, *A. australis*, and *Anguilla* sp. The scientific and English common names of the four nominal species of *Anguilla* follow Froese and Pauly (2017). After these names, a Japanese name is also provided for each eel species excluding *A. australis*. Based on the Parasite-Host List, all the parasites reported from each of *Anguilla* spp. are listed in alphabetical order in each higher taxa, and after the name of each parasite, its geographical distribution in Japan is given in parentheses. Under **Remarks**, the parasite fauna of each eel species is summarized.

The **REFERENCES** section includes works directly cited in the Parasite-Host List. If only a Japanese title was given by the original author(s), our translation of the title into English is provided in square brackets.

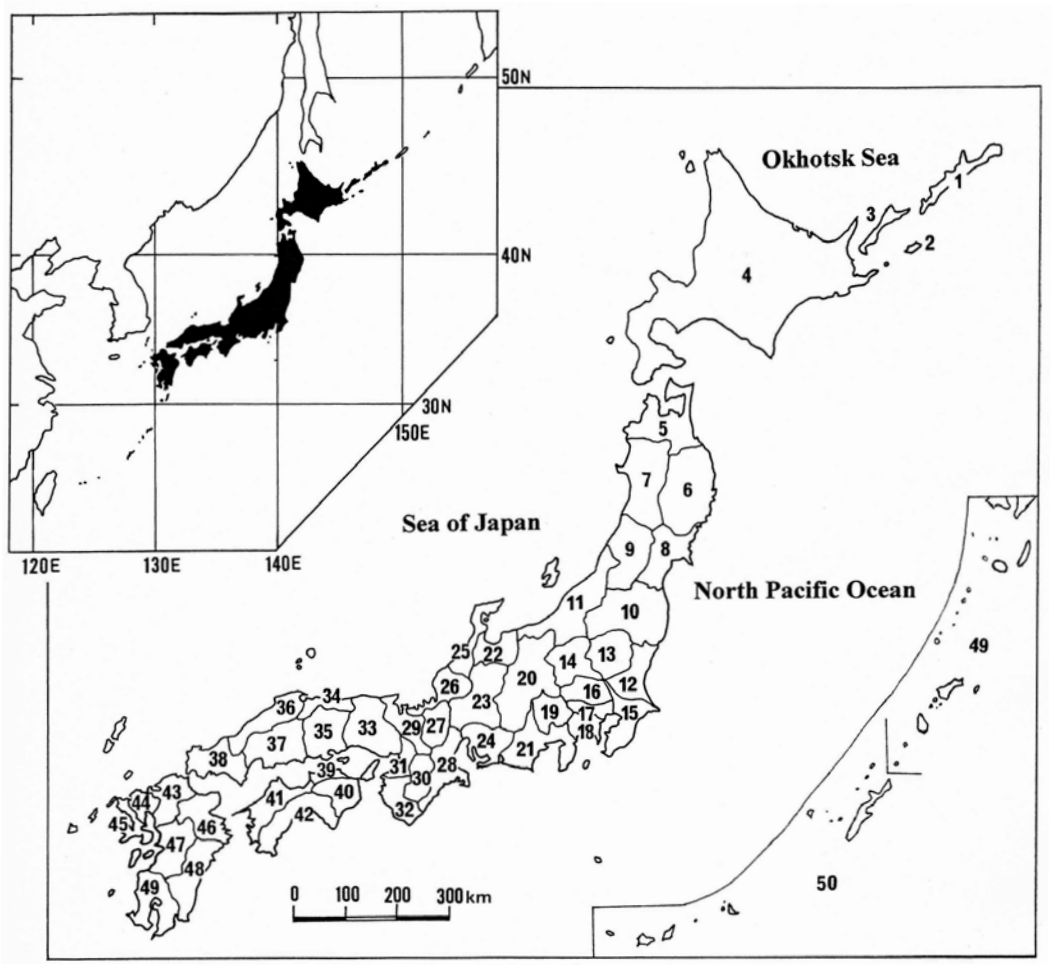

Fig. 1. Map of Japan showing the prefectural boundaries. The following prefectural names are arranged in alphabetical order: Aichi-24; Akita-7; Aomori-5; Chiba-15; Ehime-41; Etorofu Island-1; Fukui-26; Fukuoka-43; Fukushima-10; Gifu-23; Gunma-14; Hiroshima-37; Hokkaido-4; Hyogo-33; Ibaraki-12; Ishikawa-25; Iwate-6; Kagawa-39; Kagoshima-49; Kanagawa-18; Kochi-42; Kumamoto-47; Kunashiri Island-3; Kyoto-29; Mie-28; Miyagi-8; Miyazaki-48; Nagano-20; Nagasaki-45; Nara-30; Niigata-11; Oita-46; Okayama-35; Okinawa-50; Osaka-31; Saga-44; Saitama-16; Shiga-27; Shikotan Island-2; Shimane-36; Shizuoka-21; Tochigi-13; Tokushima-40; Tokyo-17; Tottori-34; Toyama-22; Wakayama-32; Yamagata-9; Yamaguchi-38; and Yamanashi-19.

PARASITE-HOST LIST

SARCOMASTIGOPHORA

Cryptobia sp. (FW)

Hosts: *Anguilla anguilla*
Anguilla japonica

Sites of infection: skin, fins

Distribution: unknown

Record: Niwa 1979 (–)

Ichthyobodo sp. (FW)

Includes: *Costia* sp. (erroneously as "*Chostia*") of Niwa, 1979

Hosts: *Anguilla anguilla*

Anguilla japonica

Sites of infection: skin, fins

Distribution: unknown

Record: Niwa 1979 (–)

Trypanosoma sp. (FW)

Host: *Anguilla japonica*

Site of infection: blood

Distribution: Shizuoka

Records: 1. Hoshina and Sano 1957 (Yoshida); 2. Egusa 1967 (Yoshida)

Ciliophora

Ambiphrya sp. (FW)

Host: *Anguilla japonica*

Sites of infection: gills, skin

Distribution: unknown

Record: Egusa 1978 (–)

Apiosoma sp. (FW)

Includes: *Glossatella* sp. of Nishio *et al.*, 1970; Egusa, 1970; Hatai and Egusa, 1973; Niwa, 1979

Hosts: *Anguilla anguilla* (3, 5)

Anguilla japonica (1, 2, 4)

Site of infection: gills

Distribution: Shizuoka

Records: 1. Nishio *et al.* 1970 (Yoshida); 2. Egusa 1970 (Yoshida); 3. Hatai and Egusa 1973 (Yaizu, Yoshida); 4. Egusa 1978 (–); 5. Niwa 1979 (–)

Capriniata piscium (Buetschli, 1889) Jankowski, 1973 (FW)

Previous identification: *Trichophrya piscium* of Egusa, 1978

Includes: *Trichophrya* sp. of Egusa and Ahmed, 1970; Nishio *et al.*, 1970; Egusa, 1970, 1971; Niwa, 1979

Hosts: *Anguilla anguilla* (1, 2, 4, 5, 6)

Anguilla japonica (1, 3, 4, 6)

Site of infection: gills

Distribution: Shizuoka

Records: 1. Egusa and Ahmed 1970 (Yaizu); 2. Nishio *et al.* 1970 (Yoshida); 3. Egusa 1970 (Yoshida); 4. Egusa 1971 (–); 5. Egusa 1978 (–); 6. Niwa 1979 (–)

Remarks: Matsui (1972: 577-578, figs. 27.44, 27.45) reported, in addition to *Capriniata piscium* (as *Trichophrya* sp.), two species of ciliates, "*Sayphidia* or *Sayphydia* sp." and "*Sudonia* sp." were

found on the gills of *A. japonica*. His identification of the latter two species, however, is definitely not correct.

Carchesium polypinum Linnaeus, 1758 (FW)

Host: *Anguilla japonica*
Site of infection: skin
Distribution: Tokushima
Record: Naruto Station, Fish. Exp. St. Tokushima Pref. 1966 (–)

Chilodonella sp. (FW)

Hosts: *Anguilla anguilla* (2)
Anguilla japonica (1, 2)
Sites of infection: gills, skin
Distribution: unknown
Records: 1. Egusa 1978 (–); 2. Niwa 1979 (–)

Ichthyophthirius multifiliis Fouquet, 1876 (FW)

Hosts: *Anguilla anguilla* (1, 3, 4, 5, 6, 7, 8, 9)
Anguilla japonica (1, 2, 6, 7, 8, 9)
Sites of infection: skin, fins, gills, buccal cavity
Distribution: Shizuoka
Records 1. Egusa *et al.* 1970 (Yaizu); 2. Nishio *et al.* 1970 (Yoshida); 3. Egusa 1971 (–); 4. Oka 1973a (near Lake Hamana); 5. Oka 1973b (–); 6. Egusa 1978 (–); 7. Egusa 1979 (–); 8. Niwa 1979 (–); 9. Egusa 1983 (–)

Trichodina acuta Lom, 1961 (FW)

Host: *Anguilla japonica*
Site of infection: gills
Distribution: Mie
Record: Imai *et al.* 1991 (Tsu)

Trichodina jadranica Haider, 1964 (FW)

Host: *Anguilla japonica*
Site of infection: gills
Distribution: Mie
Record: Imai *et al.* 1991 (Tsu)
Remarks: This trichodinid was reported from the gills of *A. japonica* cultured in freshwater ponds in central Japan (Imai *et al.*, 1991). However, it was later found on marine fishes (the bastard halibut *Paralichthys olivaceus* and the stone flounder *Kareius bicoloratus*) in China (Xu *et al.*, 2001), suggesting that *T. jadranica* is a euryhaline species.

Trichodina japonica Imai, Miyazaki and Nomura, 1991 (FW)

Host: *Anguilla japonica*

Site of infection: gills

Distribution: Mie

Record: Imai *et al.* 1991 (Tsu)

Remarks: This trichodinid was described from the gills of *A. japonica* cultured in freshwater ponds in central Japan (Imai *et al.*, 1991). However, it also occurs on marine fishes (the Japanese seabass *Lateolabrax japonicus* and the red seabream *Pagrus major* [as *Chrysophyrys major*]) and a brackish-water fish (the barramundi *Lates calcarifer*) in China and India, respectively (Xu *et al.*, 1999, 2001; Mitra and Bandyopadhyay, 2005), indicating that *T. japonica* is a euryhaline species, like *T. jadranica* (see above).

Trichodina sp. (FW)

Hosts: *Anguilla anguilla* (3, 6, 7, 8)

Anguilla japonica (1, 2, 3, 4, 5, 6, 8)

Sites of infection: gills

Distribution: Shizuoka

Records: 1. Egusa 1967 (Yoshida); 2. Egusa 1968 (Yoshida); 3. Nishio *et al.* 1970 (Yoshida); 4. Egusa 1970 (Yoshida); 5. Egusa *et al.* 1971 (Yoshida); 6. Egusa 1971 (–); 7. Hatai and Egusa 1973 (Yaizu, Yoshida); 8. Niwa 1979 (–)

Microspora

Heterosporis anguillarum (Hoshina, 1951) Lom, Dyková, Körting and Klinger, 1989 (FW)

Original combination: *Plistophora anguillarum* Hoshima, 1951

Previous identification: *Plistophora anguillarum* of Hoshina, 1972; Awakura, 1974; Hashimoto and Takinami, 1976; Hashimoto *et al.*, 1976; Niwa, 1979

Pleistophora anguillarum of Kano and Fukui, 1982; Kano *et al.*, 1982; Buchmann *et al.*, 1992

Includes: *Plistophora* sp. of Niwa, 1979

Hosts: *Anguilla anguilla* (6)

Anguilla japonica (1, 2, 3, 4, 5, 6, 7, 8, 9)

Site of infection: musculature

Distribution: Hokkaido, Kanagawa, Shizuoka, Aichi, Kagoshima

Records: 1. Hoshina 1951a (Kangawa: near Odawara; Shizuoka: Yoshida); 2. Hoshima 1972 (Kanagawa:–; Shizuoka:–; Aichi:–); 3. Awakura 1974 (Hokkaido: Shikabe); 4. Hashimoto and Takinami 1976 (Shizuoka: Hamanko Branch of Shzuoka Pref. Fish. Exp. St.); 5. Hashimoto *et al.* 1976 (Shizuoka: Hamanko Branch of Shzuoka Pref. Fish. Exp. St.); 6. Niwa 1979 (Shizuoka:–; Aichi:–; Kagoshima:–); 7. Kano and Fukui 1982 (–); 8. Kano *et al.* 1982 (–); 9. Buchmann *et al.* 1992 (Shizuoka:–)

Remarks: The present species was transferred from the genus *Pleistophora* to *Hetrosporis* by Lom *et al.* (1989). Although Awakura (1974) found this parasite in Hokkaido, the infected fish had been transported from Shizuoka, central Honshu (see Fig. 1). The species is known to infect *A. japonica* in Taiwan (T'sui and Wang, 1988; T'sui *et al.*, 1988; Tsai *et al.*, 2002) and Korea (Suh and Chun, 1988; Joh *et al.*, 2007) as well. Hoshima (1972) reported the presence of this parasite in young *A. japonica* imported from Taiwan to Japan.

Unidentified Microspora (FW)

Host: *Anguilla japonica*

Site of infection: gills

Distribution: Shizuoka

Record: Egusa 1967 (Yoshida)

Myxozoa

Myxidium giardi Cépède, 1906 (FW)

Synonyms: *Myxidium anguillae* Ishii, 1915; *Myxidium enchelypterygii* Hoshina, 1952

Previous identification: *Myxidium anguillae* of Ishii, 1915

Myxidium enchelypterygii of Hoshina, 1952

Includes: *Myxidium* sp. of Ishii, 1916b; Iwata, 1972

Hosts: *Anguilla anguilla* (5)

Anguilla japonica (1, 2, 3, 4, 6)

Sites of infection: skin, fins, gills

Distribution: Tokyo, Shizuoka, Miyazaki

Records 1. Ishii 1915a (Shizuoka: Numazu); 2. Ishii 1916b (Tokyo:–); 3. Hoshina 1952 (Shizuoka: Yoshida Fish-Cultural Laboratory); 4. Iwata 1972 (Miyazaki: Hosoda River); 5. Hine 1980 (–); 6. Oka and Egusa 1983 (Shizuoka: Hamamatsu)

Remarks: Although Hoshina (1952) reported that the spores of *Myxidium enchelypterygii* were clearly differentiated from those of *M. anguillae* by thier size and shape, Hine (1980) regarded both taxa as identical, which was supported by Oka and Egusa (1983). Hine (1980: table 1) listed a record of *M. giardi* from the gall bladder and musculature of the American eel *Anguilla rostrata* from Japan, but this record is not included herein because no references were found to support it.

Myxidium lentiforme Fujita, 1929 (FW)

Synonym: *Myxidium fusiforme* Fujita, 1927

Host: *Anguilla japonica*

Site of infection: kidney

Distribution: Shiga

Record: Fujita 1927 (Lake Biwa)

Remarks: This parasite had been originally described by Fujita (1927) as *M. fusiforme*, but it was later renamed as *Myxidium lentiforme* by Fujita (1929: 249-250) because the former had been preoccupied.

Myxidium matsuii Fujita, 1929 (FW)

Host: *Anguilla japonica*

Site of infection: skin

Distribution: Kanagawa, Shizuoka, Aichi

Records: 1. Fujita 1929 (Shizuoka: near Lake Hamana; Aichi: Toyohashi); 2. Hoshina 1952 (Kanagawa: Odawara); 3. Egusa 1978 (–); 4. Hine 1980 (–)

Myxidium uchiyamae Fujita, 1927 (FW)

Host: *Anguilla japonica*
Site of infection: kidney
Distribution: Shiga
Record: Fujita 1927 (Lake Biwa)

Myxidium sp. (FW)

Hosts: *Anguilla anguilla* (3, 4, 6)
Anguilla japonica (1, 2, 5, 6)
Sites of infection: gills, kidney, liver
Distribution: Shizuoka
Records: 1. Egusa 1967 (Yoshida); 2. Egusa 1970 (Yoshida); 3. Oka 1973a (near Lake Hamana); 4. Oka 1973b (–); 5. Ushiyama and Misaki 1977 (suburb of Hamamatsu); 6. Niwa 1979 (–)
Remarks: There is no information on the morphology and identification of this parasite. Niwa (1979) reported that its spores are more commonly found in the kidney of *A. anguilla* than *A. japonica*.

Myxobolus dermatobius (Ishii, 1915) Landsberg and Lom, 1991 (FW)

Original combination: *Lentospora dermatobia* Ishii, 1915
Previous identification: *Myxosoma* (*Lentospora*) *dermatobia* of Hoshina, 1952
Host: *Anguilla japonica*
Site of infection: skin
Distribution: Tochigi, Shizuoka
Records: 1. Ishii 1915b (Shizuoka: Numazu); 2. Hoshina 1952 (Tochigi: Lake Chuzenji)
Remarks: The present species originally described as *Lentospora dermatobia* by Ishii (1915b) was transferred to the genus *Myxobolus* by Landsberg and Lom (1991).

Myxobolus fujitai (Fujita, 1929) Eiras, Molnár and Lu, 2005 (FW)

Synonym: *Lentospora anguillae* Fujita, 1929
Previous identification: *Lentospora anguillae* of Fujita, 1929
Host: *Anguilla japonica*
Site of infection: skin
Distribution: Ibaraki
Record: Fujita 1929 (Lake Hinuma)
Remarks: The present species originally described as *Lentospora anguillae* by Fujita (1929) was renamed as *Myxobolus anguilli* by Landsberg and Lom (1991). However, because of the preoccupation of the latter name, Eiras *et al.* (2005) proposed a new name, *Mybobolus fujitai*, for *M. anguilli*.

Unidentified Myxozoa (FW)

Host: *Anguilla japonica*
Site of infection: gills
Distribution: Shizuoka, Gifu
Records: 1. Nishio *et al.* 1970 (Shizuoka: Yoshida); 2. Nishio *et al.* 1971 (Shizuoka: Yoshida); 3.

Anonymous 2002 (Gifu: a tributary of the Kiso River)

Trematoda

Azygia gotoi (Ariake, 1922) Shimazu, 1979 (FW)

Synonym: *Azygia anguillae* Ozaki, 1924

Previous identification: *Azygia anguillae* of Ozaki, 1924; Yamaguti, 1934a; Iwashita *et al.*, 2003; Shimazu, 2007

Includes: *Azygia gotoi*-like trematodes of Shimazu, 1979

Host: *Anguilla japonica*

Sites of infection: stomach, esophagus

Distribution: Aomori, Ibaraki, Chiba, Tokyo, Nagano, Shiga

Records: 1. Ozaki 1924 (Tokyo:–); 2. Yamaguti 1934a (Ibaraki: Lake Kasumiga-ura [as "Kasumiga-ura"]); 3. Shimazu 1979 (Aomori: Lake Hira-numa; Nagano: Lake Kizaki, Lake Suwa; Shiga: Lake Biwa); 4. Iwashita *et al.* 2003 (Chiba: mouth of the Tone River); 5. Shimazu 2007 (Nagano: Lake Kizaki, Lake Suwa); 6. Shimazu *et al.* 2011 (Shiga: Lake Biwa, Uso River); 7. Shimazu 2014b (Aomori: Hiranuma; Ibaraki: Lake Kasumigaura; Chiba: Tone River; Tokyo: vicinity of Tokyo; Nagano: Lake Nakatsuna and Lake Kizaki; Shiga: Lake Biwa basin)

Remarks: The taxonomy and life history of this trematode was reported in details by Shimazu (1979). Although *A. anguillae* was proposed by Shimazu (2007) as the scientific name of the species, *A. gotoi* has been currently adopted (see Shimazu *et al.*, 2011). Information on the species is available from Shimazu (1999a, 2003).

Bucephalus sp. (M)

Host: *Anguilla japonica*

Site of infection: digestive tract

Distribution: Chiba

Record: Iwashita *et al.* 2003 (mouth of the Minato River)

Remarks: This species has been suggested to be a marine parasite (Iwashita *et al.*, 2003).

Centrocestus formosanus (Nishigori, 1924) Price, 1932 (metacercaria) (FW)

Host: *Anguilla japonica*

Habitat: gills

Distribution: Kagoshima

Records: 1. Yanohara and Kagei 1983 (Tanegashima Island); 2. Kagei and Yanohara 1995 (Tanegashima Island)

Coitocaecum plagiorchis Ozaki, 1926 (FW)

Host: *Anguilla japonica*

Habitat: intestine

Distribution: Shiga

Records: 1. Shimazu *et al.* 2011 (Uso River); 2. Shimazu 2016b (Uso River)

Genarchopsis anguillae Yamaguti, 1938 (FW)

Host: *Anguilla japonica*

Site of infection: intestine

Distribution: Ibaraki

Records: 1. Yamaguti 1938 (Tsuchiura [as Tutiura]); 2. Shimazu 1995 (Tsuchiura); 3. Shimazu 2015 (Tuchiura)

Genarchopsis chubuensis Shimazu, 2015 (FW)

Previous identification: *Genarchopsis goppo* of Shimazu, 1995

Host: *Anguilla japonica*

Site of infection: stomach

Distribution: Nagano

Records: 1. Shimazu 1995 (Lake Suwa); 2. Shimazu 2015 (Lake Suwa)

Genarchopsis gigi Yamaguti, 1939 (FW)

Previous identification: *Genarchopsis goppo* of Shimazu, 1995; Shimasu *et al.*, 2011

Host: *Anguilla japonica*

Site of infection: intestine

Distribution: Shiga

Records: 1. Shimazu 1995 (Omatsu); 2. Shimazu *et al.* 2011 (Omatsu); 3. Shimazu 2015 (Omatsu)

Hemiuridae gen. sp. (FW?)

Host: *Anguilla japonica*

Site of infection: stomach

Distribution: Tokyo

Record: Ozaki 1924 (–)

Remarks: When *Azygia gotoi* (as *A. anguillae*) was described, Ozaki (1924: 426) reported that another trematode beloging to the family Hemiuridae occurred in the stomach of *A. japonica*. No description of this trematode is yet available.

Isoparorchis eurytremus (Kobayashi, 1915) Shimazu, Cribb, Miller, Urabe, Ha, Binnh and Shed'ko, 2014 (FW)

Synonym: *Isoparorchis hypselobagri* (Billet, 1898)

Previous identification: *Isoparorchis hypselobagri* of Nagasawa *et al.*, 2013

Host: *Anguilla japonica*

Sites of infection: stomach wall tissue, mesentery, outer surface of airbaldder wall

Distribution: Shimane, Ehime

Record: Nagasawa *et al.* 2013 (Shimane: Lake Shinji, Lake Nakaumi; Ehime: Sozu River)

Remarks: Information on this species (as *I. hypselobagri*) is available in Nagasawa *et al.* (2013).

Lasiotocus sp. (M)

Host: *Anguilla japonica*

Site of infection: intestine (digestive tract)

Distribution: Aomori, Chiba

Records: 1. Iwashita *et al.* 2003 (Chiba: mouth of the Tone River); 2. Shimazu 2005 (Aomori: Lake Ogawara)

Remarks: This species has been suggested to be a marine parasite (Iwashita *et al.*, 2003).

Lecithochrium musculus (Looss, 1907) Nasir and Diaz, 1971 (M)

Synonym: *Sterrhurus musculus* Looss, 1907

Previous identification: *Sterrhurus musculus* of Yamaguti, 1934a

Host: *Anguilla japonica*

Site of infection: stomach

Distribution: Mie, unspecified prefecture facing the Seto Inland Sea

Record: Yamaguti 1934a (Mie: Ise Bay; unspecified prefecture: Seto Inland Sea [as Inland Sea])

Remarks: The identification of this trematode by Yamaguti (1934a) needs confirmation (Gibson and Bray, 1986: 83-90).

Metagonimus spp. (metacercaria) (FW)

Host: *Anguilla japonica*

Site of infection: fins

Distribution: Shizuoka

Records: 1. Ito and Mochizuki 1968 (Tenryu River); 2. Ito 1968 (Tenryu River)

Palaeorchis diplorchis (Yamaguti, 1936) Szidat, 1943 (FW)

Host: *Anguilla japonica*

Site of infection: stomach

Distribution: Shiga

Records: 1. Shimazu *et al.* 2011 (Omatsu); 2. Shimazu 2016a (Omatsu)

Proctotrematoides pisodontophidis Yamaguti, 1938 (M)

Host: *Anguilla japonica*

Site of infection: intestine

Distribution: Chiba

Record: Hoshina 1951b (Urayasu)

Pseudophyllodistomum macrobrachicola (Yamaguti, 1934) Cribb, 1987 (FW)

Previous identification: *Phyllodistomum anguilae* of Shimazu, 2005, 2007, 2008

Host: *Anguilla japonica*

Sites of infection: urinary bladder, intestine

Distribution: Aomori, Nagano, Ibaraki, Shiga, Tokushima

Records: 1. Shimazu 2005 (Aomori: Lake Ogawara; Ibaraki: Tsuchiura); 2. Shimazu 2007 (Nagano: Lake Suwa); 3. Shimazu 2008 (Tokushima: Kaifu River); 4. Shimazu *et al.* 2011 (Shiga: Momose); 5. Shimazu 2014a (Aomori: Lake Ogawara; Nagano: Lake Suwa; Ibaraki: Tsuchiura; Shiga: Labe Biwa basin; Tokushima: Kaifu River)

Tubulovesicula anguillae Yamaguti, 1934 (M)

Host: *Anguilla japonica*
Site of infection: stomach
Distribution: Miyagi
Record: Yamaguti 1934a (Matsushima Bay [as Matusima Bay])

Tubulovesicula sp. (M)

Host: *Anguilla japonica*
Site of infection: stomach
Distribution: Chiba
Record: Iwashita *et al.* 2003 (mouth of the Minato River)
Remarks: This species has been suggested to be a marine parasite (Iwashita *et al.*, 2003).

Monogenea

Gyrodactylus anguillae Ergens, 1960 (FW)

Host: *Anguilla anguilla*
Sites of infection: skin, gills
Distribution: Shizuoka
Record: Ogawa and Egusa 1980 (Maisaka)
Remarks: This species was introduced into Japan with *A. anguilla* from France (Ogawa and Egusa, 1980). Hayward *et al.* (2001) showed the current worldwide distribution of the species. Ogawa and Egusa (1978) redescribed it based on the specimens from England.

Gyrodactylus egusai Ogawa and Hioki, 1986 (FW)

Host: *Anguilla japonica*
Site of infection: skin
Distribution: Shizuoka
Record: Ogawa and Hikoki 1986 (Yoshida)

Gyrodactylus joi Ogawa and Hioki, 1986 (FW)

Host: *Anguilla japonica*
Site of infection: skin
Distribution: Shizuoka
Record: Ogawa and Hikoki 1986 (Yoshida)

Gyrodactylus nipponensis Ogawa and Egusa, 1978 (B)

Host: *Anguilla japonica*
Site of infection: gills
Distribution: Chiba, Shizuoka, Tokushima, Miyazaki
Records: 1. Ogawa and Egusa 1978 (Shizuoka:–; Tokushima:–); 2. Ogawa and Egusa 1980 (Chiba:–; Shizuoka:–; Tokushima:–; Miyazaki:–); 3. Hayward *et al.* 2001 (Chiba: Minato River; Shizuoka: Lake Hamana)

Remarks: This monogenean appears to have been introduced into Japan on eels imported from elsewhere in the Indo-western Pacific region, perhaps originating in Southeast Asia (Hayward *et al.*, 2001: 422). This species prefers brackish waters (Hayward *et al.*, 2001: 422).

Gyrodactylus sp. (FW)

Host: *Anguilla japonica*

Site of infection: gills

Distribution: Shizuoka

Record: Ushiyama and Misaki 1977 (suburb of Hamamatsu)

Remarks: There is no information on the morphology and taxonomy of this gyrodactylid. Identification needs to be confirmed in comparison with the above four species of *Gyrodactylus* reported from eels in Japan.

Pseudodactylogyrus anguillae (Yin and Sproston, 1948) Gusev, 1965 (FW)

Synonym: *Pseudodactylogyrus microrchis* Ogawa and Egusa, 1976

Previous identification: *Pseudodactylogyrus microrchis* of Ogawa and Egusa, 1976; Imada and Muroga, 1977, 1978, 1979

Hosts: *Anguilla anguilla* (1, 2, 3, 4, 5, 7, 9, 10, 11)
Anguilla japonica (5, 6, 11, 12, 14)
Anguilla marmorata (13)
Anguilla sp. (8)

Site of infection: gills

Distribution: Chiba, Shizuoka, Aichi, Hiroshima, Tokushima, Ehime, Kagoshima

Records: 1. Ogawa and Egusa 1976 (Chiba:–; Shizuoka:–); 2. Imada and Muroga 1977 (Hiroshima: Hiroshima University); 3. Imada and Muroga 1978 (Hiroshima: Hiroshima University); 4. Imada and Muroga 1979 (Hiroshima: Hiroshima University); 5. Ogawa *et al.* 1985a (Chiba:–; Aichi:–; Tokushima:–); 6. Horiuchi *et al.* 1988 (Shizuoka: eel pond); 7. Iwashita *et al.* 2002 (Shizuoka: Maisaka); 8. Hayward 2004 (Aichi:–; Kagoshima: Yaku Island); 9. Yoshikawa 2005 (Shizuoka: Hamanako Branch of Shizuoka Pref. Fish. Exp. St.); 10. Umeda *et al.* 2006 (Kagoshima: Ibusuki Branch of Kagoshima Pref. Fish. Center); 11. Fang *et al.* 2008 (experimental infection); 12. Katahira *et al.* 2012 (Ehime: Renjoji River, Sozu River); 13. Katahira and Nagasawa 2014 (Ehime: Renjōji River); 14. Ogawa *et al.* 2015 (Shizuoka: Yoshida)

Remarks: Ogawa *et al.* (1985a) synonymized *P. microrchis* as a junior synonym of *P. anguillae*.

Pseudodactylogyrus bini (Kikuchi, 1929) Gusev, 1965 (FW)

Original combination: *Dactylogyrus bini* Kikuchi, 1929

Previous identification: *Dactylogyrus bini* of Kikuchi, 1929

Hosts: *Anguilla anguilla* (2, 4, 6)
Anguilla japonica (1, 5, 6, 7, 9)
Anguilla marmorata (8)
Anguilla sp. (3)

Site of infection: gills

Distribution: Chiba, Shizuoka, Aichi, Ehime, Kagoshima

Records: 1. Kikuchi 1929 (–); 2. Ogawa and Egusa 1976 (Chiba:–; Shizuoka:–); 3. Hayward 2004 (Aichi:–; Kagoshima: Yaku Island); 4. Umeda *et al.* 2006 (Kagoshima: Ibusuki Branch of Kagoshima Pref. Fish. Center); 5. Sato and Tanaka 2007 (Shizuoka: near Lake Hamana); 6. Fang *et al.* 2008 (experimental infection); 7. Katahira *et al.* 2012 (Ehime: Renjoji River, Sozu River); 8. Katahira and Nagasawa 2014 (Ehime: Renjōji River); 9. Ogawa *et al.* 2015 (Shizuoka: Yoshida)

Pseudodactylogyrus kamegaii Iwashita, Hirata and Ogawa, 2002 (B)

Host: *Anguilla japonica*

Site of infection: gills

Distribution: Chiba, Ehime

Records: 1. Iwashita *et al.* 2002 (Chiba: Minato River); 2. Katahira *et al.* 2012 (Ehime: Misho Cove, Renjoji River, Sozu River); 3. Ogawa *et al.* 2015 (Chiba: Minato River)

Remarks: This species was found on *A. japonica* collected in brackish waters (Iwashita *et al.*, 2002; Katahira *et al.,* 2012).

Pseudodactylogyrus mundayi Ogawa, Iwashita, Hayward and Kurashima, 2015 (FW)

Host: *Anguilla australis*

Site of infection: gills

Distribution: Shizuoka

Record: Ogawa *et al*. 2015 (Shizuoka: Hamamatsu)

Remarks: This species was recovered from *A. australis* which had been caught in Tasmania and then shipped alive to Japan (Ogawa *et al*., 2015).

Pseudodactylogyrus spp. (FW)

Includes: *Dactylogyrus* sp. of Kikuchi, 1929; Egusa and Ahmed, 1970; Egusa, 1970, 1971; Oka, 1973a; Hatai and Egusa, 1973; Ushiyama and Misaki, 1977 (as "*Dactylogirus*")

Pseudodactylogyrus bini or *P. anguillae* of Tanaka and Sato, 2007; Sato and Tanaka, 2007

Pseudodactylogyrus bini and *P. anguillae* of Tanaka *et al.*, 2009

Pseudodactylogyrus sp. of Niwa, 1979

"*Pseudodactylogyrus* sp. ang. 4" of Hayward, 2004

Hosts: *Anguilla anguilla* (2, 4, 5, 6, 8, 10)

Anguilla japonica (1, 3, 7, 11, 12, 13)

Anguilla sp. (9)

Site of infection: gills

Distribution: Shizuoka, Kagoshima

Records: 1. Kikuchi 1929a (–); 2. Egusa and Ahmed 1970 (Shizuoka: Yaizu); 3. Egusa 1970 (Shizuoka: Yoshida); 4. Egusa 1971 (–); 5. Oka 1973a (Shizuoka: near Lake Hamana); 6. Hatai and Egusa 1973 (Shizuoka: Yaizu, Yoshida); 7. Ushiyama and Misaki 1977 (Shizuoka: suburb of Hamamatsu); 8. Niwa 1979 (–); 9. Hayward 2004 (Kagoshima: Yaku Island); 10. Yoshikawa *et al.* 2006 (Shizuoka: Hamana Branch of Shizuoka Pref. Fish. Exp. St.); 11. Tanaka and Sato 2007 (Shizuoka: near Lake Hamana); 12. Sato and Tanaka 2007 (Shizuoka: near Lake Hanama); 13. Tanaka *et al.* 2009 (Shizuoka: Hamanako Branch of Shizuoka Pref. Fish. Exp. St.)

Unidentified Monogenea (FW)

Includes: *Gyrodactylus* sp. or *Dactylogyrus* sp. of Nishio *et al.*, 1970
"monogenetic trematodes" of Shimazu, 1979

Hosts: *Anguilla anguilla* (1)
Anguilla japonica (1, 2)

Site of infection: gills

Distribution: Nagano, Shizuoka

Records: 1. Nishio *et al.* 1970 (Shizuoka: Yoshida); 2. Shimazu 1979 (Nagano: Lake Kizaki)

Cestoda

Bothriocephalus claviceps (Goeze, 1782) Rudolphi, 1810 (FW)

Host: *Anguilla japonica* (?)

Site of infection: intestine

Distribution: Shiga

Record: Scholz *et al.* 2004 (Shiga: Lake Biwa)

Remarks: Identification of the eel from Lake Biwa examined by Scholz *et al.* (2004) was uncertain: these authors tentatively identified the fish as *A. japonica* but it may be identified as *A. anguilla*. If the eel was actually the latter species, the cestode may have been introduced into the lake via imported fish from overseas (Scholz *et al.*, 2004).

Bothriocephalus japonicus Yamaguti, 1934 (FW)

Previous identification: *Bothriocephalus claviceps* of Luo *et al.*, 2002

Host:s *Anguilla japonica* (1, 2, 4)
Anguilla marmorata (3, 4)

Site of infection: intestine

Distribution: Ibaraki, Nagano, Gifu, Shiga, Kagoshima

Records: 1. Yamaguti 1934b (Ibaraki: Lake Kasumiga-ura [as "Kasumiga-ura"]); 2. Anonymous 2002 (Gifu: a tributary of the Kiso River); 3. Luo *et al.* 2002 (Kagoshima: Yaku Island [as Yako Island]); 4. Scholz *et al.* 2004 (Ibaraki: Kasumiga-ura; Nagano: Lake Suwa; Shiga: Lake Biwa; Kagoshima: Yaku Island)

Remarks: The cestode reported as "*Bothriocephalus claviceps*" by Luo *et al.* (2002) was re-identified as *B. japonicus* by Scholz *et al.* (2004). In the 2007 version of this checklist (Nagasawa *et al.*, 2007: 103), "*Bothriocephalus claviceps*" reported by Luo *et al.* (2002) was listed as the species, but it was wrong (Nagasawa, 2015: 98-99). Information on this cestode is available from Shimazu (1997) and Scholz *et al.* (2004). The scientific name was misspelled "*japonicum*" in Anonymous (2002).

Bothriocephalus sp. (FW)

Host: *Anguilla japonica*

Site of infection: intestine

Distribution: Nagano

Record: Shimazu 1979 (Lake Kizaki)

Remarks: There is no morphological and taxonomic information on this cestode (Shimazu, 1979: 230, footnote).

Nybelinia anguillicola Yamaguti, 1952 (larva) (M)

Previous identification: *Nybelinia* sp. of Yamaguti, 1934

Host: *Anguilla japonica*

Site of infection: encysted in submucosa of intestine

Distribution: Mie

Records: 1. Yamaguti 1934b (Kuki); 2. Yamaguti 1952 (Kuki)

Unidentified Cestoda (FW)

Host: *Anguilla japonica*

Site of infection: intestine

Distribution: Shizuoka

Record: Ushiyama and Misaki 1977 (suburb of Hamamatsu)

Remarks: There is no information on the morphology and identification of this cestode. It was frequently found from June to September in cultured *A. japonica* (Ushiyama and Misaki, 1977).

Nematoda

Anguillicola crassus Kuwahara, Niimi and Itagaki, 1974 (FW)

Previous identification: *Angullicola globiceps* of Egusa *et al.*, 1969

Anguillicola crassa of Hirose *et al.*, 1976; Egusa, 1979; Niwa, 1979

Anguillicola (*Angullicoloides*) *crassus* of Moravec and Taraschewski, 1988

Includes: *Anguillicola japonica* of Matsui, 1972

Anguillicola sp. of Egusa and Ahmed, 1970; Ushiyama and Misaki, 1977

"swimbladder nematode" of Egusa, 1970

Hosts: *Anguilla anguilla* (1, 2, 5, 6, 9, 10, 11)

Anguilla japonica (1, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21)

Site of infection: swimbladder

Distribution: Chiba, Tokyo, Shizuoka, Gifu, Aichi, Mie, Wakayama, Okayama, Tokushima, Oita, Miyazaki, Okinawa

Records: 1. Egusa *et al.* 1969 (Shizuoka: Yoshida); 2. Egusa and Ahmed 1970 (Shizuoka: Yaizu); 3. Egusa 1970 (Shizuoka: Yoshida); 4. Matsui 1972 (–); 5. Kuwahara *et al.* 1974 (Shizuoka: near Hamamatsu); 6. Hirose *et al.* 1976 (Shizuoka:–; Aichi:–); 7. Ushiyama and Misaki 1977 (Shizuoka: suburb of Hamamatsu); 8. Egusa 1978 (Chiba: eel farm, Lake Inba-numa, Tone River; Shizuoka: eel farm, Lake Hamana; Aichi: eel farm; Mie: eel farm; Okayama: Kojima Bay; Tokushima: eel farm; Oita: eel farm; Miyazaki: Oyodo River; Miyazaki: eel farm; Okinawa: eel farm); 9. Egusa 1979 (–); 10. Niwa 1979 (–); 11. Moravec and Taraschewski 1988 (Shizuoka [erroneously as "Shizuka"]:–); 12. Nagasawa 1991 (Aichi:–); 13. Inui *et al.* 1998 (Shizuoka:–); 14. Hirose *et al.* 1998 (Aichi: Mikawa); 15. Ushikoshi *et al.* 1999 (–); 16. Inui *et al.* 1999 (Shizuoka:–); 17. Anonymous 2002 (Gifu: a tributary of the Kiso River); 18. Moravec *et al.* 2005 (Aichi: Isshiki); 19. Rahhou *et al.* 2005 (Tokyo: Katsushika [as 35°45′N, 139°50′E]); 20. Wielgoss

et al. 2008 (Aichi: Mikawa Bay; Yamaguchi: Fushino); 21. Laetsch *et al.* 2012 (Wakayama: "natural water system")

Remarks: The biology of this nematode was reviewed by Nagasawa *et al.* (1994) and Moravec (2006). Information on the species is also available from Shimazu (1998). A brief note on the nematode is also published by Salati (1987). Although Matsui (1972: 571) stated infection of "*Anguillicola japonica*" in the "gall bladder" of *Anguilla japonica*, the worm is identifiable as *A. crassus*, based on a picture (fig. 27.36) shown by him (see Nagasawa *et al.*, 1994: 128). The records (Inui *et al.*, 1998, 1999) were based on the species from *A. japonica* imported from Taiwan to Japan. Information on the life cycle of the nematode in Japan is available in Hirose *et al.* (1976) and Moravec *et al.* (2005). The distribution of the species in Japan is shown by Lefevre *et al.* (2012).

Anguillicola globiceps Yamaguti, 1935 (FW)

Hosts: *Anguilla japonica* (1, 2, 3, 4, 5, 7, 8)
Anguilla sp. (*A. japonica* ?)(6)

Site of infection: swimbladder

Distribution: Aomori, Nagano, Chiba, Shizuoka, Aichi, Wakayama, Okayama

Records: 1. Yamaguti 1935b (Shizuoka: Lake Hamana); 2. Suyehiro 1957 (Okayama:–); 3. Egusa 1978 (Shizuoka:–; Aichi:–); 4. Egusa 1979 (–); 5. Shimazu 1979 (Aomori: Lake Hira-numa, Nagano: Lake Kizaki); 6. Moravec and Taraschewski 1988 (–); 7. Hirose *et al.* 1998 (Chiba: Tone River); 8. Laetsch *et al.* 2012 (Wakayama: "natural water system")

Remarks: The biology of this nematode was reviewed by Nagasawa *et al.* (1994) and Shimazu (1998). A brief review on *Anguillicola* is available in Salati (1987). Although Egusa *et al.* (1969) reported *A. globiceps* from Japanese eels cultured in Shizuoka, Hirose *et al.* (1976: 27, footnote) reported that Egusa *et al.*'s worms were not *A. globiceps* but *A. crassus*. The latter authors also mentioned that the morphology of the worms collected at an eel farm in Mishima, Shizuoka was similar to that of *A. globiceps*. The distribution of the species in Japan is shown by Lefevre *et al.* (2012).

Cucullanus filiformis Yamaguti, 1935 (M)

Host: *Anguilla japonica*

Site of infection: intestine

Distribution: Mie

Record: Yamaguti 1941 (Hamajima)

Remarks: This nematode was originally reported from the conger eel *Conger myriaster* in Japan (Yamaguti, 1935b).

Gnathostoma spinigerum Owen, 1836 (larva) (FW)

Host: *Anguilla japonica*

Sites of infection: musculature, viscera

Distribution: Kagawa, Fukuoka, Kumamoto

Records: 1. Nagao 1956 (Fukuoka: Mizuma); 2. Isobe 1956 (Kumamoto: Yoshima, Tensui); 3. Kikuchi 1956 (experimental infection); 4. Irie 1958 (Kagawa:–); 5. Isobe 1962 (Kumamoto: Kikuchi River); 6. Miyazaki 1963 (unspecified prefecture in Kyushu:–); 7. Miyazaki 1966 (unspecified prefecture in Kyushu:–)

Heliconema anguillae Yamaguti, 1935 (B)

Previous identification: *Heliconema longissimum* of Katahira *et al.*, 2011

Host: *Anguilla japonica*

Site of infection: stomach

Distribution: Ehime, Saga, Kagoshima

Records: 1. Yamaguti 1935b (–); 2. Matsui 1972 (–); 3. Katahira *et al.* 2011 (Ehime: Misho Cove, Renjoji River); 4. Katahira and Nagasawa 2015 (Ehime: Misho Cove); 5. Kan *et al.* 2016 (Saga: innermost part of the Ariake Sea; Kagoshima: Shin-kawa River estuary); 6. Katahira *et al.* 2016 (Ehime: Misho Cove)

Remarks: Matsui (1972: fig. 27.33) showed pictures of the stomach of *A. japonica* heavily infected with this nematode. Information on the nematode is available from Shimazu (1998). Intertidal crabs serve as the intermediate hosts for the species (Katahira and Nagasawa, 2015; Kan *et al.*, 2016). Its seasonal infection dymamics in *A. japonica* was clarified by Katahira *et al.* (2016).

Heliconema sp. (?)

Host: *Anguilla japonica*

Site of infection: digestive tract

Distribution: Okayama

Record: Suyehiro 1957 (–)

Remarks: The morphology of this nematode is different from that of *H. anguillae* (Suyehiro, 1957).

Philometroides anguillae (Ishii, 1916) Rasheed, 1963 (FW)

Original combination: *Filaria anguillae* Ishii, 1916

Previous identification: *Filaria anguillae* of Ishii, 1916; Ishii, 1931

Host: *Anguilla japonica*

Site of infection: orbit

Distribution: Tokyo, Aichi

Records: 1. Ishii 1916a (Tokyo: Fukagawa-Fuyuki; Aichi: Toyohashi); 2. Ishii 1931 (Tokyo: Fukagawa-Fuyuki; Aichi: Toyohashi)

Remarks: Yamaguti (1935b) suggested that "*Filaria anguillae*" described by Ishii (1916a) should be placed in the genus *Philometra*. Later, Rasheed (1963) transferred it to the genus *Philometroides*. Matsui (1972: 584) mistakenly reported the species as "*Philometra parasiluri*." Information on the species is available from Shimazu (1998) and Moravec (2006: 425-427).

Raphidascaris acus (Bloch, 1779) Railliet and Henry, 1915 (FW)

Host: *Anguilla japonica*

Site of infection: intestine

Distribution: Shiga

Record: Grygier and Urabe 2003 (Lake Biwa)

Remarks: This nematode is not native to Japan. It has been suggested that the nematode was introduced into Japan by the import of *A. anguilla* from overseas (Grygier and Urabe, 2003).

Unidentified Nematoda (?)
Host: *Anguilla japonica*
Site of infection: caecum
Distribution: unknown
Record: Shimazu and Araki 2006 (–)

Acanthocephala

Acanthocephalus gotoi Van Cleave, 1925 (FW)
Hosts: *Anguilla japonica* (1, 2, 3)
Anguilla marmorata (4)
Site of infection: intestine
Distribution: Tokyo, Aichi, Ehime
Records: 1. Van Cleave 1925 (Tokyo: fish market); 2. Yamaguti 1935a (various localities in Japan); 3. Fukui and Morisita 1936 (Aichi:–); 4. Katahira and Nagasawa 2014 (Ehime: Renjōji River)
Remarks: Information on this acanthocephalan is available from Shimazu (1999b).

Acanthocephalus longiacanthus Katahira and Nagasawa, 2014 (FW)
Host: *Anguilla marmorata*
Site of infection: intestine
Distribution: Ehime
Record: Katahira and Nagasawa 2014 (Renjōji River)

Echinorhynchus cotti Yamaguti, 1935 (FW)
Host: *Anguilla japonica*
Site of infection: [intestine]
Distribution: Shiga
Record: Amin *et al.* 2007 (Lake Biwa)
Remarks: Information on this acanthocephalan is available from Shimazu (1999b).

Longicollum alemniscus (Harada, 1935) Fuki and Morisita, 1937 (immature worm) (M)
Host: *Anguilla japonica*
Site of infection: [intestine]
Distribution: Aichi
Record: Fukui and Morisita 1937 (–)
Remarks: Information on this species is available in Fukui and Morisita (1938). While Petrochenko (1956) considered this species as a junior synonym of *Longicollum pagrosomi*, his suggestion has not been supported by Yamaguti (1963), Golvan (1969) and Amin (1985). Thus, the species is treated herein as a valid species.

Pseudorhadinorhynchus samegaiensis Nakajima and Egusa, 1975 (FW)
Host: *Anguilla japonica*
Site of infection: [intestine]

Distribution: Shiga
Record: Amin *et al.* 2007 (Lake Biwa)
Remarks: Information on this acanthocephalan is available from Shimazu (1999b).

Southwellina hispida (Van Cleave, 1925) Witenberg, 1932 (cystacanth) (FW)
Host: *Anguilla marmorata*
Site of infection: encapsulated in mesentery
Distribution: Ehime, Kagoshima
Records: 1. Katahira and Nagasawa 2014 (Ehime: Renjōji River); 2. Nagasawa and Kan 2017 (Kagoshima: Okinoerabu-jima Island)

Hirudinida

Batracobdella smaragdina (Oka, 1910) (FW)
Host: *Anguilla japonica*
Site of infection: skin
Distribution: Aichi, Kagoshima
Record: Ogawa *et al.* 1985b (Aichi: Isshiki; Kagoshima:–)
Remarks: While Soós (1967) regarded *Glossiphonia smaragdina* as a junior synonym of *Batracobdella paludosa,* Ogawa *et al.* (1985b) did not follow it.

Hemiclepsis marginata (O. F. Müller, 1774) Vedjovsky, 1884 (FW and B)
Host: *Anguilla japonica*
Site of infection: skin
Distribution: Aichi
Record: Nagasawa and Miyakawa 2006 (river near Akabane Port)
Remarks: Although this species usually occurs in fresh waters (Burreson, 2006), Nagasawa and Miyakawa (2006) found the specimens on elvers from brackish waters.

Limnotrachelobdella okae (Moore, 1924) Epshtein, 1968 (B)
Host: *Anguilla japonica*
Site of infection: skin
Distribution: Oita
Record: Nagasawa and Utsumi 2015 (lower reaches of the Katsura River)

Bivalvia

Hyriopsis schlegeli (Martens, 1861) (glochidium) (FW)
Host: *Anguilla japonica*
Sites of infection: gills, fins
Distribution: Shiga
Record: Furukawa and Kobayashi 1966 (experimental infection)

COPEPODA

Lernaea cyprinacea Linnaeus, 1758 (FW)

Original combination: *Lernaea* (*Lernaeocera*) *elegans* Leigh-Sharpe, 1925

Previous identification: *Lernaea elegans* of Matsui and Kumada, 1928; Nakai and Kokai, 1931

Includes: *Lernaea* sp. of Egusa, 1958; Niwa, 1979

Hosts: *Anguilla anguilla* (11)

Anguilla japonica (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)

Sites of infection: buccal cavity, nostril, orbit, fins

Distribution: Chiba, Shizuoka, Aichi, Mie, Okayama, Hyogo, Shimane, Miyazaki

Records: 1. Leigh-Sharpe 1925 (Aichi: Kitajima near Toyohashi); 2. Matsui and Kumada 1928 (Shizuoka: on the coast of Lake Hamana; Aichi: near Toyohashi, Hekikai County); 3. Nakai and Kokai 1931 (Chiba:–); 4. Yamaguti 1939 (Shizuoka [as "Sizuoka"]:–); 5. Kasahara 1957 (–); 6. Egusa 1958 (–: Fisheries Laboratory of the University of Tokyo, and adjacent fish ponds); 7. Kasahara 1958 (Shizuoka:–; Aichi: Toyohashi; Mie:–); 8. Kasahara 1959 (–); 9. Kasahara 1962 (Shizuoka:–; Aichi:–; Mie:–; Okayama:–; Hyogo:–; Shimane:–; Miyazaki:–); 10. Tsutsumi 1978 (–); 11. Niwa 1979 (–)

Remarks: Information on this copepod as a parasite of *A. japonica* is available from Matsui (1972).

HOST-PARASITE LIST

Anguilla japonica Temminck and Schlegel, 1847 Japanese eel, "nihon-unagi"

Sarcomastigophora

Cryptobia sp. (–)

Ichthyobodo sp. (–)

Trypanosoma sp. (Shizuoka)

Ciliophora

Ambiphrya sp. (–)

Apiosoma sp. (Shizuoka)

Capriniata piscium (Shizuoka)

Carchesium polypinum (Tokushima)

Chilodonella sp. (–)

Ichthyophthirius multifiliis (Shizuoka)

Trichodina acuta (Mie)

Trichodina jadranica (Mie)

Trichodina japonica (Mie)

Trichodina sp. (Shizuoka)

Microspora

Heterosporis anguillarum (Hokkaido, Kanagawa, Shizuoka, Aichi, Kagoshima)

Unidentified Microspora (Shizuoka)

Myxozoa

Myxidium giardi (Tokyo, Shizuoka, Miyazaki)

Myxidium lentiforme (Shiga)

Myxidium matsuii (Kanagawa, Shizuoka, Aichi)
Myxidium uchiyamae (Shiga)
Myxidium sp. (Shizuoka)
Myxobolus dermatobius (Tochigi, Shizuoka)
Myxobolus fujitai (Ibaraki)
Unidentified Myxozoa (Shizuoka, Gifu)

Trematoda
Azygia gotoi (Aomori, Ibaraki, Tokyo, Nagano, Shiga)
Bucephalus sp. (Chiba)
Centrocestus formosanus (Kagoshima)
Coitocaecum plagiorchis (Shiga)
Genarchopsis anguillae (Ibaraki)
Genarchopsis chubunsis (Nagano)
Genarchopsis gigi (Shiga)
Hemiuridae gen. sp. (Tokyo)
Isoparorchis eurytremus (Shimane, Ehime)
Lasiotocus sp. (Aomori)
Lecithochrium musculus (Mie, unspecified prefecture facing the Seto Inland Sea)
Metagonimus spp. (Shizuoka)
Palaeorchis diplorchis (Shiga)
Proctotrematoides pisodontophidis (Chiba)
Pseudophyllodistomum macrobrachicola (Aomori, Nagano, Ibaraki, Shiga, Tokusima)
Tubulovesicula anguillae (Miyagi)
Tubulovesicula sp. (Chiba)

Monogenea
Gyrodactylus egusai (Shizuoka)
Gyrodactylus joi (Shizuoka)
Gyrodactylus nipponensis (Chiba, Shizuoka, Tokushima, Miyazaki)
Gyrodactylus sp. (Shizuoka)
Pseudodactylogyrus anguillae (Chiba, Shizuoka, Aichi, Tokushima, Ehime)
Pseudodactylogyrus bini (Shizuoka, Ehime)
Pseudodactylogyrus kamegaii (Chiba, Ehime)
Pseudodactylogyrus spp. (Shizuoka)
Unidentified Monogenea (Shizuoka, Nagano)

Cestoda
Bothriocephalus claviceps (Shiga)
Bothriocephalus japonicus (Ibaraki, Nagano, Gifu, Shiga)
Bothriocephalus sp. (Nagano)
Nybelinia anguillicola (Mie)
Unidentified Cestoda (Shizuoka)

Nematoda
Anguillicola crassus (Chiba, Shizuoka, Gifu, Aichi, Mie, Wakayama, Okayama, Tokushima, Oita, Miyazaki, Okinawa)

Anguillicola globiceps (Aomori, Nagano, Chiba, Shizuoka, Aichi, Wakayama, Okayama)
Cucullanus filiformis (Mie)
Gnathostoma spinigerum (Kagawa, Fukuoka, Kumamoto)
Heliconema anguillae (Ehime, Saga, Kagoshima)
Heliconema sp. (Okayama)
Philometroides anguillae (Tokyo, Achi)
Raphidascaris acus (Shiga)
Unidentified Nematoda (–)

Acanthocephala
Acanthocephalus gotoi (various localities including Tokyo, Aichi, and Ehime)
Echinorhynchus cotti (Shiga)
Longicollum alemniscus (Aichi)
Pseudorhadinorhynchus samegaiensis (Shiga)

Hirudinida
Batracobdella smaragdina (Aichi, Kagoshima)
Hemiclepsis marginata (Aichi)
Limnotrachelobdella okae (Oita)

Bivalvia
Hyriopsis schlegeli (Shiga)

Copepoda
Lernaea cyprinacea (Chiba, Shizuoka, Aichi, Mie, Okayama, Hyogo, Shimane, Miyazaki)

Remarks: This Host-Parasite List shows that 50 nominal species of parasites have so far been reported from *Anguilla japonica*. They are distributed among Ciliophora (6 spp.), Microspora (1 sp.), Myxozoa (6 spp.), Trematoda (12 spp.), Monogenea (6 spp.), Cestoda (3 spp.), Nematoda (7 spp.), Acanthocephala (4 spp.), Hirudinida (3 spp.), Bivalvia (1 sp.), and Copepoda (1 sp.). Of these species, three species, *Gyrodactylus nipponensis* (Monogenea), *Bothriocephalus claviceps* (Cestoda), and *Raphidascaris acus* (Nematoda), were most probably introduced from overseas (Hayward *et al.*, 2001; Grygier and Urabe, 2003; Scholz *et al.*, 2004), and the remaining 47 species are native to Japan.

Based on their habitat, the 47 nominal species are categorized into two groups: 39 species as freshwater (FW) parasites, and eight species as marine (M) and/or brackish-water (B) parasites. Excluding *Nybelinia angullicola* (Cestoda) occurring as a larva, the following seven nominal species in the latter group parasitize *Anguilla japonica* as an adult: *Lecithochrium musculus*, *Proctotrematoides pisodontophidis*, *Tubulovesicula anguillae* (Trematoda), *Pseudodactylogyrus kamegaii* (Monogenea), *Cucullanus filiformis*, *Heliconema anguillae* (Nematoda), and *Limnotrachelobdella okae* (Hirudinida), and three of them, *T. anguillae*, *P. kamegaii*, and *H. anguillae*, are very likely to be host-specific. The introduced monogenean, *Gyrodactylus nipponensis*, is a brackish-water species. Three unidentified species of Trematoda, *viz*., *Bucephalus* sp., *Lasiotocus* sp., and *Tubulovesicula* sp., are also likely to be marine parasites. Since the Japanese population of *Anguilla japonica* includes individiduals known as "sea eels" and "estuarine eels" inhabiting coastal marine and riverine brackish waters (Tsukamoto *et al.*, 1998; Tsukamoto and Arai, 2001), these eels are considered to serve as hosts for the above (at least nine nominal) species of marine and/or brackish-water parasites.

Anguilla marmorata Quoy and Gaimard, 1824 Giant mottled eel, "ō-unagi"

Monogenea

Pseudodactylogyrus anguillae (Ehime)

Pseudodactylogyrus bini (Ehime)

Cestoda

Bothriocephalus japonicus (Kagoshima)

Acanthocephala

Acanthocephalus gotoi (Ehime)

Acanthocephalus longiacanthus (Ehime)

Southwellina hispida (Ehime, Kagoshima)

Remarks: Only six species of parasites have been reported from *Anguilla marmorata* in Japan. This is caused by the past insufficient investigation in Japan into the parasites of *Anguilla marmorata*, on which only two papers are available (Luo *et al*., 2002; Katahira and Nagasawa, 2014). As *Anguilla marmorata* is commonly found in the subtropical region of Japan, it is desiable to clarify the parasite fauna of the species from the region.

Acanthocephalus longiacanthus was described from *Anguilla marmorata* and has been reported only from this eel species (Katahira and Nagasawa, 2014), but, like other echinorhynchid acanthocephalans, *A. longiacanthus* does not appear to be host-specific. If this is true, no parasites which are specific to *Anguilla marmorata* have been reported from Japan to date because *Southwellina hispida* utilizes a variety of freshwater fishes as its paratenic hosts and the remaining four species of parasites also can infect *Anguilla japonica*.

Anguilla anguilla (Linnaeus, 1758) European eel, "yōroppa-unagi"

Sarcomastigophora

Cryptobia sp. (–)

Ichthyobodo sp. (–)

Ciliophora

Apiosoma sp. (Shizuoka)

Capriniata piscium (Shizuoka)

Chilodonella sp. (–)

Ichthyophthirius multifiliis (Shizuoka)

Trichodina sp. (Shizuoka)

Microspora

Heterosporis anguillarum (Shizuoka, Aichi, Kagoshima)

Myxozoa

Myxidium giardi (–)

Myxidium sp. (Shizuoka)

Monogenea

Gyrodactylus anguillae (Shizuoka)

Pseudodactylogyrus anguillae (Chiba, Shizuoka, Aichi, Hiroshima, Kagoshima)

Pseudodactylogyrus bini (Chiba, Shizuoka, Kagoshima)

Pseudodactylogyrus spp. (Shizuoka)

Unidentified Monogenea (Shizuoka)

Nematoda

Anguillicola crassus (Shizuoka)

Copepoda

Lernaea cyprinacea (–)

Remarks: Due to a shortage of *Anguilla japonica* elevers for pond culture in Japan, numerous elevers of *Anguilla anguilla* were imported from several European countries (mainly France) to Japan during the late 1960's and 1970's (Egusa, 1979; Tanaka, 1979). Currently, the elever import of the species from Europe has been very strictly regulated because it has been registered as a critically endangered species. The nine nominal species of parasites* listed herein were all reported from culured or experimentally reared *Anguilla anguilla* between the years 1969 and 2008 (Egusa *et al.*, 1969; Fang *et al.*, 2008). There is no recent work on the parasites of *Anguilla anguilla* in Japan. Although some individuals of the species have been reported from Japanese rivers and lakes (Zhang *et al.*, 1999; Okamura *et al.*, 2001), nothing is known about the parasites of those fish.

Anguilla australis Richardson, 1841 Short-finned eel

Monogenea

Pseudodactylogyrus mundayi (Shizuoka)

Remarks: As a pathway to import non-native eels alive to Japan, smoll-lot commercial tradings from Oceania currently exist (see Ogawa *et al*., 2015). Further attentions are needed to monitor introductions of non-indigenous parasites, accompanied with such international eel transportations, into Japan.

Anguilla sp.

Monogenea

Pseudodactylogyrus anguillae (Aichi, Kagoshima)

Pseudodactylogyrus bini (Aichi, Kagoshima)

Pseudodactylogyrus sp. (Kagoshima)

Nematoda

Anguillicola globiceps (–)

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* The number of parasite species reported from *Anguilla anguilla* in Japan was errorneously reported as 10 in Nagasawa *et al.* (2007: 91).

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日本産ウナギ類の寄生虫目録：追補改定版（1915–2017年）

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要　旨　1915-2017年の103年間に出版された文献に基づき，日本産ウナギ属魚類3種（ニホンウナギ *Anguilla japonica*，オオウナギ *Anguilla marmorata*，ヨーロッパウナギ *Anguilla anguilla*）と日本に輸入された *Anguilla australis* の寄生虫に関する情報を2つのリスト（寄生虫－宿主リスト，宿主－寄生虫リスト）に整理して目録を作成した。宿主のニホンウナギとオオウナギは在来種であり，ヨーロッパウナギはシラスウナギとして輸入され養殖された個体，*Anguilla australis* はオーストラリアから輸入された個体である。本目録は2007年に出版した同名目録の追補改定版である。本目録には，54名義種の寄生虫（繊毛虫類6種，微胞子虫類1種，ミクソゾア類6種，吸虫類12種，単生類8種，条虫類3種，線虫類7種，鉤頭虫類6種，ヒル類3種，二枚貝類1種，カイアシ類1種）に加えて，学名がまだ決定していない寄生虫の情報が含まれる。寄生虫－宿主リストでは，各寄生虫は高位分類群ごとに配列され，最新の学名，シノニム，寄生部位，地理的分布および報告者の情報が示されている。上記54名義種のうち，ニホンウナギから50種，オオウナギから6種，ヨーロッパウナギから9種，*Anguilla australis* から1種の寄生虫が報告されていた。単生類の *Gyrodactylus anguillae*，*Gyrodactylus nipponensis* および *Pseudodactylorgyrus mundayi*，条虫類の *Bothriocephalus claviceps*，線虫類の *Raphidascaris acus* は海外から持ち込まれたと推察されており，残りの49名義種が日本にもともと分布するものである。ニホンウナギから報告された寄生虫のうち，9名義種（*Lecithochrium musculus*, *Proctotrematoides pisodontophidis*, *Tubulovesicula anguillae*［吸虫類］, *Gyrodactylus nipponensis*, *Pseudodactylogyrus kamegaii*［単生類］, *Nybelinia angullicola*［条虫類］, *Cucullanus filiformis*, *Heliconema anguillae*［線虫類］, *Limnotrachelobdella okae*［ヒル類］）は海産または汽水産であり，海ウナギや河口ウナギとして知られる個体がそれら寄生虫の宿主になっていると考えられる。

キーワード：オオウナギ，寄生虫，ニホンウナギ，目録，ヨーロッパウナギ，*Anguilla australis*