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A Subsequent Monograph of Cercariae in Japan (1962 – 1988)

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Introduction

About ninety years have passed since the study on cercariae was initiated by Osafune in 1898 in Japan. In 1962 the author reviewed the results of cercarial investigations carried out during the period from 1898 to 1961, entitled as "A Monograph of Cercariae in Japan and Adjacent Territories" in Japanese, which was translated into English in 1964. Both of these works were published by the Meguro Parasitological Museum, Tokyo. In those publications more than 160 species of cercariae from Japan and adjacent territories were listed and illustrated, citing 214 references.

Since then, more than 200 scientific works including original papers and abstracts of annual meetings of the Japanese Society of Parasitology, have been published up to the present. From these works 22 new species of cercariae were added, six species were newly reported without specific names, and 43 already known species were morphologically and/or ecologically investigated. These investigations during the period 1962–1988 include the following: 1) studies of the host-parasite relationship between snail hosts and cercariae, 2) surveys of dermatitis-producing cercariae in the endemic areas of paddy field dermatitis, 3) morphological observations of cercariae using not only the light microscope, but also using the electron microscope, 4) studies of marine cercariae describing or redescribing 12 species of cercariae.

With regard to the studies of host-parasite relationships, many experiments have been carried out on exposing snails to miracidia of trematodes, especially of *Paragonimus* spp. and *Schistosoma japonicum*. Detailed observations between trematodes and snails were extended not only to the difference in species but also to that in strains or localities.

As for paddy field dermatitis in Japan, following the initial report of Tanabe (1948), the occurrence of such dermatitis has been subsequently reported in about 40 papers throughout 20 prefectures. As a result, the causative agents were attributed to bird schistosome cercariae such as *Giganthobilharzia* spp. and *Trichobilharzia* spp. At present, discussion on the specific name of these cercariae is resulting in some agreement among researchers.

As far as the morphological study is concerned, many scanning and transmission electron microscope observations have been made on several parasites, including cercariae. Researchers have investigated mainly *Paragonimus* spp. and *Metagonimus* spp., hypothesizing that differences would exist between the species, but so far only a few differences have been observed.

Though there were very few studies on marine cercariae in Japan, Shimura and his co-workers extensively investigated marine cercariae during the period 1980–1984. Unfortunately he could not continue these studies because of a change in employment. It is hoped that future studies of marine cercariae will be forthcoming.

Investigations on cercarial fauna have also been carried out in several localities such as Fukuoka, Shimane, Akita, Aomori, Iwate, Yamagata, Hiroshima, Yamanashi, Hokkaido, Fukui, Kanagawa, and Kagawa. In spite of discovering several different species of cercariae, those cercariae were merely numbered in some reports as No. 1, No. 2, *etc.* Careful morphological observation is necessary for identification, if not so, such records are of little assistance for others.

In the present monograph, each study on the period 1962–1988 is mentioned in chronological order, and reviewed with a short explanation. Next, following the style of the former monograph of 1964, 22 new species and six non named species are listed with brief

notes and illustrations. Then, additional new data on the already known 43 species of cercariae are introduced together with the data in the former monograph. A list of snail hosts and their cercariae is also presented. In the last section, 204 references, including the original papers and the abstracts of annual meetings, are listed in alphabetical order. However, some abstracts are omitted when the same authors have reported the same results in another paper.

Chronological Review of References on Cercariae in Japan

(Parenthesized number on the end of line indicates the number of reference in the bibliography.)

1962:

"A Monograph of Cercariae in Japan and Adjacent Territories" was published by the Meguro Parasitological Museum, Tokyo. In this monograph, all cercariae reported in the period of 1898–1961 were listed into 161 species, including 28 non-named cercariae. Notes on locality, host, parthenita, cercaria, life cycle, and reference were made on each species of cercariae with a illustration. Moreover a detailed explanation on the method for investigation of cercariae, on the morphology of cercariae, on the classification of cercariae was added as well as a list of snail host and 214 references. This monograph was much useful for further studies on cercariae[52].

1963:

Kawashima and Miyazaki reported that the miracidia of *Paragonimus ohirai* can develop into cercariae in the snail, *Oncomelania nosophora* experimentally. In all of 63 snails examined between 123–134 days after exposure, 2nd generation rediae and mature cercariae were obtained[80,71].

Kawashima and Miyazaki subsequently reported the experimental infection of *Oncomelania nosophora* with *Paragonimus iloktsuenensis*. Between 207 and 228 days after exposure, rediae and cercariae were found in four out of five snails examined. In another experiment, rediae and cercariae were found in seven out of 11 snails between 92 and 127 days after exposure[81].

1964:

"A Monograph of Cercariae in Japan and Adjacent Territories" was translated into English and published by the Meguro Parasitological Museum again[53].

Hamajima and Ishii examined 8500 snails of *Semisulcospira libertina* in Fukuoka Prefecture, and discovered 15 species of cercariae. Those were, *Centrocestus armatus, Cercaria yoshidae, Acanthatrium hitaensis, Pseudexorchis major, Metagonimus yokogawai, Cercaria incerta, Centrocestus nycticoracis, Echinochasmus tobi, Cercaria nipponensis, Cercaria manei, Cercaria innominatum, Paragonimus westermani, Cercaria libertina, Cercaria monostyloides,* and *Notocotylus magniovatus.* Seasonal fluctuation and sex difference in the infection rate of those cercariae were reported[21].

Kawashima and Miyazaki reported *Oncomelania nosophora* was served as a snail host of *Paragonimus miyazakii* experimentally. Rediae and cercariae were found in 86 days or 99 days after exposure. The natural intermediate small host was not known until that time, because this paragonimus was proposed as a new species only three years before. This report was therefore the first one on the cercaria of *P. miyazakii*[82].

Kawashima and Miyazaki also proved in five experiments that the miracidia of *Paragonimus westermani* could not develop into rediae or into cercariae in the body of *Oncomelania nosophora*[83].

1965:

No original report was published, but several available abstracts were given at annual meetings.

Yasuraoka studied the photokinesis and thigmokinesis on two species of cercariae, *Clonorchis sinensis* and *Holostephanus nipponicus*[196].

Kawashima made a detailed observation on the development of larval stages of *Paragonimus ohirai* in the body of *Oncomelania nosophora* by serial sections[72].

Miyazato and others reported the occurrence of rice-field dermatitis in Yamaguchi Prefecture. Through the examination of many snails, *Lymnaea japonica,* they detected one species of furcocercous cercaria which was identified as *Trichobilharzia physellae*[117].

Itagaki observed the behavior of cercaria of *Fasciola* sp., especially the place of encystment[49].

Kagei and others studied the cercarial fauna of *Semisulcospira libertina* in Shimane Prefecture, detecting 12 species of cercariae including *Metagonimus yokogawai*[60].

Iwakura and Tanikawa reported on the decrease of infection rates of cercariae and metacercariae of *Paragonimus westermani* during 1958–1965 in Miyazaki Prefecture, and discussed for this reasons[58].

1966:

Hatsushika and others, after trying many researches, discovered a paragonimid cercaria from a very minute snail, *Bythinella (Moria) nipponica akiyoshiensis* in Yamaguchi Prefecture. After comparing the morphology of the cercaria with that reported by Kawashima and Miyazaki (1964), they identified it as *Paragonimus miyazakii.* This is therefore the first report of a natural snail host of *P. miyazakii*[35].

Miyazato and others reported again the result of further investigations of *Lymnaea japonica* in the endemic areas of rice-field dermatitis in Yamaguchi Prefecture[118].

1967:

Hatsushika made a comprehensive study on the morphology and ecology of all stages of *Paragonimus miyazakii*, namely on the stages of adult, egg, miracidium, redia, cercaria and metacercaria. He also stated that there are slight differences in the shape of pharynx and intestine of redia between *P. miyazakii* and *P. westermani*[32].

Komiya and Ito redescribed *Cercaria longissima* obtained from *Oncomelania nosophora* in Yamanashi Prefecture. They added many new morphological facts, especially on the sensory hairs and the excretory systems to the original description made by Suzuki and Nishio (1914)[90].

Komiya described a new species of cercaria, *Cercaria miyagiensis* from *Parafossarulus manchouricus* in Miyagi Prefecture. This cercaria is a gymnocephalous one of the echinostome type, and the first report on this type of snail[88].

Komiya and Enomoto found a brevifurcate monostome furcocercaria from *Parafossarulus manchouricus* in Saitama Prefecture. They succeeded in experimental infection of a fresh water fish, *Pseudorasbora parva* with the cercariae, and proved the metacercaria of *Holostephanus nipponicus* can develop in the muscle of the fish. A detailed morphology of the cercaria and the development of its metacercaria was described[89].

Hayano and others reported on the occurrence of paddy field dermatitis in Saitama Prefecture. They examined the snails, *Physa acuta* and *Lymnaea ollula,* but could not detected any dermatitis producing cercariae[36].

Hashiguchi observed that 7.9% of *Bythinella (Moria) nipponica akiyoshiensis* were infected with paragonimus-like cercariae in Fukuoka Prefecture. He doubted whether this cercaria is identifiable as *Paragonimus miyazakii* or not, because only 2% of crabs were infected with the metacercaria of *P. miyazakii* in the same areas. So he refrained from identification at that time. It is possible that *Cercaria* sp. described by Hatsushika and Maejima (1978), or by Gyoten (1931) may correspond to this cercaria[25].

Hashiguchi carried out the experimental infection of a snail, *Bythinella (Moria) nipponica akiyoshiensis* with the miracidia of *Paragonimus miyazakii.* Seventy days after exposure, cercariae were found in 85.7% of the snail examined[26].

Hamajima detected cercariae of *Paragonimus* sp. in a fresh water snail, *Tricula minima* on

Sado Island, Niigata Prefecture. The next year, this was again reported as an original paper, and proposed as a new species, *Paragonimus sadoensis* with his co-workers. Nevertheless it is considered to be a synonym of *P. ohirai* by many following investigators[18,22].

1968:

Hashiguchi and Miyazaki reported that the miracidia of *Paragonimus miyazakii* could easily invade the snail, *Bythinella (Moria) nipponica akiyoshiensis* and develop into cercariae about 70 days after invasion under a temperature of 22–24°C, indicating high susceptibility of this snail host to *P. miyazakii*[28].

Hashiguchi and Miyazaki subsequently reported that the miracidia of *Paragonimus westermani* had no ability not only to develop but also to invade the body of *Bythinella (Moria) nipponica akiyoshiensis* experimentally. Therefore it is not considered that *P. westermani* takes this snail as the first intermediate host under natural conditions[29].

Hamajima and others reported that *Tricula minima* on Sado Island was the first intermediate snail host of a lung fluke which was reported by Otsuru and others (1957) and Kawashima and others (1967) on Sado Island[22].

Kifune and Takao examined the emergence condition of cercariae of *Schistosoma japonicum* from the snail host, *Oncomelania nosophora,* and concluded that most cercariae emerge during a period of 2–12 hours[84].

Hashiguchi and Miyazaki carried out an experimental infection of *Bythinella (Moria) nipponica akiyoshiensis* with *Paragonimus ohirai,* and concluded that although the miracidia of *P. ohirai* could easily invade the snail, and develop to the first generation rediae, but these rediae could not develop to the second generation rediae and cercariae[30,27].

Ishii and Miyazaki observed the body surface of fully developed cercariae of *Paragonimus sadoensis* under a scanning electron microscope. They reported that cilla-like hairs and spines found on the body surface were different in distribution and shape in each position, and observed that the image of papillae as sensory ending occurred on the oral sucker. This study was the first carried out using electron microscopical observation of the cercariae[47].

Ozu and others studied paddy field dermatitis in Saitama Prefecture, and detected a dermatitis-producing schistosome cercariae in 25 of 1516 snails, *Austropeplea ollula*[132]

Suzuki and others continued reporting on the paddy field dermatitis in Saitama Prefecture. After surveying many snails, *Austropeplea ollula* (=*Bakerilymnaea ollula*), they found four species of cercariae, *Echinostoma revolutum, Plagiorchis muris,* and two species of furcocercariae[166].

Okabe and Takao found a new species of snail, *Radix hamadai* in Oita Prefecture. They tried to infect the snail with *Fasciola* sp. and succeeded in obtaining cercariae 50 days after exposure[130].

Nakade and others studied cercarial fauna of a snail, *Semisulcospira libertina* in Aomori, Akita and Iwate prefectures, and obtained 17 species of cercariae. They included brief notes on the morphology and ecology[125,124,123].

1969:

Kawashima and Hamajima compared the development of *Paragonimus sadoensis* and *P. ohirai* in the snail, *Tricula minima,* and concluded that both species of *Paragonimus* develop easily in the snail. Cercariae were obtained 40 days after exposure, and emerged 45 days after exposure, so that it was difficult to differentiate each other[77].

Kawashima compared the development of Formosan and Japanese strains of *Schistosoma japonicum* in the snail *Oncomelania formosana.* Cercariae were obtained 16 weeks after exposure in the Formosan strain, whereas the larvae of the Japanese strain degenerated and disappeared at the sporocyst stage seven weeks after exposure[73].

Ito and others compared the morphological features of rediae and cercariae of *Paragonimus ohirai* and *P. sadoensis.* Materials of *P. ohirai* were obtained from experimentally infected snails, *Assiminea parasitologica,* while those of

P. sadoensis were from experimentally infected snails, *Tricula minima*. As a result, they concluded that there seemed to be no difference between *P. ohirai* and *P. sadoensis*. As for *P. sadoensis*, it was at first identified as *P. ohirai* by Otsuru and Katagiri (1956), but designated as a new species, *P. sadoensis* by Miyazaki, Kawashima, Hamajima and Otsuru (1968). At present, both species are believed to be the same species, namely *P. sadoensis* being a synonym of *P. ohirai*[57].

Yasuraoka and Kojima observed experimentally the susceptibilities between *Schistosoma japonicum* and *Oncomelania nosophora*, especially among two strains of the parasite and two strains of the snail host. The highest infection rate was obtained in the case of the parasite of the Kyushu strain and the snail of the Kyushu strain, followed by the case of the parasite of the Yamanashi strain and the snail of the Kyushu strain. The lowest infection rate was observed in the case of the snails of the Yamanashi strain and the parasite of the Kyushu and the Yamanashi strains[197].

Kokubo and others reported the occurrence of schistosome dermatitis in Aichi Prefecture. Kumada and others examined three species of about 30,000 snails in the endemic areas of the schistosome dermatitis in Aichi Prefecture, and detected three species of cercariae from *Austropeples ollula*, including *Trichobilharzia* sp.[87,93].

Hatsushika and Maejima reported a paragonimus-like, but different microcercous cercaria from *Bythinella (Moria) nipponica akiyoshiensis* in Yamaguchi and Ehime Prefectures. It is possible that this cercaria may correspond to the cercaria reported by Hashiguchi (1967) in Fukuoka Prefecture[33].

Saito and others studied cercarial fauna of *Semisulcospira libertina* in Hiroshima Prefecture. After examining about 20,000 snails, they detected 23 species of cercariae[139].

Saito studied morphology of Heterophyid cercariae from *Semisulcospira libertina*, and grouped by the number of anterior oral spines as follows; three-spine group (=*Pseudexorchis major*), four-spine group (=*Metagonimus yokogawai*), five-spine group (=*Metagonimus takahashii*), and six-spine group (=*M. otsurui* ? or *M. katsuradai* ?)[133].

Kamachi and Takao redescribed the morphology of *Cercaria longissima* in Saga Prefecture, and pointed out some differences in the measurements and the number of sensory hairs, comparing with that of Komiya and Ito (1967)[65].

1970:

Kawashima and Hamajima examined 892 snails of *Assiminea castanea satumana* on the island of Amami-Oshima, Kagoshima Prefecture, and found that six of them harboured *Paragonimus iloktsuenensis*. They tried to infect the snail with *P. iloktsuenensis*, and proved that this snail served as natural and experimental snail hosts of this fluke[78].

Tongu and others reported the result of an electron microscope observation on the morphological features of *Cercaria longissima* obtained from *Oncomelania nosophora* in Saga Prefecture. They noted especially the penetration glands, the arrangement and density of body surface spines and myofilaments of muscle fibers[175].

Yoshimura and others studied the susceptibility of *Oncomelania minima* (=*Tricula minima*) and *Assiminea parasitologica* snails to infection with both *Paragonimus sadoensis* and *P. ohirai* to establish the similarities or differences in the first intermediate host's susceptibility between the two species of lung flukes. As a result, they concluded that it would be difficult to distinguish both species in susceptibility or in the larval morphology[203].

Ishii and Tokunaga observed the ultrastructure of the body surface of *Paragonimus miyazakii* with a scanning electron microscope, describing the shape and the distribution of spines or papillae[48].

Saito carried on the experiment of the infection of gold fish with heterophyid cercariae from *Semisulcospira* spp. As a result, he confirmed that three-spine group develops to *Pseudexorchis major*, four-spine group does not develop, and five-spine group develops to *M.*

takahashii[134].

Iwanaga and others studied the cercarial fauna of *Semisulcospira* spp. in Hiroshima Prefecture. After examining about 30,000 snails, they detected 23 species of cercariae, and noted their geographical distributions and seasonal fluctuations[59].

Matsuda and others carried on the experiment of infection by several strains of *Oncomelania* spp. with Yamanashi-strain of *Schistosoma japonicum*, and compared the infection rate in each strains of the snail[103].

Koyama and others also carried on the experiment of infecting *Oncomelania nosophora* with *Schistosoma japonicum*, especially with regard to the relation of the number of miracidium to the infection rate, period of the maturity, the number of produced cercariae, and the death rate of snails infected[92].

Sakumoto and others observed the minute spines, sensory hairs and fin-folds on the tail of the cercaria of *Metagonimus takahashii* by using a scanning electron microscope[147].

Kawashima made a detailed observation on the development of larval stages of *Paragonimus westermani* in the body of *Semisulcospira libertina* by serial sections. He noted also the miracidium of *P. westermani* can not invade into the body of the snail, *Oncomelania nosophora* and *O. minima*[74].

Yoshimura and others reported on an experimental infection of three species of snails with *Paragonimus sadoensis* and *P. ohirai*, and concluded that the first intermediate host susceptibility of *P. sadoensis* is similar to that of *P. ohirai*[204].

Kumada and others made a comprehensive survey on the paddy field dermatitis in Aichi Prefecture. They examined about 70,000 snails involving five species, and discovered seven species of cercariae from *Austropeplea viridis* (=*A. ollula* ?). Among seven species of cercariae, one species of *Trichobilharzia* sp. was proved to be the causative agent of producing dermatitis experimentally. A specific name for this carcaria was again not given in this report. As for other six species of cercariae, they noted briefly as follows; cercaria of *Echinostoma revolutm, E. hortense, Plagiorchis* spp., *Cercaria ellipsoidea*, and a cercaria of strigeid type[94,95].

1971:

Bridgman studied on the life cycle of *Maritrema setoensis* n. sp. on the coast of Kagawa Prefecture. The common snail, *Littorina brevicula* Philippi, 1844 was found to shed cercariae[3].

Ishii observed the ultrastructure of the body surface of cercaria of *Paragonimus iloktsuenensis*, especially on the cutaneous spines and ciliated hairs[44].

Endo and Suzuki observed the tissue response of the snail, *Semisulcospira libertina* to the sporocyst of *Paragonimus westermani*. Cell infiltrations occurred around the sporocyst 24 hours after invasion, then the sporocyst was surrounded by fibrous tissues three days after invasion, with most of the sporocyst falling into a state of degeneration seven days after invasion[5].

1972:

Kamachi and others redescribed *Cercaria longissima* obtained from *Oncomelania nosophora* in Saga and Fukuoka Prefectures, comparing with the description made by Komiya and Ito (1967). They found some differences on the shape of the sporocyst, the position of flame cells, spines and hairs, and attributed these differences to the difference between the geographical location of Yamanashi and Kyushu[66].

Ishii observed the ultra-structure of the body surface of cercaria of *Paragonimus westermani* using a scanning electron microscope, especially the cutaneous spines and hairs[45].

Saito and others surveyed the geographical and seasonal distribution of *Metagonimus yokogawai* and *M. takahashii* cercariae in Okayama Prefecture[141].

Saito and Moriyama observed the behavior of cercariae of *Metagonimus takahashii*. The stimulation of light or water current activated the cercariae in contacting fish[142].

Suzuki and others completed the life cycle of *Trichobilharzia* sp. in the laboratory. Three

ducklings were infected with the cercariae *per os*, and discharged crescent-shaped eggs one month after infection. The miracidia from these eggs were infected to the snail, *Austropeplea ollula*, and many cercariae emerged from the snails 24 or 26 days after exposure[163].

Miyazato and Inoue observed the internal ultra-structure of the cercaria of *Trichobilharzia physellae* by transmission electron microscope. This was the first report on the internal ultra-structure of cercaria using the transmission electron microscope, by the serial sections[115].

Saito observed the differences between *Metagonimus yokogawai* and *M. takahashii* cercariae and summarized then as follows; 1) parapleurolophocercous cercariae in *Semisulcospira libertina* were classified into four species, 2) both cercariae of *M. yokogawai* and *M. takahashii* were differenciated more clearly by the shape and arrangements of penetration gland cells, 3) the color of body was yellowish in *M. yokogawai*, brownish in *M. takahashii*, and the excretory bladder was black in *M. yokogawai*, dark blue in *M. takahashii* in the metacercaria[135].

Nakade examined about 30,000 snails, *Semisulcospira libertina* in Aomori, Akita and Iwate Prefectures, and discovered 17 species of cercariae. Among them seven species were identified as already known species, and the other 10 species were unidentified, being only numbered from No. 1 to No. 10. A detailed investigation on the geographical and seasonal distributions of these cercariae, especially of the cercaria of *M. yokogawai* was made[122].

1973:

Suzuki and others continued the research on paddy-field dermatitis in Saitama Prefecture. They found the cercaria of *Giganthobilharzia sturniae* from a new endemic area of Chichibu City. At the same time, they carried on the experiment of infecting three species of snails with the miracidia of *Trichobilharzia* sp., and observed the emergence of cercariae only from *Austropeplea ollula* during 24–188 days after exposure[164,167].

Habe and Ishii observed the ultra-structure of the cercarial body surface of *Paragonimus iloktsuenensis* by scanning electron microscope, especially the cutaneous spines and pappilae[16].

Kawashima and Hashiguchi discovered the cercaria of *Paragonimus ohirai* from one of 778 snails, *Augustassiminea nitida* in Kagoshima Prefecture. They carried out an experimental exposure of snails with miracidia of *P. ohirai*, obtaining all positive results. So it was confirmed that *A. nitida* is a new molluscan host of *P. ohirai*[79].

Suzuki and others again reported on their examination of snails in order to discover dermatitis producing cercariae in Saitama Prefecture during 1967–1971. They discovered two species of such cercariae, one of which was *Giganthobilharzia sturniae* from the snail, *Polypylis hemisphaerula*, and another was *Trichobilharzia* sp. from the snail, *Austropeplea ollula*. A detailed investigation in the infection rate and the seasonal fluctuation of these cercariae were made[168].

1974:

Miyazato and others observed the ultra-structure of the cercarial body surface of *Trichobilharzia physellae* by scanning electron microscope[116].

Tongu and others observed the internal ultrastructure of the cercaria of *Metagonimus yokogawai* and *M. takahashii*, especially the gland cells by transmission electron microscope[177,176].

Inatomi and others observed the internal ultrastructure of the cercaria of *Clonorchis sinensis* by transmission electron microscope[43].

1975:

Saito and others examined about 50,000 snails, *Semisulcospira* spp. in Hiroshima Prefecture during 1969–1971, and found eight genera and 24 species of cercariae, the infection rate being about 3%. They noted chiefly the geographical distribution and the seasonal fluctuation of these cercariae. The species of cercariae were as follows; *Metagonimus yoko-*

gawai, Centrocestus spp., *Cercaria nipponensis, Pseudexorchis major, Metagonimus takahashii, Cercaria incerta, Cercaria monostyloides, Cercaria yoshidae, Cercaria innominatum, Cercaria introverta, Cercaria longicerca, Acanthatrium hitaensis, Echinochasmus tobi, Cercaria creta, Cercaria melaniarum, Pseudobilharzia corvi, Metagonimus* sp., *Notocotylus magniovatus, Cercaria distyloides, Cercaria pseudodivaricata, Cercaria libertina,* and three unknown species[140].

Tongu and others observed the ultrastructure of penetration gland cells of the cercaria of *Metagonimus takahashii* and *M. yokogawai* by transmission electron microscope, and noted that there was no remarkable difference between the two species[179,178].

Tomita and others observed the ultrastructure of cercarial body surface of *Paragonimus ohirai* by transmission and scanning electron microscope[173].

Shimazu reported a new furcocercous cercaria from a viviparid snail, *Sinotaia quadrata* in Nagano Prefecture. He identified it as a cercaria of *Amblosoma suwaense* Shimazu, 1974, and briefly described its morphology. Later on he published his findings in detail in 1978[149,150].

Habe and Ishii compared the results of ultrastructures of cercarial body surface of *Paragonimus westermani, P. ohirai, P. iloktsuenensis* and *P. sadoensis,* and concluded that there was no recognizable difference among three species of *Paragonimus,* except in the case of *P. westermani*[17].

1976:

Fujino and others observed the ultrastructure of the cercarial body surface of *Metagonimus yokogawai* and *M. takahashii* by scanning electron microscope. They concluded that there was no remarkable difference between them, although the body size was smaller and the number of the first row of oral spines was four in *M. yokogawai,* whereas it was larger and five (rarely six) spines in *M. takahashii*[9,6,8].

Yokogawa and others reported on the occurrence of paddy field dermatitis in Chiba Prefecture. By the examination of 10,000 snails, *Austropeplea ollula,* they discovered a dermatitis-producing cercaria, *Trichobilharzia* sp. in the endemic area[199,200].

Suzuki and others reported on the occurrence of paddy field dermatitis in Kagoshima Prefecture. By examining 1,000 snails, *Austropeplea ollula,* they discovered a dermatitis-producing cercaria, *Trichobilharzia* sp. in the endemic area[169].

Tomimura and others carried out a fecal examination of Japanese deer in Nara Park, and revealed that 85% of deers yielded a positive count for the egg of *Fasciola* sp. They further examined twenty thousand snails of *Bakerlymnaea viridis* (=*Austropeplea ollula* ?) in the same localities, and discovered 3.8% of the snails were infected with cercariae of *Fasciola* sp.[172]

Kawanaka and others studied the experimental infection of *Austropeplea ollula* and *Lymnaea japonica* with the miracidium of *Trichobilharzia* sp. As a result, a high infection rate and many sporocysts were obtained in the case of *A. ollula,* whereas only a 60% infection rate and a small number of mother sporocysts were obtained in the case of *L. japonica*[70].

Yamaguti and others discussed the relation between the size of snail, *Semisulcospira bensoni* (=*S. libertina* ?), and the infection rate of the cercaria of *Pseudexorchis major* and *Cercaria incerta* in Saitama Prefecture[190].

Fujino and others observed the ultrastructure of the cercarial body surface of *Clonorchis sinensis* by scanning electron microscope, especially the cutaneous spines, oral spines and sensory papillae[7].

Kikuchi and others observed the fine structures of the cercarial body surface of *Schistosoma japonicum* by scanning electron microscope, especially the cutaneous spines, suckers and excretory pores[85].

Suzuki and others reported on the occurrence of paddy field dermatitis in Kagoshima Prefecture, and detected *Trichobilharzia* sp. from *Austropeplea ollula,* and *Giganthobilharzia* sp. from *Polypylis hemisphaerula* in the

endemic area[162].

1977:

Chinone and Itagaki examined about one thousand planorbid snails, *Polypylis hemisphaerula* collected from a rice field in Shizuoka Prefecture, and found that 4.3% of the snails were infected with paramphistome cercariae and metacercariae. They attempted to infect four calves and a goat with the metacercariae, and obtained many adult worms of *Homalogaster paloniae* from the ileum and caecum of these ruminants[4].

Saito observed the ultrastructure of cercarial integment of *Clonorchis sinensis* by transmission electron microscope in detail with many photographs[136].

Saito and others reported discovering one species of microcercous cercaria from *Semisulcospira* sp. in Iwate Prefecture, and identified it as *Nanophyetus* sp. temporarily. They noted also that extensive observation would be necessary to separate this cercaria from that of *Paragonimus,* because these cercariae closely resembled each other[145].

Suzuki and Kawanaka carried out the experimental infection of the cercaria of *Trichobilharzia* sp. in domestic ducklings in Saitama Prefecture. They obtained the adult male worms from the mesenteric vein. After observing the structure of this worm carefully, they suggested that this worm is closely related to *Trichobilharzia brevis* Basch, 1966, and not the same as *T. ocellata* or *T. physellae.* This suggestion was confirmed later by the same authors in 1980[160,161].

Kobayashi and others reported on the occurrence of paddy field dermatitis in Gifu Prefecture, and detected the cercaria of *Trichobilharzia* sp. in two out of 3680 *Austropeplea ollula*[86].

Miyazato and others observed the detailed structure of the anterior tip of *Trichobilharzia physellae* cercariae by transmission electron microscope, and redescribed the structures of opening pores of penetration glands, papillae, hairs, etc.[113].

Saito and others studied the cercarial fauna of *Semisulcospira* spp. in Yamagata Prefecture, and detected 11 species of cercariae in 235 of 2793 snails. The species of cercariae were as follows; *Pseudexorchis major, Metagonimus yokogawai, Cercaria andoi, Metagonimus takahashii, Echinostoma tobi, Cercaria nipponensis, Centrocestus armatus, Acanthatrium hitaensis, Cercaria longicerca, Cercaria innominatum,* and one unknown species[143].

Yasuraoka and others reported the occurrence of paddy field dermatitis in Ibaraki Prefecture. By the examination of snails, *Austropeplea ollula,* they discovered a dermatitis-producing cercaria, *Trichobilharzia* sp., the infection rate being 0.7–0.9%[198].

Takao and others studied the fluctuation of cercarial emission of *Schistosoma japonicum.* The largest number of cercarial emission was observed 17–23 hours after immersing the snail in water at temperature of 15–30°C[170].

Maejima and others reported the occurrence of paddy field dermatitis in Tottori Prefecture. By the examination of snails, *Polypylis hemisphaerula,* they discovered a dermatitis-producing cercaria, *Giganthobilharzia sturniae,* with a high infection of 9.4%[98].

1978:

Ito examined about 10,000 snails, *Austropeplea ollula,* and found six species of cercariae. Three of them were identified as cercaria of *Trichobilharzia physellae,* cercaria of *Echinostoma hortense* and cercaria of *Glypthelmins rugocaudata.* The remaining three were named respectively as *Cercaria shizuokaensis, Cercaria cristophora* and *Cercaria nigrofurca.* Descriptions and redescriptions were made[54].

Kawanaka studied the susceptibility of lymnaeid snails to the cercaria of *Trichobilharzia brevis* and *Fasciola* sp. In the case of *Lymnaea ollula,* the rate of larval recovery of *T. brevis* was 82.6%, and that of *Fasciola* sp. was 53.3%. In the case of *Lymnaea japonica,* the larvae of both species of parasites were surrounded by amoebocytes and fibloblasts of the snail, and could not develop to cercariae[67].

Hatsushika and Maejima demonstrated two types of microcercous cercariae from *Bythinella*

(Moria) nipponica in Yamaguchi and Ehime Prefectures. One was apparently the cercaria of *Paragonimus miyazakii,* but the other was different in internal structure such as the shape of the excretory vesicle, the arrangement of penetration glands, etc. They hypothesized that the new cercaria will be classified in the family Nanophyetidae[34].

Shimazu reported on a furcocercous cercaria of *Amblosoma suwaense* from a viviparid snail, *Sinotaia quadrata,* found in Nagano Prefecture. He made a detailed description of the sporocyst and cercaria[150].

Ito and Mochizuki reported on the occurrence of paddy field dermatitis in Shizuoka Prefecture. By the examination of snails, *Austropeplea ollula,* they found that two out of ten thousand snails were infected with a dermatitis-producing cercaria, *Trichobilharzia* sp.[55].

Saito carried on an experimental infection of a fish, *Oncorhynchus milktschitsch macrostomus* with a cercaria of *Nanophyetus* sp., and obtained the metacercariae which was closely related to that of *Nanophyetus salmincola.* He made a detailed report on the life cycle of this cercaria in 1985[137,138].

Ishii and others made a detailed examination of the cercarial body surface of *Paragonimus westermani* and *P. miyazakii* by scanning electron microscope, and described the shape and distribution of cutaneous spines and papillae[46].

Ohkubo and others reported on the occurrence of paddy field dermatitis in Tokushima Prefecture. By the examination of snails, *Austropeplea ollula,* they found that two out of ten thousand snails were infected with a dermatitis-producing cercaria, *Trichobilharzia* sp.[129].

1979:

Murata and others reported on the occurrence of paddy field dermatitis in Fuchu-City, Tokyo, but failed to find the dermatitis-producing cercaria from many snails of *Austropeplea ollula* examined[120].

Kawanaka and others carried out an experiment to infect the snail, *Bythinella (Moria) nipponica akiyoshiensis* with the miracidia of *Paragonimus miyazakii.* The sporocyst initially appeared after 18 days, the redia after 27 days and the cercaria after 82 days of exposure. This experiment was nearly identical to that of Hashiguchi and Miyazaki (1968), but differed from it in the strain of materials; the strain of the parasite was from Shizuoka, and that of snail was from Kyushu[69].

Sano and others discovered another intermediate snail host of *Paragonimus miyazakii* in Shizuoka Prefecture. This hydrobiid small snail was identified as *Saganoa* sp. (*S. kawanensis* ?). Since the discovery of the metacercaria of *P. miyazakii* in Shizuoka by Yokogawa and others (1974), the first intermediate snail host had not been known until that time. This report was therefore the first one to describe the complete life cycle of *P. miyazakii* in Shizuoka. Ecological research of the snail and morphological observations of rediae and cercariae were made[148].

Kajiyama and others performed an experimental infection of *Polypylis hemisphaerula* with the miracidia of *Pharyngostomum cordatum* in Yamaguchi Prefecture. The snails were examined from 25 to 28 days after exposure, and 82–83% of the snails were found to harbor cercariae of the fluke. Therefore they concluded that *P. hemisphaerula* is an experimental snail host of *P. cordatum.* The same authors later reported the discovery of naturally infected snails, *P. hemisphaerula* in Yamaguchi Prefecture in 1981[62,64].

Shimazu found a furcocercous cercaria in the snail, *Sinotaia quadrata* in Nagano Prefecture. He noted that this cercaria was identifiable as *Cercaria senoi* belonging to the family Sanguinicolidae, and seemed to have two types of symmetrical and asymmetrical excretory system[151].

Kawanaka and Saito compared the susceptibilities of *Lymnaea ollula* and *L. japonica* to the miracidium of *Echinostoma hortense* in Ibaraki Prefecture. In the case of *L. ollula,* the infection rate was 73.6 or 61.1%, and many

cercariae emerged from all of the snails infected, whereas in the case of *L. japonica*, the infection rate was 80.6 or 75.0%, but cercariae emerged from only 67% of infected snails[68].

Maejima and others studied the fine structure of cercariae of *Giganthobilharzia sturniae* using a scanning electron microscope, especially on the anterior tip papillae, sensory papillae, finfolds on the tail furcae, etc.[99].

Tani and others examined the fresh water snails, *Semisulcospira libertina* in Akita Prefecture, and detected two species of cercariae, *Metagonimus yokogawai* and *Nanophyetus* sp.[183].

Miyamoto and Kutsumi examined the fresh water snails, *Semisulcospira libertina* in Hokkaido, and detected the cercaria of *Metagonimus yokogawai*, as well as other two species of cercariae. The same authors had already reported on the presence of adult flukes in dogs and metacercariae in fish in Hokkaido. This report therefore confirmed the autochthonous distribution of *M. yokogawai* in Hokkaido[111].

Asada and others reported on the occurrence of paddy field dermatitis in Okinawa Prefecture, and detected a dermatitis-producing cercaria, *Giganthobilharzia* sp. in 30 out of 4025 snails, *Polypylis hemisphaerula* in the endemic area[2].

1980:

Suzuki and Kawanaka made an experimental infection of domestic ducklings with the cercaria of *Trichobilharzia* sp., obtained from *Austropeplea ollula* in Saitama Prefecture. About 17–19 days after infection, the ducklings passed crescent-shaped schistosome eggs in the feces. Male worms were obtained from the mesenteric vein of the birds, and identified as *Trichobilharzia brevis* Basch, 1966. Up to that time, most reporters of the dermatitis-producing cercariae from *A. ollula* had refrained from specifically naming the cercariae, noting them only as *Trichobilharzia* sp. Therefore, the researchers hypothesized that those cercariae found in many prefectures might be the same as *T. brevis*[160,161].

Shimura and Ito reported on two new species of cercariae, *Cercaria brachycaeca* n. sp. and *Cercaria misakiana* n. sp. from marine snails. *C. brachycaeca* is a tailless type, parasitic in *Batillus cornutus* from Chiba and Kanagawa Prefectures. *C. misakiana* is a cotylocercous type, parasitic in *B, cornutus* and *Marmarostoma stenogyrum* from Kanagawa Prefecture. Detailed descriptions were made[155].

Ito and Shimura reported on a new lepocreadiid cercaria, *Cercaria isoninae* n. sp. from a littoral gastropod, *Japeuthria ferrea* in Kanagawa and Chiba Prefectures. A detailed description of this ophthalmo-trichocercous cercaria was made[56].

Shimura and Ito reported again on two new species of cercariae, *Cercaria batillariae* n. sp. and *Cercaria hosoumininae* n. sp. from a intertidal gastropod, *Batillaria cumingii* in Kanagawa and Chiba Prefectures. The former is a heterophyid type, and the latter is a xiphidiocercaria of the Ubiquita type. Detailed descriptions of these were made[156].

Higo and others observed the surface ultrastructure of *Paragonimus westermani* cercaria by scanning electron microscope. Materials were obtained from *Semisulcospira libertina* in Nagasaki Prefecture. They noted two types of spines, large and small, and also two types of papillae, ciliated and domed one. The shape and the distribution of these spines and papillae were recognized as a typical character of *P. westermani* cercaria as an efficient mean for differentiating this species from other paragonimid cercariae[37].

Fukuda and Hamajima observed the tegument and associated fine structures of the second generation redia of *Paragonimus ohirai* by transmission electron microscope. The results were compared to those of other trematode rediae, and possibility of the absorption of nutrition through the tegument was discussed by them[10,11].

Saitoh and others carried out an experiment of infecting the snail, *Oncomelania nosophora* with the miracidia of *Paragonimus miyazakii* from Shizuoka Prefecture, and found that the larger the snail, the higher the infection rate[146].

Asada and others examined the snail, *Semisulcospira libertina* in Fukui Prefecture, and detected 16 species of cercariae such as *Metagonimus yokogawai, Pseudexorchis major, Centrocestus armatus, Cercaria innominatum.* The total infection rate was 587 out of 1732, or 33.9%[1].

Kumazawa and others reported on existing two types of flame cell formula of *Giganthobilharzia sturniae* cercariae in Okinawa Prefecture. One type of the formula was 2[(1+1+1) + (1+1+1+[1])]=14 as described by Tanabe, and the other was 2[(1+1+1) + (1+1+[1])]=12 as described by Komiya and Ito. They therefore suggested that *G. sturniae* includes presumably two species[97].

Kajiyama and others reported briefly on the finding of a new apharyngeal brevifurcate cercaria from *Polypylis hemisphaerula* in Yamaguchi Prefecture[63].

Shogaki surveyed the epidemiology of *Paragonimus miyazakii* in Aichi Prefecture, and discovered a naturally infected snail host, *Saganoa* sp. with the cercaria of *P. miyazakii*[159].

1981:

Hamajima and others carried out an experiment of infecting the snail, *Semisulcospira libertina* with *Paragonimus westermani.* While carrying out this experiment, they observed some intimate interplay between intramolluscan larvae of *P. westermani* and the other cercariae such as *Cercaria monostyloides,* cercaria of *Metagonimus, Cercaria yoshidae,* cercaria of *Pseudexorchis major,* etc. They considered that the change of immune response and chemical composition of the snails caused by infection with other cercariae may be a possible factor in determining the development of *P. westermani* cercariae[19].

Kumazawa and others examined 2780 snails of *Semisulcospira* sp. in Kochi Prefecture, and found nine species of cercariae; *Pseudexorchis major, Metagonimus yokogawai, M. takahashii, Acanthatrium hitaensis, Centrocestus armatus, Notocotylus magniovatus, Cercaria longicerca, Cercaria innominatum* and one unknown species. The infection rate and seasonal fluctuation of cercariae were noted, with some findings relating to the structure of *Centrocestus armatus* cercaria[96].

Makiya and Ishiguro made a survey focusing on paddy field dermatitis in Aichi Prefecture, and proposed a new technique for the measurement of cercarial densities[102].

Kajiyama and others examined 3480 snails of *Polypylis hemisphaerula* in Yamaguchi Prefecture, and detected one snail harboring the cercaria of *Pharyngostomum cordatum.* This report confirmed the complete life cycle of *P. cordatum*[64,62].

Yamamoto examined the snail, *Polypylis hemisphaerula,* by surveying paddy field dermatitis in Kagoshima Prefecture, and discovered the cercaria of *Pharyngostomum cordatum.* The infection rate was four out of 640, or 0.6%[191].

Gyoten reported briefly on the finding of a new microcercous cercaria from *Bythinella nipponica* in Ehime Prefecture. This cercaria closely resembled *Paragonimus* cercaria, but differed in eight pairs of penetration gland cells, Y-shaped excretory bladder, etc. He tentatively identified it as *Nanophyetus* sp.[12].

Miyamoto reported briefly on the finding of a new echinostome cercaria from *Cipangopaludina japonica* in Hokkaido. He tentatively identified it as *Echinostoma* sp.[109].

1982:

Shimura and others reported on three marine cercariae, *Cercaria pectinata, Cercaria tapidis* and *Cercaria* sp. from a clam, *Tapes philippinarum* in Shizuoka Prefecture. Out of 3200 clams examined, they found 110 infections of *C. pectinata,* three of *C. tapidis* and one of *Cercaria* sp. Detailed redescriptions as well as their ecology were made[158].

Miyamoto and others examined about 34,000 snails of *Semisulcospira libertina,* and found that 0.2–3.7% of them were infected with four species of cercariae in Hokkaido. The species of the cercariae were *Metagonimus yokogawai, Echinochasmus tobi, Notocotylus magniovatus* and *Cercaria nipponensis* (?). This

study confirmed the existence of the first intermediate snail host of *M. yokogawai* even in Hokkaido[110].

Uchida and others studied the cercarial fauna of *Austropeplea ollula* in Kanagawa Prefecture. Through the examination of more than 80,000 snails, four species of cercariae, *Trichobilharzia* sp., *Cercaria shizuokaensis, Cercaria nigrofurca* and *Echinoparyphium recurvatum* were detected. Brief notes on the incidence and seasonal fluctuations were made[187].

Kagei and others surveyed on the cercaria of *Centrocestus formosanus* from *Thiara scabra* and *Semisulcospira libertina* in Tane-Island, Kagoshima Prefecture. The incidence rate was 0.84% in *T. scabra,* and 1.9% in *S. libertina*[61].

Higo and Ishii observed the ultrastructure of cercarial body surface of *Paragonimus iloktsuenensis* by scanning electron microscope, and reported that the general appearance of large and small spines, ciliated and domed papillae was nearly the same as that of *P. westermani*[39].

Mizokawa and others reported the occurrence of paddy field dermatitis in Osaka Prefecture, and detected the cercariae of *Trichobilharzia physellae* and *Echinostoma hortense* from *Austropeplea ollula*[119].

Tani and others reported the occurrence of paddy field dermatitis in Akita Prefecture, and detected several species of cercariae from *Lymnaea japonica, L. truncatula* and *Gyraulus hiemantium.* A dermatitis-producing cercaria, *Trichobilharzia* sp. was found in *L. truncataula* only[184].

Suzuki and others reported the occurrence of paddy field dermatitis in Nara Prefecture. By the examination of 3163 snails of *Polypylis hemisphaerula,* they found four species of cercariae, *Giganthobilharzia* sp., *Pharyngostomum cordatum, Diplodiscus japonicus,* and one unidentified cercaria[165].

Higo and Ishii observed the ultrastructure of cercarial body surface of *Paragonimus ohirai* by scanning electron microscope. By comparing the three species of *P. westermani, P. ohirai* and *P. iloktsuenensis,* they observed no fundamental differences among them[38].

Uchida and others studied on the cercariae fauna in Kanagawa Prefecture. From the snail, *Gyraulus chinensis* (=*G. hiemantium* ?), three species of cercariae, *Giganthobilharzia sturniae, Diplodiscus japonicus* and *Cercaria shizuokaensis,* from the snail, *Physa acuta,* two species of cercariae, *Echinoparyphium recurvatum* and *Cercaria shizuokaensis,* from the snail, *Lymnaea japonica,* one species of cercaria, *Echinoparyphium recurvatum,* and from the snail, *Succinea lauta,* no cercaria were reported[186].

1983:

Shimura reported a new monorchid cercaria, *Cercaria corbiculae* n. sp., from a clam, *Corbicula japonica* in Shimane Prefecture, and made a detailed description of this cercaria[153].

Shimura and Kudo reported two new marine cercariae from three species of trochid gastropods in Tokyo. One species, *Cercaria hachijoensis* n. sp., obtained from *Trochus sacellus rota, Tectus pyramis* and *Omphalius nigerrimus,* was a cotylocercous cercaria with a stylet. The other one, *Cercaria rhipidocaudata* n. sp., obtained from *Trochus sacellus rota,* was a fan shaped tailed cercaria with a stylet. Detailed descriptions and discussions were made[157].

Higo and Ishii studied the ultrastructure of cercarial body surface of *Paragonimus ohirai, P. iloktsuenensis* and *P. miyazakii* by scanning electron microscope. They observed the shape and distribution of spines and papillae, and concluded that it was difficult to determine the pattern of the distribution of these papillae because of individual variations[41].

Miyamoto and others found three species of cercariae, *Echinostoma hortense, Plagiorchis muris* and one unidentified furcocercaria, from *Lymnaea japonica* in Hokkaido. They described the distribution of these cercariae, especially in *Echinostoma hortense*[112].

Yanohara and others examined the cerithioid snails, *Melanoides tuberculatus, Semisulcospira bensoni libertina, Thiara scabra* and *Tarebia granifera obliquigranosa,* to detect the cercaria of *Centrocestus formosanus* in Okinawa Prefecture. About 53% of *M. tuber-*

culatus, and 2% of *S. libertina* were infected with the cerceria of *C. formosanus,* but none of the latter two species of the snails were infected[194].

Higo and Ishii compared the surface ultrastructure of four species of paragonimid cercariae by scanning electron microscope, and recognized that there exists a difference in the length of large-typed spines on postero-ventral surface among *P. ohirai, P. iloktsuenensis, P. miyazakii* and *P. westermani*[40].

Matsumura and others reported on the occurrence of paddy field dermatitis in Hyogo Prefecture. They examined the snails, *Polypylis hemisphaerula, Physa acuta* and *Austropeplea ollula,* and detected the cercaria of *Gigantho-bilharzia sturniae* in 38% of the snail, *P. hemisphaerula*[105].

Miyazato and others reported also on the occurrence of paddy field dermatitis in Osaka Prefecture, and detected a dermatitis-producing cercaria, *Trichobilharzia* sp. from *Austropeplea ollula*[114].

Saito and others reported on a new microcercous cercaria from *Semisulcospira libertina* in Akita Prefecture. This cercaria resembled the cercaria of *Nanophyetus japo-neneis,* but differed from it in the flame cell pattern, the shape of the excretory bladder and mucoid gland, etc. The infection rate was seven out of 145 snails. They refrained from identication, and did not propose any specific name[144].

Tani examined the snails, *Lymnaea japonica, L. ollula* and *L. truncatula* in Akita Prefecture, and detected four species of cercariae, *Echi-nostoma hortense, Echinoparyphium recur-vatum, Plagiorchis muris* and *Cercaria cristo-phora* from *L. japonica* only. Special reports were made in the epidemiology of *E. hortense*[180].

1984:

Shimura reported a new marine cercaria, *Cercaria itoi* n. sp., from a spindle shell, *Fusinus perplexus* in Kanagawa Prefecture. This cercaria is a biocellate, with a long simple tail, and probably belongs to the family Acanthocolpi-dae. He made a detailed description with a discussion[154].

Shimazu and Shimizu obtained a cysto-phorous cercaria, *Cercaria yoshidae,* from *Semisulcospira libertina* in Nagano Prefecture, and redescribed its flame cell formula as 2[(2+2)+[2]]=12, instead of 2[(2+2)]=8 by Ito (1952)[152].

Yanohara and others examined the snails, *Melanoides tuberculatus* and *Thiara scabra* in Okinawa Prefecture, and detected the cercaria of *Centrocestus formosanus* from both species of the snails. They also reported the geographi-cal and seasonal distributions of the cer-caria[195].

Habe carried out an experimental infection of the snails, *Augustassiminea parasitologica* of Miyazaki and Fukuoka strains with the miracidia of *Paragonimis ohirai* of Hyogo strain. The infection rate in the snail of the Miyazaki strain was 78.7–81.8% with many cercariae, whereas that of the Fukuoka strain was only 27.5–31.8%, producing a small number of cercariae[14].

Nakamoto and Kajiyama reported that *Polypylis hemisphaerula* is a natural and experimental intermediate snail host of *Pharyngostomum cordatum.* At the same time they observed the cercarial body and tail ultrastructures by scanning electron micro-scope, adding some new findings on the structure[128].

Matsuo examined the snails, *Assiminea parasitologica* and *A. japonica* in Mie Pre-fecture, and detected the cercaria of *Paragoni-mus ohirai* in only one of 420 snails of *A. parasitologica*[106].

Koori and others examined the snails, *Semisulcospira libertina* in Kochi Prefecture, and detected the cercaria of *Metagonimus yokogawai,* the infection rate being 0–9%[91].

Kawashima and Habe observed the cercarial emergence of *Schistosoma japonicum* from experimentally infected snails, *Oncomelania nosophora.* Based on observations made at two hourly intervals, they reported that the initial emergence occurred after 16 hours, with peak emergence at 18–20 hours, and final emergence

being 3–4 days after immersing the snails. They also noted the existence of daily periodicity under outdoor conditions of light and temperature[75].

Minai and others reported on the occurrence of paddy field dermatitis is Yamanashi Prefecture, and detected a dermatitis-producing cercaria, *Giganthobilharzia sturniae* from *Polypylis hemisphaerula*[108].

Uchida and others studied the cercariae fauna in Kanagawa Prefecture with the following results: six species of cercariae from *Austropeplea ollula* (*Trichobilharzia* sp., *Cercaria shizuokaensis, Cercaria nigrofurca, Glypthelmins rugocaudata, Echinoparyphium recurvatum* and *Echinostoma* sp.), two species from *Segmentina hemisphaerula* (*Giganthobilharzia* sp. and *Diplodiscus japonicus*), two species from *Gyraulus hiemantium* (*Echinostoma* sp. and one unknown species), and none from *Physa acuta*[188].

1985:

Saito studied the life cycle of a microcercous cercaria from *Semisulcospira libertina* in Iwate, Akita and Yamagata Prefectures, and identified it as *Nanophyetus japonensis.* This cercaria had been reported by Saito and others in 1977, as a cercaria which closely resembled *Paragonimus,* and preliminarily noted it as *Nanophyetus* sp. This report confirmed the complete life cycle of this cercaria[138].

Yanohara studied in detail the ecology of the cercaria of *Centrocestus formosanus* in Okinawa Prefecture. This cercaria was found from *Melanoides tuberculatus* and *Thiara* sp. The relation between the infection rate and the size of snails was discussed[192].

Nakamoto observed the ultrastructure of cercarial body and tail surface of *Pharyngostomum cordatum* by scanning electron microscope. By the observation of spines, sensory hairs, etc., she noted the characteristic features of this cercaria[126].

Nakamoto reported also that *Rana rugosa* tadpoles were readily infected with *Pharyngostomum cordatum* cercariae. *Xenopus laevis* tadpoles, which have frequently been used as laboratory animals, were not infected with the cercaria[127].

Hamajima and others carried out an experimental infection of the snail, *Semisulcospira libertina* with the miracidia of *Paragonimus westermani.* The miracidia easily invade the snails of 2–4 mm in wdith. Usually most sporocysts in the snail body disappeared within one weeks after exposure because of snail tissue infiltration, but such disappearance of sporocysts and tissue infiltrations of the snail could not be observed when the snails were first infected with other species of cercariae[20].

Yamagami and others observed the number and emergence pattern of cercariae from the snail, *Austropeplea ollula* infected with a single miracidium of *Fasciola* sp. The initial emergence of cercariae was observed 49–63 days after exposure, the maximal emergence was 7–14 days after the initial emergence, and lasted until the death of the snail. The total number of emerged cercariae was 25–1329[189].

Habe reported the experimental infections of *Paragonimus ohirai, P. iloktsuenensis* and *P. sadoensis* miracidia to the snail, *Augustassiminea parasitologica* of Miyazaki and Fukuoka strains. The snails of the Miyazaki strain were easily infected with all of three species of *Paragonimus,* but the snails of the Fukuoka strain indicated less susceptibility compared with those of *Paragonimus.* In addition, *Augustassiminea kyushuensis* had no susceptibility to any of the *Paragonimus*[15].

Yoneda and Takao surveyed the cercarial fauna in Saga Prefecture. They examined eight species of snails, and discovered about eight species of cercariae from three species of snails, *Hippeutis cantori, Lymnaea japonica* and *Stenothyra japonica*[201,202].

Yanohara and others reported on the cercaria of *Centrocestus armatus* from *Semisulcospira libertina* in Kagoshima and Okinawa Prefectures, and discussed five species of the genus *Centrocestus*[193].

Matsumura and others experimented with producing the dermatitis by the cercaria of *Giganthobilharzia sturniae* to four volunteers, and observed its pathological features[104].

Higuchi and others examined 4,000 snails, *Semisulcospira libertina* in Hokkaido, and detected four species of cercariae, *Metagonimus yokogawai, Notocotylus magniovatus, Echinochasmus tobi* and *Cercaria creta*[42].

Tani experimentally infected the snail, *Lymnaea ollula* with the miracidia of *Echinostoma hortense* derived from single worm infections. Cercariae were observed 35–36 days after exposure in two out of 45 snails examined[181].

Itagaki and Itagaki experimentally infected the snails, *Lymnaea truncatula* of Hokkaido strain, and *L. ollula* of Kanagawa strain with the miracidia of *Fasciola,* sp. As a result, *L. ollula* indicated a good susceptibility, with mature cercariae emerging 33 days after exposure, whereas *L. truncatula* indicated a little susceptibility, maturing only to the rediae 40 days after exposure, though *L. truncatula* proved to be the natural snail host of *Fasciola* sp. in Hokkaido[50].

Tani and Yoshimura reported that when *Austropeplea ollula* was infected with *Echinostoma hortense* and *Fasciola* sp. separately, the infection rate was 90% in the former, and 20% in the latter. But when the snail was doubly infected with the trematodes simultaneously, the infection rate was 84% in *Echinostoma hortense,* or only 5% in *Fasciola* sp., and no double infection was observed[185].

Hata and others reported that when *Oncomelania nosophora* of previously infected with *Paragonimus ohirai,* was infected with *Schistosoma japonicum,* the sporocyst of *S. japonicum* disappeared 10–18 weeks after exposure. And when the snail was doubly infected with two species of the trematodes simultaneously, both sporocysts were observed until 13 weeks after exposure, but only the sporocysts of *P. ohirai* remained 16 weeks after exposure. They therefore concluded that there exists some antagonism between these two species of trematodes, indicating *P. ohirai* being more dominant than *S. japonicum*[31].

Gyoten observed the morphological changes of mucoid glands of *Paragonimus miyazakii* cercariae. In the case of cercariae obtained by crushing the snail, several stages of secretion of mucoid substance were observed. On the other hand, in the case of cercariae emerged naturally, the secretion of mucoid substance was already finished, and the mucoid glands in the body of cercariae could not be observed[13].

Murata and others studied the life cycle of *Giganthobilharzia* sp. in the laboratory. Cercariae from *Polypylis hemisphaerula* were used to infect ducklings, and the eggs were obtained from the feces of the birds 25–35 days after infection. The miracidia from these eggs were exposed to snails, and many cercariae were observed 15 days after exposure. The flame cell formula of the cercaria was $2[(1+1+1)+(1+1+[1])]=12^{12}{}_{1}$[1].

1986:

Itagaki and Itagaki reported the relationship between miracidial number and cercarial number in *Lymnaea ollula* infected with *Fasciola* sp. Snails were grouped into three groups of 1, 5 and 10 miracidial infections. The initial emergence and the number of cercariae were compared among three groups[51].

Matsuo and Makiya reported the discovery of cercaria of *Paragonimus ohirai* from *Assiminea parasitologica* in Mie Prefecture, the infection rate being 0.15–0.4%[107].

Kawashima and others carried out an experiment involving the transplant of the 2nd generation sporocysts of *Schistosoma japonicum* into the snail, *Oncomelania nosophora.* They discovered the 3rd generation sporocysts (grand-daughter sporocysts) four weeks after transplantation, and observed the emergence of cercariae eight weeks after transplantation[76].

1987:

Maejima and others observed the papillae on the cercarial body surface of *Giganthobilharzia sturniae* by silver nitrate staining. Twenty-four pairs of papillae on the body surface, ten pairs of papillae on the anterior tip, and six pairs of secretion pores on the anterior tip were noted with their features and distributions[100].

Tongu and others reported the occurrence of paddy field dermatitis in Okayama Prefecture.

By the examination of three species of snails, they discovered the cercaria of *Giganthobilharzia sturniae* from the snail, *Segmentina nitidella* (=*Polypylis hemisphaerula*), and *Cercaria shizuokaensis* from *Austropeplea ollula*[174].

Tani detected one species of echinostome cercaria from the snail, *Polypylis hemisphaerula* in Akita Prefecture. He obtained the adult flukes from mice experimentally, and identified it as *Echinostoma cinetorchis*[182].

Yoneda and Takao examined 10 species of fresh water snails in Fukuoka and Saga Prefectures, and reported more than 10 species of cercariae, though they did not identify the cercariae[202].

Maejima and others redescribed the inner structure of the cercaria of *Giganthobilharzia sturniae* by normal light microscope and transmission electron microscope, and added several new findings[101].

Tomimura and others obtained one species of paragonimid cercaria from *Semisulcospira libertina* in Mie Prefecture. By the observation of its cercaria in detail, they identified it as *Paragonimus westermani*-diploid type[171].

1988:

Harada and Suguri examined three species of brackish water snails, *Cerithidea rhizophorarum, Batillaria multiformis* and *B. cumingii,* and discovered five species of cercariae, though they did not identify them. They noted briefly the geographical distribution and the relation between cercariae and snail hosts[23].

Harada and Suguri reported on a new method for detecting the flame cell in cercariae. The technique for fixation, mounting and staining of cercariae was improved, and serial sections of 1.5 μm thick of the cercariae were of benefit for light, or transmission electron microscope observations. They added that this method may be more useful for observing the large type cercariae[24].

Oshima and others reported on the occurrence of paddy field dermatitis in Yokohama City, Kanagawa Prefecture. They examined three species of snails in the endemic areas, and detected high infection rates of cercariae of *Giganthobilharzia sturniae* from *Polypylis hemisphaerula.* This cercaria had a flame cell formula of $2[(1+1+1)+(1+1+[1])]=12$, and produced a dermatitis on the volunteers. They noted also the discovery of *Cercaria shizuokaensis* and one echinostome cercaria from *P. hemisphaerula*[131].

Special Treatise

Part I. Additional New Species of Cercariae (1962–1988)

1. *Cercaria shizuokaensis* Ito, 1978 (Fig. 1)

Locality: Shizuoka, Aichi, Kanagawa, Okayama.

Host: *Austropeplea ollula, Physa acuta, Gyraulus chinensis, Polypylis hemisphaerula.*

Parenthenita: Whitish filamentous sporocyst, about two mm long, fairly mobile. Many yellowish pigments are scattered in the wall. Numerous flame cells are in the wall too. Only a few cercariae with several germ balls are contained in a old sporocyst.

Cercaria: Oculate, pharyngeal longifurcate distome furcocercaria. Measurements are; body 140x58 μm, oral sucker 32x29 μm, acetabulum 29x31 μm, tail stem 125x40 μm, and tail furca 154x15 μm. Body is ellipsoidal in shape, tapering slightly in the anterior part of the body. A distinct pharynx follows the oral sucker with a short prepharynx, and is followed by a short esophagus and ceca extending to posterior extremity. Two pairs of penetration gland cells are at the both sides of the acetabulum. Non-epithelial excretory vesicle is small. Flame cell formula is $2[(2+2)+(2+2+[2])]=20$. Tail stem is provided with more than 10 pairs of sensory hairs, but no spine. Tail furca, on the while, is provided with many minute spines but no sensory hair. Caudal excretory tube runs backward along the axis of the tail. An Islet of Cort is present.

Life cycle: Unknown (presumably develops to Diplostomatidae, especially to the genus,

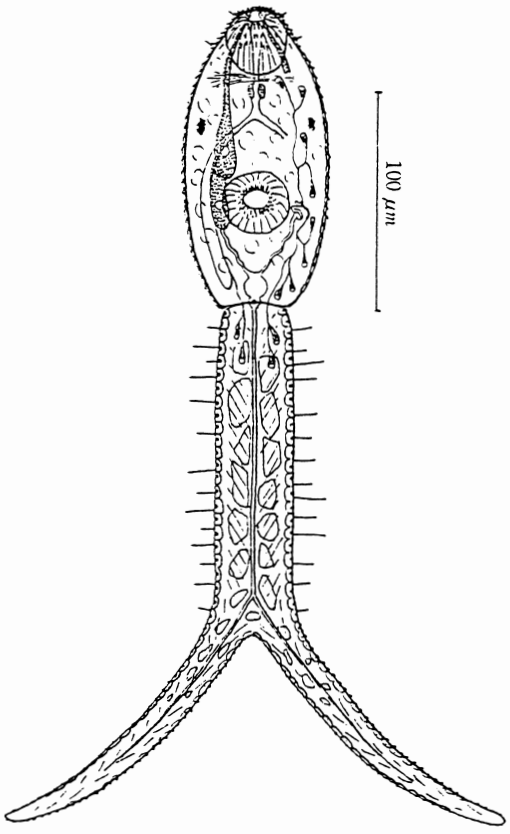

Fig. 1. *Cercaria shizuokaensis* Ito, 1978
– (Ito, 1978) –

Diplostomum or *Alaria*).

Reference: Ito (1978), Jpn. J. Parasit., 27, 171–184; Kumada *et al.* (1971); Uchida *et al.* (1982, 1984); Tongu *et al.* (1987); Oshima *et al.* (1988).

2. Cercaria of *Pharyngostomum cordatum* (Diesing, 1850) (Fig. 2)

Locality: Yamaguchi, Kagoshima, Nara.

Host: *Polypylis hemisphaerula.*

Parthenita: No description.

Cercaria: Pharyngeal longifurcate distome furcocercaria without eye spot. Measurements are; body 114x53 μm, oral sucker 28x29 μm, acetabulum 23x22 μm, pharynx 11x13 μm, tail stem 196x39 μm, and tail furca 127x20 μm. Anterior part of the body surface is covered with many minute spines. Two pairs of

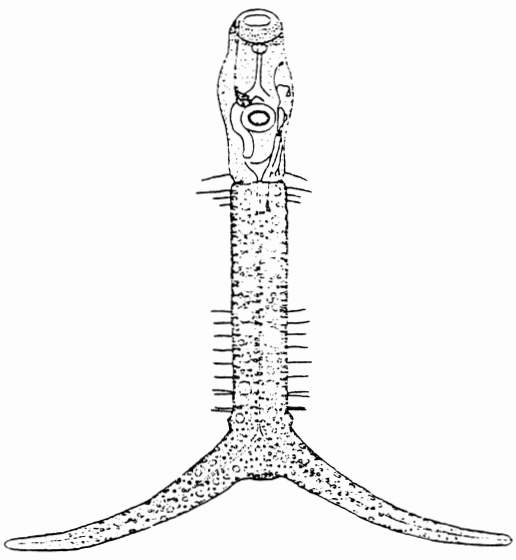

Fig. 2. Cercaria of *Pharyngostomum cordatum*
– (Kajiyama *et al.*, 1979) –

penetration gland cells are on the anterior part of the acetabulum. Prepharynx is very short, pharynx is small, and ceca terminate at the anterior margin of the excretory bladder. Flame cell formula is 2[(1+1)+(1+1+[1])]=10. Sensory hairs are one pair on the posterior part of the body and 13 pairs on the tail stem.

Life cycle: 2nd host ... *Rana nigromaculata.*
Final host ... dog and cat.

Reference: Kajiyama *et al.* (1979), Jpn. J. Parasit., 28, 235–239; Kajiyama *et al.* (1981); Yamamoto (1981); Suzuki *et al.* (1982); Nakamoto and Kajiyama (1984); Nakamoto (1985).

3. Cercaria of *Holostephanus nipponicus* Yamaguti, 1939 (Fig. 3)

Locality: Saitama.

Host: *Parafossarulus manchouricus.*

Parthenita: Long sausage-shaped sporocyst, measuring 1.05–1.23 mm long by 0.20–0.22 mm wide. It contains 40–60 cercariae.

Cercaria: Furcocercaria belonging to Vivax-subgroup. Measurements by raw materials are; body 230x 120 μm, tail stem 350x50 μm, and tail furca 260x31 μm. Pharynx is followed by a

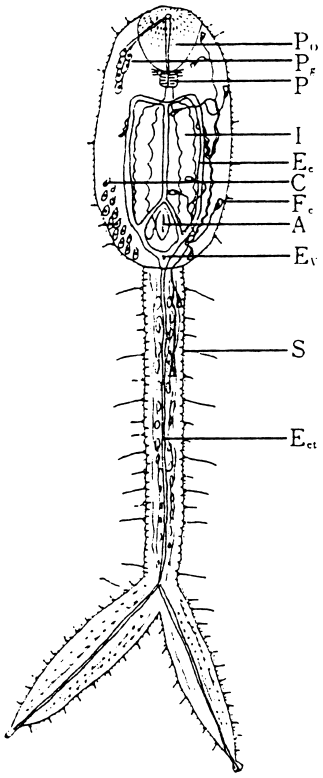

Fig. 3. Cercaria of *Holostephanus nipponicus* – (Komiya and Enomoto, 1967) –

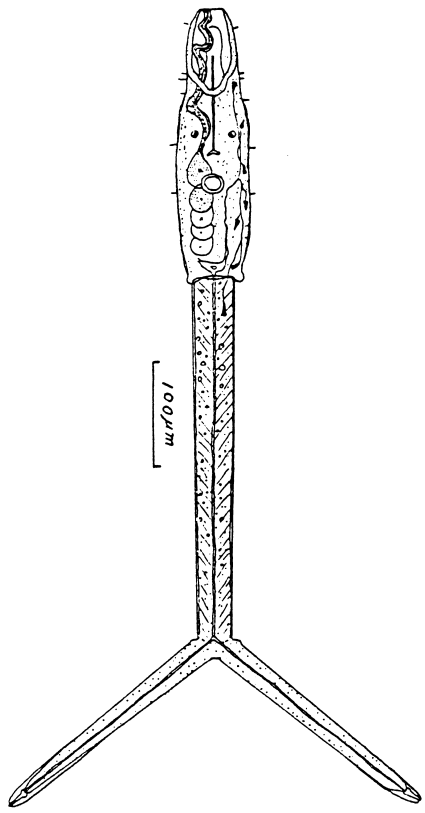

Fig. 4. Cercaria of *Trichobilharzia brevis* – (Suzuki and Kawanaka, 1980) –

short esophagus and ceca extending to near the posterior end of the body. Cephalic glands, penetration glands and many cystogenous gland cells are observed. Body surface is covered with many minute spines. Sensory hairs are 7–8 on the lateral side of the body, long 7 and short 7 on the tail stem, long 1 and short 11–12 on the outer side of tail furca, and short 8–9 on the inner side of tail furca. Excretory system is a typical Vivax-type, flame cell formula is 2[(2+2)+(2+2+[2])]=20.

Life cycle: 2nd host ..... *Pseudorasbora parva.*

Final host ... *Milvus migrans lineatus* (experimentally).

Reference: Komiya and Enomoto (1967), Jpn. J. Parasit., 16, 127–133; Yasuraoka (1965).

4. Cercaria of *Trichobilharzia brevis* Basch, 1966 (Fig. 4)

Locality: Saitama.

Host: *Austropeplea ollula.*

Parthenita: Whitish, delicate filamentous shaped sporocyst. It contains a number of immature and mature cercariae.

Cercaria: Oculate, apharyngeal brevifurcate distome cercaria. Measurements are; body 254x63 μm, head organ 85x49 μm, acetabulum 23 μm long, tail stem 342x42 μm, and tail furca 210x26 μm. Body is covered with minute spines. Head organ and acetabulum are muscular. Among five pairs of penetration glands, first two are coarse and the next three are fine granules. Flame cell formula is 2[(1+1+1)+(1+1+1+[1])]=14. Island of Cort is observed. Two main collecting tubes arise from the excretory vesicle, run forward until the level of acetabulum, where they divide into two branches. Tail stem is much longer than the body. It is beset with many minute spines but

no hair. Tail furca is slightly shorter than the body. A dorso-ventral finfold on the whole length of the furcae is connected each other around the distal end of the furcae.

Life cycle: Final host ..... domestic duck (experimentally).

Reference: Suzuki and Kawanaka (1980), Jpn. J. Parasit., 29, 1–11; Kawanaka (1978).

Note: Paddy field dermatitis-producing cercariae parasitic in *Austropeplea ollula* had been reported from many prefectures in Japan by many reporters. Those cercariae were tentatively identified as *T. physellae* or *T. ocellata*. But Suzuki and Kawanaka assumed that those cercariae are the same as *T. brevis*. Refer to the former monograph by Ito (1964).

5. Cercaria of *Amblosoma suwaense* Shimazu, 1974 (Fig. 5)

Locality: Nagano.

Host: *Sinotaia quadrata*.

Parthenita: Sporocysts are white in color, unbranched or branched in shape. They are easily torn to pieces when dissected out. They contain the cercarial generation at various stages of development.

Cercaria: Body is elongated oval, slightly wider anteriorly. Tail is forked, well developed, functional and aspinose. Measurements are; body 203–257x63–102 μm, tail stem, 50–84x21–27 μm, furcae 63–143 μm long, oral sucker 42–46x38–49 μm, acetabulum 37–46x34–44 μm, pharynx 20–27x17–20 μm. Sensory hairs numbering at least 32, five pairs on lateral margins of anterior part of body, three pairs on dorso-ventral mid-lines of tail stem, and four pairs on ventral and dorsal margins of tail furcae. Both suckers are well developed. Prepharynx very short, pharynx barrel-shaped, esophagus short and intestinal ceca extending only to mid level of ventral sucker. Two grouped penetration gland cells, anterior group is 6 or 7 pairs of cells, and posterior one is about 5 pairs of cells. Many unicellular glands are observed as well as 5 pairs of mucoid glands. Primordium of reproductive organs are anterior to the excretory bladder which is unepithelial, thick-walled, globular, small, in posterior part of the body. Flame cell formula is $2[(1+1)+(1+1)]=8$. Cort's Island present.

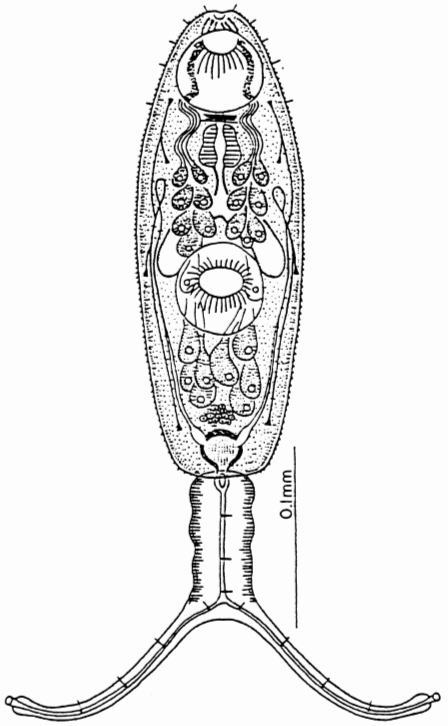

Fig. 5. Cercaria of *Amblosoma suwaense* – (Shimazu, 1978) –

Life cycle: 2nd host ..... *Sinotaia quadrata*.
Final host ... on the chick chorio-allantois (experimentally).

Reference: Shimazu (1978), Jpn. J. Parasit., 27, 489–493; Shimazu (1975).

6. *Cercaria nigrofurca* Ito, 1978 (Fig. 6)

Locality: Shizuoka, Kanagawa.

Host: *Austropeplea ollula*.

Parthenita: No description.

Cercaria: Brevifurcate distome furcocercaria. Measurements are; body 173–192 μm long by 77–96 μm wide, tail stem 230x48 μm, and tail furca 115x28 μm. Body is cylindrical or ellipsoidal in shape, covered with many minute spines. Two or three pairs of cephalic glands are in the oral sucker. Pharynx is followed by a long narrow esophagus and two broad ceca terminating near the posterior end of the body.

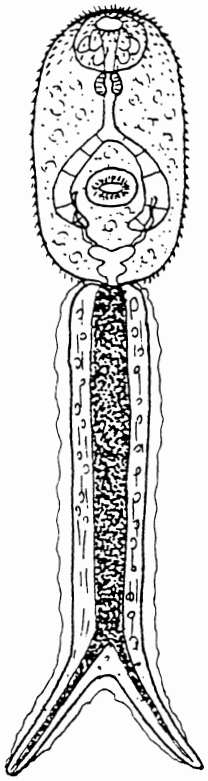

Fig. 6. *Cercaria nigrofurca* Ito, 1978
– (Ito, 1978) –

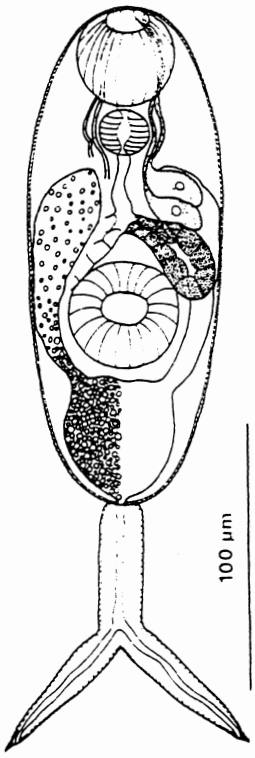

Fig. 7. *Cercaria* sp. by Shimura *et al.*, 1982
– (Shimura *et al.*, 1982) –

Around the opening of acetabulum, many small spines are arranged circularly. Excretory Vesicle is clover-shape. Flame cell formula is unknown. Tail surface is covered with a rather thick but very frail cuticle. It has neither spine nor hair. The cavity of the tail is filled with darkly pigmented granules which may be originated from the excretory granules.

Life cycle: Unknown (presumably Fellodistomatidae or Gymnophallidae).

Reference: Ito (1978); Jpn. J. Parasit., 27, 171–184; Uchida *et al.* (1982, 1984).

7. *Cercaria* sp. by Shimura, Yoshinaga and Wakabayashi, 1982 (Fig. 7)

Locality: Shizuoka.

Host: *Tapes philippinarum.*

Parthenita: Long ellipsoidal shaped sporocyst, tapering one extremity where a birth pore is observed. It measured 1.0–1.3 mm long by 0.24–0.34 mm wide. Many cercariae and germ balls are contained in a sporocyst.

Cercaria: Pharyngeal brevifurcate distome furcocercaria without eye spot. Measurements are; body 185×71 µm, oral sucker 36×36 µm, pharynx 19×17 µm, acetabulum 39×40 µm, tail stem 52×15 µm and tail furca 54×12 µm. Body surface is covered with many minute spines. Well developed pharynx is followed by an esophagus and ceca terminating in blind at the both sides of acetabulum. Two pairs of penetration gland cells are at the anterior half of the body. Y-shaped excretory vesicle contains dark-colored excretory granules. Flame cell formula is unknown. Excretory canal in the tail opens at the subterminal end of the tail furca.

Life cycle: Unknown (presumably Gymnophallidae).

Reference: Shimura, Yoshinaga and Wakabayashi (1982), Fish Pathol., 17, 129–137.

8. *Cercaria* sp. by Kajiyama, Kajiyama and Suzuki, 1980 (no Fig.)

Locality: Yamaguchi.

Host: *Polypylis hemisphaerula.*

Parthenita: No description.

Cercaria: Apharyngeal brevifurcate cercaria. Measurements are; body 109x250 μm, anterior organ 57x49 μm, acetabulum 70 μm in diameter, tail stem 563x68 μm and tail furca 116x34 μm. Body and tail stem is covered with minute spines. Eye spots are prominent. Seven pairs of flame cells are observed. Tail furca is provided with a dorso-ventral fin-fold.

Life cycle: Unknown (presumably Spirorchidae).

Reference: Kajiyama, Kajiyama and Suzuki (1980), Jpn. J. Parasit., 29 (suppl.), 106.

9. *Cercaria cristophora* Ito, 1978 (Fig. 9)

Locality: Shizuoka, Akita.

Host: *Austropeplea ollula. Lymnaea japonica.*

Parthenita: No description.

Cercaria: Small sized furcocercaria with a dorsal fin-fold on the body. measurements are; body 95x36 μm, tail stem 160x19 μm and tail furca 30x8 μm. Body is ellipsoidal in shape, being more acute anteriorly and being curved ventrally. Prominent dorsal fin-fold is along the dorsal median line of the posterior four fifths. Body wall is covered with many minute spines being more densely anteriorly. At the anterior tip of the body is furnished with one pair of lip-like papillae which forms a mouth opening. The body cavity is filled with various sized, not yet differentiated parenchymatous cells only. Tail stem is much longer than the body, and is provided with many weakly developed oblique muscles in it. Neither spine nor hair, but many fine annulations. Tail furca is short lanceolate in shape, provided with a dorso-ventral fin-fold forming a cup-shaped projection at the distal end of furcal ramus.

Life cycle: Unknown (presumably Sanguinicolidae).

Reference: Ito (1978), Jpn. J. Parasit., 27, 171–184; Tani (1983).

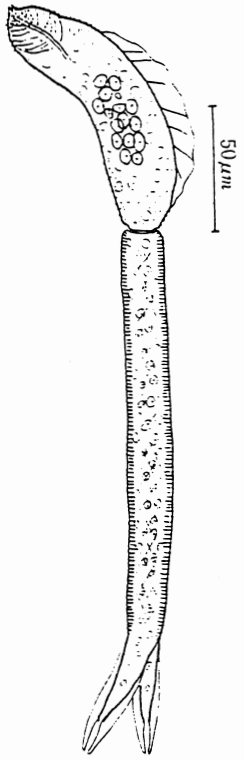

Fig. 9. *Cercaria cristophora* Ito, 1978 – (Ito, 1978) –

10. *Cercaria itoi* Shimura, 1984 (Fig. 10)

Locality: Kanagawa.

Host: *Fusinus perplexus.*

Parthenita: Redia is long sausage-shaped, tapering posteriorly, measured 1.15 mm long by 0.17 mm wide. Well developed pharynx is 52 μm long and 54 μm wide, and is followed by a short intestine. It contains 5–15 immature cercariae and some germ balls.

Cercaria: Distome and biocellate cercaria with large flat body and long simple tail. Measurements are; body 762x222 μm, oral sucker 65x68 μm, prepharynx 73 μm long, pharynx 26x24 μm, eye spot 22x17 μm, acetabulum 72x73 μm, excretory vesicle 298x100 μm and tail 973x45 μm. Body surface is covered with many spines but no sensory hair. Prepharynx is long, pharynx is globular, esophagus is very short and bifurcates into slender ceca which are not discernible. One pair

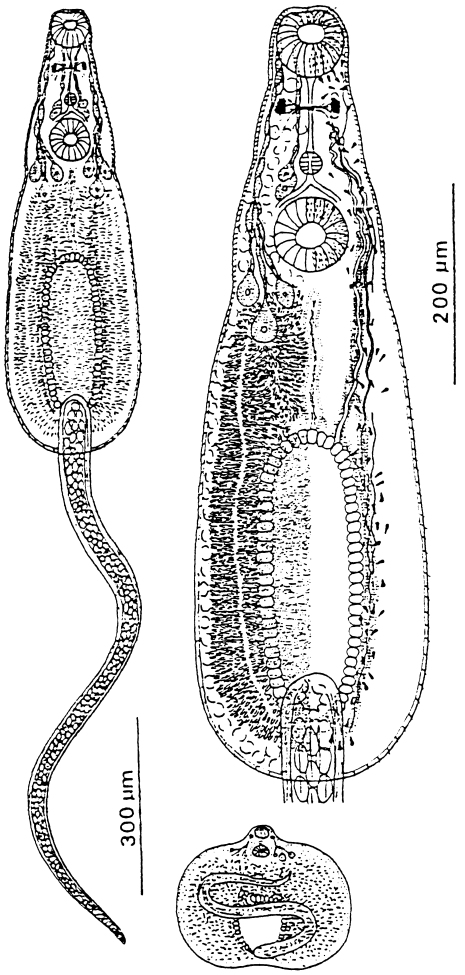

Fig. 10. *Cercaria itoi* Shimura, 1984
– (Shimura, 1984) –

of eye spots are at the prepharyngeal level. Well developed acetabulum is embedded in fleshy protrusion at the anterior fourth of the body. Two groups of penetration gland cells are on each side; three large cells posterolateral to the acetabulum and two small ones close to the median line anterior to the acetabulum. Cystogenous glands are packed beneath cuticle of the body. Excretory vesicle is saccular to tubular, thick-walled, and lies on the posterior half of the body. Flame cell formula is unknown but at least 66 flame cells on each side. A long genital anlage is discernible. Tail is long and aspinose, filled with parenchyma.

Life cycle: Unknown (presumably Acanthocolpidae).

Reference: Shimura (1984), Fish Pathol., 18, 179–183.

11. Cercaria of *Homalogaster paloniae* Poirier, 1883 (Fig. 11)

Locality: Shizuoka.

Host: *Polypylis hemisphaerula.*

Parthenita: No description.

Cercaria: Paramphistome cercaria with eye spot. Measurements by fixed specimens are; body 449x276 µm, eye spot 33x23 µm, oral sucker 39–65x42–61 µm, oral pouch 40x78 µm, acetabulum 93x102 µm, esophagus 55 µm long, ceca 180 µm long, ovary enlage 29x24 µm, testes anlage 18x13 µm long and

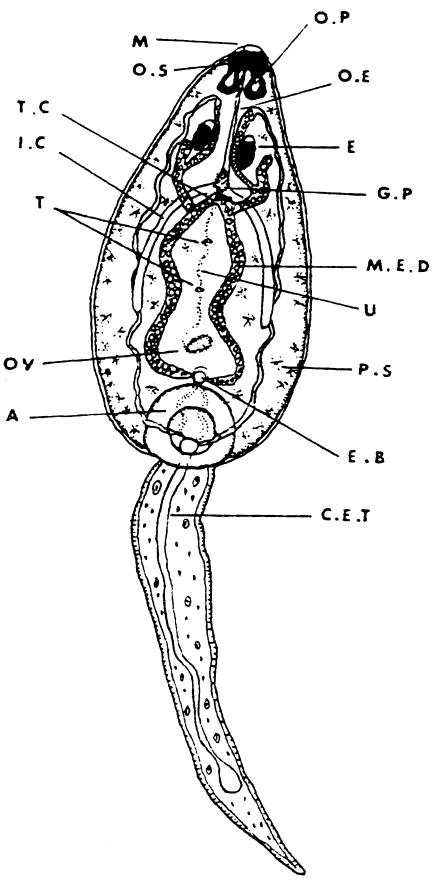

Fig. 11. Cercaria of *Homalogaster paloniae*
– (Chinone and Itagaki, 1977) –

tail 442 μm long. Eye-spot with a clear lens is hemispherical in shape. Main excretory ducts are filled with granules. A transverse connection exists between the two main excretory ducts, reaching the level of the bifurcation of the ceca, and a short diverticulum is given off externally from each ducts so as to surround the eye spot. Then each main duct is continued to a thinner vessel, which turns backwards near the oral pouches and is connected with the caudal excretory tube. Anlage of the ovary is oval in shape, and those of the testes are oval to spherical in shape.

Life cycle: 2nd host .... in the same snail.
Final host ... cattle, water buffaloes, sheep and goats.

Reference: Chinone and Itagaki (1977), Jpn. J. Vet. Sci., 39, 665–670.

12. *Cercaria miyagiensis* Komiya, 1967 (Fig. 12)

Locality : Miyagi.

Host: *Parafossarulus manchouricus.*

Parthenita: Echinostome-type redia, having the collar and the locomotive appendages, measuring about 2.6 mm long. Pharynx is relatively small, its intestinal gut attaining to the middle of the body. About 20 cercariae are contained in a matured redia.

Cercaria: Gymnocephalous cercaria of echinostome-type. Measurements of living specimens are; body 290–310x180–210 μm, oral sucker 28–29 μm in diameter, acetabulum 34–36 μm in diameter and tail 350–400x180–210 μm. Body is flat and oval in shape, providing five pairs of long and short sensory hairs, but no spine on the cuticle. Neither pigments nor fatty granules in the parenchyma of the body. Prepharynx is very short, pharynx is oval in shape, esophagus is long, and ceca terminate near the posterior end of the body. Both esophagus and ceca are filled with transparent ingesta. Neither penetration gland nor cystogenous gland, but rod-like and granular substances are in the body. Genital primordia are poorly developed. Excretory system is typical echinostome type. The ascending part of the main collecting tube is swollen and contains 11–15 excretory concretions. Flame cell formula is $2[(2+2+2)+(2+2+2)]=24$. Tail is longer than the body, providing neither furca nor finfold, but three pairs of sensory hairs at the level beneath the opening of the excretory canal.

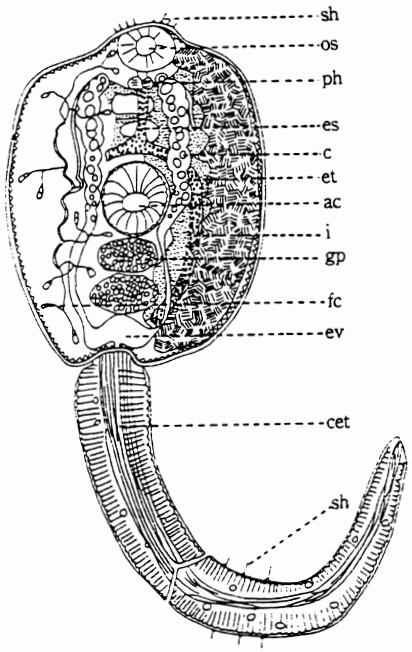

Fig. 12. *Cercaria miyagiensis* Komiya, 1967 – (Komiya, 1967) –

Life cycle: Unknown.

Reference: Komiya (1967), Jpn. J. Med. Sci. and Biol., 29, 421–424.

13. *Cercaria* sp. by Miyamoto, 1981 (no Fig.)

Locality: Hokkaido.

Host: *Cipangopaludina japonica.*

Parthenita: No description.

Cercaria: Echinostome cercaria. Measurements are; body 524x257 μm, oral sucker 66x55 μm, acetabulum 86x91 μm, tail 613x90 μm. Head collar and collar spines are observed. Tail is provided with a fin-fold, being wider at its posterior part.

Life cycle: Unknown. Metacercariae are detectable within the same snail host.

Reference: Miyamoto (1981), Jpn. J. Parasit., 30 (suppl.), 105.

14. *Cercaria corbiculae* Shimura, 1983 (Fig. 14)

Locality: Shimane.

Host: *Corbicula japonica.*

Parthenita: Sporocyst is oval, thick-walled with a birth pore at one end, measured 861 μm long by 264 μm wide. It contains 3–7 cercariae and some germ balls.

Cercaria: Distome, pharyngeate cercaria with a slender long tail, no stylet, no eye-spot. Measurements are; body 281×100 μm, oral sucker 49×47 μm, prepharynx 8 μm long, pharynx 19×19 μm, acetabulum 46×46 μm and tail 203×20 μm. Body surface is covered with many minute spines but no sensory hair. Well developed oral sucker is followed by a short prepharynx, a globular pharynx, and a esophagus bifurcating into two ceca reaching to the posterior end of the body. Three pairs of penetration gland cells are situated in the middle part of the body, immediately anterior to the acetabulum. Well developed acetabulum is in the posterior part of the middle third of the body. Genital anlage is posterodextral to the acetabulum. Excretory vesicle is large and long, lined with a layer of epithelial cells, extending to the anterior end of the acetabulum, displacing sinistrally in the middle part, then curving inward at its anterior end. Flame cell formula is 2[(2+2)+(2+2)]=16. Slender and aspinose tail is about two thirds of body length. No caudal excretory tube is observed.

Life cycle: Unknown (presumably Monorchiidae).

Reference: Shimura (1983), Fish Pathol., 18, 61–64.

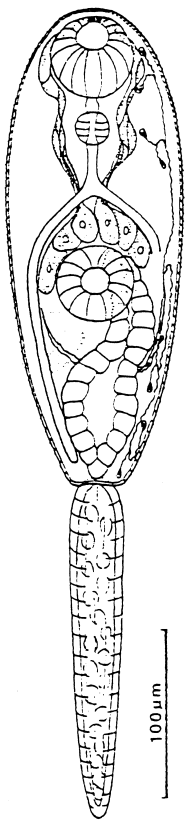

Fig. 14 *Cercaria corbiculae* Shimura, 1983 – (Shimura, 1983) –

15. *Cercaria batillariae* Shimura *et* Ito, 1980 (Fig. 15)

Locality: Kanagawa and Chiba.

Host: *Batillaria cumingii.*

Parthenita: Fusiform or sausage-shaped redia, measuring about 930×150 μm. Many short sensory hairs are around the mouth opening. It contains about 20 mature and saturing cercariae.

Cercaria: Biocellate pleurolophocercous cercaria, measurements are; body 165×65 μm, oral sucker 27×22 μm, eye spot 9×7 μm, prepharynx 60 μm long, pharynx 9×10 μm, tail 351×27 μm, and lateral fin 145×13 μm. Body is elliptical in shape, providing with many minute spines and 8 pairs of sensory hairs. Three transverse rows of oral spines are found, the number in each row being 7–10, 8–9, and 5–6 respectively. Oral sucker is well developed, but acetabulum is rudimentary. Penetration glands are 7 pairs. Excretory vesicle is cordate and lined with one layer of epithelium. Flame cell formula is 2[(2+2)+(2+2)]=16. Tail is twice as long as the body, providing with a pair of lateral finfolds and a dorso-ventral finfold. Caudal excretory tube runs backward throughout the tail.

Life cycle: Unknown (presumably Heterophyidae).

Reference: Shimura and Ito (1980), Jpn. J.

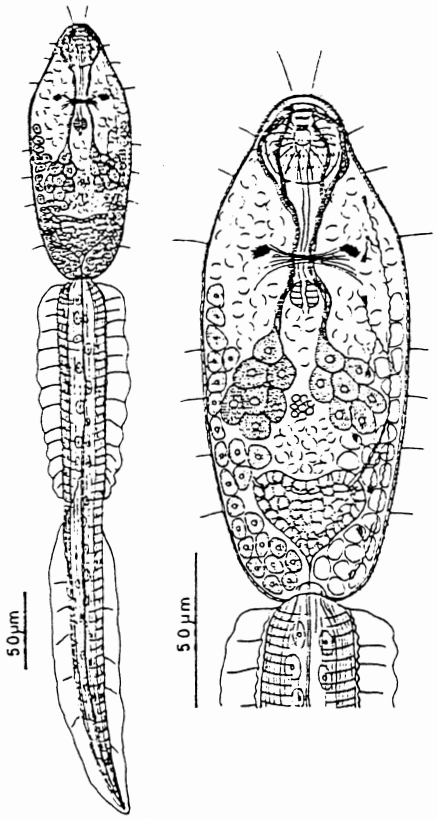

Fig. 15 *Cercaria batillariae* Shimura *et* Ito, 1980 – (Shimura and Ito, 1980) –

Parasit., 29, 369–375.

16. *Cercaria isoninae* Ito *et* Shimura, 1980 (Fig. 16)

Locality: Kanagawa and Chiba.

Host: *Japeuthria ferrea.*

Parthenita: Ellipsoidal redia, tapering posteriorly. It measures 920–1250×190–240 μm. Well developed pharynx, short esophagus and a small saccular gut compacted by brownish ingesta are observed. It contains many cercarial embryos only.

Cercaria: Ophthalmo-trichocercous cercaria. Measurements are; body 832×186 μm, oral sucker 70 μm in diameter, prepharynx 202 μm long, pharynx 81×68 μm, acetabulum 77×79 μm, tail 1017×68 μm, and seta 150 μm long. Body surface is covered with many triangular spines. Long prepharynx is composed of an

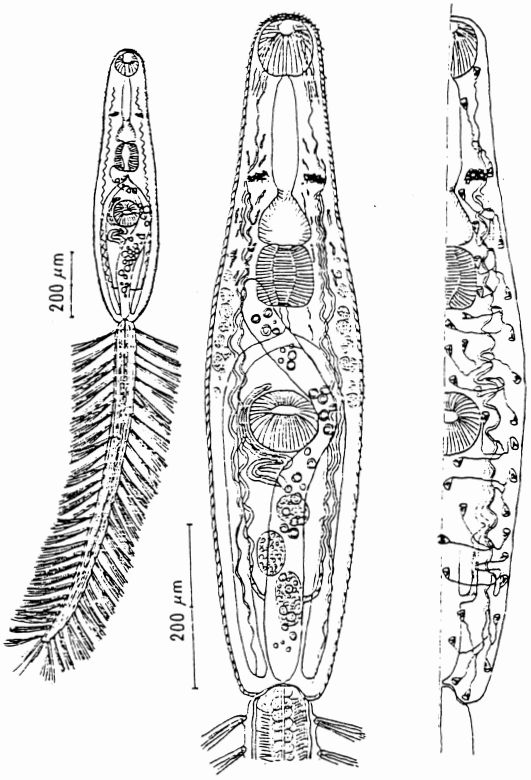

Fig. 16 *Cercaria isoninae* Ito *et* Shimura, 1980 – (Ito and Shimura, 1980) –

anterior long cylindrical cavity and a posterior broad, finely striated cavity. Well developed pharynx is followed by a short esophagus and two ceca terminating near the posterior end of the body. A small number of penetration gland cells are faintly observable. Two testes, one ovary and a primordium of oviduct and/or uterus are observed. Large I-shaped tubulo-saccular excretory vesicle extends forward to the region of the pharynx, bending near the side of acetabulum. It contains about 20 to 50 refractive excretory concretions. Flame cell formula is 2[(3)+(3×11)]=72. Tail is much longer than the body, providing with 27–29 pairs of lateral tufts and one pair of terminal tuft. Each lateral tuft has a row of 6–8 setae, terminal tuft of 3–4 setae.

Life cycle: Unknown (presumably Lepocreadiidae).

Reference: Ito and Shimura (1980), Jpn. J. Parasit., 29, 181–187.

17. *Cercaria rhipidocaudata* Shimura *et* Kudo, 1983 (Fig. 17)

Locality: Tokyo.

Host: *Trochus sacellus rota.*

Parthenita: Saccate redia with a small pharynx. Measurements are; body 784x200 μm, and pharynx 15x16 μm. It contains 7–13 cercariae and some germ balls.

Cercaria: Fan-tailed cercaria. Measurements are; body 141x39 μm, oral sucker 22x24 μm, stylet 9x2 μm, prepharynx 36 μm long, pharynx 7x12 μm, acetabulum 25x26 μm, tail stem 183x28 μm, and tail fan 189x183 μm. Body is aspinose. Around the mouth opening numerous scale-like small projections and a pair of single-pointed shouldered stylet are observed. Mouth leads to a prepharynx and a pharynx but no esophagus. Genital anlage is discernible anterior to the acetabulum. Excretory vesicle is I-shaped with undulated margin. Flame cell formula is 2[(2+2)+(2+2)]=16. Tail stem is slender cylindrical with annulations in its anterior third, but is thick and smooth in the posterior two thirds. Six large cells form a longitudinal row in the stem. Tail fan is thin and cordate with three pairs of projections.

Life cycle: Unknown.

Reference: Shimura and Kudo (1983), Fish Pathol., 18, 125–133.

18. Cercaria of *Maritrema setoensis* Bridgman, 1971 (Fig. 18)

Locality: Kagawa.

Host: *Littorina brevicula.*

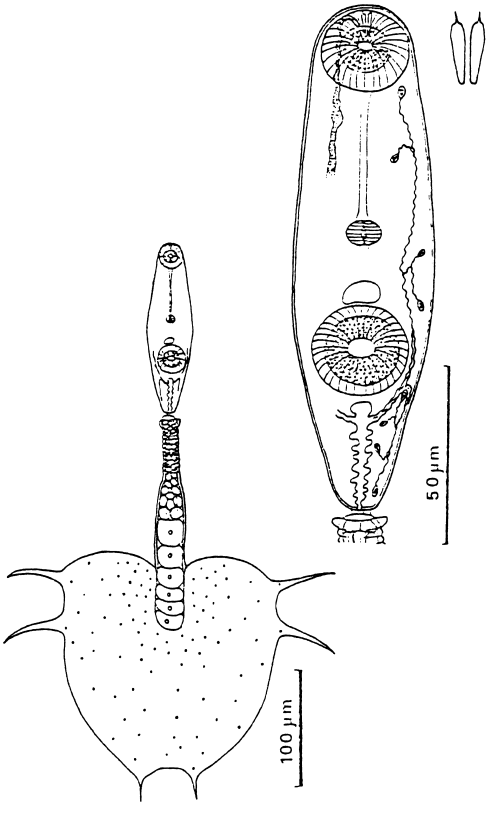

Fig. 17 *Cercaria rhipidocaudata* Shimura *et* Kudo, 1983
– (Shimura and Kudo, 1983) –

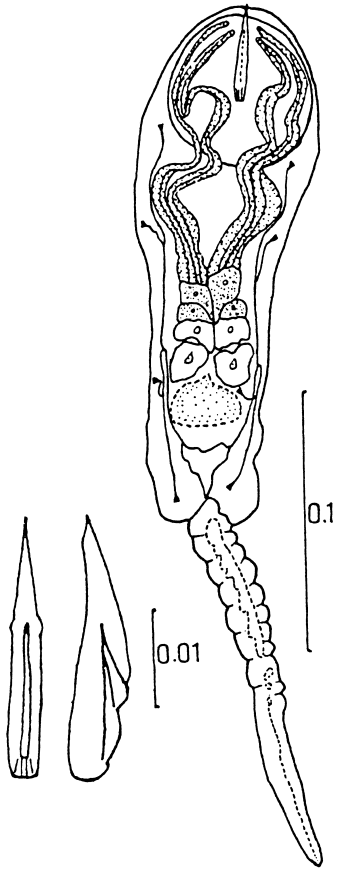

Fig. 18 Cercaria of *Maritrema setoensis*
– (Bridgman, 1971) –

Parthenita: Round to elongate sporocysts, measuring 499–600x175–225 μm. It contains 10–50 cercariae. The birth pore is terminal, and the opposite end contains rounded structures considered to be developed cercariae and germ balls.

Cercaria: Small monostome xiphidiocercaria with the characters of the Ubiquita group. Measurements are; body 145–150x43–48 μm, oral sucker 38–40 μm in diameter, stylet 25x2.5 μm, and tail 100–113x7.5–8.5 μm. Body is ovoid to elongate in shape. Stylet base squared lightly colonnaded longitudinally, shaft cylindrical, then tapered to slightly ventrally directed point, asymmetrical in side view. Digestive system not observed. Four pairs of thin penetration gland cells are observed. The anterior two pairs are staining darker than the posterior two pairs. Genital anlage is a small mass posterior to penetration glands. Excretory bladder is heart-shaped. Flame cell formula is 2[(1+1)+(1+1)]=8.

Life cycle: 2nd host .... *Hemigrapsus sanguineus.*
Final host ... *Numenius madagascariensis.*

Reference: Bridgman (1971), Jpn. J. Parasit., 29, 13–23.

19. *Cercaria hosoumininae* Shimura *et* Ito, 1980 (Fig. 19)

Locality: Kanagawa and Chiba.

Host: *Batillaria cumingii.*

Parthenita: Roundish oval sporocyst, about 350 μm long and 200 μm wide. It contains 15–30 cercariae with some germ balls.

Cercaria: Xiphidiocercaria of Ubiquita type belonging to Microcotyle group. Measurements are; body 166x55 μm, oral sucker 38x34 μm, stylet 26x5.5 μm, and tail 142x14 μm. Body is elongate oval in shape, neither spine nor hair. Within a well developed oral sucker a solid non-shouldered stylet is embedded. No digestive system and acetabulum. Among three pairs of penetration gland cells, the first two are coarse granule, and the last one is fine granules. Excretory vesicle is epithelial and cordate with a collecting duct. Flame cell formula is 2[(1+1)+(1+1)]=8. Tail is slender and aspinose. It is coated with fine cuticular annulations. No caudal excretory tube is observed.

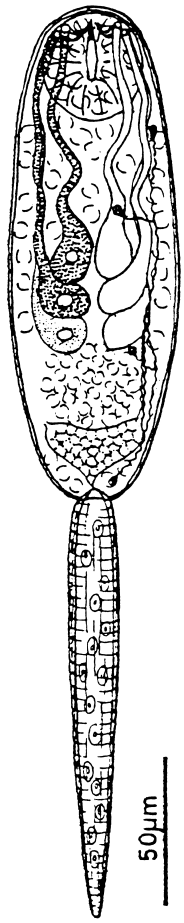

Fig. 19 *Cercaria hosoumininae* Shimura *et* Ito, 1980 – (Shimura and Ito, 1980) –

Life cycle: Unknown (presumably Microphallidae).

Reference: Shimura and Ito (1980), Jpn. J. Parasit., 29, 369–375.

20. Cercaria of *Glypthelmins rugocaudata* (Yoshida, 1916) (Fig. 20)

Locality: Shizuoka, Kanagawa.

Host: *Austropeplea ollula.*

Parthenita: Sporocyst is 2–4 mm long, brownish yellow in color. Many sporocysts are

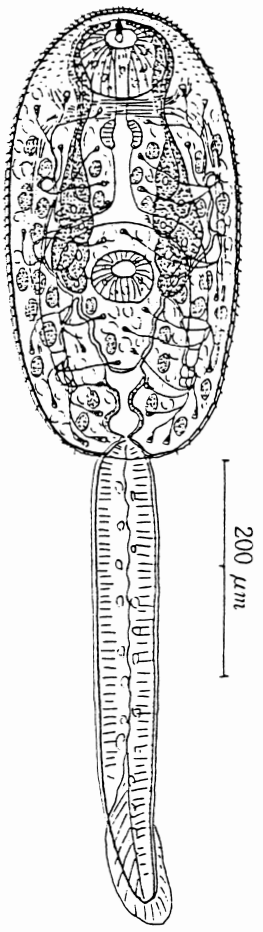

Fig. 20 Cercaria of *Glypthelmins rugocaudata* – (Ito, 1978) –

tangled, so that it looks like a complicated branched one. Several cercariae with some germ balls are contained in one sporocyst.

Cercaria: Lophocercous xiphidiocercaria belonging to Ornatae group of Lühe (1909). Measurements are; body 406×206 μm, oral sucker 74×80 μm, stylet 23×8 μm, prepharynx 13 μm long, pharynx 30×46 μm, acetabulum 56×55 μm, and tail 433×51 μm. Body is ellipsoidal in shape, covered with many minute spines. Short prepharynx, pyriform pharynx, long esophagus and intestines are observed. Nervous cord is prominent. About five pairs of penetration gland cells and many cystogenous gland cells are in the body. A thick lined epithelial, two-chambered excretory vesicle is at the posterior end of the body. Flame cell formula is 2[(3+3+3)+(3+3+3)]=36. Slender tail is provided with a caudal-fin-fold along the whole length of dorsal and ventral median line. These are connected each other around the tail tip.

Life cycle: 2nd host .... presumably skin of frogs.
Final host ... presumably frogs.

Reference: Ito (1978), Jpn. J. Parasit., 27, 171–184; Uchida (1984).

21. Cercaria of *Paragonimus miyazakii* Kamo *et al.*, 1961 (Fig. 21)

Locality: About 20 Prefectures.

Host: *Bythinella (Moria) nipponica akiyoshiensis.*
Saganoa sp. (*Saganoa kawanensis* ?).
Oncomelania nosophora (experimentally).

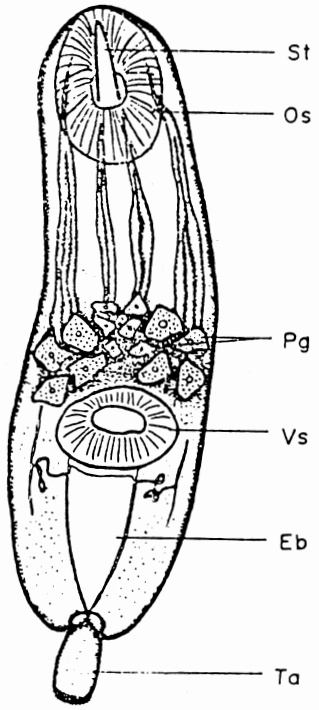

Fig. 21 Cercaria of *Paragonimus miyazakii* – (Hatsushika, 1967) –

Parthenita: According to Hatsushika (1967), Measurements of the first generation redia are; body 669x102 μm, Pharynx 61x57 μm, intestine 95 μm long. That of the second generation redia is; body 550x150 μm, pharynx 60x57 μm, and intestine 125 μm long. Intestine is yellow-brown in color. The second generation redia contains 4–7 cercariae.

Cercaria: According to Hatsushika (1967), Measurements of cercariae are; body 191x75 μm, oral sucker 48x43 μm, acetabulum 38x35 μm, pharynx 17x15 μm, stylet 28x5 μm, and tail 16 μm long. Body surface is covered with many minute spines. Stylet is prominent. Among seven pairs of penetration gland cells, the outer four pairs contain coarse granules, and the inner three pairs contain fine granules. Tail is short, distal end of which is provided with many small spines.

Life cycle: 2nd host .... *Potamon dehaani.*
Final host ... Mammals (including man).

Reference: Hatsushika (1967), J. Yonago Med. Ass., 18, 241–271; Kawashima and Miyazaki (1964); Hatsushika *et al.* (1966); Hashiguchi (1967); Hashiguchi and Miyazaki (1968); Yoshimura *et al.* (1970); Ishii and Tokunaga (1970); Kawanaka *et al.* (1979); Sano *et al.* (1979); Saitoh *et al.* (1980); Shogaki (1980); Higo and Ishii (1983); Gyoten (1985).

22. Cercaria of *Nanophyetus japonensis* Saito *et al.*, 1982 (Fig. 22)

Locality: Iwate, Akita, Yamagata.

Host: *Semisulcospira libertina.*

Parthenita: Cylindrical redia, measuring 200–1945 μm long and 50–444 μm wide. Spherical pharynx is 42–75x46–70 μm. Sac-like or cylindrical gut reaches from one third to two thirds of the redia. Birth pore is side of the pharynx. Numerous cercariae in various stages of development are contained in the redia.

Cercaria: Microcercous xiphidiocercaria. Measurements are; body 305x125 μm, oral sucker 54x57 μm, acetabulum 50x53 μm, pharynx 22x18 μm, tail 18x14 μm, and stylet

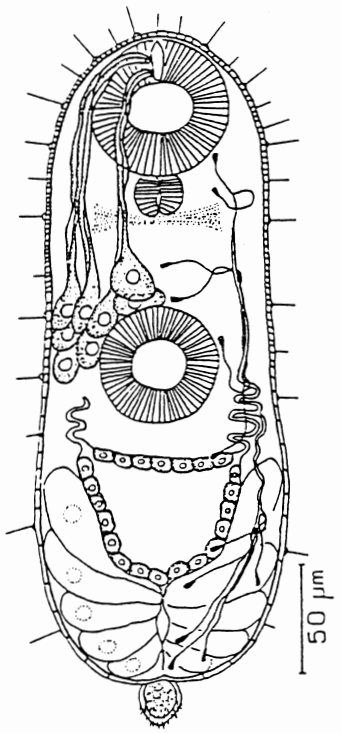

Fig. 22 Cercaria of *Nanophyetus japonicus* – (Saito, 1985) –

15x5 μm. Body is covered with many minute spines and long sensory hairs. No prepharynx. Esophagus and intestine can not be traced. Eight pairs of homogenous penetration gland cells are anterio-lateral side of the acetabulum. Posterior body is occupied by a large U- or V-shaped excretory bladder. Its wall is lined with a thick layer of cuboid epithelia containing coarse granules. Flame cell formula is 2[(2+2+2)+(2+2+2)]=24. A pronounced median groove is on the ventral side of the hind body. Several pairs of large crescent adhesive gland cells are in the hind body too. Many cystogenous gland cells and 6 pairs of mucoid gland cells are in the body. Tail is short and smooth except for the tip, where hair-like spines grew.

Life cycle: 2nd host .... *Oncorhynchus masou, Carassius carassius auratus,* and other fishes.
Final host .... mammals.

Reference: Saito (1985), Jpn. J. Parasit., 34, 41–53; Saito *et al.* (1977); Saito (1978).

23. *Cercaria* sp. by Hatsushika and Maejima, 1978 (Fig. 23)

Locality: Yamaguchi, Ehime.

Host: *Bythinella (Moria) nipponica.*

Parthenita: Elongated ellipsoidal redia. Measurements of 1st generation rediae are; body 284x90 μm, pharynx 52x54 μm, and intestine 75 μm long. Those of 2nd generation rediae are; body 558x123 μm, pharynx 39x42 μm, and intestine 106 μm in length. Two to five cercariae are contained in the 2nd generation rediae.

Cercaria: Microcerous xiphidiocercaria. Measurements are; body 165x71 μm, oral sucker 37x40 μm, acetabulum 32x34 μm, stylet 26x5 μm, and tail 12x11 μm. Body is covered with many minute spines. Acetabulum is slightly smaller than the oral sucker. Central groove of the hind body is not so clear. Excretory vesicle is Y-shape, and lined with thick walled epithelia. Two rows of penetration gland cells are at the lower level of the acetabulum. Flame cell formula is unknown. Mucoid substances are an appearance of the thick basal layer in the hind body.

Life cycle: Unknown (presumably Nanophyetidae).

Reference: Hatsushika and Maejima (1978), Jpn. J. Parasit., 27, 375–385; Hatsushika and Maejima (1969).

24. *Cercaria* sp. by Saito, Watanabe, Tani and Ishida, 1983 (Fig. 24)

Locality: Akita.

Host: *Semisulcospira libertina.*

Parthenita: Elongated ellipsoidal redia, measuring 1677x336 μm. Pharynx and gut is nearly the same size, measuring 56x54 μm. The redia contains 100–150 cercariae in various stages of development.

Cercaria: Microcercous cercaria. Measurements are; body 207x70 μm, oral sucker 37 μm in diameter, acetabulum 31 μm in

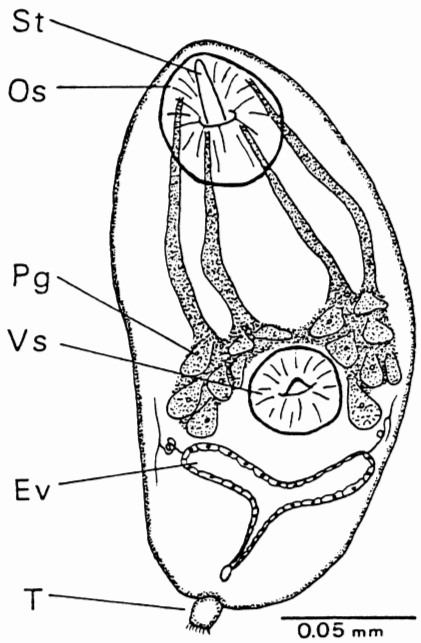

Fig. 23 *Cercaria* sp. by Hatsushika and Maejima, 1978
– (Hatsushika and Maejima, 1978) –

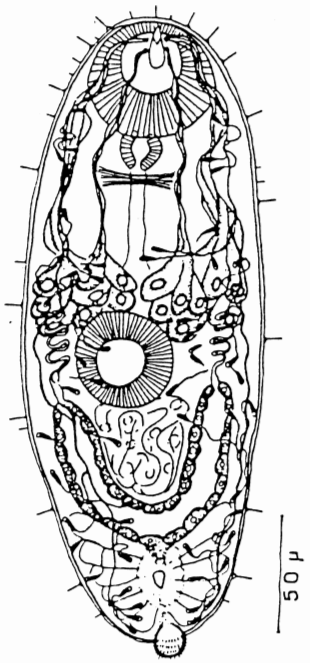

Fig. 24 *Cercaria* sp. by Saito *et al.*, 1983
– (Saito *et al.*, 1983) –

diameter, tail 14×12 μm, and stylet 20 μm in length. Body is covered with many minute spines and sensory papillae. No prepharynx. Esophagus is observed but intestine can not be traced. Eight pairs of homogenous penetration gland cells are observed. Posterior body is occupied by a large Y-shaped excretory bladder. Its wall is lined with a thick layer of cuboid epithelia containing coarse granules. Flame cell formula is estimated as 2[(4+4+4)+(4+4+4+4)]=56. A pronounced median groove is on the ventral side of the hind body. Several pairs of large crescent gland cells are in the hind body. Many cystogenous gland cells and 6 pairs of mucoid gland cells are in the body. Tail is short and smooth except for the tip, where hair-like spines grew.

Life cycle: Unknown

Reference: Saito *et al.* (1983), Jpn. J. Parasit., 32 (suppl.), 6.

25. *Cercaria* sp. by Gyoten, 1981 (no Fig.)

Locality: Ehime.

Host: *Bythinella nipponica.*

Parthenita: Ellipsoidal or cylindrical redia. Measurements are; body 204–379×80–136 μm, pharynx 26–47×19–29 μm and intestine 44–67×14–29 μm. Birth pore is anterior lateral side of the redia. Many sensory hairs are around the mouth opening. Only two to four rediae are in one snail, and 6–10 cercariae are in one redia.

Cercaria: Microcercous xiphidiocercaria. Measurements are; body 145–160×60–68 μm, oral sucker 33–53×29–52 μm, acetabulum 20–33×23–36 μm, stylet 19–32×3–6 μm and tail 10–17×10–17 μm. Spindle-shaped body is covered with many minute spines. Eight pairs of penetration gland cells are homogenous, situating antero-lateral side of the acetabulum. Excretory vesicle is Y-shape, and lined with thick walled epithelia containing refractive granules. Several pairs of gland cells are in the posterior part of the body. Tail is short, distal end of which is provided with many small spines.

Life cycle: Unknown (presumably Nanophyetidae).

Reference: Gyoten (1981), Jpn. J. Parasit., 30 (suppl.), 104.

26. *Cercaria hachijoensis* Shimura *et* Kudo, 1983 (Fig. 26)

Locality: Tokyo (Hachijo-Shima).

Host: *Trochus sacellus rota, Tectus pyramis, Omphalius nigerrimus.*

Parthenita: Sporocyst is large, saccate, and contains 30–60 cercariae and some germ balls. It measures 3.1×0.3 mm. Some sporocysts contain a few tailless or encysted metacercariae. Sporocyst wall contains large masses of bright orange pigments.

Cercaria: Cotylocercous cercaria. Measurements are; body 343×91 μm, oral sucker 52×53 μm, stylet 8×5 μm, prepharynx 40 μm long, pharynx 23×26 μm, acetabulum 56×48 μm, and tail 60×45 μm. Body is aspinose.

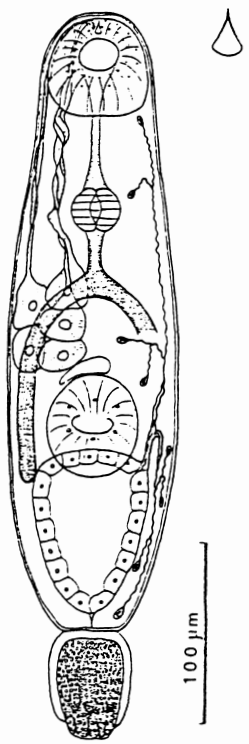

Fig. 26 *Cercaria hachijoensis* Shimura *et* Kudo, 1983

– (Shimura and Kudo, 1983) –

Sensory papillae are around the mouth opening, and a single pointed non-shouldered stylet at the apical end. Esophagus is short, bifurcating into two long intestines ending at the level of the posterior end of acetabulum. Among five pairs of penetration glands, three pairs are inside, and two pairs are outside at the middle third of the body. Acetabulum is provided with six low papillae around the opening. Genital anlage is slightly discernible. An epithelial excretory vesicle is large saccate, occupying the greater part of the hind body. Flame cell formula is 2[(2+2)+(2+2)]=16. Tail is short, containing long glandular cells filled with small granules stainable with neutral red.

Life cycle: Unknown (presumably Opecoelidae).

Reference: Shimura and Kudo (1983), Fish Pathol., 18, 125–133.

27. *Cercaria misakiana* Shimura *et* Ito, 1980 (Fig. 27)

Locality: Kanagawa.

Host: *Batillus cornutus*, *Marmarostoma stenogyrum*.

Parthenita: Fusiform redia, 0.50–0.67 mm long, more blunt at the anterior end, bearing setae and a birth pore at the head region. It contains several cercariae and some germ balls. Pharynx is very small and poorly defined.

Cercaria: Cotylocercous cercaria. Measurements are; body 186x59 μm, oral sucker 37x33 μm, stylet 12x9 μm, prepharynx 49 μm long, pharynx 13x16 μm, acetabulum 32 μm in diameter, and tail 25x32 μm. Body is very contractile, with about 15 pairs of sensory hairs set on papillae. Stylet is cleft anteriorly with two points directed anterolaterally. Mouth leads into a long prepharynx, which is followed by a pharynx. Four pairs of penetration gland cells are poorly defined. Well developed acetabulum is provided with eight sensory hairs on its ventral surface. Excretory vesicle is large and sac-like, lined with very large secretory cells. Flame cell formula is 2[(2)+(2+2)]=12. Tail is filled with eosinophilic granules and ten to twelve ducts open posteriorly.

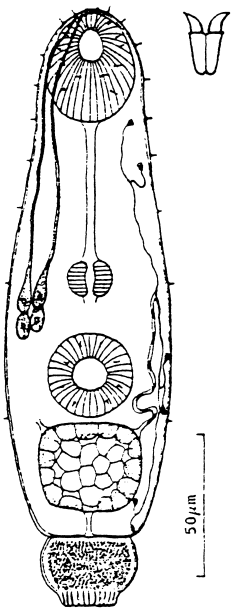

Fig. 27 *Cercaria misakiana* Shimura *et* Ito, 1980 – (Shimura and Ito, 1980) –

Life cycle: Unknown (presumably Opecoelidae).

Reference: Shimura and Ito (1980), Jpn. J. Parasit., 29, 69–76.

28. *Cercaria brachycaeca* Shimura *et* Ito, 1980 (Fig. 28)

Locality: Kanagawa, Chiba.

Host: *Batillus cornutus*.

Parthenita: Large, mature sporocysts are elongated saccular, 1.3–2.4 mm long and 0.19–0.38 mm wide, containing 20–40 cercariae. Their walls contain large masses of bright orange pigments.

Cercaria: Cercariaeum. Measurements are; body 198x83 μm, oral sucker 46x52 μm, stylet 6 μm long, prepharynx 4 μm long, pharynx 20x18 μm, and acetabulum 51x59 μm. Body is oval in shape and very contractile, with many minute spines but no sensory hair. A small, single-pointed, non-shouldered stylet is in the oral sucker. Two short caeca reaching to the middle of the body, are thick-walled and contain ingesta stainable with neutral red. Six pairs of penetration gland cells are at the

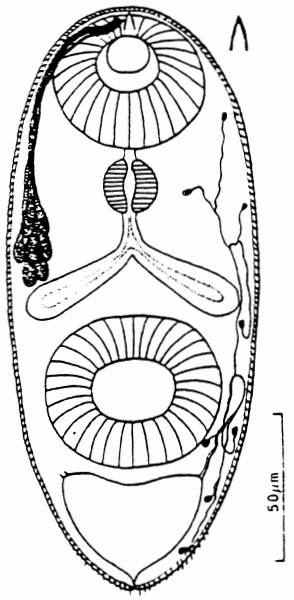

Fig. 28 *Cercaria brachycaeca* Shimura *et* Ito, 1980 – (Shimura and Ito, 1980) –

middle part of the body. Large excretory vesicle is triangulate or cordate, and non-epithelial. Flame cell formula is 2[(2+2)+(2+2)]=16.

Life cycle: Unknown.

Reference: Shimura and Ito (1980), Jpn. J. Parasit., 29, 69–76.

Special Treatise

PART II. Additional Data to the Former Monograph

* Parenthesized number on the end of each species indicates the number in the former monograph.

** Data on the locality, host and reference include both of the former monograph and the new additional one.

1. *Cercaria pseudodivaricata* (Ando, 1918) Faust, 1924 (No. 1)

Locality: Gifu, Shizuoka, Kumamoto, Hiroshima.

Host: *Semisulcospira libertina.*

Reference: Ando (1918); Kobayashi (1922); Faust (1924); Ueno *et al.* (1930); Ito (1960); Saito *et al.* (1969).

2. *Cercaria longissima* (Suzuki et Nishio, 1914) Faust, 1924 (No. 6) (Fig. A)

Locality: Saga, Fukuoka, Yamanashi.

Host: *Oncomelania nosophora.*

Parthenita: Long sausage-shaped sporocyst, measuring 1.8 mm long by 0.18 mm wide. It contains 3–20 matured cercariae.

Cercaria: Pharyngeal longifurcate distome furcocercaria without eye spot. Measurements are; body 150x61 μm, oral sucker 28x29 μm, acetabulum 22x28 μm, pharynx 11x10 μm, tail stem 175x34 μm, and tail furca 189x20 μm. Pharynx is followed by a short esophagus and ceca extending to near the posterior end of the body. Four pairs of penetration gland cells are on the posterior lateral side of the acetabulum. Flame cell formula is 2[(2+2)+(2+2+[2])] =20. Sensory hairs are 8 pairs on the body, 5 pairs on the tail stem and 7 pairs on the tail furca. Caudal excretory tube runs backward along the axis of the tail and

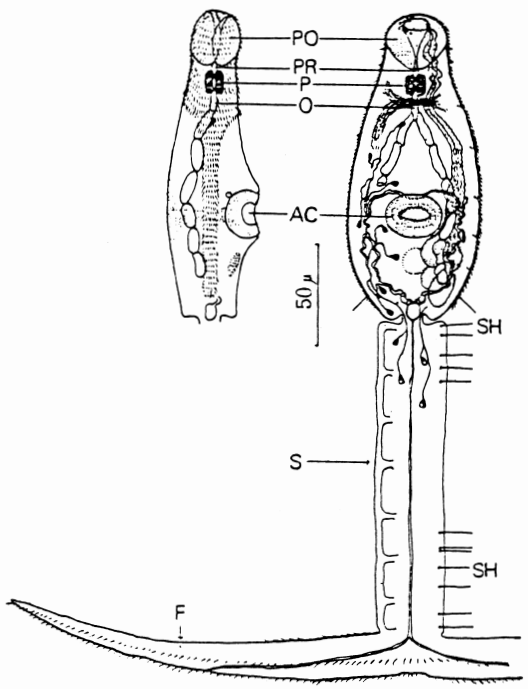

Fig. A *Cercaria longissima* Faust, 1924 – (Kamachi *et al.*, 1972) –

opens at the middle of tail furcae.

Reference: Suzuki and Nishio (1914); Kobayashi (1922); Faust (1924); Komiya and Ito (1967); Kamachi and Takao (1969); Tongu *et al.* (1970); Kamachi *et al.* (1972).

Note: Above description is based on the report of Kamachi *et al.* (1972). Comparing with the report of Komiya and Ito (1967), there exist some differences on the measurements and the number of sensory hairs. These differences seem to be due to the different materials, because the former is based on Saga materials, and the latter is on Yamanashi materials.

3. Cercaria of *Schistosoma japonicum* Katsurada, 1904 (No. 7)

Locality: Yamanashi, Fukuoka, Saga, Hiroshima, Yamaguchi, Shizuoka, Tokyo, Chiba, Saitama.

Host: *Oncomelania nosophora.*

Reference: Kifune and Takao (1968); Kawashima (1969); Yasuraoka and Kojima (1969); Matsuda *et al.* (1970); Koyama *et al.* (1970); Kikuchi *et al.* (1976); Takao *et al.* (1977); Kawashima and Habe (1984); Hata *et al.* (1985); Kawashima *et al.* (1986).

Note: As to the old literatures, refer the former monograph of Ito (1964), No. 7.

4. Cercaria of *Giganthobilharzia sturniae* (Tanabe, 1948) (No. 8)

Locality: Shimane, Aichi, Saitama, Tottori, Nara, Kanagawa, Yamanashi, Hyogo, Okayama, Okinawa.

Host: *Polypylis hemisphaerula* (=*Segmentina nitidella*).

Reference: Tanabe (1948, 1951); Komiya *et al.* (1951, 1952); Oda (1953); Nomura (1961); Suzuki *et al.* (1973); Maejima *et al.* (1977); Kumazawa *et al.* (1980); Suzuki *et al.* (1982); Uchida *et al.* (1982); Matsumura *et al.* (1983); Minai *et al.* (1984); Uchida (1984); Matsumura *et al.* (1985); Murata *et al.* (1985); Maejima *et al.* (1987); Tongu *et al.* (1987); Oshima *et al.* (1988).

Note: This cercaria is considered to include two species, because there is two types of flame cell formula, one is $2[(1+1+1)+(1+1+1+[1])]=14$, and the another one is $2[(1+1+1)+(1+1+[1])]=12$.

5. Cercaria of *Psedobilharzia corvi* Yamaguti, 1941 (No. 10)

Locality: Tokushima, Shizuoka, Hiroshima.

Host: *Semisulcospira libertina.*

Reference: Yoshida (1917); Kobayashi (1922); Faust (1924); Ito (1960); Saito *et al.* (1969); Saito *et al.* (1975).

6. Cercaria of *Trichobilharzia physellae* (Talbot, 1936) McMullen *et* Beaver, 1945 (No. 11)

Locality: Shimane, Ibaraki, Saitama, Chiba, Tokyo, Kanagawa, Shizuoka, Aichi, Gifu, Osaka, Okayama, Tottori, Yamaguchi, Tokushima, Kanagawa, Akita.

Host: *Austropeplea ollula* (=*Lymnaea ollula*), *Lymnaea japonica.*

Reference: Tanabe (1953); Oda (1958, 1959); Tanaka (1959, 1960); Iwagami (1960); Miyazato *et al.* (1965); Kumada *et al.* (1971); Miyazato and Inoue (1972); Miyazato *et al.* (1974, 1977); Ito (1978). Mizokawa *et al.* (1982).

7. Cercaria of *Trichobilharzia* sp.

Locality: As some as the case of *T. physellae.*

Host: *Austropeplea ollula, Lymnaea japonica, L. truncatula.*

Reference: Miyazato (1965, 1966); Ozu *et al.* (1968); Kumada *et al.* (1969); Kokubo *et al.* (1969); Kumada *et al.* (1970, 1971); Suzuki *et al.* (1972, 1973); Yokogawa *et al.* (1975, 1976); Suzuki *et al.* (1976); Kawanaka *et al.* (1976); Suzuki and Kawanaka (1977); Kobayashi *et al.* (1977); Yasuraoka *et al.* (1977); Maejima *et al.* (1977); Ito and Mochizuki (1978); Ohkubo *et al.* (1978); Murata *et al.* (1978); Yamamoto (1981); Uchida *et al.* (1982); Mizokawa *et al.* (1982); Suzuki *et al.* (1982); Tani *et al.* (1982); Matsumura *et al.* (1983); Minai *et al.* (1984); Matsumura *et al.* (1985); Tongu *et al.* (1987).

Note: During 1965–1984, more than 30 reports were made on the occurrence of paddy field dermatitis in about 20 prefectures in Japan. As to the dermatitis-producing cercariae, 7 reports determined as *Giganthobilharzia sturniae,* but the

other reports noted as *Trichobilharzia physellae* or merely *Trichobilharzia* sp. Suzuki and Kawanaka (1980) assumed that those cercariae, except the cercaria of *Giganthobilharzia*, are the same as *T. brevis* Basch, 1966. Refer the Part I (item of *T. brevis*).

8. *Cercaria senoi* (Senoo, 1903) Faust, 1924 (No. 18)
Locality: Okayama, Nagano.
Host: *Viviparus malleatus, Sinotaia quadrata.*
Reference: Senoo (1903); Kobayashi (1922); Faust (1924); Inatomi (1953); Shimazu (1979).

9. Cercaria of *Echinostoma cinetorchis* Ando et Ozaki, 1923 (No. 35)
Locality: Akita, etc.
Host: *Polypylis hemisphaerula* (=*Segmentina nitidella*).
Reference: Takahashi (So) (1927); Tani (1987).

10. Cercaria of *Echinostoma hortense* Asada, 1926 (No. 37)
Locality: Tokyo, Hokkaido, Hiroshima, Kyoto, Aichi, Shizuoka, Osaka, Akita.
Host: *Lymnaea japonica, Austropeplea ollula* (=*Lymnaea ollula*).
Reference: Asada (1926, 1939); Yamaguti (1941); Okamoto (1954); Kumada *et al.* (1971); Ito (1978); Kawanaka and Saito (1979); Mizokawa *et al.* (1982); Miyamoto *et al.* (1983); Tani (1983); Tani and Yoshimura (1985).

11. Cercaria of *Echinostoma revolutum* (Froelich, 1802) (No. 39)
Locality: Chiba, Aichi, etc.
Host: *Austropeplea ollula* (=*Lymnaea ollula*).
Reference: Nakagawa (1915); Tsuchimochi (1924, 1926); Ono (1935); Suzuki (1932); Suzuki *et al.* (1968); Kumada *et al.* (1971).

12. Cercaria of *Echinoparyphium recurvatum* (v. Linst., 1873) Dietz, 1909 (No. 41)
Locality: Kanagawa, Akita.
Host: *Austropeplea ollula, Lymnaea japonica, Physa acuta.*
Reference: Tsuchimochi (1924, 1926); Ono (1935); Uchida *et al.* (1982); Tani (1983); Uchida *et al.* (1984).

13. Cercaria of *Echinochasmus tobi* Yamaguti, 1939 (No. 54)
Locality: Shiga, Tokushima, Fukuoka, Hiroshima, Akita, Aomori, Iwate, Yamagata, Hokkaido.
Host: *Semisulcospira libertina.*
Reference: Yamaguti (1941, 1942); Shimizu (1958); Hamajima and Ishii (1964); Saito *et al.* (1969, 1975, 1977); Nakade (1972); Miyamoto (1982); Higuchi (1985).

14. Cercaria of *Fasciola* sp.
Locality: Nara, Oita, Hokkaido, Akita, etc.
Host: *Austropeplea ollula, Lymnaea truncatula.*
Reference: Itagaki (1965); Okabe and Takao (1968); Tomimura et al. (1976); Itagaki and Itagaki (1985, 1986); Tani and Yoshimura (1985).

Note: With regard to the Japanese liver-fluke, the scientific name is not clear, so that the investigators used to note as *Fasciola* sp.

15. Cercaria of *Diplodiscus japonicus* Yamaguti, 1936 (No. 70)
Locality: Fukuoka, Nara, Kanagawa.
Host: *Gyraulus hiemantium, Polypylis hemisphaerula* (=*Segmentina nitidella*).
Reference: Takahashi (So) (1927); Yamaguti (1940); Suzuki *et al.* (1982); Uchida *et al.* (1982, 1984).

16. Cercaria of *Notocotylus magniovatus* Yamaguti, 1934 (No. 72)
Locality: Fukuoka, Hiroshima, Kochi, Hokkaido, etc.
Host: *Semisulcospira libertina, S. japonica, Melanoides obliquigranosa.*
Reference: Kurokawa (1936); Yamaguti (1938); Ito (1959); Hamajima and Ishii (1964); Saito *et al.* (1969); Saito *et al.* (1975);

Kumazawa *et al.* (1981); Miyamoto *et al.* (1982); Higuchi *et al.* (1985).

17. Cercaria of *Clonorchis sinensis* (Cobbold, 1875) (No. 73)
Locality: Many places in Japan.
Host: *Parafossarulus manchouricus japonicus.*
Reference: Kobayashi (1914); Muto (1918); Yamaguti (1935); Komiya and Tajimi (1940); Inatomi (1953); Yasuraoka (1965); Inatomi *et al.* (1974); Fujino *et al.* (1976); Saito (1977).

18. Cercaria of *Metagonimus yokogawai* Katsurada, 1913 (No. 75)
Locality: Fukuoka, Shimane, Aomori, Akita, Iwate, Hiroshima, Yamagata, Fukui, Kochi, Hokkaido, Shizuoka, etc.
Host: *Semisulcospira libertina.*
Reference: Muto (1917); Takahashi (Sho) (1929); Shimizu (1958); Hamajima and Ishii (1964); Kagei *et al.* (1965); Nakade *et al.* (1968); Saito *et al.* (1969, 1972); Saito (1969, 1970, 1972); Nakade (1972); Tongu *et al.* (1974); Saito *et al.* (1975, 1977); Tongu *et al.* (1975); Fujino and Ishii (1975); Fujino *et al.* (1976); Miyamoto and Kutsumi (1979); Asada *et al.* (1980); Hamajima *et al.* (1981); Kumazawa *et al.* (1981); Miyamoto *et al.* (1982); Koori *et al.* (1984); Higuchi *et al.* (1985).

19. Cercaria of *Metagonimus takahashii* Suzuki, 1929 (No. 76)
Locality: Hiroshima, Yamagata, Kochi, etc.
Host: *Semisulcospira libertina.*
Reference: Takahashi (Sho) (1929); Ogita (1954); Saito (1969, 1970, 1972); Saito *et al.* (1972, 1975, 1977); Sakumoto *et al.* (1972); Saito and Moriyama (1972); Tongu *et al.* (1974, 1975); Fujino and Ishii (1975); Fujino *et al.* (1976); Kumazawa *et al.* (1981).

20. Cercaria of *Centrocestus armatus* (Tanabe, 1922) Yamaguti, 1933 (No. 79)
Locality: Fukuoka, Hiroshima, Akita, Aomori, Iwate, Yamagata, Kochi, Kagoshima, Okinawa, etc.
Host: *Semisulcospira libertina, S. japonica, S. reiniana, Melanoides obliquigranosa.*
Reference: Takahashi (Sho) (1929); Yamaguti (1938); Ito and Watanabe (1958); Hamajima and Ishii (1964); Saito *et al.* (1969, 1975); Nakade (1972); Saito (1977); Hamajima *et al.* (1981); Kumazawa *et al.* (1981); Yanohara (1985); Yanohara *et al.* (1985).

21. Cercaria of *Centrocestus nycticoracis* (Izumi, 1935) (No. 80)
Locality: Hyogo, Fukuoka, Hiroshima.
Host: *Semisulcospira libertina.*
Reference: Izumi (1935); Kurokawa (1939); Hamajima and Ishii (1964); Saito *et al.* (1969, 1975).

22. Cercaria of *Centrocestus formosanus* (Nishigori, 1924) (No. 81)
Locality: Kagoshima, Okinawa.
Host: *Semisulcospira libertina, S. subplicosa, S. reiniana, Thiara scabra, Melanoides tuberculatus, M. obliquigranosa.*
Reference: Nishigori (1924); Takahashi (So) (1928); Kagei *et al.* (1982); Yanohara (1983, 1984, 1985).

23. Cercaria of *Pseudexorchis major* (Hasegawa, 1935) Yamaguti, 1938 (No. 87)
Locality: Shizuoka, Fukuoka, Hiroshima, Saitama, Yamagata, Kochi, etc.
Host: *Semisulcospira libertina, S. japonica, S. reiniana.*
Reference: Takahashi (1929); Ito (1956); Hamajima and Ishii (1964); Saito *et al.* (1969, 1975, 1977); Saito (1969, 1970); Yamaguti *et al.* (1976); Hamajima *et al.* (1981); Kumazawa *et al.* (1981).

24. *Cercaria pectinata* Huet, 1891 (No. 90) (Fig. B)
Locality: Chiba, Shizuoka.
Host: *Tapes philippinarum, T. pullasteri, T. decusates, Venerupis semidecussata, Donax anatinum, D. trunculus, Pholos candida.*
Parthenita: Large saccular sporocyst, measuring 3370x293 μm. A birth pore is observed

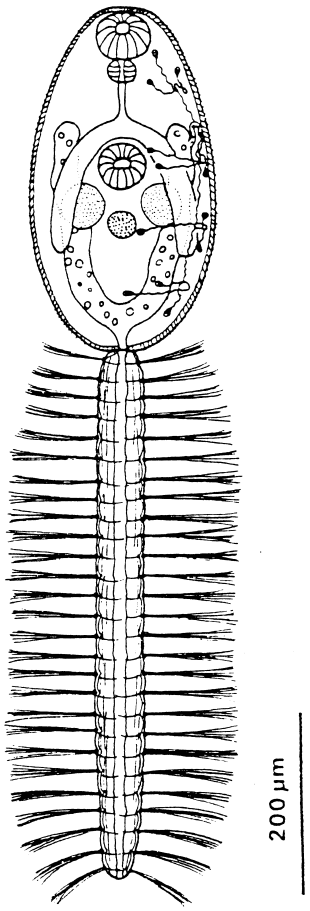

Fig. B *Cercaria pectinata* Huet, 1891
– (Shimura *et al.*, 1982) –

at the tip of the sporocyst. One sporocyst contains 17–38 cercariae and many germ balls.

Cercaria: Yellowish, non-oculate trichocercous cercaria. Measurements are; body 375x198 μm, oral sucker 52x58 μm, pharynx 28x31 μm, acetabulum 49x50 μm, and tail 581x66 μm. Body surface is covered with many minute spines. No prepharynx, long esophagus, and ceca terminating at the level of one-third posteriorly to the body are observed. Excretory bladder is a large V-shaped in shape, non-epitherial, and contains 50–60 excretory granules. Flame cell formula is 2[(3+3)+(3+3)]=24. Primordia of ovary and testes are posterior to the acetabulum. Tail is twice as long as the body, providing with 27 pairs of prominent lateral tufts. Each tuft is composed of 6–9 setae covering by a thin membrane.

Life cycle: Unknown (presumably develops to *Pseudobacciger harengulae* of the family Fellodistomidae).

Reference: Fujita (1906, 1907); Kobayashi (1922); Yamaguti (1938); Shimura et al. (1982).

25. *Cercaria yoshidae* (Osafune, 1898) Cort *et* Nichols, 1920 (No. 93) (Fig. C)

Locality: Nagano, Fukuoka, Aomori, Akita, Iwate, Hiroshima, etc.

Host: *Semisulcospira libertina, S. reiniana, S. japonica.*

Parthenita: Redia is 690–1760 μm long. Distal end of redia moves actively. Pharynx is 59x48 μm in size. Intestine reaches the posterior half of body. Many sensory hairs and

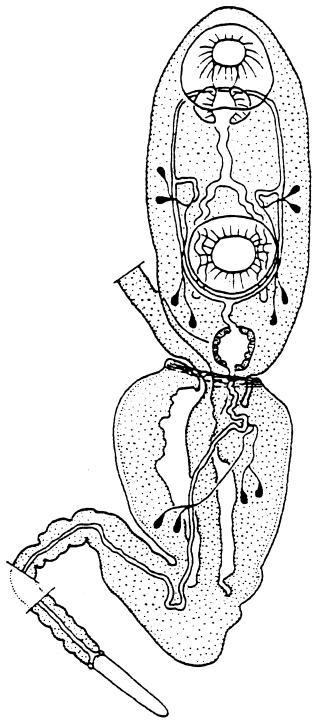

Fig. C *Cercaria yoshidae* Cort *et* Nichols, 1920
– (Shimazu and Shimizu, 1984) –

a birth pore are observed. One redia contains 20–30 cercariae.

Cercaria: The present cercaria agreed well with that of *C. yoshidae* as described by Ito (1952) in every respect except in the excretory system. An epithelial excretory vesicle is saccular. From its anterior tip, a median tube runs forward and bifurcates into lateral collecting tubes, which units behind the pharynx. A short common collecting tube arises from each of them, and divides into an anterior and a posterior collecting tube. Each of them receives tubules from a pair of flame cells. A caudal tube extends from the excretory vesicle through the bulb and tail, and opens at lateral excretory pores. Two pairs of caudal flame cells are in the bulb. Flame cell formula is 2[(2+2)+[2]]=12.

Life cycle: Unknown (presumably develops to the genus *Halipegus*).

Reference: Osafune (1898); Senoo (1903); Miyagawa (1913); Ando (1918); Yoshida (1917); Cort and Nichols (1920); Faust (1924); Fukui and Shimizu (1936); Ito (1952); Shimizu (1958); Hamajima and Ishii (1964); Nakade *et al.* (1968); Nakade (1972); Saito *et al.* (1968, 1975); Hamajima *et al.* (1981); Shimazu and Shimizu (1984).

26. *Cercaria longicerca* Ito, 1953 (No. 96)

Locality: Kochi, Tokushima, Hiroshima, Yamagata.

Host: *Semisulcospira libertina, S. japonica.*

Reference: Ito (1953); Shimizu (1958); Saito *et al.* (1969, 1975, 1977); Kumazawa *et al.* (1981).

27. *Cercaria introverta* (Ando, 1918) Faust, 1924 (No. 97)

Locality: Gifu, Okayama, Shizuoka, Kochi, Fukuoka.

Host: *Semisulcospira libertina, S. japnica.*

Reference: Ando (1918); Kobayashi (1922); Faust (1924); Ito (1953); Saito *et al.* (1969, 1975).

28. *Cercaria manei* Ito, 1960 (No. 99)

Locality: Shizuoka, Kumamoto, Fukuoka, Okayama.

Host: *Semisulcospira libertina.*

Reference: Ueno *et al.* (1930); Ito (1960); Hamajima and Ishii (1964); Saito *et al.* (1972).

29. Cercaria of *Acanthatrium hitaensis* Koga, 1953 (No. 100)

Locality: Oita, Fukuoka, Hiroshima, Yamagata, Kochi.

Host: *Semisulcospira libertina.*

Reference: Koga (1953); Kurokawa (1939); Hamajima and Ishii (1964); Saito *et al.* (1969, 1975, 1977); Kumazawa *et al.* (1981).

30. *Cercaria nipponensis* (Asada, 1915) Faust, 1924 (No. 102)

Locality: Fukuoka, Aomori, Akita, Hiroshima, Iwate, Yamagata, Hokkaido, etc.

Host: *Semisulcospira libertina, S. reiniana, S. japonica.*

Reference: Ando (1915); Nakagawa (1915); Kobayashi (1917); Yoshida (1917); Faust (1924); Yokogawa and Wakeshima (1934); Fukui and Shimizu (1936); Ito (1952); Shimizu (1958); Hamajima and Ishii (1964); Nakade *et al.* (1968); Saito et al. (1969, 1975, 1977); Nakade (1972); Miyamoto *et al.* (1982).

31. *Cercaria creta* (Kobayashi, 1922) Faust, 1924 (No. 106)

Locality: Yamanashi, Okayama, Kumamoto, Hiroshima, Hokkaido.

Host: *Semisulcospira libertina.*

Reference: Kobayashi (1922); Faust (1924); Ueno *et al.* (1930); Ito (1960); Saito *et al.* (1969, 1975); Higuchi *et al.* (1985).

32. Cercaria of *Plagiorchis muris* (Tanabe, 1922) (No. 111)

Locality: Chiba, Aichi, Hokkaido, etc.

Host: *Austropeplea ollula* (=*Lymnaea ollula*), *L. japonica.*

Reference: Tanabe (1921, 1922); Takahashi (1927); Hirasawa and Asada (1929); Yamaguti (1943); Yamashita (1952); Okamoto (1954); Suzuki *et al.* (1968); Kumada *et al.* (1971); Miyamoto *et al.* (1983).

33. *Cercaria ellipsoidea* (Kobayashi, 1918) Faust, 1924 (No. 116)
Locality: Aichi.
Host: *Lymnaea japonica.*
Reference: Kobayashi (1918, 1922); Faust (1924); Kumada et al. (1971).

34. *Cercaria melaniarum* (Ando, 1918) Faust, 1924 (No. 123)
Locality: Gifu, Hiroshima.
Host: *Semisulcospira libertina.*
Reference: Ando (1918); Kobayashi (1922); Faust (1924); Saito *et al.* (1969, 1975).

35. *Cercaria incerta* (Kobayashi, 1922) Faust, 1924 (No. 130)
Locality: Fukuoka, Aomori, Akita, Iwate, Hiroshima, Saitama, etc.
Host: *Semisulcospira libertina, S. reiniana, S. japonica.*
Reference: Kobayashi (1922); Faust (1924); Ito (1953); Hamajima and Ishii (1964); Nakade *et al.* (1968); Saito *et al.* (1969, 1975); Nakade (1972); Yamaguti *et al.* (1976).

36. *Cercaria distyloides* (Nakagawa, 1915) Faust, 1924 (No. 132)
Locality: Okayama, Tokushima, Gifu, Hiroshima.
Host: *Semisulcospira libertina.*
Reference: Nakagawa (1915); Yoshida (1917); Ando (1918); Kobayashi (1922); Ando and Iwahashi (1924); Faust (1924); Saito *et al.* (1969, 1975).

37. *Cercaria libertina* (Osafune, 1899) Faust, 1924 (No. 135)
Locality: Okayama, Fukuoka, Hiroshima.
Host: *Semisulcospira libertina.*
Reference: Osafune (1899); Kobayashi (1922); Faust (1924); Hamajima and Ishii (1964); Saito *et al.* (1975).

38. Cercaria of *Paragonimus westermani* (Kerbert, 1878) (No. 136)
Locality: Many places in Japan.
Host: *Semisulcospira libertina, S. japonica.*
Reference: Yoshida (1917); Nakagawa (1918); Kobayashi (1918); Ando (1920); Yokogawa and Wakeshima (1934); Yamaguti (1943); Komiya and Ito (1950); Hamajima and Ishii (1964); Kawashima and Miyazaki (1964); Iwakura and Tanikawa (1965); Hashiguchi and Miyazaki (1968); Kawashima (1970); Endo and Suzuki (1971); Ishii (1972); Habe and Ishii (1975); Higo *et al.* (1980); Fukui *et al.* (1980); Higo and Ishii (1983); Hamajima *et al.* (1985).

39. Cercaria of *Paragonimus ohirai* Miyazaki, 1939 (No. 137) (Fig. D)
Locality: Kyushu, Chiba, Shizuoka, Hyogo, Mie, etc.
Host: (Natural host) ... *Assiminea parasitologica, A. japonica, A. yoshidayukioi, Paludinella japonica, Augustassiminea nitida.*
(Laboratory host) ... *Oncomelania nosophora, O. minima, O. chiui, Bythinella (Moria) nipponica akiyoshiensis.*
Parthenita: Measurements of rediae are;

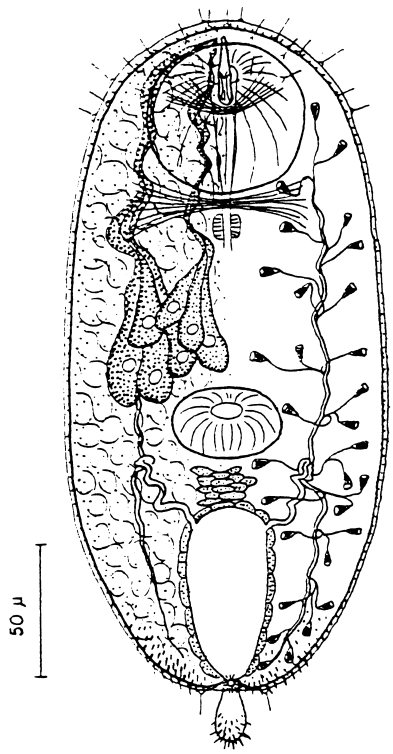

Fig. D Cercaria of *Paragonimus ohirai* – (Ito *et al.*, 1969) –

body 882x209 μm, pharynx 52x53 μm, and intestine 107x64 μm. The intestinal contents were usually bright red-brown or somewhat red in color. Flame cell pattern of the mature redia is 2[(n+n)+(n+n)] or 2[(n+n)+(n)], (n=2–7, usually 3–6). It contains 2–22 germ balls and 1–8 cercariae.

Cercaria: Measurements of cercariae are; body 234x114 μm, oral sucker 55x50 μm, acetabulum 26x37 μm, stylet 30x7 μm, excretory bladder 58x37 μm, and tail 21x18 μm. Flame cell formula of the mature cercaria is 2[(3+3+3+3+3) + (3+3+3+3+3)]=60. The other general morphological feature is almost similar to the cercariae of genus *Paragonimus*.

Life cycle: Refer the former monograph (1964).

Reference: Ogita (1954); Ikeda (1957); Yoshida *et al.* (1959); Yokogawa *et al.* (1958, 1960); Kawashima and Miyazaki (1963); Kawashima (1964, 1965); Hashiguchi *et al.* (1968); Hashiguchi and Miyazaki (1968); Kawashima and Hamajima (1969); Ito *et al.* (1969); Yoshimura *et al.* (1970), Kawashima and Hashiguchi (1973); Tomita *et al.* (1975); Habe and Ishii (1975); Fukuda *et al.* (1980); Higo and Ishii (1982, 1983); Habe (1984, 1985); Matsuo (1984); Hata *et al.* (1985); Matsuo and Makiya (1986).

Note: *Paragonimus sadoensis* Miyazaki, Kawashima, Hamajima et Otsuru, 1968 is considered to be a synonym of *P. ohirai*. References dealt with *P. sadoensis* are as follows; Hamajima (1967); Hashiguchi *et al.* (1968); Ishii and Miyazaki (1968); Kawashima and Hamajima (1969); Ito *et al.* (1969); Yoshimura *et al.* (1970); Habe and Ishii (1975).

40. Cercaria of *Paragonimus iloktsuenensis* Chen, 1940 (No. 138)

Locality: Osaka, Kagoshima, Hyogo, etc.

Host: (Natural host) ... *Assiminea parasitologica, A. yoshidayukioi.*

(Laboratory host) ... *Oncomelania nosophora.*

Reference: Komiya *et al.* (1960); Kawashima and Miyazaki (1963); Kawashima and Hamajima (1970); Ishii (1971); Habe and Ishii (1973, 1975); Higo and Ishii (1982, 1983); Habe (1985).

41. *Cercaria monostyloides* Ito, 1960 (No. 142)

Locality: Fukuoka, Hiroshima, Shizuoka, etc.

Host: *Semisulcospira libertina, S. reiniana.*

Reference: Nakagawa (1915); Yoshida (1917); Ando (1918); Kobayashi (1922); Faust (1924); Ueno *et al.* (1930); Ito (1960); Hamajima and Ishii (1964); Saito *et al.* (1969, 1975); Hamajima *et al.* (1981).

42. *Cercaria innominatum* (Kobayasyi, 1918) Faust, 1924 (No. 146)

Locality: Okayama, Shiga, Gifu, Shizuoka, Fukuoka, Aomori, Akita, Hiroshima, Yamagata, Kochi.

Host: *Semisulcospira libertina.*

Reference: Kobayashi (1918); Ando (1918); Okumura (1919); Kobayashi (1922); Faust (1924); Ueno *et al.* (1930); Ito (1960); Hamajima and Ishii (1964); Nakade *et al.* (1968); Saito *et al.* (1969, 1975, 1977); Hamajima *et al.* (1981); Kumazawa *et al.* (1981).

43. *Cercaria tapidis* (Fujita, 1906) Faust, 1924 (No. 150) (Fig. E)

Locality: Shizuoka, Chiba.

Host: *Tapes philippinarum* (=*Venerupis philippinarum*), *T. semidecussata.*

Parthenita: Long cylindrical sporocyst measures about 1267 μm long and 243 μm wide. A birth pore is at one extremity. It contains many cercariae and germ balls.

Cercaria: Oculate cercaria with long tail of five times as body. Measurements are; body 278x120 μm, oral sucker 54x74 μm, prepharynx 13 μm long, pharynx 22x30 μm, eye spot 15x11 μm, acetabulum 45 μm in diameter, and tail 1335x39 μm. Body surface is covered with many minute spines. Pharynx is followed by a esophagus and intestine reaching to the posterior end of the body. One pair of prominent eye spot is at the level of the pharynx. About ten pairs of the penetration gland cells are grouped into two. A large epithelial excretory vesicle is reversely tri-

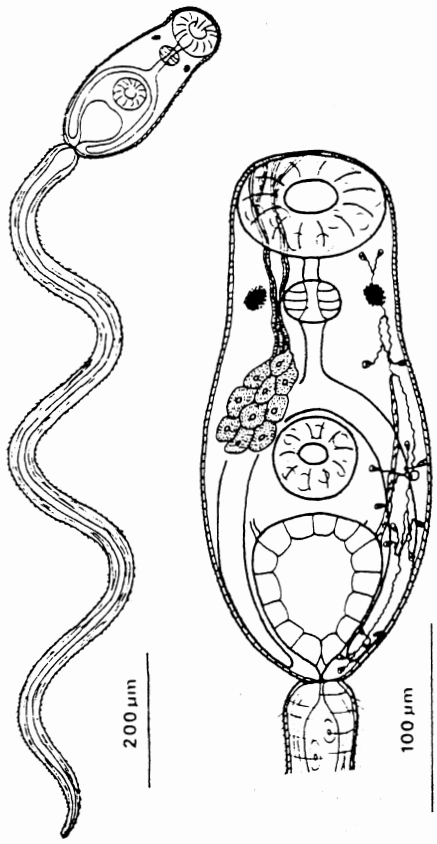

Fig. E *Cercaria tapidis* Faust, 1924
– (Shimura *et al.*, 1982) –

angular or heart-shape, and occupy the hind body. Flame cell formula is 2[(2+2) + (2+2+2+2+2+2)]=32. Tail is very long and covered with many minute spines. Caudal excretory canal opens at the distalend of the tail.

Life cycle: Unknown (presumably Cryptogonimidae).

Reference: Fujita (1906); Kobayashi (1922); Faust (1924); Shimura, Yoshinaga and Wakabayashi (1982).

A List of Snail Hosts and Their Cercariae

Reviewing the whole list of snail hosts, it is necessary to refer the former monograph by Ito (1964), because the followings are merely the additional data to the former list.

Parenthesized number indicates the cercarial number in the present monograph.

A. GASTROPODA-PROSOBRANCHIA-MESOGASTROPODA

1. Viviparidae
   - *Cipangopaludina japonica*
     - *Cercaria* sp. by Miyamoto (13)
   - *Sinotaia quadrata*
     - Cercaria of *Amblosoma suwaense* (5)
     - *Cercaria senoi* (II-8)

2. Truncatellidae
   - *Oncomelania nosophora*
     - Cercaria of *Paragonimus miyazakii* (experimental) (21)
     - Cercaria of *P. ohirai* (experimental) (II-39)
     - Cercaria of *P. iloktsuenensis* (experimental) (II-40)
   - *Oncomelania minima* (=*Tricula minima*)
     - Cercaria of *P. ohirai* (=*P. sadoensis*) (II-39)
   - *Oncomelania hupensis chiui* (=*Tricula chiui, Trichuris chiui*)
     - Cercaria of *P. ohirai* (II-39)

3. Hydrobiidae
   - *Bythinella (Moria) nipponica akiyoshiensis*
     - Cercaria of *Paragonimus miyazakii* (21)
     - Cercaria of *P. ohirai* (experimental) (II-39)
   - *Bythinella (Moria) nipponica*
     - *Cercaria* sp. by Hatsushika and Maejima (23)
     - *Cercaria* sp. by Gyoten (25)
   - *Saganoa* sp. (*Saganoa kawanensis*?)
     - Cercaria of *Paragonimus miyazakii* (21)

4. Bithyniidae (=*Bulimidae*)
   - *Parafossarulus manchouricus japonicus*

Cercaria of *Holostephanus nipponicus* (3)
Cercaria miyagiensis (12)

5. Assimineidae
Augustassiminea nitida satumana (=*Assiminea castanea satumana*)
Cercaria of *Paragonimus ohirai* (II-39)

6. Thiaridae
Thiara scabra
Cercaria of *Centrocestus formasanus* (II-22)
Melamoides tuberculatus
Cercaria of *Centrocestus formosanus* (II-22)

7. Pleuroceridae
Semisulcospira libertina
Cercaria of *Nanophyetus japonensis* (22)
Cercaria sp. by Saito *et al.* (24)

8. Littorinidae
Littorina brevicula
Cercaria of *Maritrema setoensis* (18)

9. Potamididae
Batillaria cumingii
Cercaria batillariae (15)
Cercaria hosoumininae (19)

10. Turbinidae
Batillus cornutus
Cercaria misakiana (27)
Cercaria brachycaeca (28)

11. Buccinidae
Japeuthria ferrea
Cercaria isoninae (16)

12. Trochidae
Trochus sacellus rota
Cercaria rhipidocaudata (17)
Cercaria hachijoensis (26)
Tectus pyramis
Cercaria hachijoensis (26)
Omphalius nigerrimus
Cercaria hachijoensis (26)

13. Fasciolariidae
Fusinus perplex
Cercaria itoi (10)

B. GASTROPODA-PULMONATA-BASOMMATOPHORA

14. Physidae
Physa acuta
Cercaria shizuokaensis (1)
Cercaria of *Echinoparyphium recurvatum* (II-12)

15. Lymnaeidae
Lymnaea japonica
Cercaria cristophora (9)
Cercaria of *Echinoparyphium recurvatum* (II-12)
Lymnaea truncatula
Cercaria of *Trichobilharzia* sp. (II-7)
Austropeplea ollula (=*Lymnaea ollula, Lymnaea viridis*)
Cercaria shizuokaensis (1)
Cercaria of *Trichobilharzia brevis* (4)
Cercaria nigrofurca (6)
Cercaria cristophora (9)
Cercaria of *Glypthelmins rugocaudata* (20)
Cercaria of *Trichobilharzia physellae* (II-6)
Cercaria of *Trichobilharzia* sp. (II-7)
Radix hamadai
Cercaria of *Fasciola* sp. (II-14)

16. Planorbidae
Polypylis hemisphaerula (=*Polypylis nitidella*)
Cercaria of *Pharyngostomum cordatum* (2)
Cercaria sp. by Kajiyama *et al.* (8)
Cercaria of *Homalogaster paloniae* (11)
Cercaria shizuokaensis (1)
Gyraulus chinensis (=*Gyraulus hiemantium* ?)

Cercaria of *Giganthobilharzia sturniae* (II-4)
Cercaria shizuokaensis (1)

C. BIVALVIA (=PELECYPODA)

17. Veneridae
Tapes philippinarum (=*Venerupis philippinarum*)
Cercaria sp by Shimura *et al.* (7)
Cercaria pectinata (II-24)
Cercaria tapidis (II-43)

18. Corbiculidae
Corbicula japonica
Cercaria corbiculae (14)

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