Studies on the Geographical Distribution of the Lung Fluke, *Paragonimus westermani* (Kerbert, 1878) in the Southern Prefectures of the Kinki District, Japan: Observations on the Incidence of Encysted Larvae of *P. westermani* in *Geothelphusa dehaani* in Higashi-Yoshino Area, Nara Prefecture

Hiromu SUGIYAMA, Jiro SONODA, Tamotsu TOMIMURA,
and Hiroshi NISHIDA¹⁾

Department of Veterinary Pathology, College of Agriculture, University of Osaka Prefecture, Sakai,
Osaka 591, and ¹⁾Department of Parasitology, Ehime University School
of Medicine, Shigenobu, Ehime 791-02

(Received 30 August 1982/Accepted 26 January 1983)

ABSTRACT. During the period from July, 1979 to May, 1981, the freshwater crab, *Geothelphusa dehaani*, which is known as the second intermediate host of the lung fluke, *Paragonimus westermani*, was collected at 16 different localities in Higashi-Yoshino area of Nara Prefecture. A total of 4,833 crabs were examined for the metacercariae of *P. westermani*. At the 5 localities, a total of 290 metacercariae of the lung fluke were obtained from 172 (6.1%) of 2,812 crabs captured. The number of metacercariae per positive crab varied from 1 to 13, with an average of 1.7. No metacercarial infestation was found in 2,021 crabs at the remaining localities. On the basis of the morphological features of the metacercariae, as well as the adults and their eggs recovered from the experimental cats, all the *Paragonimus* metacercariae collected in this investigation were identified as the metacercariae of the "Original type" of *P. westermani* (Kerbert, 1878) as proposed by Miyazaki. Based on the present results, Higashi-Yoshino area of Nara Prefecture has to be added to the list of prevalent areas of this lung fluke in Japan.

To date, the following 5 species of lung flukes had been recorded in Japan: *Paragonimus westermani* (Kerbert, 1878) Braun, 1899; *P. ohirai* Miyazaki, 1939; *P. iloktsuenensis* Chen, 1940; *P. miyazakii* Kamo, Nishida, Hatsushika and Tomimura, 1961; and *P. sadoensis* Miyazaki, Kawashima, Hamajima and Otsuru, 1968. In 1977, Miyazaki [4] reported that the lung fluke, which had been regarded as *P. westermani* for a hundred years, could be divided into 2 types of *Paragonimus*, i.e., one was the fluke which had diploid chromosomes and bisexual reproduction, and the other was that with triploids and parthenogenetic reproduction. Then he [5–7] proposed to

call only the bisexual (diploid) type as *P. westermani* (Kerbert, 1878) which was first found by Kerbert from Indian tigers, and to give the parthenogenetic (triploid) type another name, *P. pulmonalis* (Baelz, 1880) which was found by Baelz from man in Japan. Thus far the latter had been considered to be a synonym of the former.

Miyazaki's theory has its base on the results of the chromosome study of Japanese lung flukes by Sakaguchi and Tada [13, 14] and Terasaki [19]. They [13, 14, 19, 20] revealed that the chromosomes of *P. westermani*, *P. ohirai*, *P. iloktsuenensis*, *P. miyazakii*, and *P. sadoensis* were all diploid, while those of *P. pulmonalis* in

Kyushu Island were triploid. In addition, Terasaki [19] stated that sperms were hardly recognized in the testes of *P. pulmonalis* with triploid chromosomes. Therefore, Miyazaki [5–7] examined a large number of stained specimens of *P. westermani* and *P. pulmonalis* to differentiate the 2 species, both of which had been collected by him not only from Japan but also from many parts of the world. It was proved that they were easily differentiated by the contents of the seminal receptacle; in the former it was filled with sperm, but in the latter it was occupied by eggcells and vitelline cells, instead of sperm. Furthermore, Miyazaki [9] reported that in Japan, encysted metacercariae of *P. westermani* were found in potamoid crabs, *Geothelphusa dehaani* (White), without exception. On the other hand, those of *P. pulmonalis* were primarily detected in Japanese mitten crabs, *Eriocheir japonicus* de Haan, with exception of 2 localities in Kagoshima Prefecture [1, 8, 15], where larval *P. pulmonalis* was also found in *G. dehaani*.

These findings, from the new taxonomical point of view, have stimulated many surveys on larval lung flukes parasitizing *G. dehaani* in various parts of Japan [10–12, 16, 18, 21], and have added new dimensions to studies of the lung fluke, *P. westermani*, in particular.

Since April 1979, extensive examinations of the crabs, *G. dehaani*, have been made by the authors in order to obtain information about the genus *Paragonimus* in Nara Prefecture. Consequently, the presence of 2 species of lung flukes, *P. miyazakii* and *P. westermani*, has been confirmed. The findings relating to the *P. miyazakii* in Yoshino area, Nara Prefecture have been reported heretofore [17]. The present paper describes the results obtained in surveys of *P. westermani* in-

fections in the crabs, *G. dehaani*, in Higashi-Yoshino area of the same prefecture.

MATERIALS AND METHODS

G. dehaani, the second intermediate host of *Paragonimus*, was collected from mountain streames at 16 localities in Higashi-Yoshino area, Nara Prefecture. These localities include Takino, Kakino-ki-Daira, Kami-Tanjiri, Shimo-Tanjiri, Hirano, Sugitani, Kotsu, Washika, Izuo, Sannose, Hiura, Mio, Mameo, Oku-Sebato, Ohmata and Mugitani as shown in Fig. 1.

After removing carapace, the gills, heart, liver, gonads, intestine and other internal organs were picked up with a pair of forceps or teasing needles and separately compressed between 2 slides of 9 cm by 6 cm. The specimen was examined for metacercariae under a stereoscopic microscope. In order to recover metacercariae from the muscles of the body, the cephalothorax without carapace were minced with a pair of scissors and a knife and then chitinous substances were removed with a pair of forceps or teasing needles. All the remaining soft tissues of the cephalothorax were compressed between the 2 slides and examined for metacercariae. 35 positive crabs collected at Sannose were examined for the distribution of metacercariae in their body. The gills, heart, liver and viscera were examined separately according to the above-mentioned method and then the cephalothorax and legs of the crab were cut off along the coxa and minced separately with a pair of scissors. After digestion in artificial gastric juice, the digested materials of each part were thoroughly filtered through 40 mesh wire sieves with a small quantity of water. The sediment of the filtrate was washed repeatedly with water and poured into a

Fig. 1. Map of Higashi-Yoshino area, Nara Prefecture showing the localities where the freshwater crab, *G. dehaani* was collected for encysted larvae of *P. westermani*.

watch glass for examination of metacercariae. Metacercariae isolated from the crab were preserved in 0.8% NaCl solution. Size of 60 metacercariae was determined by the usual micrometer technique. Morphology of the larvae were carefully investigated, paying special attention to a stylet embedded dorsally to their oral sucker.

In order to get adult flukes for identification, 7 cats were used for the experimental infection with metacercariae; 1 cat each for 3 localities and 2 each for 2 localities. An individual cat was separately given 2 to 10 metacercariae. Prepatent periods were determined by examining the feces of experimental cats, beginning about 45 days after infection. All the cats were killed 90 to 175 days after infection, and adult flukes were recovered from the lungs and pleural cavities. The majority of the adult worms obtained were fixed with

Schaudinn's fluid while compressed within 2 slide glasses, stained with borax carmine, and mounted with Canada balsam. All specimens were provided for observations and measurements. 7 adult flukes were fixed in 10% formalin and the arrangement of the cuticular spines was studied by peeling off their cuticles. Morphological observation on 100 eggs from the feces of cat No. 2 was made. Mitotic chromosomes of 8 adult flukes obtained from experimentally infected cats were studied using preparations of the testis and ovary made by air-drying method.

RESULTS

1. Prevalence and intensity of infection with *Paragonimus metacercariae* in crabs:

A total of 4,833 *G. dehaani* were collected for examination from 16 different places of Higashi-Yoshino area, Nara Prefecture. Of these, 172 crabs captured

at 5 localities, which include Sugitani, Izuo, Hiura, Sannose and Ohmata, harbored *Paragonimus* metacercariae, giving an overall infection rate of 3.6%. As shown in Table 1, the infection rate varied from 1.0 to 9.6% depending upon the places surveyed. The highest (9.6%) incidence was found at Sannose and the lowest (1.0%) at Izuo. A total of 290 metacercariae were obtained from these 172 infected crabs. The intensity of metacercarial infection was relatively light. The number of metacercariae collected from positive crabs ranged from 1 to 13, with an average of 1.7 in positive crab, and 0.06 in the total crabs examined. With regard to local differences of the mean burden per positive crab, the largest number (2.6) occurred at Sugitani and the smallest (1.0) at Ohmata. No larval lung fluke infection was found in 2,021 crabs collected from the remaining 11 localities such as Takino, Kakinoki-Daira, Kami-Tanjiri, Shimo-Tanjiri,

Hirano, Kotsu, Washika, Mio, Mameo, Oku-Sebato and Mugitani.

2. Size and shape of metacercariae and their distribution in crabs:

Paragonimus metacercariae of *G. dehaani* were spherical in shape as shown in Fig. 9. The larvae had 2 layers of cyst wall, a thin outer and a thick inner cyst wall. The thickness of the outer wall ranged from 1.0 to 4.5 μm (average, 2.7 μm), and inner wall, 3.0 to 22.0 μm (average, 14.6 μm). In 60 fresh specimens measured, excluding the outer cyst wall, the long diameter of the metacercariae varied from 370 to 460 μm , and the short diameter from 360 to 450 μm , averaging 415 μm and 403 μm , respectively (Fig. 2). On the dorsal aspect of the oral sucker, a small slender oral stylet (average, 16.5 $\times$ 2.8 μm , Fig. 10) was discernible in all the larvae examined, but no pinkish granules were found in their parenchyma.

In 35 positive crabs collected at San-

Table 1. Prevalence and intensity of infection with encysted larvae of *P. westermani* in *G. dehaani* from various localities of Higashi-Yoshino area, Nara Prefecture

Localities	No. of crabs		% infected	Total no. of larvae recovered	No. of larvae per positive crab	
	Examined	Infected			Range	Average
Takino	117	0				
Kakinoki-Daira	35	0				
Kami-Tanjiri	50	0				
Shimo-Tanjiri	95	0				
Hirano	588	0				
Sugitani	680	49	7.2	126	1-13	2.6
Kotsu	138	0				
Washika	678	0				
Izuo	486	5	1.0	7	1-2	1.4
Hiura	440	13	3.0	14	1-2	1.1
Sannose	1,061	102	9.6	140	1-5	1.4
Mio	66	0				
Mameo	133	0				
Oku-Sebato	108	0				
Ohmata	145	3	2.1	3	1	1.0
Mugitani	13	0				
Total	4,833	172	3.6	290		1.7

nose, the highest infection was demonstrated in the cephalothoracic muscles where 31 or 47.0% out of total of 66 encysted metacercariae were found. The number of encysted larvae recovered from other parts of the crab was 19 or 28.8% in the liver, 4 or 6.1% in the inner membrane of carapace, 4 or 6.1% in the gills, 3 or 4.5% in the pericardiac regions, 2 or 3.0% in the genital organs, 2 or 3.0% in the intestine, and 1 or 1.5% in the leg muscles.

3. Experimental inoculation of cats with metacercariae:

The prepatent period, duration of in-

Fig. 2. Measurements of 60 encysted larvae of *P. westermani*. Measured on living specimens under coverglass.

fection, and the location and number of flukes found at necropsy are given in Table 2. The prepatent period in these 7 cats averaged 60 days, ranging from 56 to 63 days. The percentage recovery of inoculated metacercariae varied from 75.0 to 100.0%, with an average of 93.1%.

4. Morphology of adult flukes and their eggs from cats:

In 39 mounted specimens of adult flukes from the lungs of 7 cats, the average size was 6.1×3.3 mm, with its length varying from 4.0 to 9.6 mm and its width from 2.1 to 5.6 mm. The ratio of their width to length varied from 1:1.35 to 1:2.28, with an average of 1:1.83. The average of transverse diameter of the oral and ventral suckers measured $657 \mu\text{m}$ and $599 \mu\text{m}$, respectively. The ventral sucker was slightly smaller than the oral sucker and was situated somewhat anterior to the middle of the worm's body. The ovary was divided into 6 lobes as shown in Fig. 5. In 39 mounted specimens examined, the seminal receptacle and seminal vesicle were filled with a large number of spermatozoa as shown in Figs. 6 and 7, re-

Table 2. Results of experimental inoculation of cats with encysted larvae of *P. westermani*

Cat			Dose of encysted larvae	Prepatent period (days)	Interval between infection and necropsy (days)	% recovery	No. of adult flukes recovered			Localities in which infected crabs were obtained
No.	Body weight at necropsy (kg)	Sex					Total	Pleural cavities	Lungs	
1	3.50	M	10	56	105	100.0	10	0	10	Sugitani
2	2.60	F	10	59	175	90.0	9	0	9	Sugitani
3	2.80	F	6	ND	95	100.0	6	0	6	Izuo
4	2.00	M	6	59	93	100.0	6	2	4	Hiura
5	2.20	F	4	63	90	75.0	3	1	2	Hiura
6	2.28	M	20	63	110	90.0	18	0	18	Sannose
7	1.30	M	2	ND	98	100.0	2	0	2	Ohmata

ND: Not done.

spectively. As shown in Fig. 8, the spines in peeled cuticle preparations as well as those in mounted specimens were all arranged singly. The chromosome number was $2n=22$ in the spermatogonial and the oogonial metaphase of the adult flukes.

The size of eggs varied from 64 to 86 μm in length and from 39 to 48 μm in width, with an average of $75 \times 43 \mu\text{m}$ as shown in Fig. 3. Representative *Paragonimus* eggs of the present species obtained from cat No. 2 are shown in Fig. 11. Based on the location of the widest transverse diameter of the specimens, the formalin fixed eggs were classified into 3 types such as those with the maximum width at middle, on operculated half, and on aboperculated half. The frequency distribution of these 3 types of eggs was 69% for those with the maximum width at middle, 21% for on operculated half, and 10% for on aboperculated half; the eggs with the maximum width at middle were most commonly encountered.

The thickness of the eggshell of the lateral side of 100 ova was found to be 1.5 μm in average, with a range of 1.0 to 2.0 μm . In the majority of specimens, varying degrees of thickening of the eggshell at the non-operculated end was ob-

served. The thickening was graded as smooth for no discernible thickening, minimal for 2.1 to 3.0 μm thick, moderate for 3.1 to 4.0 μm thick, and remarkable for 4.1 μm thick and over. The frequency distribution of the thickening of eggshell at the non-operculated end was 48% for smooth, 43% for slight, 6% for moderate, and 3% for remarkable; the eggs with conspicuous thickening of the shell at the non-operculated end were not so common in *Paragonimus* eggs of the present species.

DISCUSSION

At the present time, it is recognised that *G. dehaani* harbors 4 species of Japanese lung flukes, i.e., *P. westermani*, *P. pulmonalis*, *P. miyazakii*, and *P. sadoensis*. Of these, the former 3 species of lung flukes closely resemble in the size and shape of their metacercariae. For a correct identification of the species, it is, therefore, imperative that a careful anatomical observation on the internal organs, particularly the gonads such as ovary, seminal receptacle and seminal vesicle, should be made on the mounted specimens of adult flukes obtained from the lungs of artificially infected test animals.

According to Hatsushika [2] and Maejima *et al.* [3], the encysted metacercariae of *P. miyazakii* can be distinguished from those of other species of *Paragonimus* in the following morphological characters; the large size of the inner cyst (average, 445 μm) freed from the outer cyst, the spherical shape of the cyst, very thick outermost "membranous substance", and oral sucker without stylet.

The encysted metacercariae of the present species collected from the crabs, *G. dehaani*, were spherical in shape. The size of 60 encysted metacercariae ranged from 360 to 450 $\times$ 370 to 460 μm , with an

Fig. 3. Measurements of 100 eggs of *P. westermani* from cat No. 2. Measured on fixed specimens under coverglass.

average of $403 \times 415 \mu\text{m}$. The oral stylet, a small dagger-like structure situated in the dorsum of the oral sucker, was readily visible during movement of the anterior part of the larvae. No pinkish granules were found in their body. In addition, very thick outermost "membranous substance", with which the thin outer cyst wall of larvae of *P. miyazakii* [2, 3] was tightly enveloped, were not found in the present specimens. As to the distribution of encysted larvae in crab hosts, *Paragonimus* metacercariae of the present species were found not only in the liver but more frequently in the cephalothoracic muscles, whereas those of *P. miyazakii* were mainly found in the cardiac regions [2, 3]. In the crabs, *G. dehaani*, examined in this survey, there was no evidence of the coexistence of encysted metacercariae of *P. miyazakii*. Furthermore, the various features evaluated on the present metacercariae completely agree with the description of larval *P. westermani* given by Suzuki *et al.* [18], Nishida *et al.* [10–12], Shibahara [16], and Yoshimura *et al.* [21].

On the structure of the ovary of adults, *P. miyazakii* is different from both *P. westermani* and *P. pulmonalis*; in the former it is profusely branched, but in the latter 2 it is usually simply branched off into 6 lobes. It has also been shown by Miyazaki [5–7] that *P. westermani* and *P. pulmonalis* can easily be distinguished from each other in mounted specimens of adult flukes by observing the contents of the seminal receptacle; in the former it is filled with sperm, but in the latter it is occupied by eggcells and vitelline cells, instead of sperm.

In the present studies, adults recovered from the experimental cats usually had the ovary divided into 6 lobes (Fig. 5). In 39 mounted specimens examined, the seminal receptacle and seminal ves-

icle were filled with a large number of spermatozoa (Figs. 6 and 7). The spines in peeled cuticle preparations as well as those in mounted specimens were all arranged singly (Fig. 8). The chromosome number was $2n=22$ in the spermatogonial and the oogonial metaphase of the adult flukes. As to the morphology of eggs, they were somewhat smaller and shorter than those of *P. pulmonalis*. In the majority of specimens examined, the widest portion of the eggs was located at middle, and the eggs with conspicuous thickening of the shell at the non-operculated end were rare in comparison to those of *P. pulmonalis*.

On the basis of the morphological features of the metacercariae, as well as the adults and their eggs recovered from the experimental cats, all the *Paragonimus* metacercariae discovered in this investigation were identified as the metacercariae of the "Original type" of *P. westermani* (Kerbert, 1878) as proposed by Miyazaki [4–7].

As to the human paragonimiasis due to *P. westermani*, a case of subcutaneous infection has recently been reported by Suzuki *et al.* [18] in Akita Prefecture which was caused by ingesting raw freshwater crabs, *G. dehaani*. Up to now no evidence of paragonimiasis *westermani* has been found among the human population in the mountain villages of Higashi-Yoshino area, Nara Prefecture, where the crabs, *G. dehaani*, harboring metacercariae of *P. westermani* were discovered by us. Although the prevalence of the metacercarial infection in crabs of the same species was rather low in this area, the present investigation suggested the possibility of the occurrence of human paragonimiasis due to the consumption of raw or insufficiently cooked crabs. Therefore, it is necessary to carry on persistent health education campaigns

for the prevention of the disease in these villages because the main source of human infection comes from eating raw or inadequately cooked crabs, *G. dehaani*.

ACKNOWLEDGMENTS. In the present study, the identification of parasites was verified by Emeritus Professor Ichiro Miyazaki, of the Kyushu University. The authors wish to thank for his invaluable opinions and suggestions. They are also grateful to Professor Jun-ichi Furuyama, of the Hyogo College of Medicine for his guidance regarding the chromosomal study of flukes. This investigation was supported, in part, by a grant in aid for Fundamental Scientific Research from the Ministry of Education, Japan.

This work was presented in part at the 91st Meeting of the Japanese Society of Veterinary Science, Tokyo, April 7–9, 1981.

REFERENCES

1. Habe, S., and Terasaki, K. (1982). On the type of *Paragonimus westermani* from crab hosts in Yaku Island, Kagoshima Prefecture. *Jpn. J. Parasitol.* **31**, 27–32 (in Japanese with English summary).
2. Hatsushika, R. (1967). Studies on the biological aspects of *Paragonimus miyazakii* Kamo, Nishida, Hatsushika and Tomimura, 1961. *J. Yonago Med. Assn.* **18**, 241–271 (in Japanese).
3. Maejima, J., Kamo, H., and Hatsushika, R. (1971). Studies on *Paragonimus miyazakii* Kamo, Nishida, Hatsushika et Tomimura, 1961. 2. Second intermediate host and intra-crab stage. *Yonago Acta Med.* **15**, 35–44.
4. Miyazaki, I. (1977). A newly introduced question on *Paragonimus westermani* (Kerbert, 1878). *Jpn. Med. J.* (2788), 43–46 (in Japanese).
5. Miyazaki, I. (1978). On two types of the lung fluke which has been called *Paragonimus westermani*, with proposition of the new Japanese name. *Jpn. Med. J.* (2819), 43–48 (in Japanese).
6. Miyazaki, I. (1978). Two types of the lung fluke which has been called *Paragonimus westermani* (Kerbert, 1878). *Med. Bull. Fukuoka Univ.* **5**, 251–263.
7. Miyazaki, I. (1979). On the newly proposed lung fluke, *Paragonimus pulmonalis* (Baelz, 1880). *Med. Bull. Fukuoka Univ.* **6**, 267–276 (in Japanese with English summary).
8. Miyazaki, I., Terasaki, K., and Habe, S. (1981). Comparison of single-worm infection to cats between *Paragonimus westermani* and *P. pulmonalis*. *Med. Bull. Fukuoka Univ.* **8**, 405–416 (in Japanese with English summary).
9. Miyazaki, I. (1982). Geographical distribution of *Paragonimus westermani* and *P. pulmonalis* in Asia. *Med. Bull. Fukuoka Univ.* **9**, 11–22 (in Japanese with English summary).
10. Nishida, H., Sakai, M., and Shibahara, T. (1980). On the lung fluke, *Paragonimus westermani*, found from the freshwater crab, *Geothelphusa dehaani*, in Tango district, Kyoto Prefecture, Japan. *Jpn. J. Parasitol.* **29** (Suppl.), 77 (in Japanese).
11. Nishida, H., Sakai, M., Uemoto, K., and Shibahara, T. (1981). On the lung fluke, *Paragonimus westermani*—diploid type—, found from the freshwater crab, *Geothelphusa dehaani*, in Shiga Prefecture, Japan. *Jpn. J. Parasitol.* **30**, 331–336 (in Japanese with English summary).
12. Nishida, H., Sakai, M., Kunou, I., and Shibahara, T. (1982). On the lung fluke, *Paragonimus westermani*—diploid type—, found from the freshwater crab, *Geothelphusa dehaani*, in Reinan district of Fukui Prefecture, Japan. *Jpn. J. Parasitol.* **31**(2), Suppl. 2, 57 (in Japanese).
13. Sakaguchi, Y., and Tada, I. (1976). A comparative karyotype study on lung flukes, *Paragonimus ohirai* and *P. miyazakii*. *Jpn. J. Parasitol.* **25**, 5–7.
14. Sakaguchi, Y., and Tada, I. (1976). Chromosomes of a lung fluke, *Paragonimus westermani*. *Chromosome Inf. Serv.* (20), 23–24.
15. Sato, A., Uchikawa, R., Noda, S., Niiyama, T., and Miyazaki, I. (1982). On the *Paragonimus westermani* found from the freshwater crab, *Geothelphusa dehaani*, in the northern part of Kagoshima Prefecture. *Jpn. J. Parasitol.* **31** (Suppl.), 8 (in Japanese).
16. Shibahara, T. (1980). On the lung fluke, *Paragonimus westermani*, found from the freshwater crab, *Geothelphusa dehaani*, in Tajima district, Hyogo Prefecture, Japan. *Jpn. J. Parasitol.* **29** (Suppl.), 107 (in Japanese).
17. Sugiyama, H., Sakamoto, T., Tomimura, T., and Nishida, H. (1982). Studies on the occurrence and distribution of *Paragonimus miyazakii* Kamo et al., 1961 in the Kinki districts. (4) Observations on the incidence of encysted larvae of *P. miyazakii* in *Geothelphusa dehaani* in Yoshino area of Nara Prefecture. *Jpn. J. Parasitol.* **31**, 81–88 (in Japanese with English summary).
18. Suzuki, T., Tani, S., Ishida, K., Ohmori, Y., Sugawara, M., and Banzai, A. (1978). A case

- of subcutaneous infection with lung fluke, *Paragonimus westermani*, in Akita Prefecture, Japan. Jpn. J. Parasitol. **27**, 91–96 (in Japanese with English summary).
19. Terasaki, K. (1977). Studies on chromosomes of the lung flukes in Japan. Jpn. J. Parasitol. **26**, 222–229.
20. Terasaki, K. (1980). Comparative studies on the karyotypes of *Paragonimus westermani* (s. str.) and *P. pulmonalis*. Jpn. J. Parasitol. **29**, 239–243.
21. Yoshimura, H., Kondo, K., Ohnishi, Y., and Akao, N. (1982). Lung fluke found from raccoon dog captured in the secluded place of Komatsu City and its metacercariae found in *Potamon dehaani*. Jpn. J. Parasitol. **31**(2), Suppl. 2, 56 (in Japanese).

EXPLANATION OF FIGURES

- Fig. 4. The lungs of cat No. 1 killed 105 days after infection with 10 metacercariae of *Paragonimus westermani*, showing its worm cysts (arrows).
- Fig. 5. A mounted adult fluke specimen from the lung of cat No. 2, 175 days after infection, stained with borax carmine, dorsal view, showing the ovary (O), seminal receptacle (SR), and seminal vesicle (SV).
- Fig. 6. Microphotograph of the seminal receptacle, as shown in Fig. 5, which was filled with numerous spermatozoa.
- Fig. 7. Microphotograph of the seminal vesicle, as shown in Fig. 5, which was filled with numerous spermatozoa.
- Fig. 8. Microphotograph of cuticular spines of the adult fluke. Region just behind the oral sucker on ventral surface.
- Fig. 9. Metacercaria, measuring 360 to 450×370 to 460 μm, encysted with a thin outer (arrow) and a thick inner membrane, detached from the liver of the crab, *Geothelphusa dehaani*.
- Fig. 10. Microphotograph of the oral sucker of the encysted metacercaria, showing a stylet (arrow) embedded dorsally to the oral sucker.
- Fig. 11. Eggs of *Paragonimus westermani* from cat No. 2.

要 約

南近畿地方におけるウェステルマン肺吸虫 *Paragonimus westermani* (Kerbert, 1878) の地理的分布に関する研究：奈良県東吉野地方産サワガニ *Geothelphusa dehaani* におけるウェステルマン肺吸虫メタセルカリアの寄生状況について：杉山 広・園田二郎・富村 保・西田 弘¹⁾ (大阪府立大学農学部家畜病理学教室, ¹⁾愛媛大学医学部寄生虫学教室) —1979年7月から、1981年5月までの間に、奈良県吉野郡東吉野村の16箇所で、サワガニ4,833匹を採集し、これらを対象として肺吸虫メタセルカリアの寄生状況に関する調査を行った。5箇所において捕獲した2,812匹のサワガニから、合計290個のメタセルカリアを検出することができた。これらのメタセルカリア、およびネコへの感染試験を行って得た成虫と卵を精査したところ、ウェステルマン肺吸虫(宮崎のいうウェステルマン肺吸虫「基本型」、あるいは、真のウェステルマン肺吸虫)であることが確認された。よって、奈良県吉野郡東吉野村を本虫の分布地として新たに追加する。