

Food-borne Helminthiases in Southeast Asia

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Food-borne Helminthiases

Most Neglected Diseases among the Neglected Tropical Diseases

Why neglected?

Lack of understanding, limited data

Prevalence and burden underestimated

Chronic and mild clinical course

Low mortality in general

Food-borne Helminths

Nematodes

Gnathostomiasis
Anisakiasis
Trichinosis
Capillariasis
Angiostrongyliasis

Cestodes

Diphyllobothriasis
Taeniasis
Sparganosis

Trematodes

Opisthorchiasis/Clonorchiasis
Paragonimiasis
Fascioliasis & Fasciolopsiasis
Echinostomiasis
Heterophyidiasis
Lecithodendridiasis
Plagiorchiasis
Neodiplostomiasis
Gymnophalloidiasis

Source of Infection

Aquatic Vegetation

Snails & Clams

Crustaceans (Crab, Crayfish)

Fish (Freshwater, Brackish-water, or Marine)

Amphibians (Frog, Salamander)

Reptiles (Snake)

Meat (Bird or Mammal)

PART I

Food-borne Nematodiases

Gnathostomiasis

Occurs when people ingest improperly cooked fish.

Gnathostoma spinigerum

Gnathostoma hispidum

Gnathostoma doloresi

Gnathostoma nipponicum

Gnathostoma malaysiae

Gnathostoma binucleatum (in Mexico and South America)

(Waikagul and Diaz Camacho, 2007)

Thailand, Myanmar, Laos, Japan, China, and Malaysia.

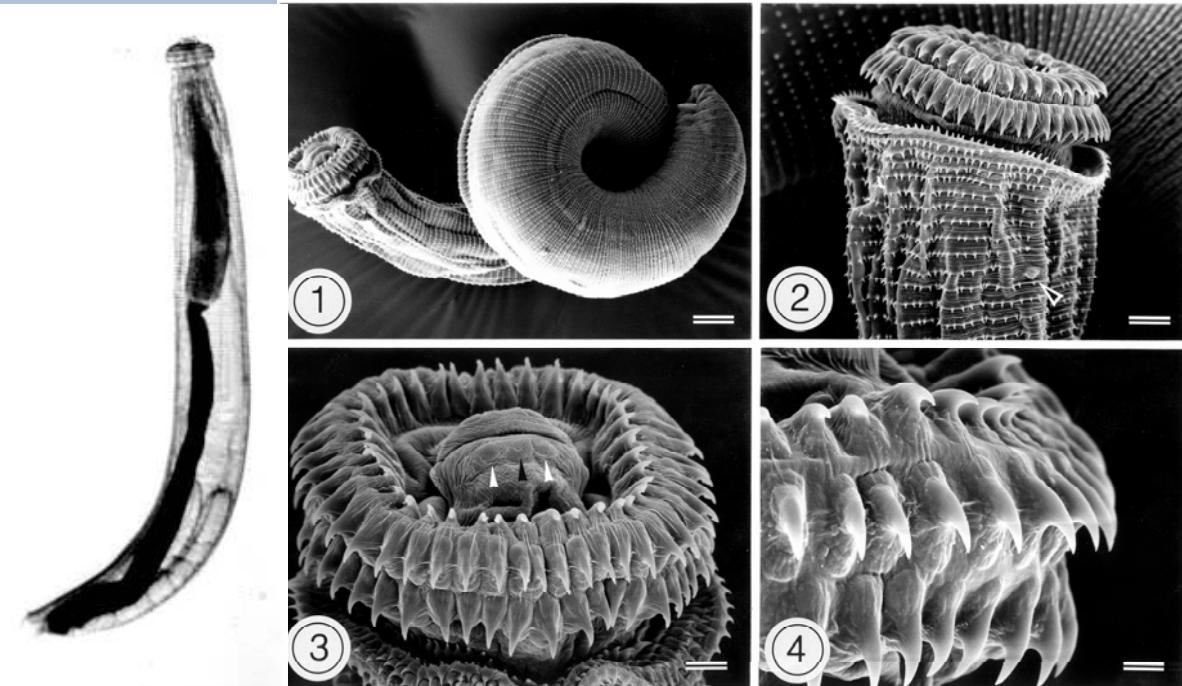
Creeping eruption in the subcutaneous tissues and muscles.

Parasites can invade other organs, including the eye and brain.

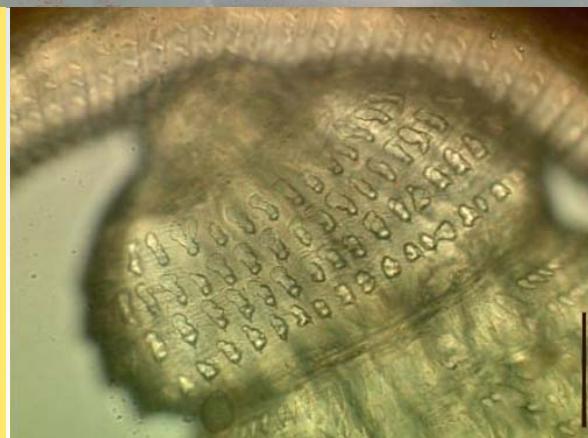
AN OUTBREAK OF GNATHOSTOMIASIS AMONG KOREAN EMIGRANTS IN MYANMAR

JONG-YIL CHAI, EUN-TAEK HAN, EUN-HEE SHIN, JAE-HWAN PARK, JONG-PHIL CHU, MASAKI HIROTA,
FUKUMI NAKAMURA-UCHIYAMA, AND YUKIFUMI NAWA

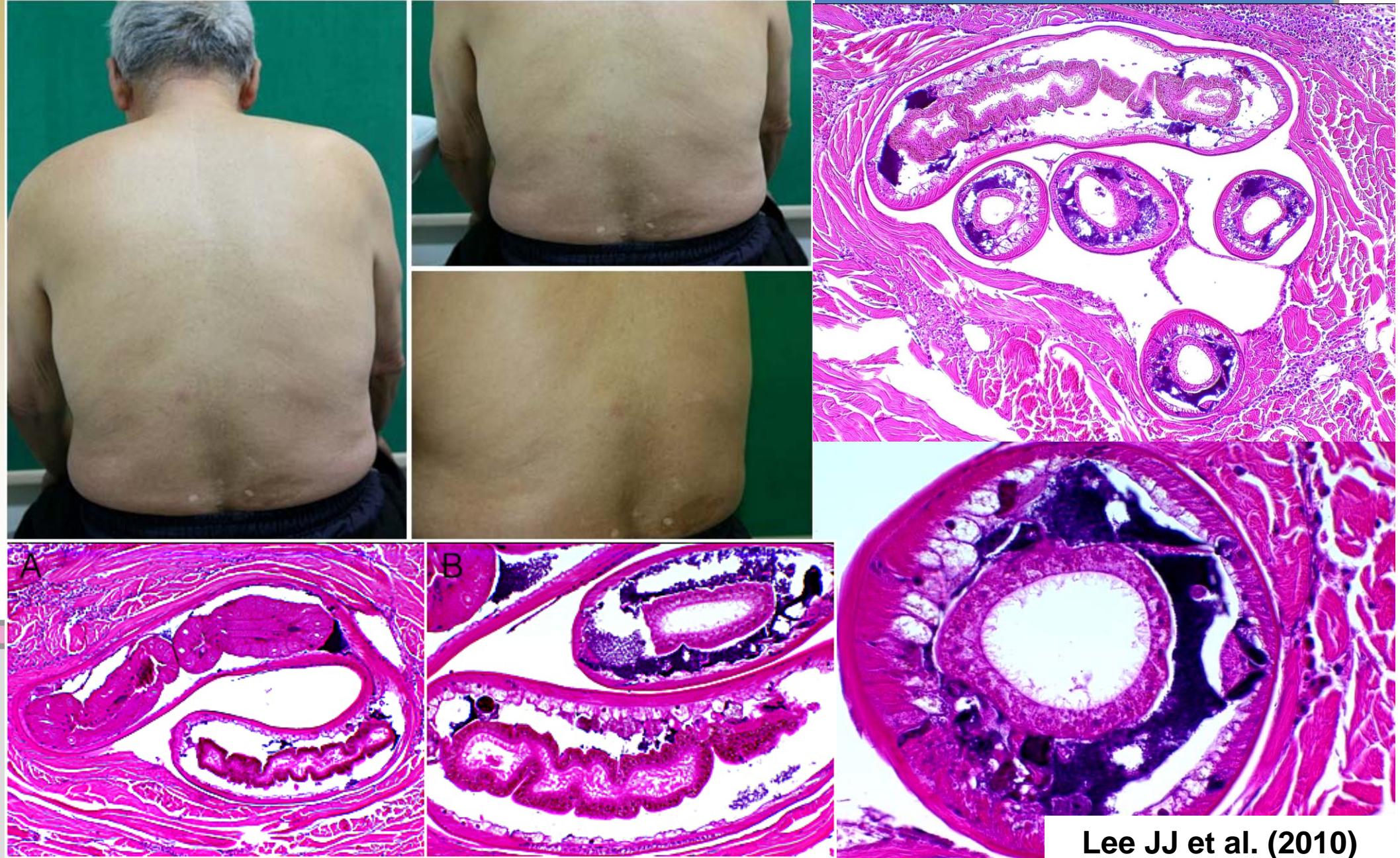
Department of Parasitology and Tropical Medicine, Seoul National University College of Medicine, and Institute of Endemic Diseases, Seoul National University Medical Research Center, Seoul, Republic of Korea; Department of Parasitology, Kangwon National University College of Medicine, Chunchon, Republic of Korea; Department of Parasitology, College of Medicine, Kyunghee University, Seoul, Republic of Korea; Embassy of Japan, Washington, District of Columbia; Department of Parasitology, Miyazaki Medical College, Kiyotake, Miyazaki, Japan



Snakehead fish from a central part of Myanmar infected with *G. spinigerum* larva



A human case of *G. hispidum* infection in a Korean man (an imported case from



Lee JJ et al. (2010)

Anisakiasis

Occurs by ingesting third-stage larvae in a wide range of fish and cephalopod species.

Larval worms invade the gastric or intestinal wall without further development.

Anisakis simplex complex (incl. A. pegreffii)

Anisakis physteteris

Pseudoterranova decipiens

Contracaecum osculatum

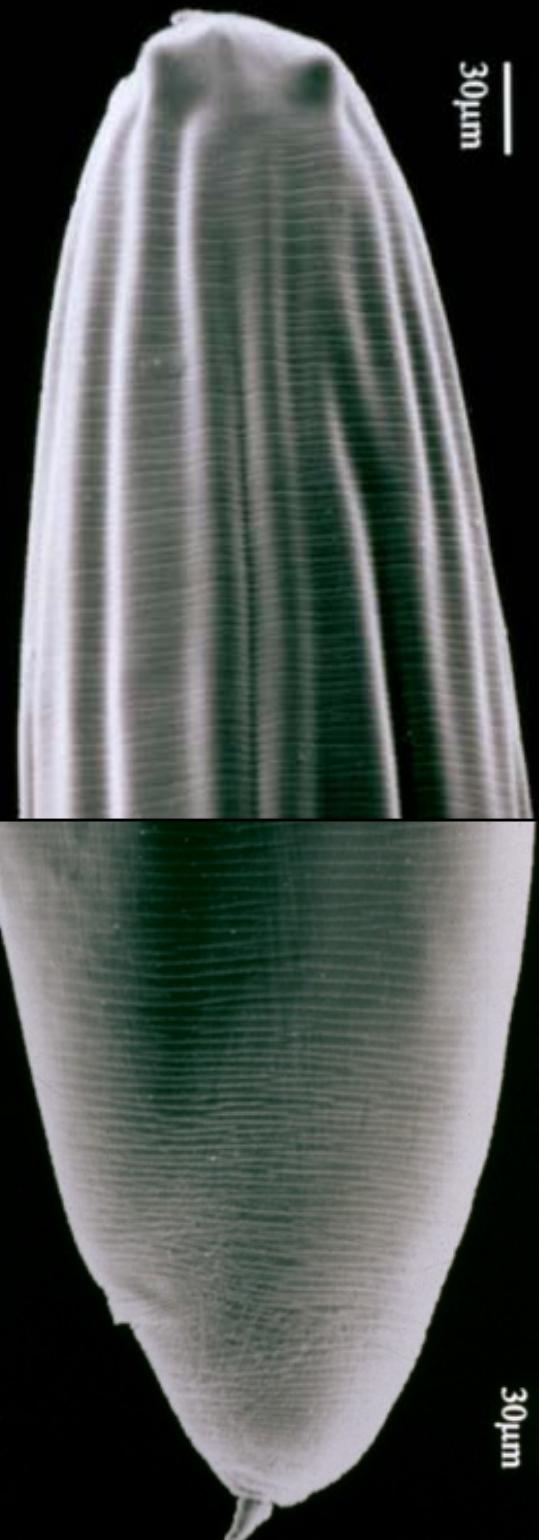
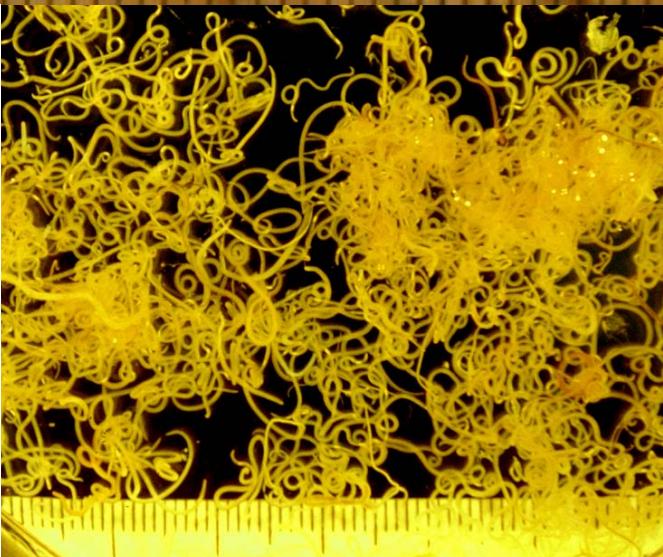
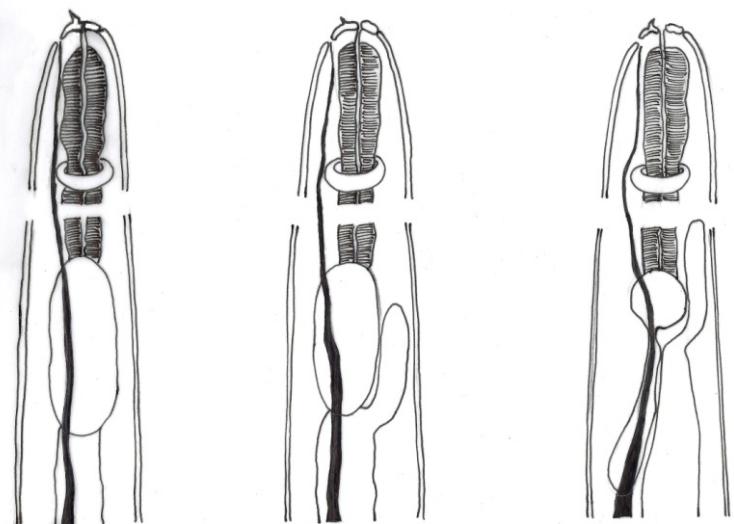
Japan, South Korea, Europe, US.

Acute abdominal pain and digestive symptoms.

Anisakis larvae and fish host



Anisakis larvae in fish



Trichinosis

Occurs by consumption of raw or improperly cooked meat of pigs, horses, dogs, and wild life game animals.

Trichinella spiralis (less commonly *T. nativa*,
T. pseudospiralis, *T. papuae*, *T. britovi*, *T. murrelli*,
T. nelsoni)

Almost all over the world.

Larvae are encysted in the muscle and survive for many years being nourished by the host through the typical “nurse cells”.

Gastrointestinal symptoms resemble acute food poisoning and muscle pain during chronic stages.

Capillariasis

Caused by consumption of raw or undercooked freshwater fish

Capillaria philippinensis

Asian countries, including the Philippines, Thailand, Taiwan, South Korea, Japan, and Indonesia.

Severe gastroenteritis with profuse diarrhea, gurgling stomach, abdominal pain, and wasting (Cross and Belizario, 2007).

Angiostrongyliasis

Caused by consumption of the large snail, *Achatina fulica*, and other molluscan species

Angiostrongylus cantonensis

Taiwan, Thailand, Cambodia, Malaysia, the Philippines (Cross and Chen, 2007).

Eosinophilic meningitis and severe neurologic symptoms.

PART II

Food-borne Cestodiases

Diphyllobothriasis

Caused by consumption of raw or improperly cooked fish
(trout, salmon, perch)

D. latum (cosmopolitan), *D. dendriticum* (northern parts of northern hemisphere), *D. nihonkaiense* (Japan, South Korea, eastern Russia, and Canada), *D. pacificum* (Peru and Chile)

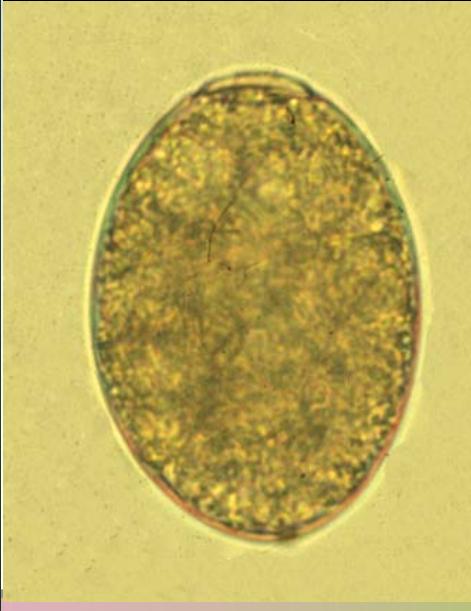
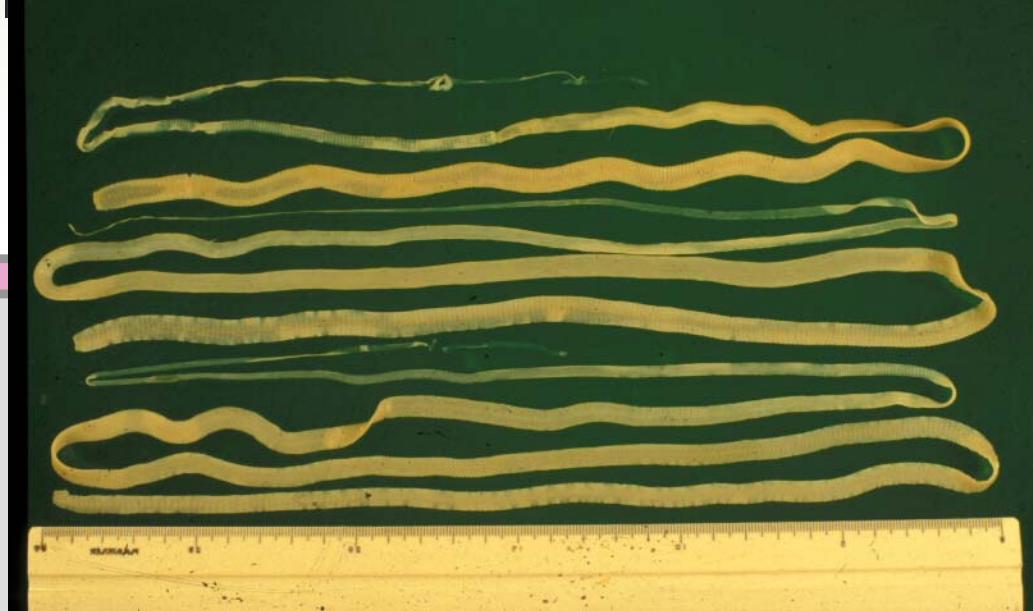
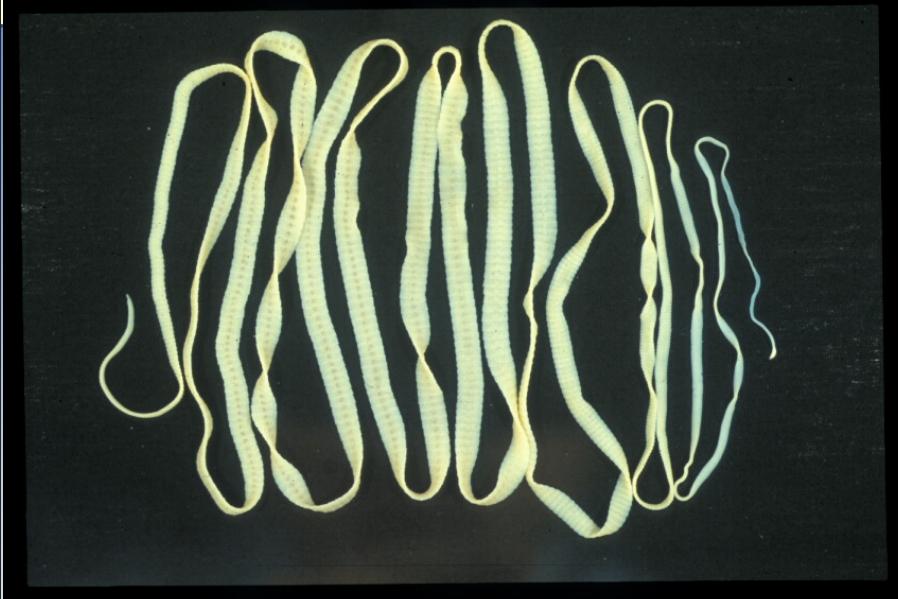
D. alascense, *D. cameroni*, *D. cordatum*, *D. dalliae*,
D. hians, *D. klebanovskii*, *D. lanceolatum*, *D. ursi*,
D. yonagoense

(Chai et al., 2005. Int J Parasitol)

Around the world.

Diarrhea, abdominal pain (Dorny et al., 2009).

Diphyllobothrium latum specimens collected from Korean patients: now they are considered to be *D. nihonkaiense*



Taeniases

Occurs when humans ingest inadequately cooked beef or pork.

T. solium, T. saginata (almost all around the world)

T. asiatica (in Asian countries, including Taiwan, South Korea, China, Vietnam, Indonesia, and the Philippines).
(Jeon et al., 2009. Korean J Parasitol)

Adult *Taenia* infections → little symptoms

Cysticercosis due to *T. solium* → significant clinical problems.

Sparganosis

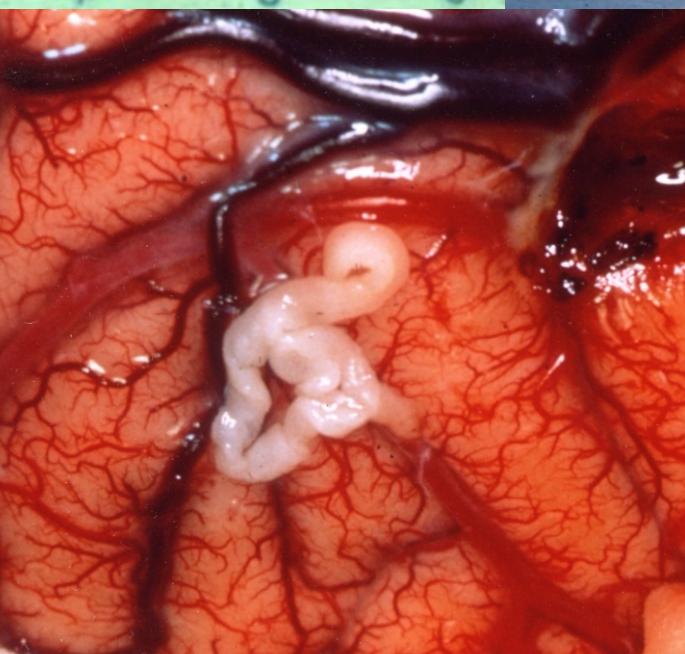
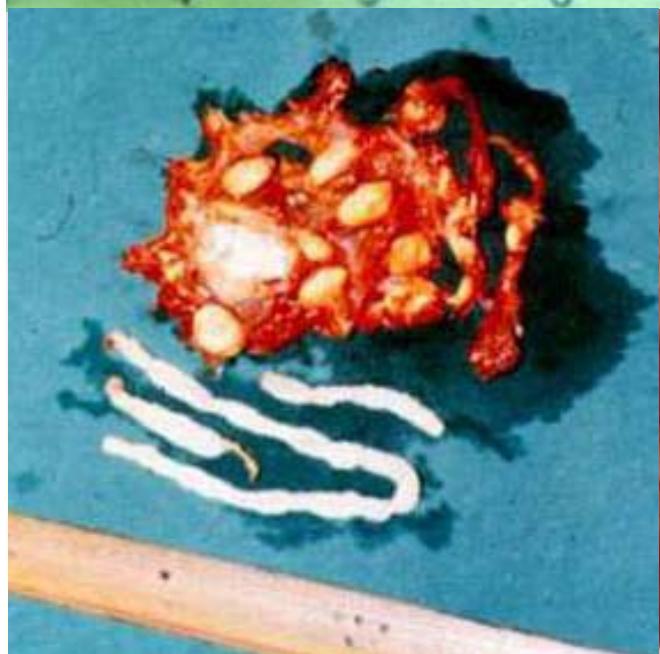
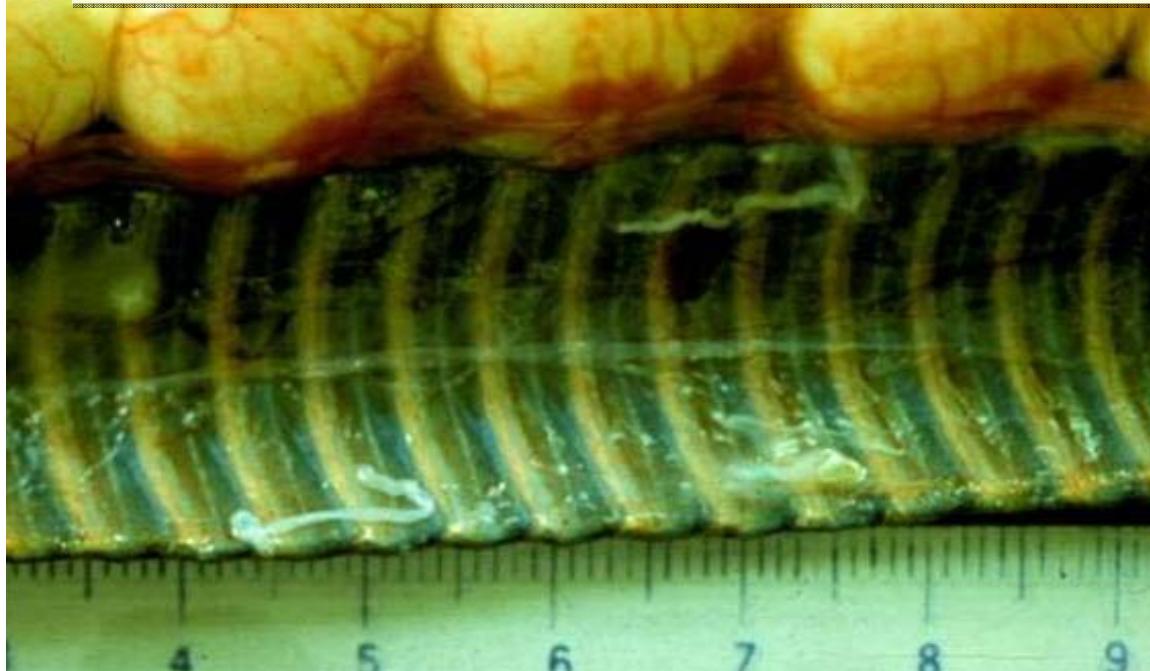
Occurs by consumption of undercooked frogs, chickens, or snakes having the plerocercoid stage (= sparganum), or drinking untreated water contaminated with the procercoid.

**Plerocercoids (spargana) of
*Spirometra erinacei, S. mansoni, S. mansonioides***

Asian countries, in particular, South Korea
(definitive host: dogs, cats).

Clinical manifestations depend on lesion areas involved.

Spargana in the snake and human sparganosis in the scrotum, or brain (South Korea)



PART III

Food-borne Trematodiases

Paragonimiasis

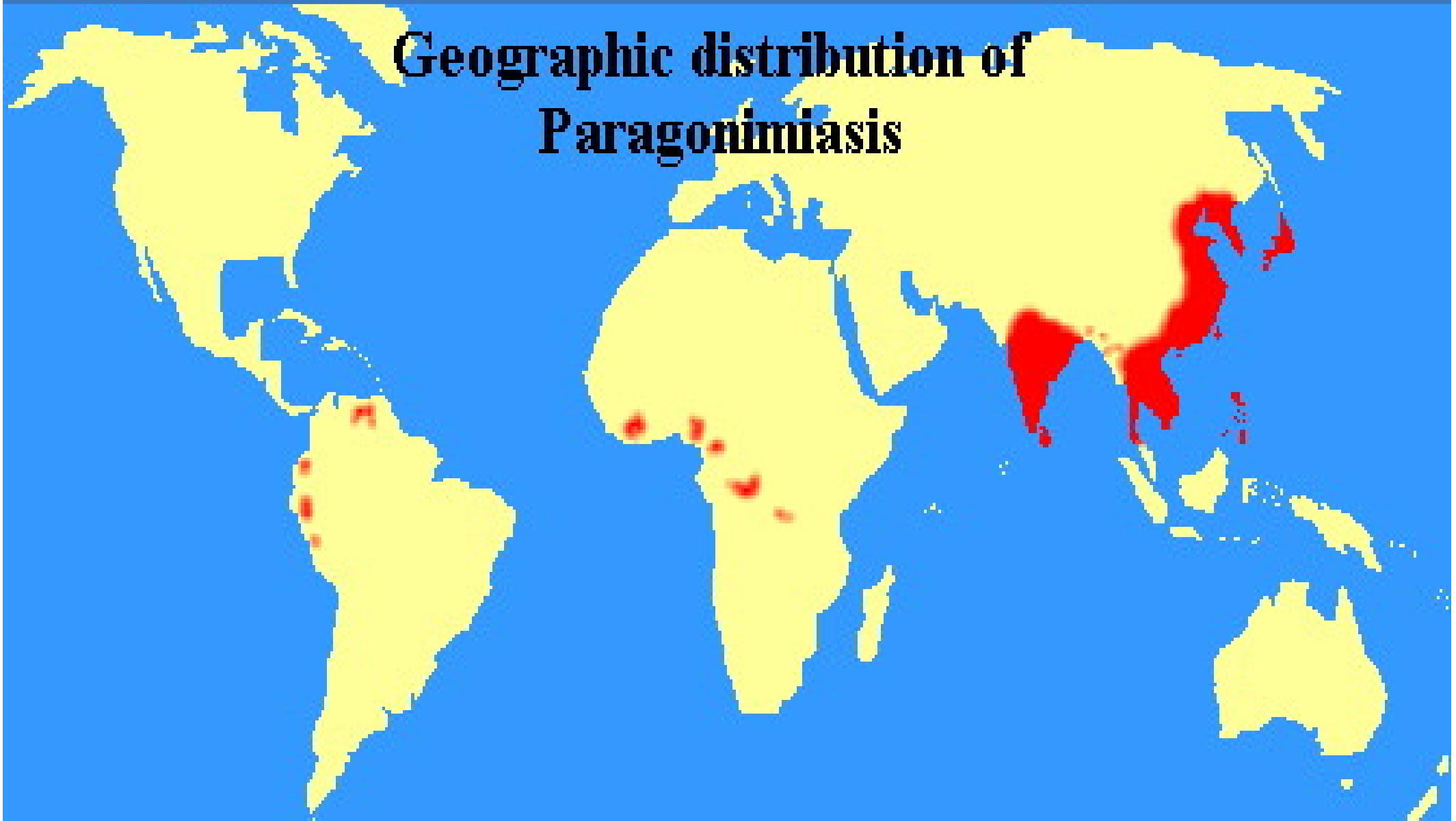
Contracted to humans by eating improperly cooked freshwater crayfish and crabs.

Paragonimus westermani, P. skrjabini, P. heterotremus, P. africanus, P. uterobilateralis, P. mexicanus, P. hueitungensis, P. kellicotti

Around the world
(Narain et al., 2010)

Bloody sputum, cough, chest pain, and lethargy in pulmonary infections, and headache, seizure, and other neurological symptoms in the cerebral type.

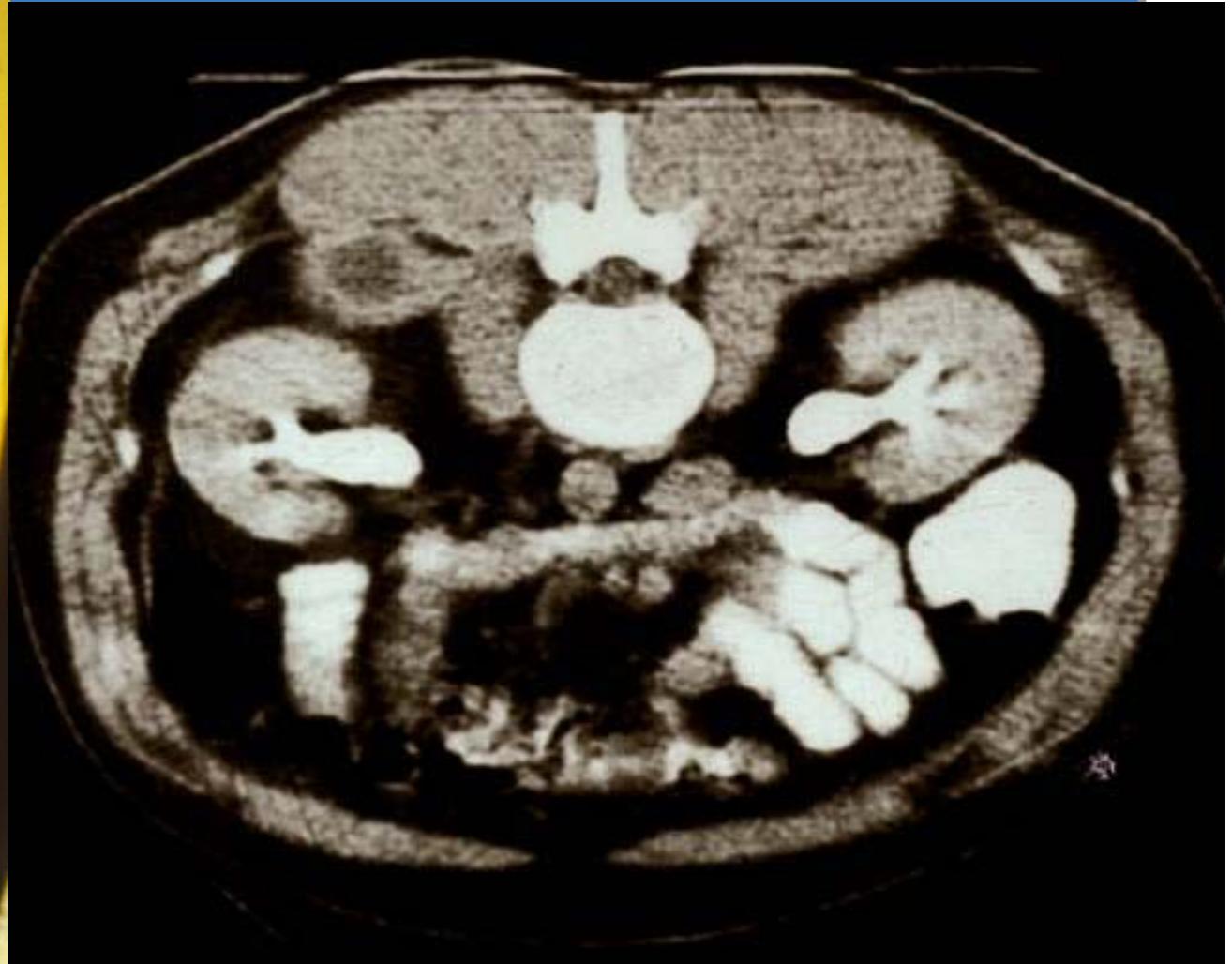
Geographic distribution of Paragonimiasis



Map prepared by WHO



Paragonimus westermani



Ectopic paragonimiasis in quadratus lumborum muscle in South Korea



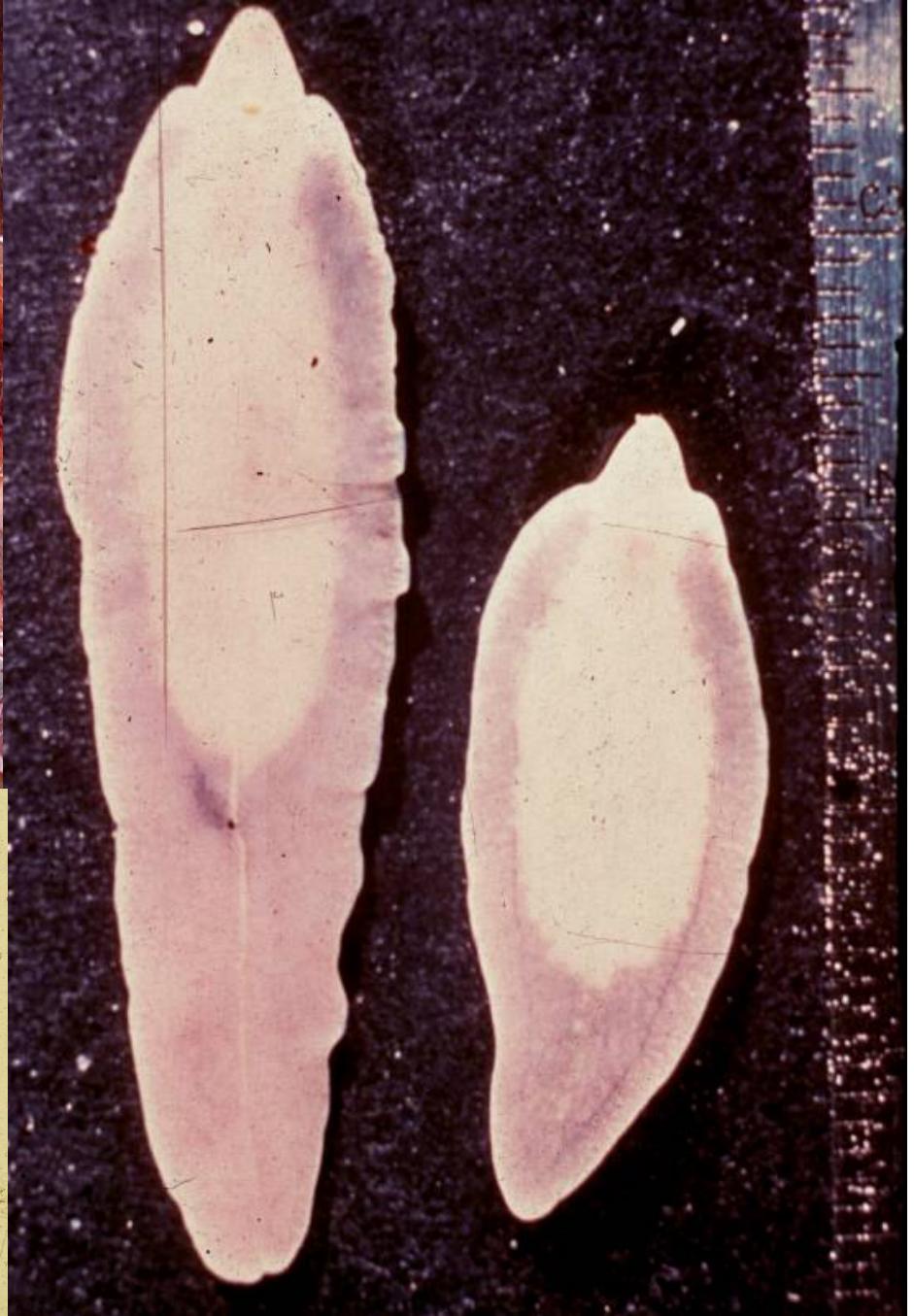
Fascioliasis & Fasciolopsiasis

Contracted to humans by consumption of freshwater vegetables, including watercress containing metacercariae or food dishes and soups made from contaminated water and infected raw liver of cattle (Mas-Coma et al., 2007).

Fasciola hepatica, F. gigantica
Fasciolopsis buski

Almost all over the world

Cholangitis, cholecystitis, cholelithiasis,
and biliary obstruction (intestinal troubles: *F. buski*)



Opisthorchiasis

Caused by consumption of various species of freshwater fish

Opisthorchis viverrini

Thailand, Laos, Vietnam, and Cambodia

O. felineus Russia and Eastern Europe

Cholangitis, choledocolithiasis, pancreatitis, and cholangiocarcinoma are the major clinical problems

(Chai et al., 2005. Int J Parasitol)

Clonorchiasis

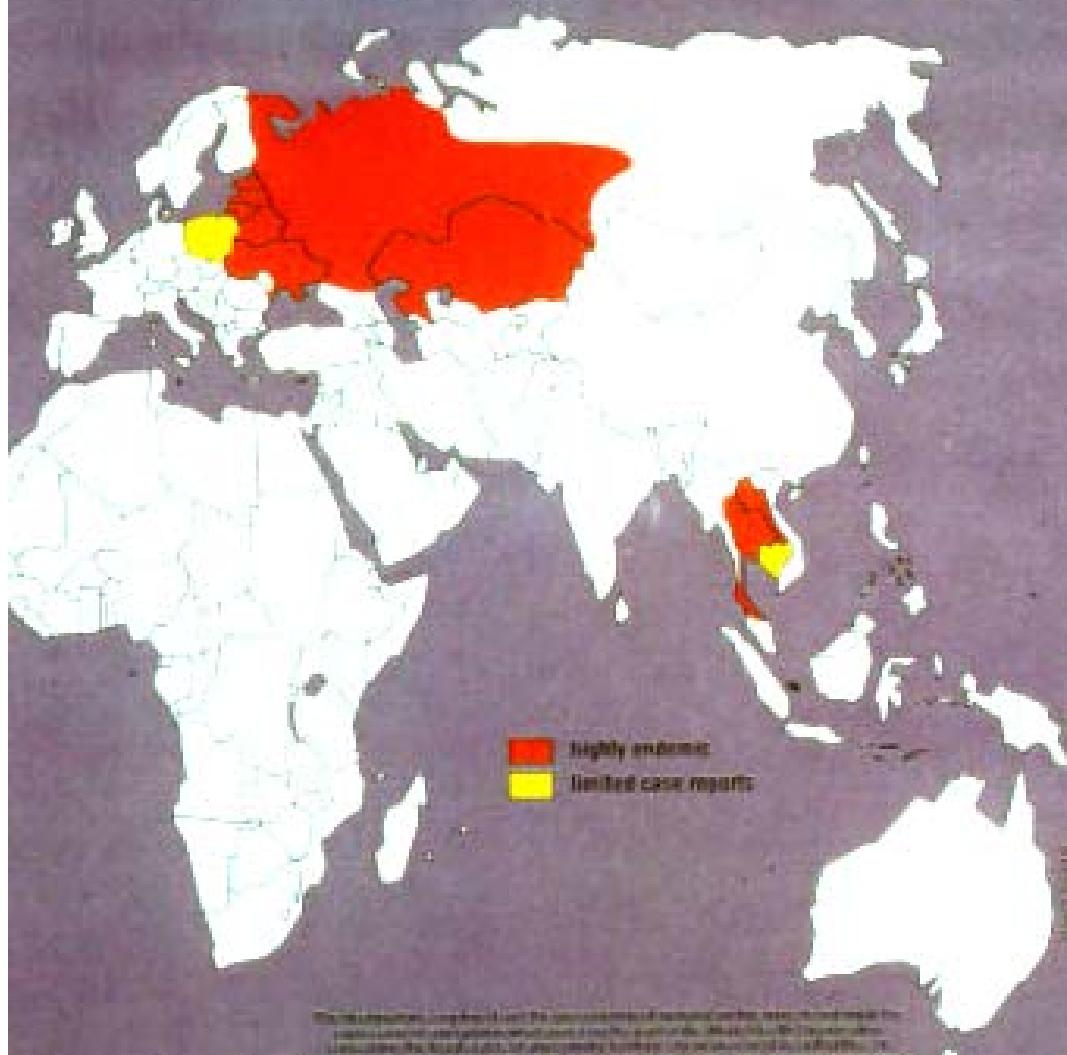
Caused by ingestion of raw or improperly cooked flesh of various species of freshwater fish.

Clonorchis sinensis

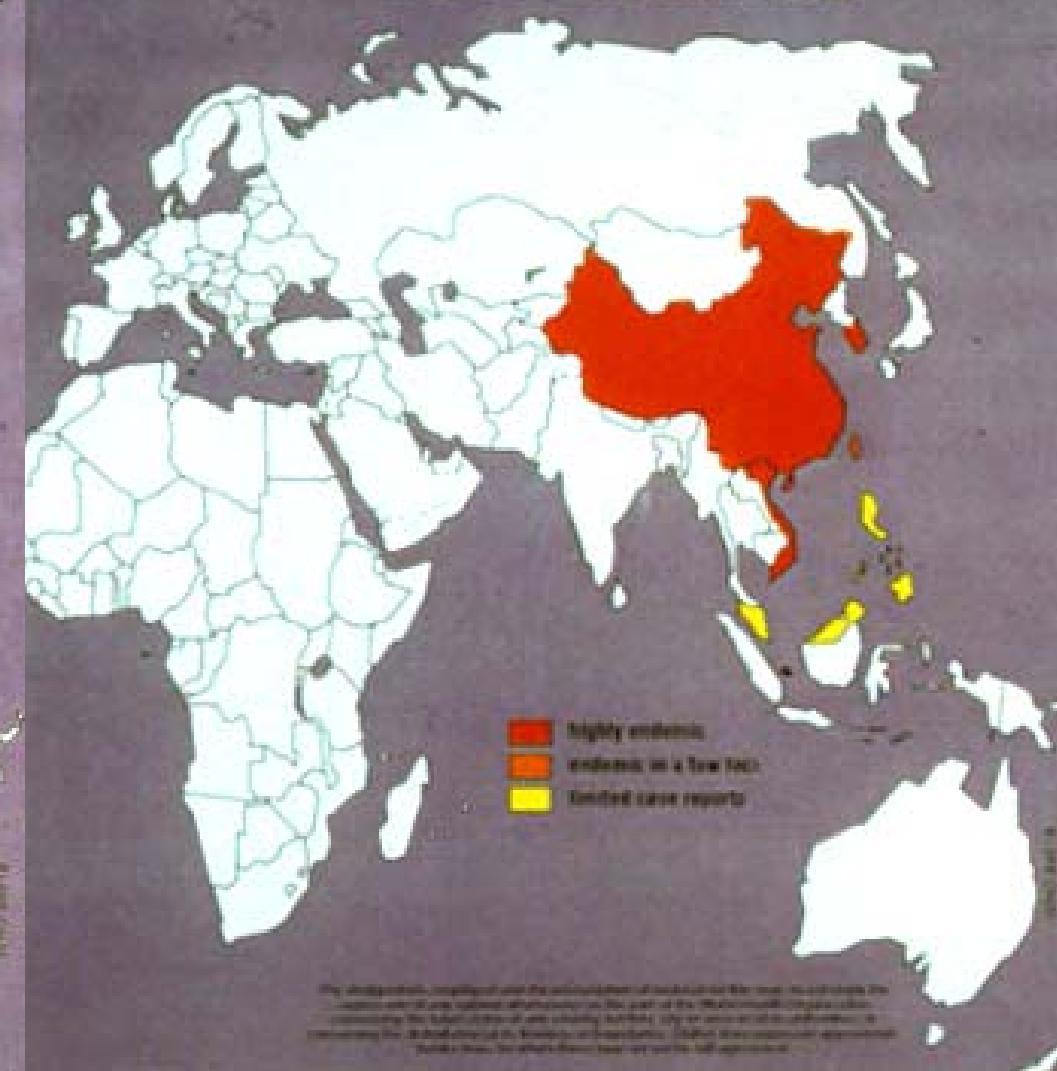
China, Taiwan, South Korea, and Vietnam
(Chai et al., 2005. Int J Parasitol).

Cholangitis, gall stone, jaundice, liver cirrhosis, and cholangiocarcinoma.

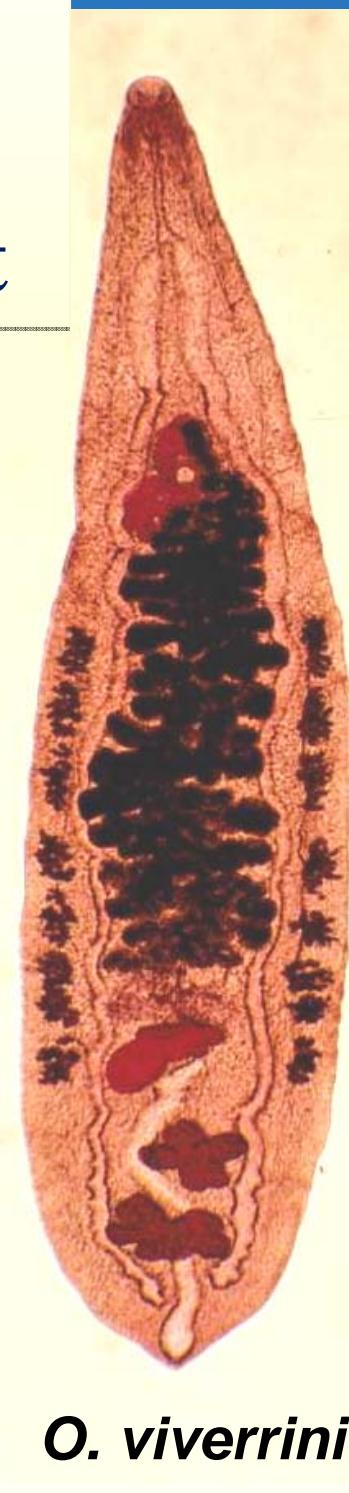
Opisthorchis felineus and O. viverrini



Clonorchis sinensis



Opisthorchis viverrini adults
collected from a Laothian
after praziquantel treatment



O. viverrini



C. sinensis

Opisthorchis viverrini
metacercariae and fish
hosts in Lao PDR



Clonorchis sinensis
metacercariae and a fish
host in South Korea

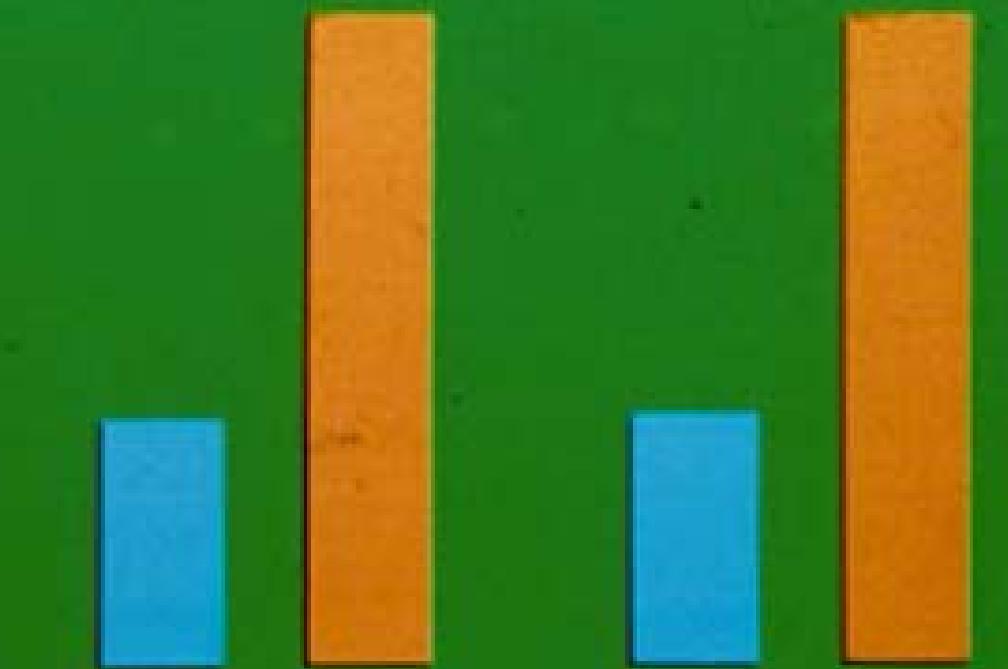


Clonorchis sinensis

Endemic areas in
South Korea



Prevalence & intensity

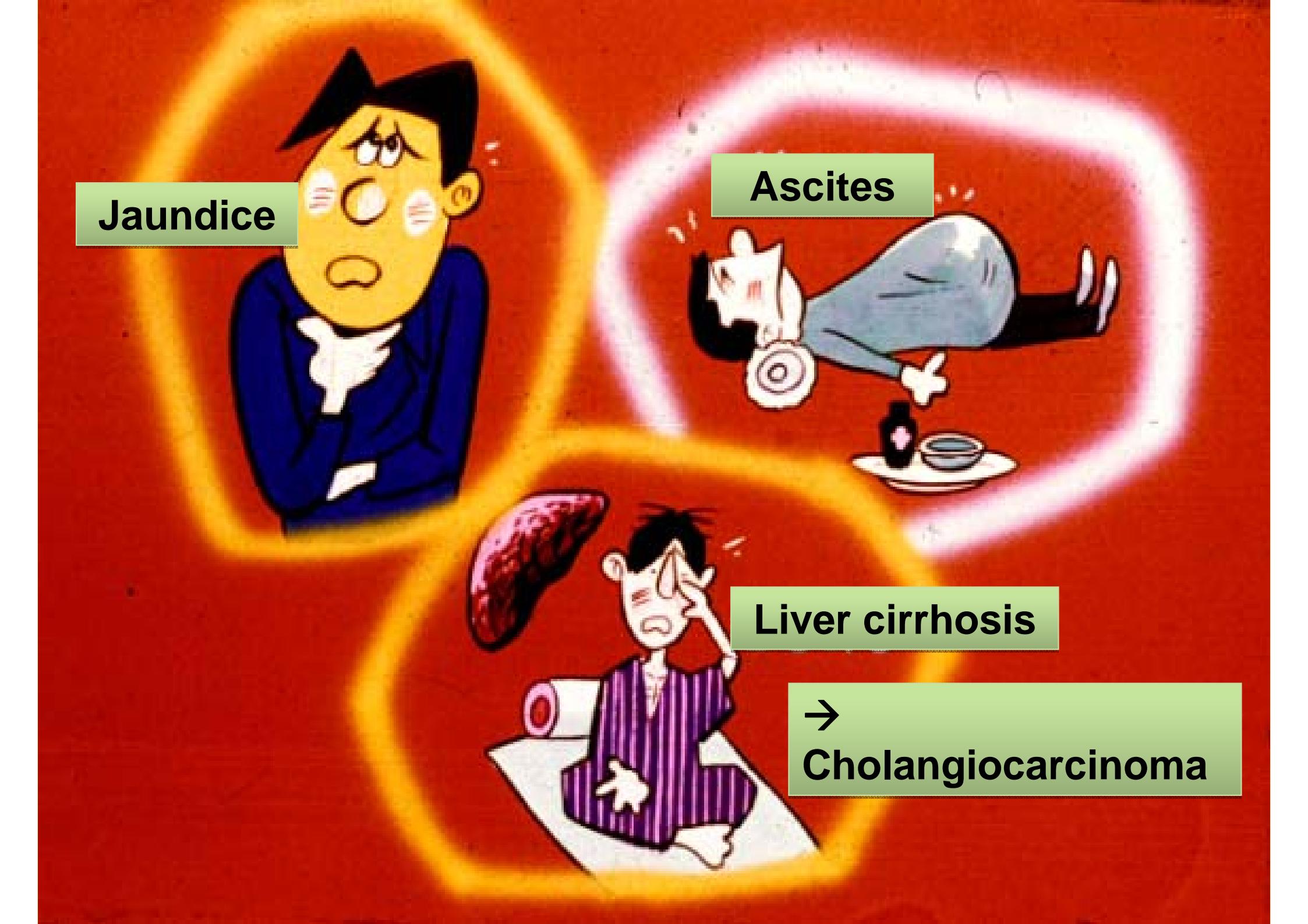


Child
Adults

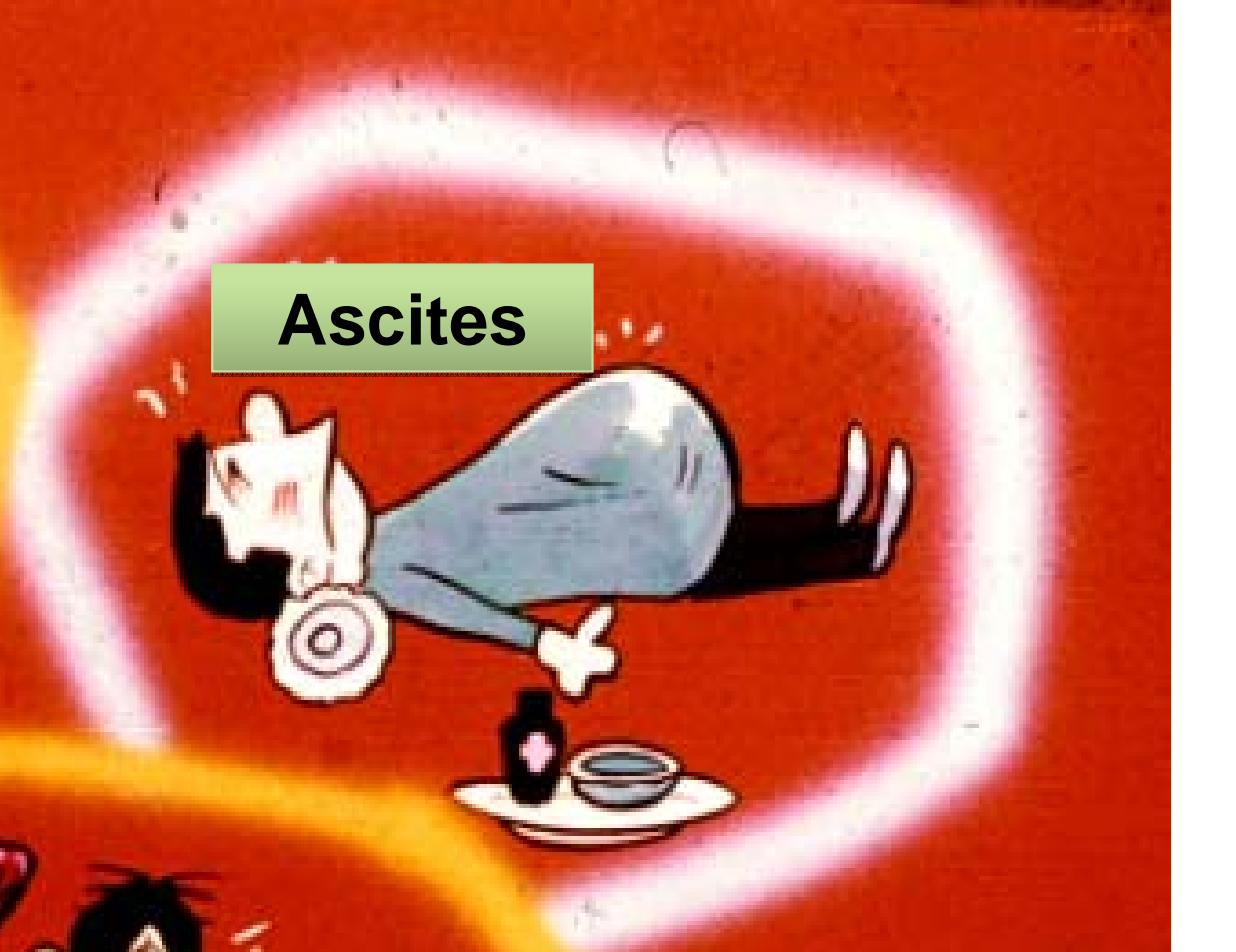
Female Male

National prevalence: 2-5%

No. of infections: 2 million people



Jaundice



Ascites



Liver cirrhosis



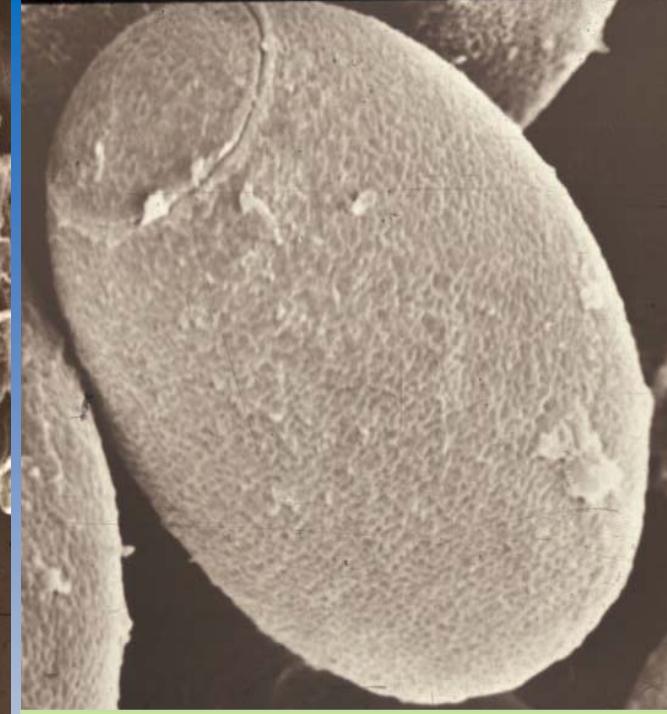
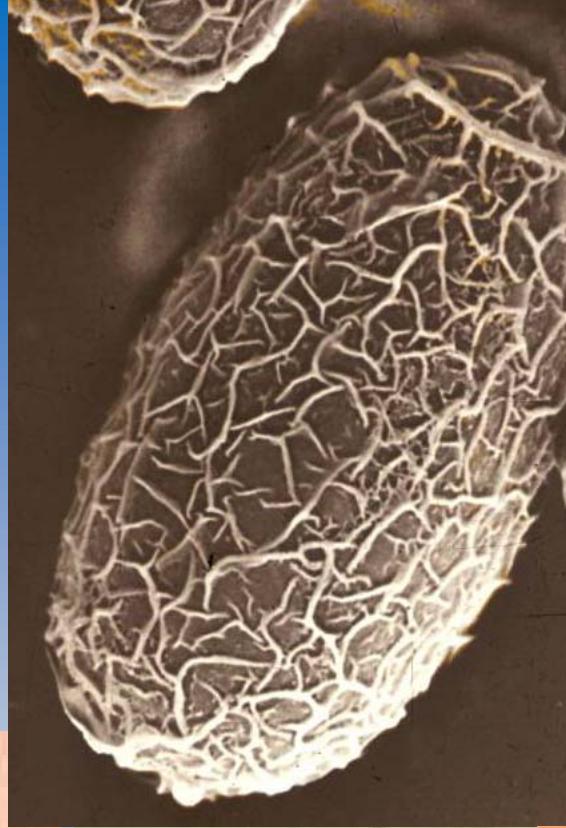
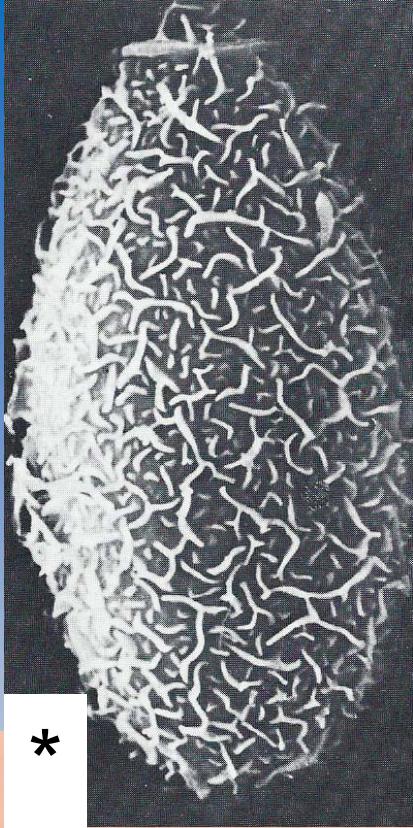
→
Cholangiocarcinoma

Diagnostic problems with opisthorchiasis/clonorchiasis

Their eggs are morphologically **similar to** eggs of intestinal flukes, i.e., heterophyids and lecithodendriids. (Tesana et al., 1992; Sripa et al., 1992; Chai and Lee, 2002)

Endemic areas of heterophyid or lecithodendriid flukes are **mistakenly interpreted as** endemic areas of opisthorchiasis or clonorchiasis (examples: South Korea, Thailand, Vietnam, Lao PDR)

Molecular diagnostic techniques are not yet established.



Metagonimus yokogawai

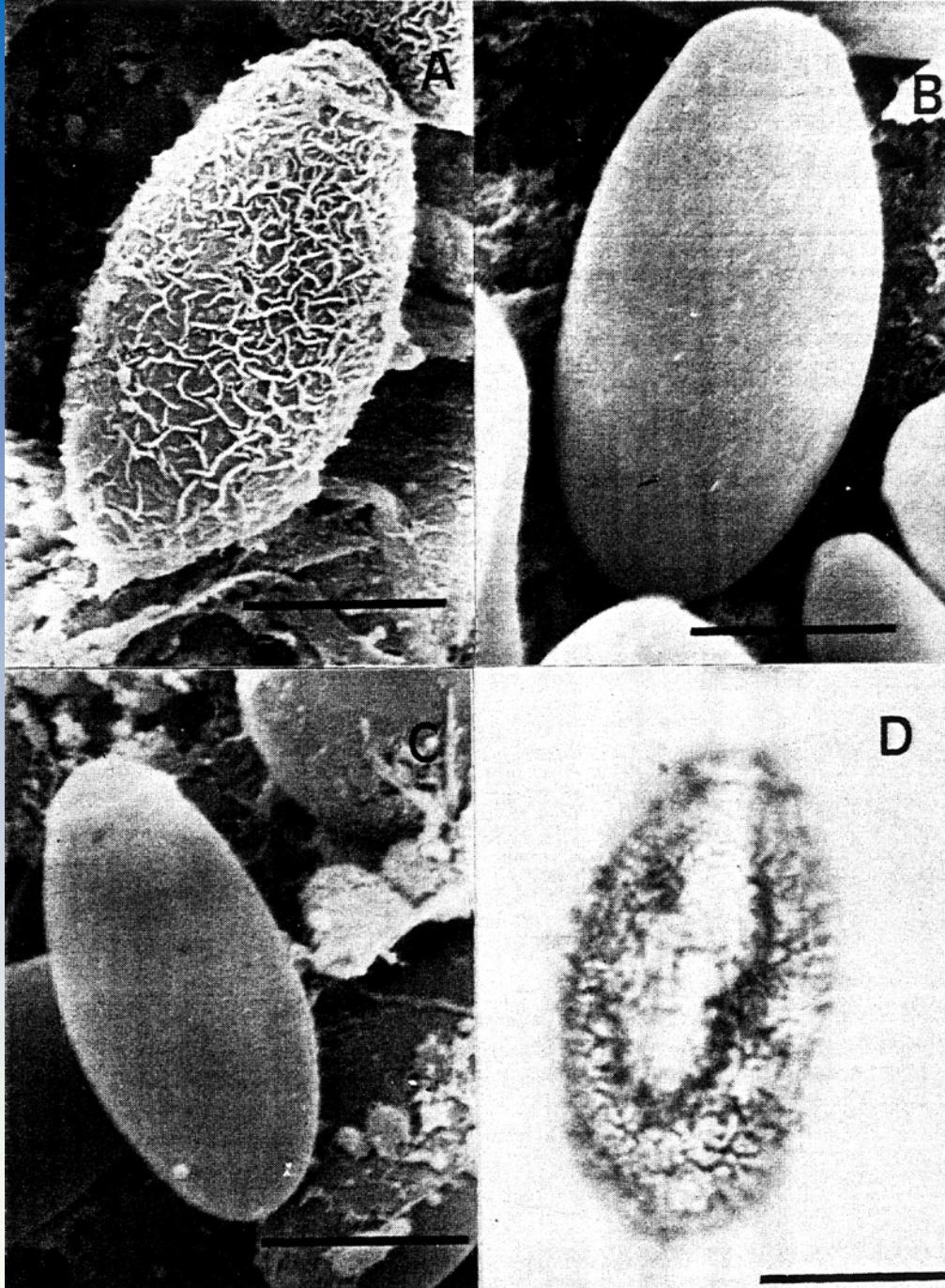


***Heterophyes
nocens***

O. viverrini

C. sinensis

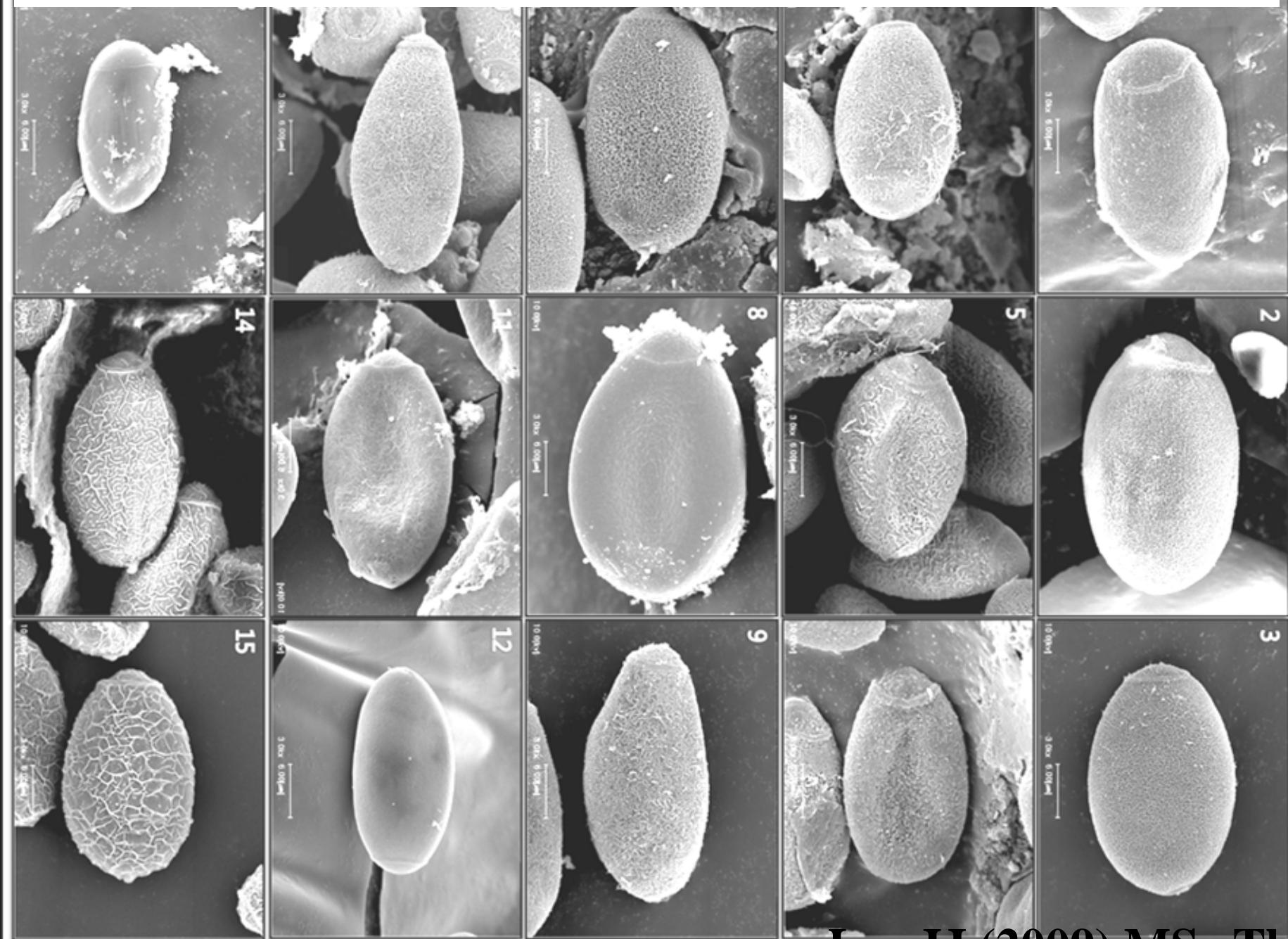
* Scholz et al. (1992) Ann Parasitol Hum Comp



Eggs of *Opisthorchis viverrini* (A), *Phaneropsolus bonnei* (B),
Prosthodendrium molenkampi (C) and the surface of an *O. viverrini* egg (D).

Ov vs lecithodendriids
Kaewkes et al. (1991)

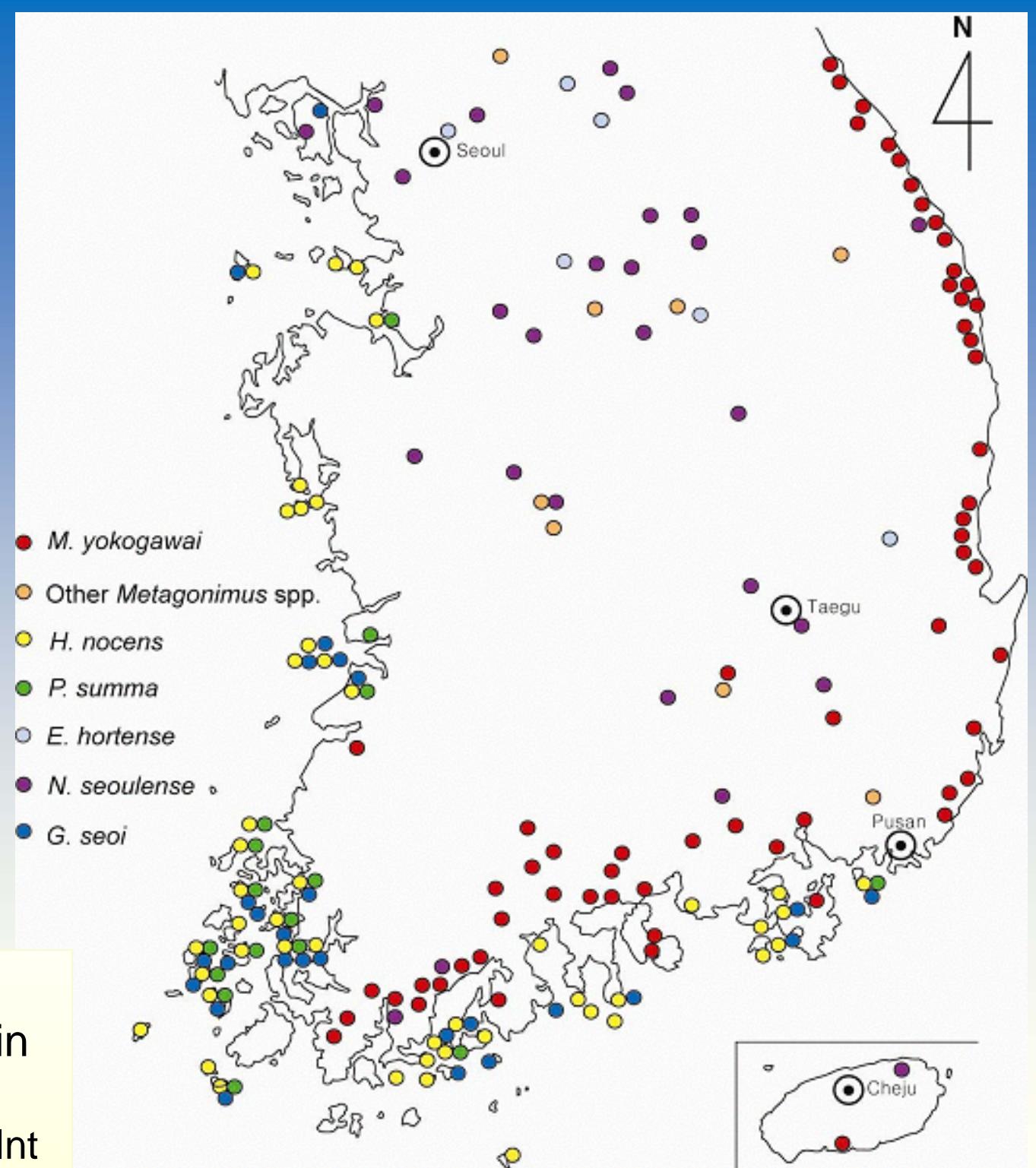
Eggs of heterophyids and lecithodendriids in comparison to eggs of *Opisthorchis* (14) and *Clonorchis* (15)



HETEROPHYIDAE

- ◆ *Haplorchis taichui*, *H. pumilio*, *H. yokogawai*
- ◆ *Heterophyes nocens*
- ◆ *Metagonimus yokogawai*, *M. miyatai*, *M. takahashii*
- ◆ *Centrocestus armatus*, *C. formosanus*
- ◆ *Stellantchasmus falcatus*, *S. formosanus*
- ◆ *Heterophyopsis continua*, *Procerovum varium*,
Procerovum calderoni, *Pygidiopsis summa*,
Stictodora fuscata, *Stictodora lari*

Geographical distribution of food-borne intestinal flukes in South Korea.
Chai and Lee (2002) Parasitol Int



Species of intestinal flukes reported from South Korea Chai and Lee (2002) Parasitol Int

| Species | No. of worm-proven human cases in the whole country ^a | Estimated No. of human infections |
|------------------------------------|--|-----------------------------------|
| <i>Metagonimus yokogawai</i> | > thousands | 120,000 |
| <i>Metagonimus takahashii</i> | > 15 | 20,000 |
| <i>Metagonimus miyatai</i> | > 200 | 100,000 |
| <i>Heterophyes nocens</i> | > 200 | 50,000 |
| <i>Heterphyopsis continua</i> | 8 | 10,000 |
| <i>Pygidiopsis summa</i> | 31 | 50,000 |
| <i>Stellantchasmus falcatus</i> | 4 | 5,000 |
| <i>Centrocestus armatus</i> | 1 | 1,000 |
| <i>Stictodora fuscata</i> | 1 | 2,000 |
| <i>Stictodora lari</i> | 6 | 1,000 |
| <i>Echinostoma hortense</i> | > 100 | 50,000 |
| <i>Echinostoma cinetorchis</i> | 4 | 1,000 |
| <i>Echinochasmus japonicus</i> | 4 | 5,000 |
| <i>Acanthoparyphium tyosenense</i> | 10 | 1,000 |
| <i>Neodiplostomum seoulense</i> | 28 | 1,000 |
| <i>Plagiorchis muris</i> | 1 | 500 |
| <i>Gymnophalloides seoii</i> | > 100 | 40,000 |

* Population in the Republic of Korea was about 47,732,000 as of August, 2001.

Worm collection in Lao PDR (I)

| Parasites | No. of worms collected | | | | Total |
|-----------------------------------|------------------------|-----------|----------|--|---------|
| | Savannakhet | Vientiane | Saravane | | |
| No. people examined | 29 | 18 | 18 | | 65 |
| <i>Opisthorchis viverrini</i> | 3,347 | 1,041 | 395 | | 4,783 |
| <i>Haplorchis taichui</i> | 2,977 | 484 | 153,253 | | 156,714 |
| <i>Haplorchis yokogawai</i> | 3 | 65 | 22 | | 90 |
| <i>Haplorchis pumilio</i> | 80 | 1 | 1,125 | | 1,206 |
| <i>Prosthodendrium molenkampi</i> | 887 | 61 | 441 | | 1,389 |
| <i>Phaneropsolus bonnei</i> | 27 | 0 | 366 | | 393 |

(to be continued)

* In Phongsali province, only *Haplorchis* adults were recovered from people, where prevalence of *O. viverrini* was suspected by fecal examination (Chai et al., 2010, in preparation)

Worm collection in Lao PDR (II)

No. of worms collected

| Parasites | Savannakhet | Vientiane | Khammouane | Total |
|--------------------------------|-------------|-----------|------------|-------|
| <i>Echinostoma</i> sp. | 372 | 5 | 44 | 421 |
| <i>E. revolutum</i> | 0 | 0 | 6 | 6 |
| <i>E. aegyptica</i> | 18 | 0 | 0 | 18 |
| <i>E. macrorchis</i> | 18 | 0 | 0 | 18 |
| <i>Echinochasmus japonicus</i> | 0 | 0 | 27 | 27 |
| <i>Artyfechinostomum</i> | | | | |
| <i>malayanum</i> | 0 | 0 | 2 | 2 |
| Unidentified echinostomes | 6 | 0 | 9 | 15 |
| Others | 239 | 121 | 329 | 689 |

Chai et al. (2005) J Helminthol

Chai et al. (2009) Korean J Parasitol

Haplorchiasis

Caused by consumption of freshwater fish (Koi pla, Pla som, Pla la, Som fak)

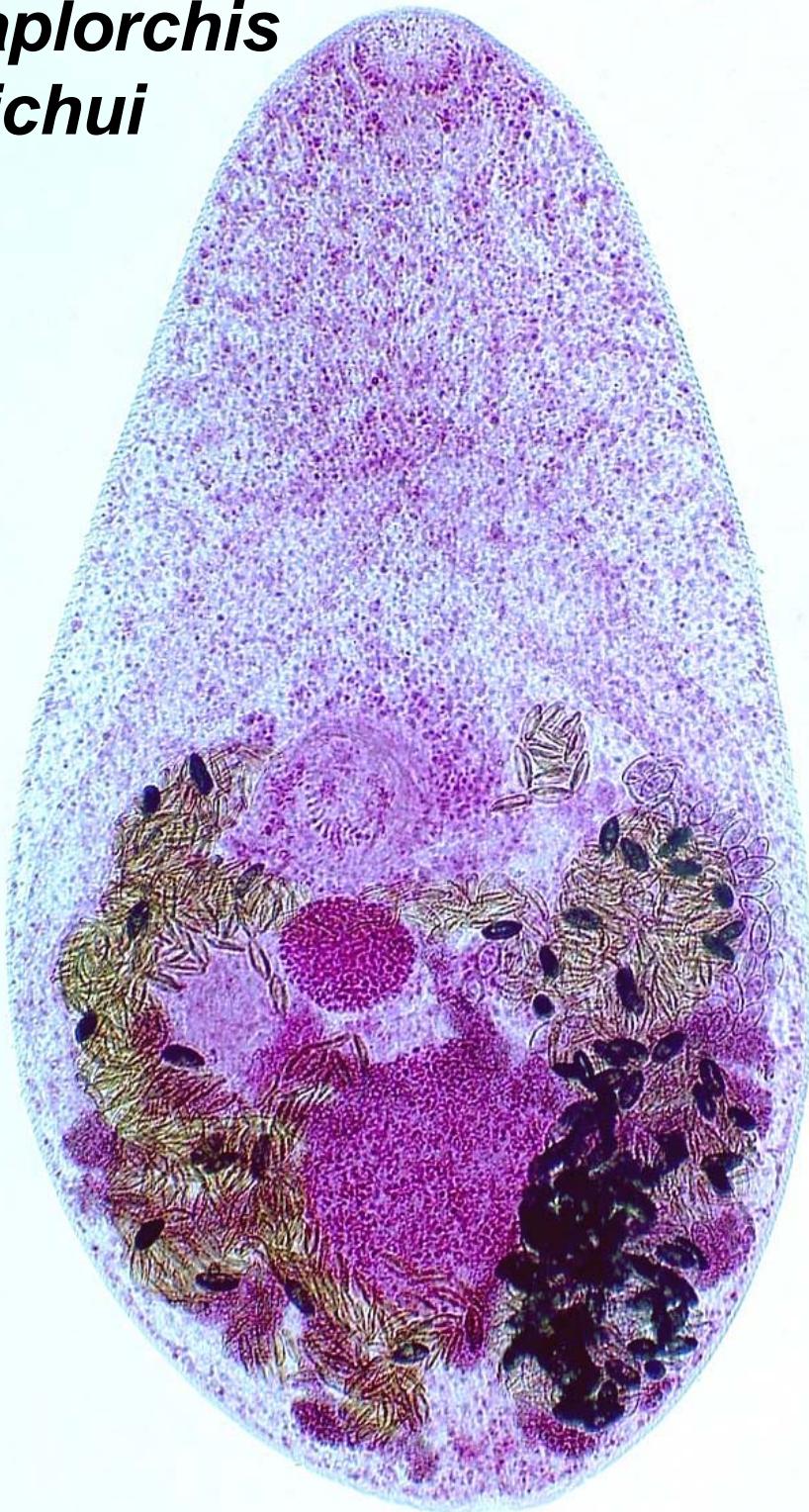
Haplorchis taichui, H. pumilio, H. yokogawai, H. pleurolophocerca (in Egypt), *H. vanissimus*

Thailand, Laos, Vietnam, and China (Chai, 2007).

Gastrointestinal troubles.

Erratic parasitism in the heart, brain, spinal cord (Africa et al., 1940).

*Haplorchis
taichui*



*Haplorchis
pumilio*





Fish in a local market in Lao PDR



Metacercaria of *Haplorchis taichui* in the fish muscle

Metagonimiasis

Caused by consumption of freshwater fish (sweetfish, carp, chub, minnow)

*Metagonimus yokogawai, M. miyatai, M. takahashii,
M. minutus*

South Korea, Japan, China, Taiwan, Russia (Chai, 2007).

Gastrointestinal troubles.



Metagonimus yokogawai, *M. miyatai*, *M. takashii*
Chai et al. (1993) Korean J Parasitol



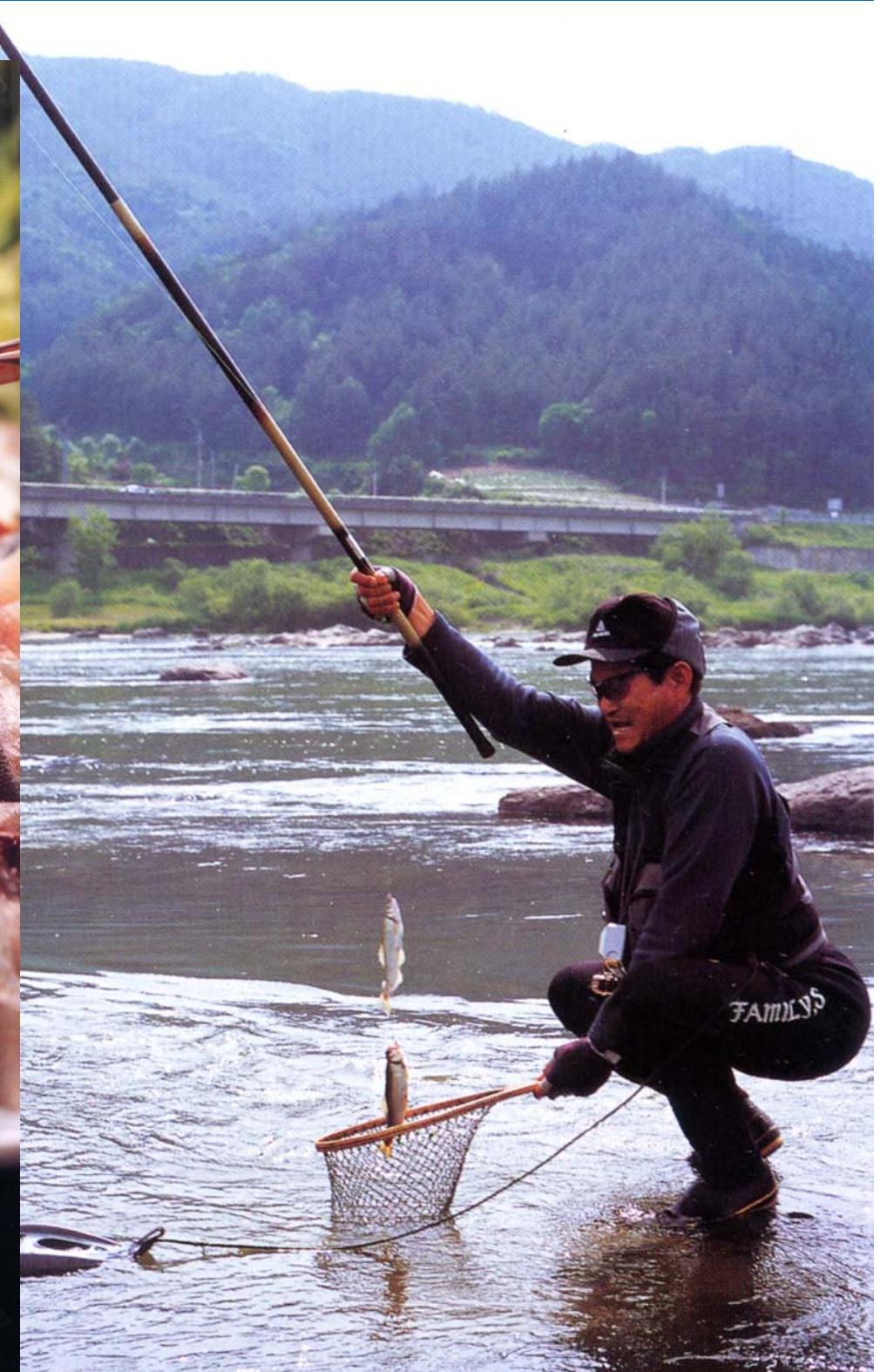
Heavy *Metagonimus yokogawai* infection in a patient

은어회
은어회는 6월에서 7월
중순까지가 가장 맛이
좋다. 고소하고 단맛이
나며 살은 물론 뼈까지
연해 오뚝오뚝 씹히는 맛이
일품이다.



Special food: sweetfish

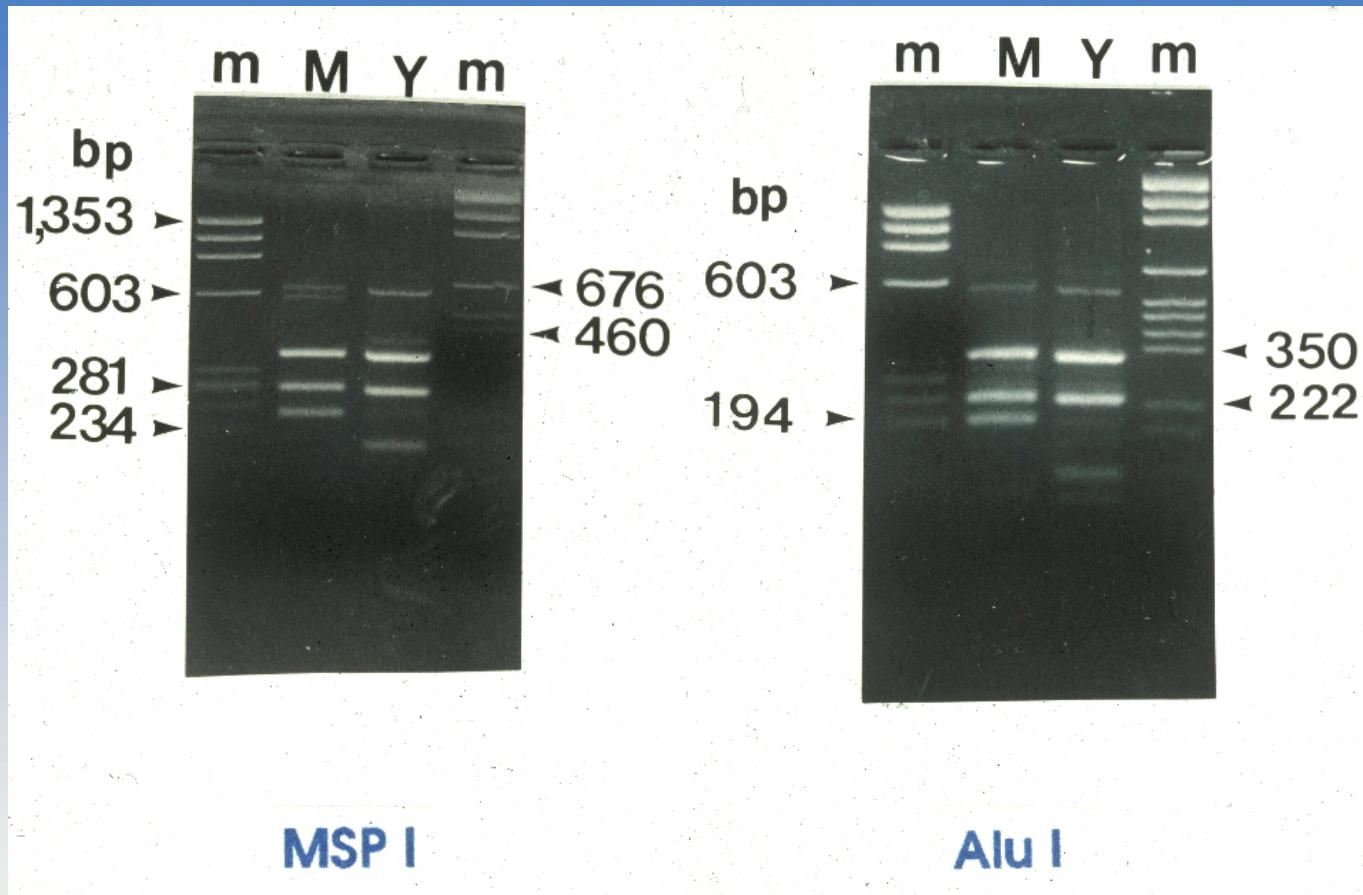
섬진강 대표음식 두 가지, 재첩국과 은어회. 독특한 향과 진한 국물의 재첩도 별미지만 씹을 수록 고소하고 담백한 은어회를 빼놓을 수 없다. 6월, 한창 제철을 맞은 은어. 그리고 은어낚시 도사가 주인인 14년 전통의 자연산 은어회 전문점 전원가든. 에디터 최현주 | 사진 홍상돈





Metacercariae and sweetfish (*Plecoglossus altivelis*), restaurant
Metagonimus yokogawai

Molecular/Genetic studies on *Metagonimus*



Yu and Chai (2010) In Molecular Detection of Foodborne Pathogens

(Liu D, ed). Taylor & Francis, USA.

Yu et al. (1997a, 1997b) Korean J Parasitol

Lee et al. (1999, 2004) Korean J Parasitol

Yang et al. (2000) J Parasitol

Centrocestus formosanus and a metacercaria from a fish
Lao PDR



Han et al. (2008) Korean J Parasitol

Heterophyiasis

Caused by consumption of freshwater fish (brackish water fish, mostly in sashimi style)

Heterophyes nocens (South Korea, Japan)

H. heterophyes, H. dispar, H. aequalis

(Egypt, Middle East, India?)

Gastrointestinal troubles.



Heterophyes nocens
mullet, perch, metacercaria

Pygidiopsiasis

Caused by consumption of freshwater fish (brackish water fish)

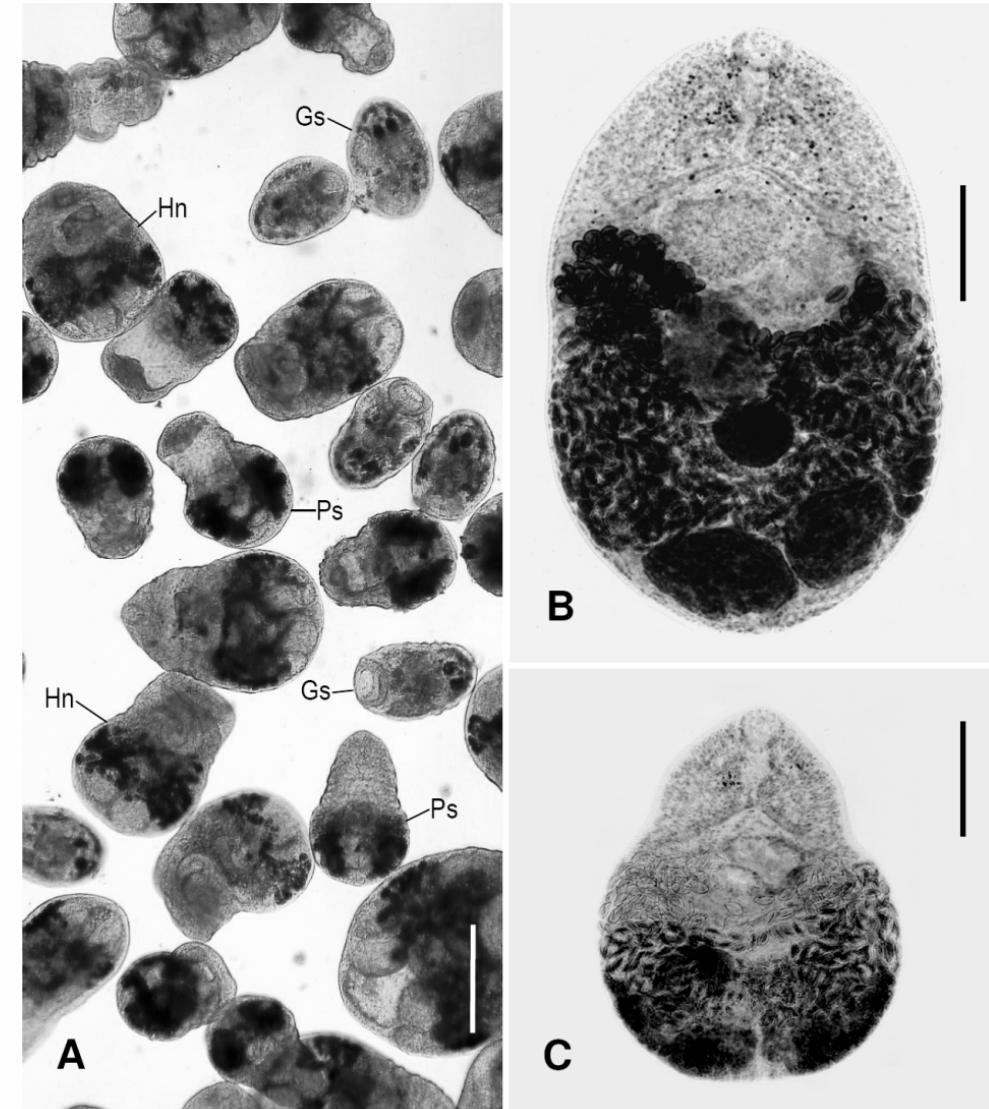
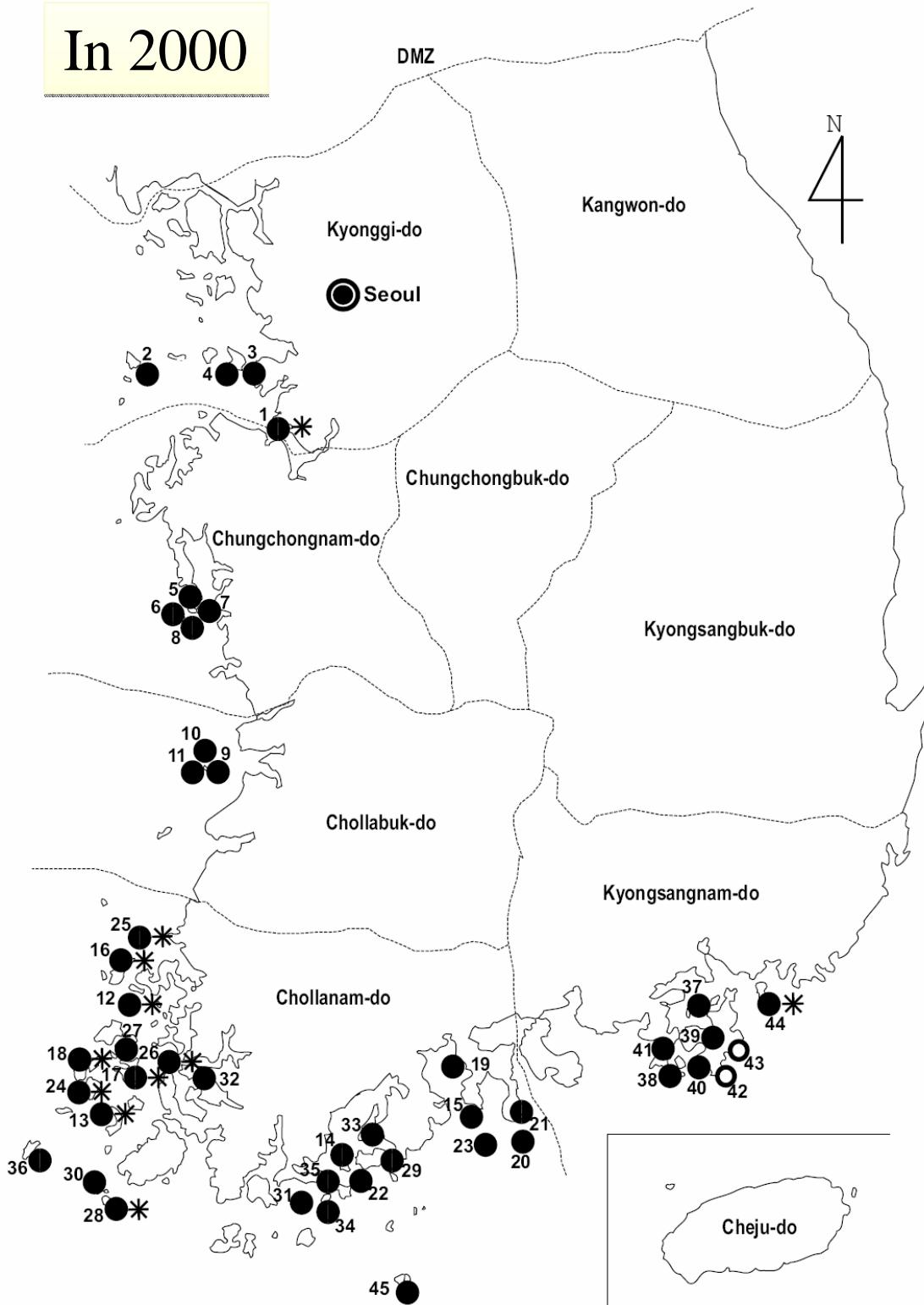
Pygidiopsis summa (South Korea, Japan)
P. genata (Egypt, Middle East)

Gastrointestinal troubles.



Pygidiopsis summa adult and a metacercaria

In 2000



***H. nocens* (B) and *P. summa* (A)
from residents of islands in
South Korea**

Chai et al. (2004) Am J Trop Med Hyg

Lecithodendriidiasis

Caused by consumption of uncooked insect larvae
(example, naiads of dragonfly), adults

Prosthodendrium molenkampi

Phaneropsolus bonnei

Phaneropsolus spinicirrus

Indonesia, Thailand, Lao PDR

Not precisely known.

Lecithodendriid flukes (family Lecithodendriidae) from Laothians

Prosthodendrium molenkampi



Phaneropsolus bonnei



Chai et al. (2005) J Helminthol



Naiads (larvae) of the dragonfly, in a local market in Lao PDR

Echinostomiasis

Caused by consumption of freshwater fish, snails, or clams

Echinostoma revolutum, E. ilocanum,

E. echinatum, E. hortense

Echinochasmus japonicus, E. perfoliatus,

E. liliputanus

Artyfechinostomum oraoni, A. malayanum

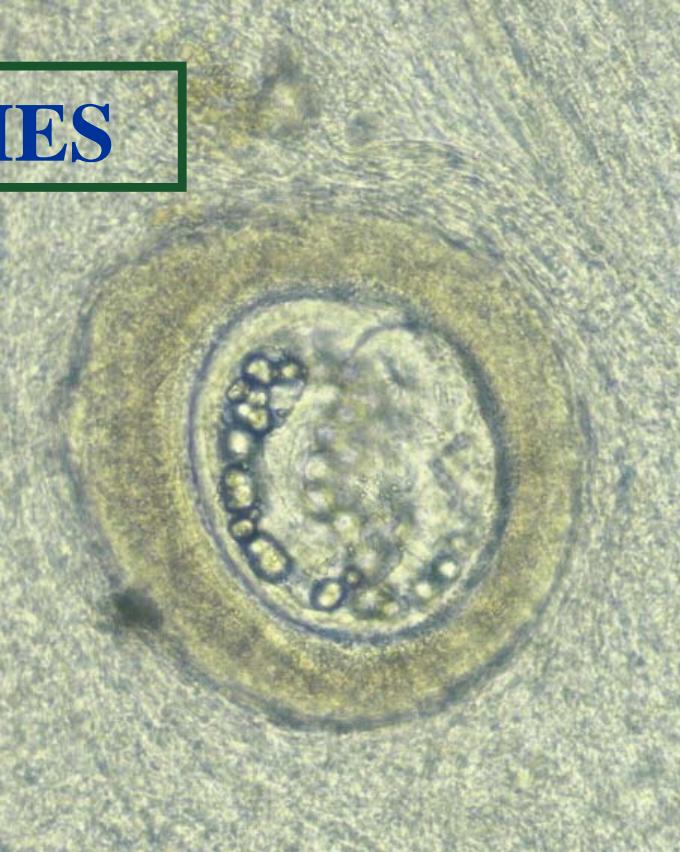
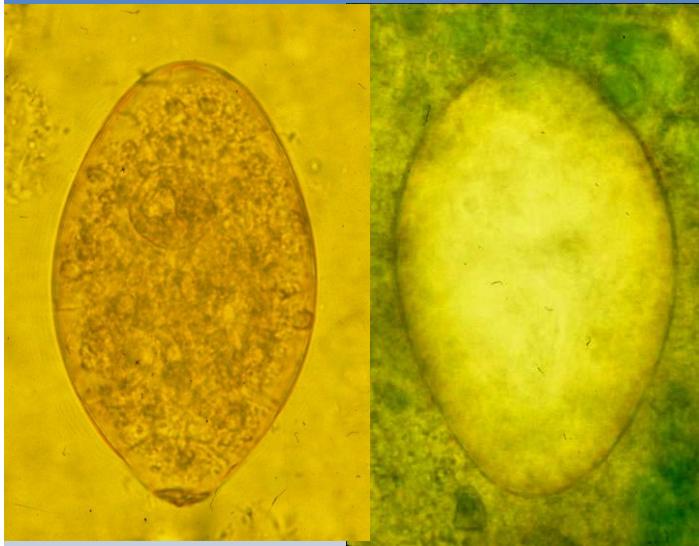
Acanthoparyphium, Echinoparyphium, Episthmium,

Himasthla, Hypoderaeum, Isthmiophora

Mostly in Asia, less common in America and Europe

Gastrointestinal troubles.

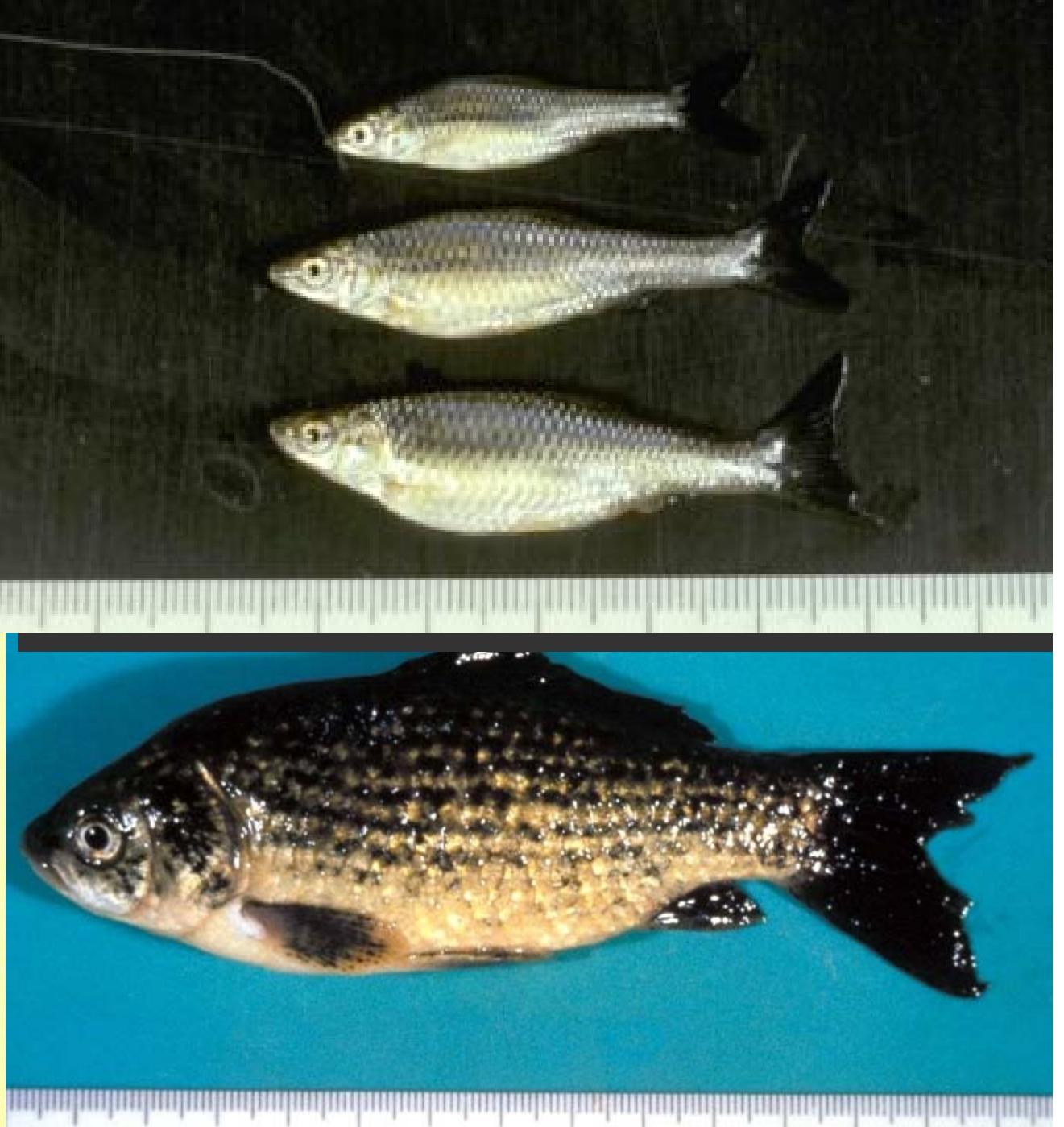
ECHINOSTOMES



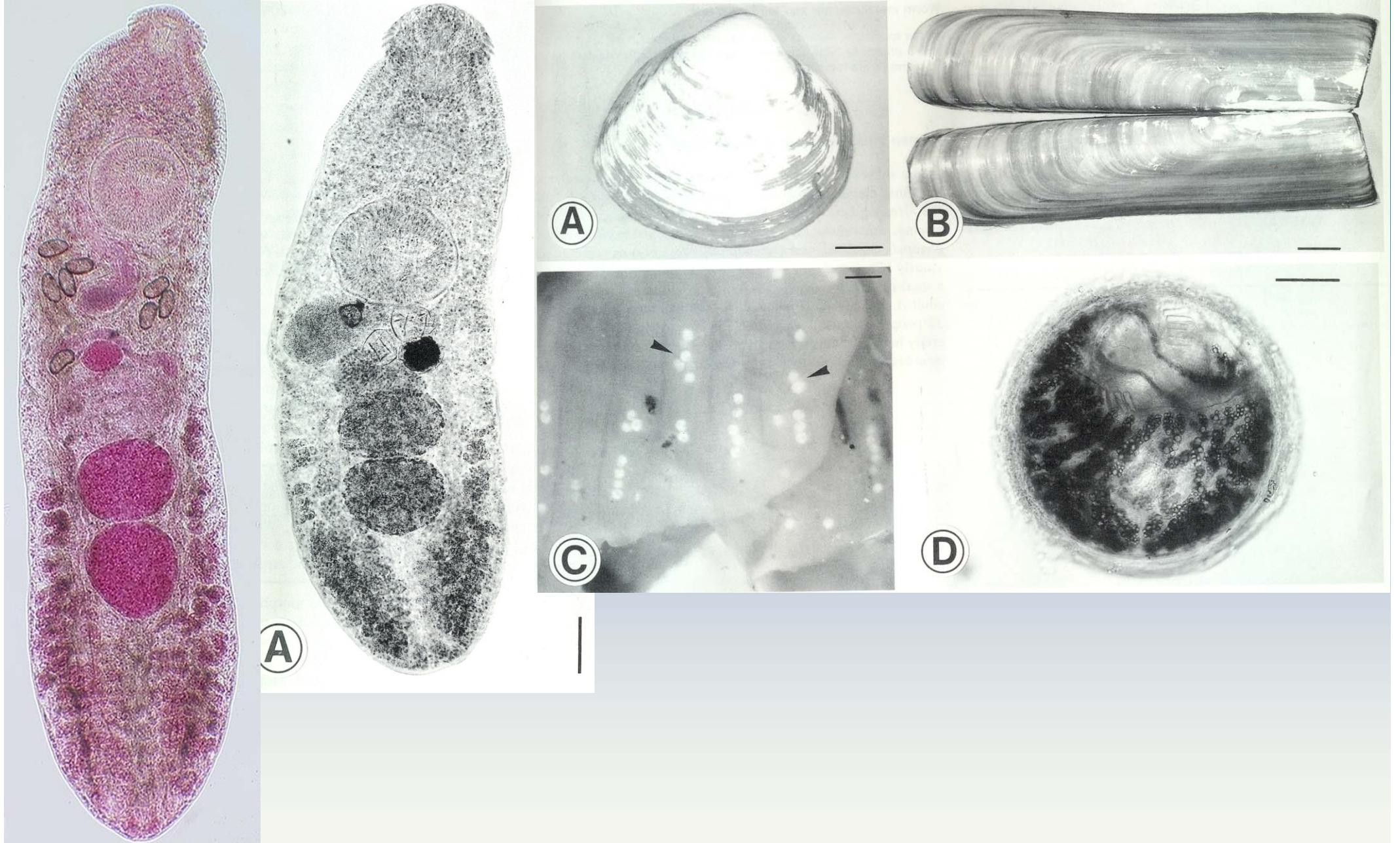
Echinostoma hortense: eggs, metacercaria, fish host, and adult



Echinostoma cinetorchis and *E. revolutum* adult worms,
and the molluscan intermediate host
Sohn and Chai (2005) Korean J Parasitol



Echinochasmus japonicus: adult worm, and the fish hosts



Acanthoparyphium tyosenense adult (left), intermediate host (2nd), and metacercariae (right)

ECHINOSTOMES



Artyfechinostomum malayanum from Laothians

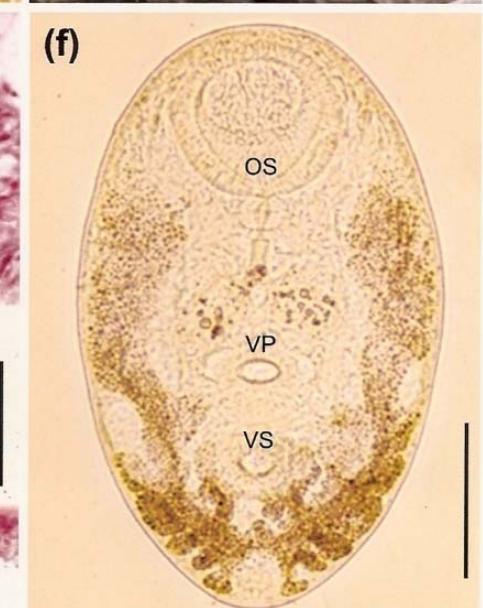
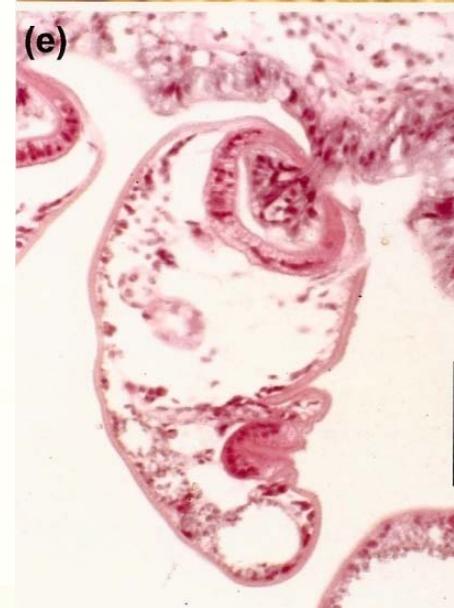
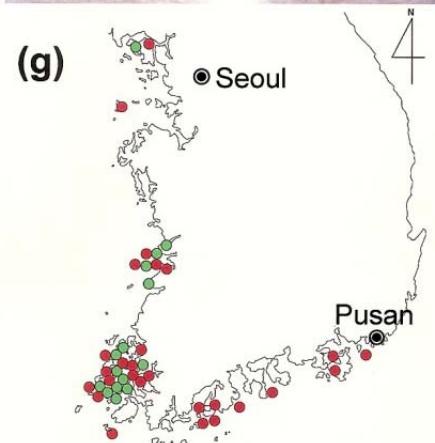
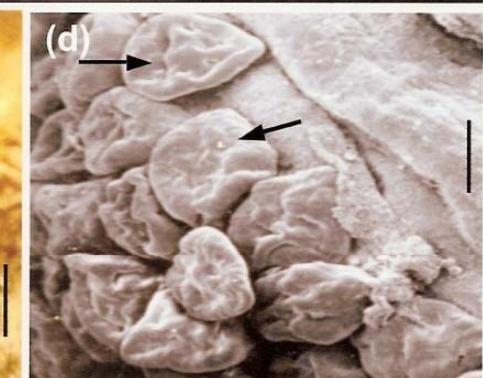
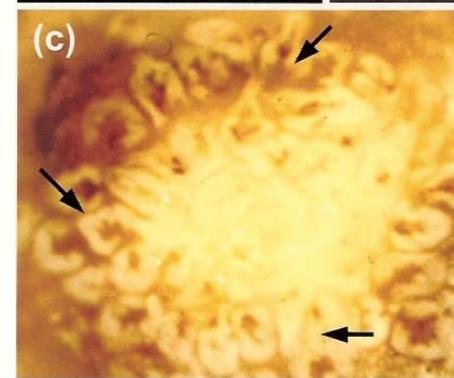
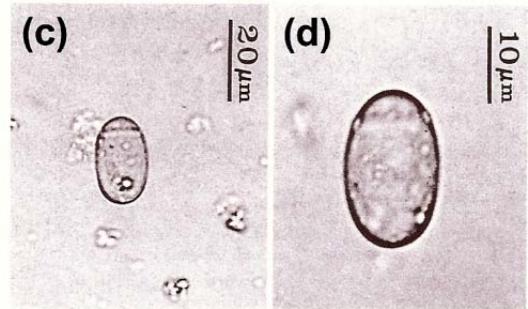
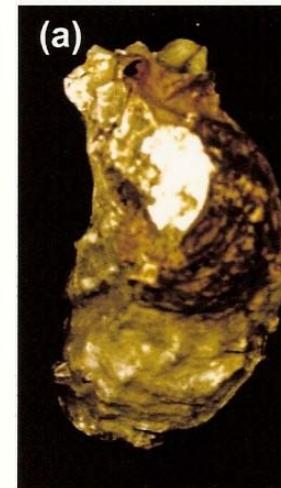
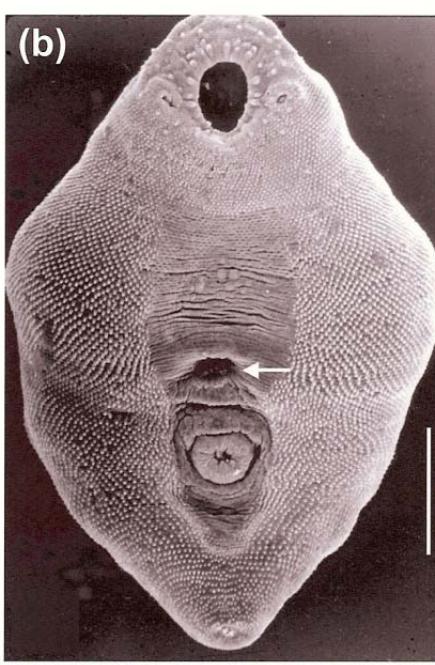
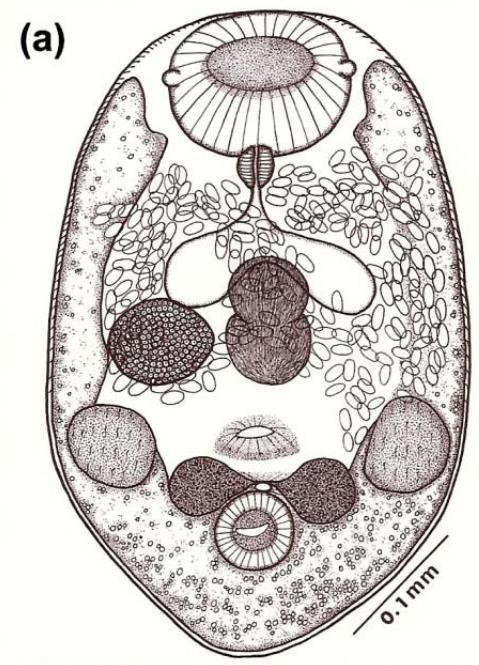
Gymnophalloidiasis

Caused by consumption of oysters

Gymnophalloides seoii

South Korea
(Chai et al., 2003. Trends Parasitol)

Gastrointestinal troubles, pancreatitis, diabetes (?).



Gymnophalloides seoi

Chai et al. (2003) Trends Parasitol

Neodiplostomiasis

Caused by consumption of improperly cooked frogs or snakes

Neodiplostomum seoulense

South Korea (Seo, 1990; Chai, 2007).

Gastrointestinal troubles, intestinal paralysis.

Neodiplostomum seoulense



10k 200
0.30k x



Hong ST et al. (1984, 1986) Korean J Parasitol
Huh et al. (1994) Korean J Parasitol

Seo et al. (1982) Korean J Parasitol



Tadpoles, frogs, and grass snake, intermediate and paratenic hosts for *Neodiplostomum seoulense*

Plagiorchiasis

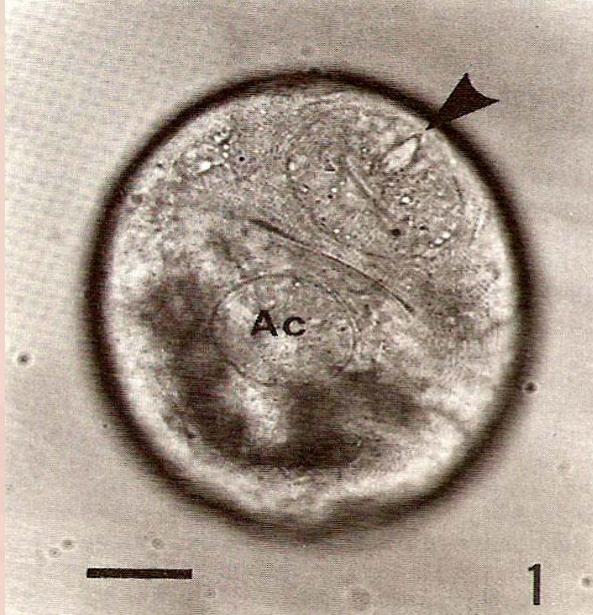
Caused by consumption of uncooked insects, fish

*Plagiorchis muris, P. javensis, P. harinasutai,
P. vespertilionis*

South Korea, Indonesia, Japan, Thailand (Chai, 2007; Guk et al., 2007).

Not known.

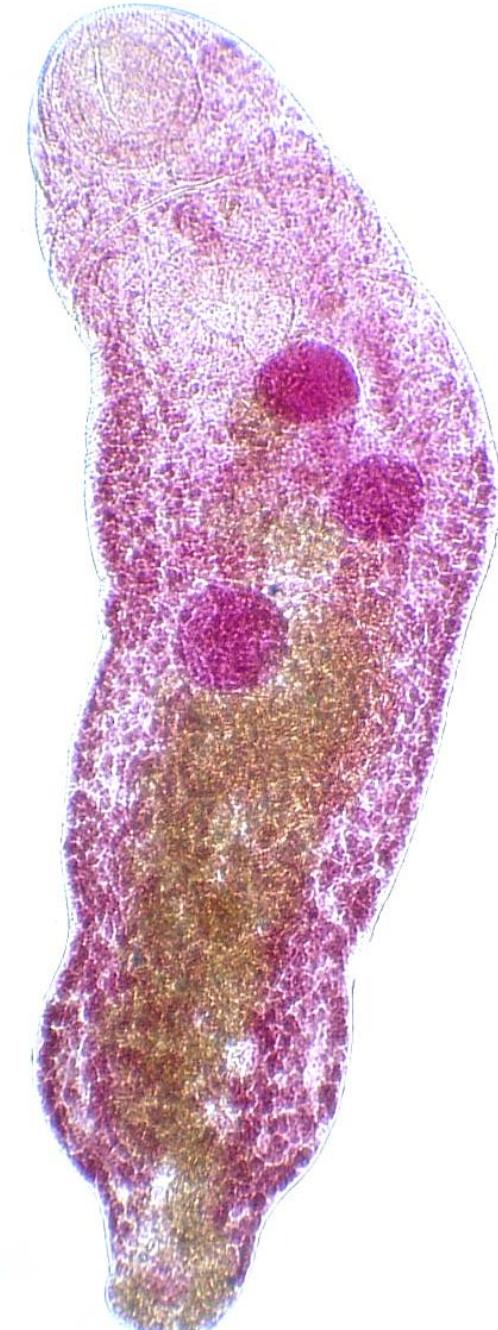
Plagiorchis muris and *P. vespertilionis*



A metacercaria
from a dragonfly

Hong SJ et al. (1996) J Parasitol

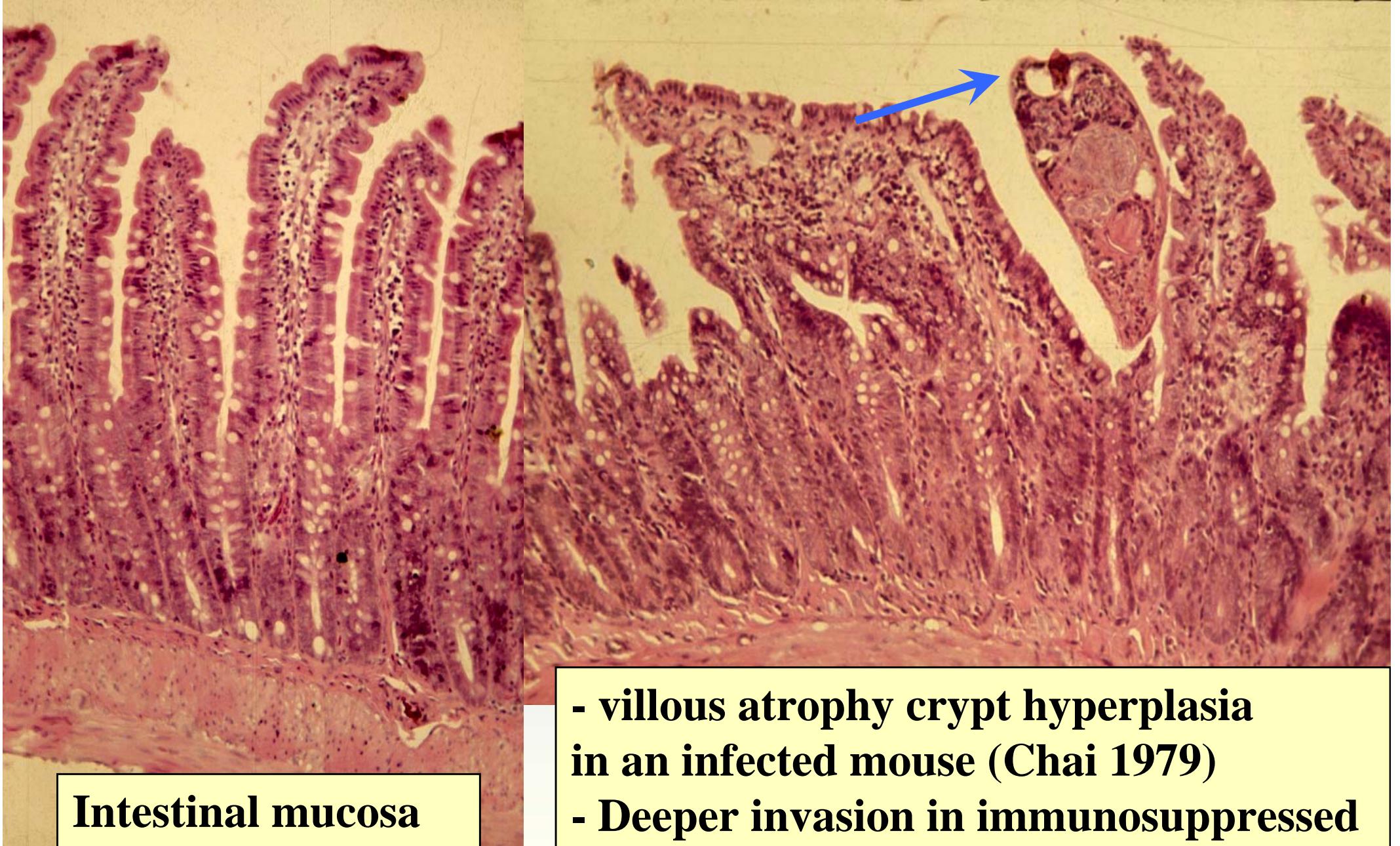
Guk et al. (2007) J Parasitol



PATHOGENICITY AND SYMPTOMS OF INTESTINAL TREMATODIASES

- . Depending on **worm burden, parasite species**
- . Pathological features: **villous atrophy, crypt hyperplasia, catarrhal inflammation**
- . Symptoms
 - General: abdominal pain, diarrhea, anorexia, weakness, easy fatigue**
 - Specific: mucosal ulcer, bleeding (echinostomes), intestinal paralysis, gonad dysplasia, infertility (*Neodiplostomum*)**

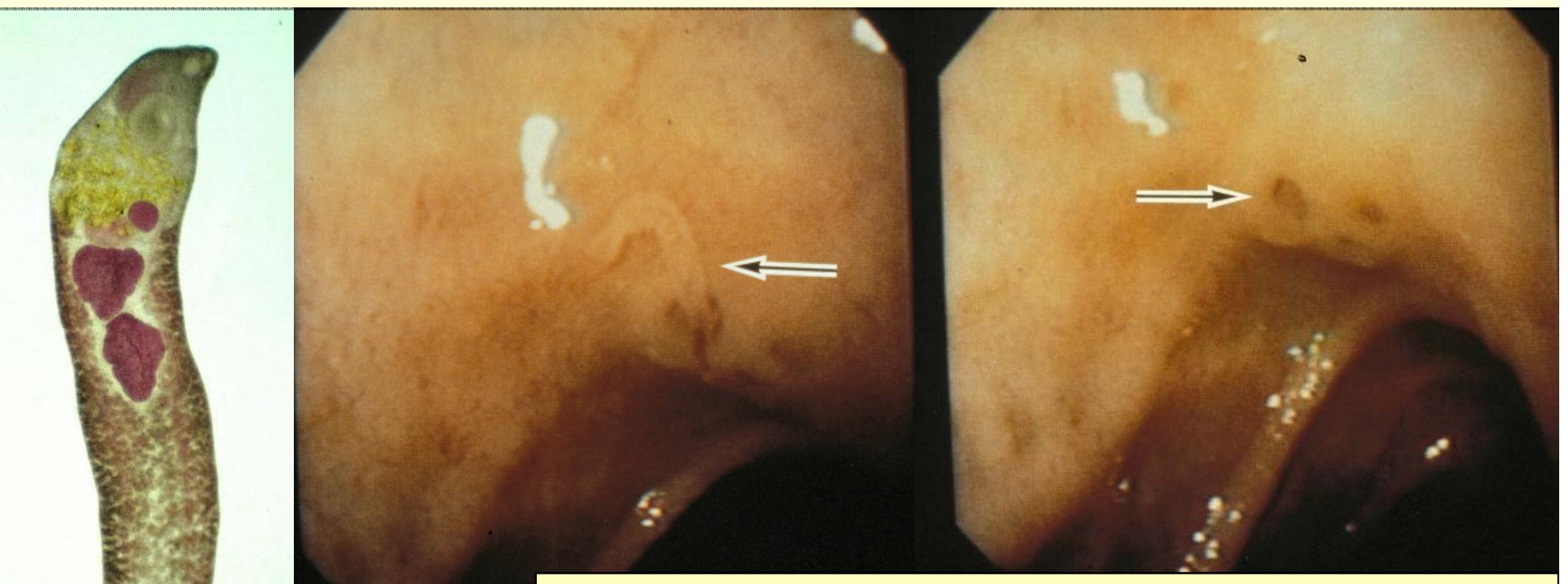
Intestinal mucosa of a mouse infected with *Metagonimus yokogawai* (arrow)



Intestinal mucosa
of a control mouse

- villous atrophy crypt hyperplasia in an infected mouse (Chai 1979)
- Deeper invasion in immunosuppressed mice (Chai et al. 1994)

Echinostoma hortense infection in a patient (Gastrofiberscopy)



Experimental *E. hortense* infection in a rat



Chai et al. (1994)

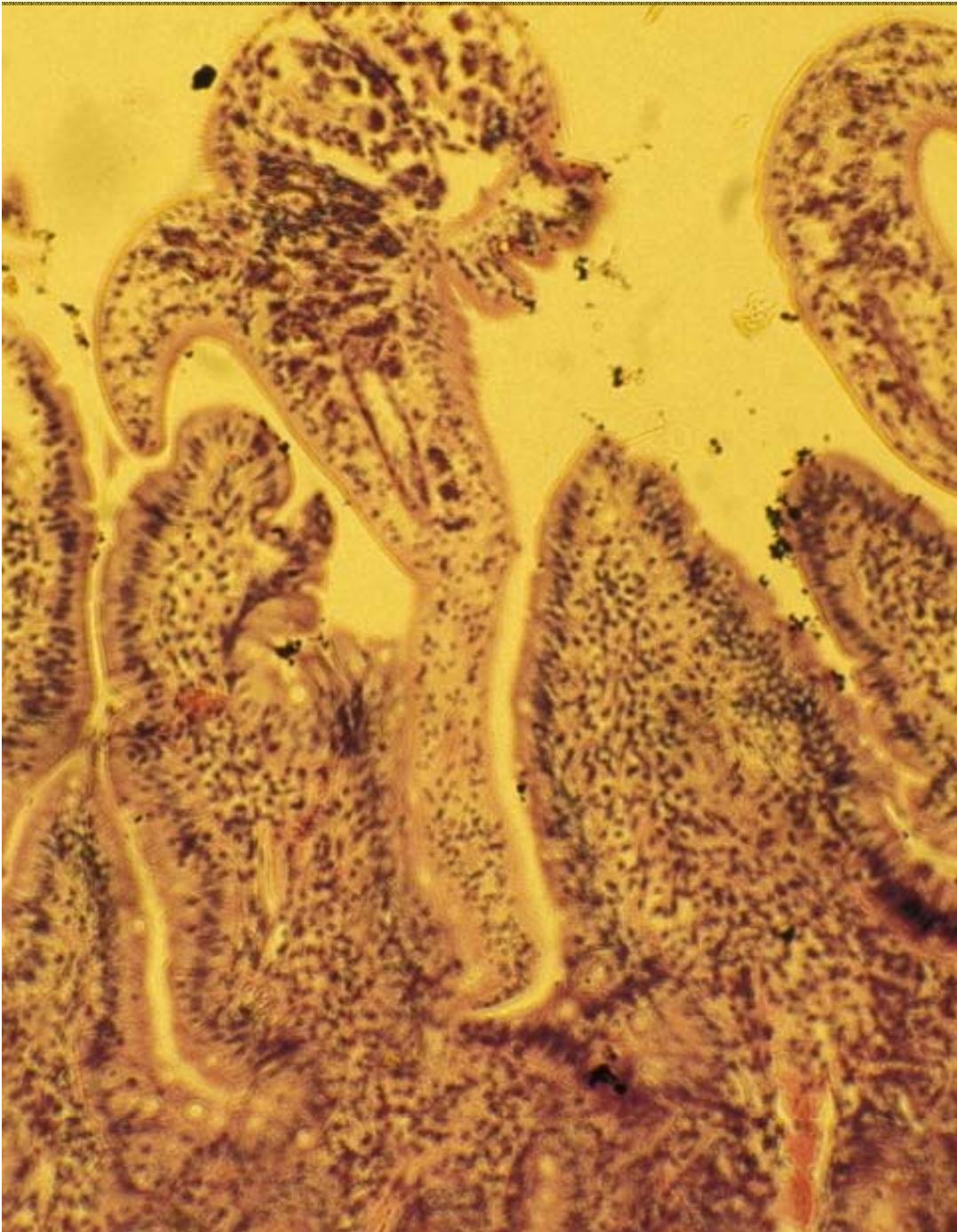
Lee et al. (1995)
Korean J Parasitol





Heavy *Echinostoma hortense* infection in a patient

Duodenal mucosa of a rat infected with *Neodiplostomum seoulense*



Lee et al. (1985) Korean J Parasitol

PATHOGENICITY AND LETHALITY OF A MINUTE INTESTINAL FLUKE, *NEODIPLOSTOMUM SEOULENSE*, TO VARIOUS STRAINS OF MICE

Jina Kook, Yukifumi Nawa*, Soon-Hyung Lee, and Jong-Yil Chai†

Department of Parasitology and Institute of Endemic Diseases, Seoul National University College of Medicine, Seoul 110-799, Korea

ABSTRACT: Pathogenicity and lethality of *Neodiplostomum seoulense* to various strains of mice (mast cell-deficient W/W^v, their normal littermate +/+, C57BL/6, BALB/cA, C3H/HeJ), and a hybrid (BALB/cA × C3H/HeJ)F₁ were investigated. When the mice were infected orally each with 200 metacercariae, their abdomen became distended, and all mice died by day 23 postinfection (PI) except BALB/cA, which were severely weakened but recovered after 28 days. Even a smaller infection dose of 25 metacercariae was highly lethal to C3H/HeJ mice. Despite treatment with praziquantel (3 mg/mouse) on day 10 PI, 80% of C57BL/6 mice did not recover and died. After day 14 PI, the whole intestine of C57BL/6 mice was contracted and significantly shortened in length, and charcoal meal transit was significantly faster compared with uninfected controls. After incubation in papaverine, the contracted intestines of C3H/HeJ mice did not relax, suggesting that the change is irreversible. In conclusion, *N. seoulense* has the potential to kill most strains of mice by causing irreversible damage to their intestine. The effects of mucosal mast cells on the survival rate of mice were negligible, because both W/W^v and +/+ mice died around day 20 PI.

J. Parasitol., 86(5), 2000, p. 1140–1144
© American Society of Parasitologists 2000

Genetic Difference in Susceptibility and Fatality of Three Strains of Mice Experimentally Infected with *Neodiplostomum seoulense*

J.-Y. Chai*, E.-H. Shin, E.-T. Han, S.-M. Guk†, M.-H. Choi, and S.-H. Lee, Department of Parasitology, Seoul National University College of Medicine, and Institute of Endemic Diseases, Seoul National University Medical Research Center, Seoul 110-799, Korea; †Department of Parasitology, Yonsei University College of Medicine, Seoul 120-752, Korea; *author for correspondence

ABSTRACT: The genetic influence on host susceptibility to *Neodiplostomum seoulense* infection and fatality of the host was studied in 3 inbred strains of mice (BALB/c [H-2d], C3H/He [H-2k], and C57BL/6 [H-2b]). The survival of the mice, worm expulsion kinetics, worm size, number of eggs produced per day (EPD), and number of uterine eggs were observed from day 1 to day 40 postinfection (PI) with 100 or 200 metacercariae per mouse. Infection with *N. seoulense* was highly lethal

(Seo, 1990). Since human infection was first observed in a man who consumed the viscera of undercooked snakes and experienced severe gastrointestinal troubles and eosinophilia (Seo et al., 1982), 26 additional cases have been reported (Hong et al., 1984, 1986). The site of infection in the definitive host is the duodenum, but the parasites extend into the jejunum and ileum

Testes of *N. seoulense*-infected (B) vs normal (A) mice

(A)

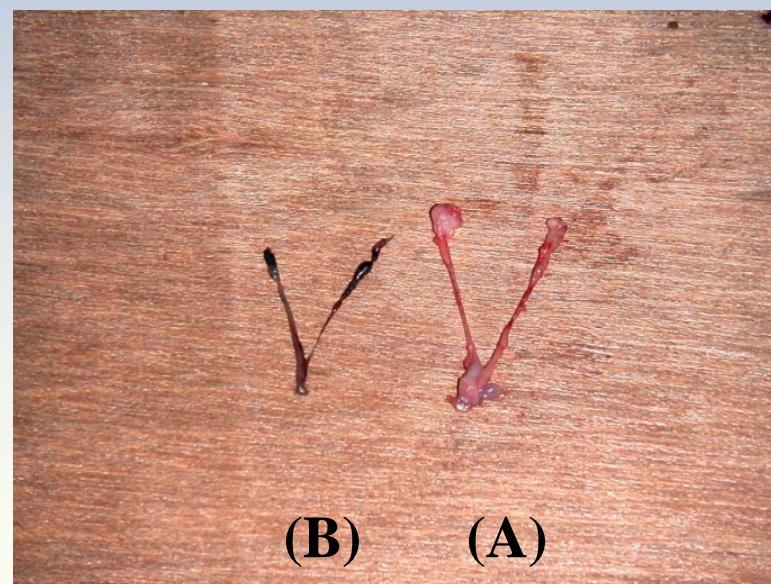


(B)



Ovary and uterus of infected (B) vs normal (A) mice

(B)



(A)

CONCLUSION

Food-borne helminths are taxonomically diverse, and a variety of intermediate hosts (the infection source) are involved.

PREVENTION

Consumption of improperly cooked food (the infection source) should be avoided.

**THANKS A
LOT !**