List of organisms for this lecture:

“**The Blood Flukes**”
A-E: Schistosomes (in the previous handout)

“**The Liver Flukes**”
F. *Clonorchis sinensis*—the Chinese liver fluke
G. *Opisthorcis viverrini*
H. *Opisthorchis felineus*
I. *Dicrocoelium dendriticum*
J. *Fasciola hepatica*—the sheep liver fluke
K. *Fasciola gigantica*—the giant liver fluke

“**The Intestinal Flukes**”
L. *Fasciolopsis buski*—the giant intestinal fluke
M. *Echinostoma ilocanum*

“**The Lung Fluke**”
N. *Paragonimus westermani*

“**The Heterophyids**”—Heterophyids are also Intestinal Flukes
O. *Heterophyes heterophyes*
P. *Metagonimus yokogawai*

**THE LIVER FLUKES**

Several trematodes are parasites of the human biliary passages. They are **elongate, narrow-bodied** worms that tend to localize in the **smaller, more DISTAL parts** of the **biliary tree**.

- Of all the liver flukes, **ONLY Fasciola** is confined to the **larger biliary passages** due to its size
- **ONLY** in heavy infections are these worms found in the **Common Bile Duct (CBD)** or within the **gallbladder**

The liver flukes produce **hyperplastic changes** in the **epithelium** of the **bile ducts** and **fibrosis** around them. Thus, massive infection by any of them can lead to **portal cirrhosis**.

Egg similarities based on appearance:
- **Opisthorchid** eggs—**Heterophyid** eggs
- **Fasciola** eggs—**Fasciolopsis** eggs—**Echinostoma** eggs
  - If these eggs are found in the **stool**, the diagnosis of **hepatic** or **intestinal** infection can **NOT** be made
    - Examination of the **bile** obtained by **duodenal drainage** will lead the clinician to proper diagnosis
If uncontaminated bile is obtained and eggs are found in this material, they must have been produced by worms in the liver or gallbladder.

**F. Clonorchis sinensis**
- Occurs in: China, Japan, Korea, and Vietnam
- Adult worms live in the **bile ducts** and but they localize **first** in the **more distal portions** just under the capsule of the liver
- In massive infections, they occupy most of the bile passages and may be even found in the **gallbladder** and **pancreatic duct**
- Life span: **30 years**
- Reservoir host: **Dogs** and **cats**

**Morphology**
- Moderate in size
  - **1-2.5cm** by **0.3-0.5 cm**
- It is **broadest** in the **midportion** of the body and it tapers at both ends
- Eggs:
  - Resemble the eggs of **Heterophyes** and **Metagonimus** but have a **small comma-shaped** (this is a comma: ,) **process** at the **abopercular end**
  - Average length: **29 microns**
  - Average breadth: **16 microns**
  - Daily egg output: **2,400 eggs/day**

**Life Cycle**
- 1—Embryonated eggs (diagnostic stage) are passed out in feces
  - Eggs appear in the human feces **1 month AFTER** the infection takes place and the acute symptoms subside
- 2—Eggs are ingested by an aquatic snail
  - Eggs within the aquatic snail develop to become **cercariae**
- 3—The cercariae makes its way from the snail to the water and parasitize freshwater fish by encysting in the skin of the fish
- 4—The now **metacercariae** (infective stage) lodged in the skin of the fish infects human when the person eats the fish raw
- 5—Parasite excysts in the duodenum
  - It also travels and matures in the **biliary duct**
- 6—Ulit sa #1

**Diagnosis**
- Recovery of eggs from:
  - Stool
  - Duodenal aspirates
  - EnteroTest
- The adults worms are seen only at **autopsy** or rarely, upon surgical removals
Pathogenesis

- **Thickening** and **localized dilation** of the **bile ducts** are seen in heavy infections accompanied by moderate to marked **hyperplasia** of the small **mucinous glands** of the **ductal mucosa**
  - The degree of severity of the thickening and the hyperplasia is **directly proportional to the intensity of the infection**
  - However, these adenomatous changes may persist for many years in patients whose infections have become light
  - **Adenocarcinoma** arising from the **hyperplastic bile ductal mucosa** is observed

Symptoms

- Light infections are asymptomatic
- Heavier infections, if acquired over an extended period (meaning: paulit-ulit siyang kumain ng fishda na infected kaya naging heavy na yung infection), seldom cause early symptoms
  - However, the ingestion of large numbers of metacercariae over a **short period of time** may produce symptoms:
    - **The acute phase (less than 1 month):**
      1. Fever
      2. Diarrhea
      3. Epigastric pain
      4. Anorexia
      5. Hepatomegaly + Hepatic tenderness
      6. Sometimes, Jaundice
    - There may be **leukocytosis; eosinophilia** is generally present
- Again, the eggs appear in the human feces after 1 month of infection
  - If the person is **NOT** reinfected, then the person does not present with any more recognizable symptoms
- **Heavy Worm Burdens**
  - Results from repeated infection over a period of years
  - May result in a degree of functional impairment of the liver and this impairment is **secondary** to the **localized biliary obstruction**
    - The liver dysfunction is **enhanced** by the following:
      1. Intrahepatic stone formation
      2. Cholangitis
      3. Formation of multiple liver abscesses
- **Cholecystitis** and **cholelithiasis** can occur as a result of the invasion of the gallbladder by these worms
- **Pancreatitis** can also occur if worms reach the **pancreatic duct** and affect the flow of pancreatic secretions
- **Cirrhosis** is rare
If it ever occurs, it is more attributable to **malnourishment** than to the parasitic infection

**Treatment**

- **Praziquantel**
  - 25mg/kg for 1 day
- **Albendazole**
  - 10mg/kg for 7 days

**G. Opisthorchis viverrini**

- Found in: Thailand, Laos (also occurs in Cambodia and Malaysia)
- Prevalence: 80-90% in rural areas, 55% in urban areas
- Acquired via consumption of **uncooked freshwater fish**
- Mild to moderate infections seem to produce few symptoms
  - Heavy infections:
    - Abdominal Distress
    - Epigastric pain
    - Generalized malaise
- Infection with *O. viverrini* is associated with **cholangiocarcinoma**
- Cholangiocarcinoma is also associated with infections by *Clonorchis*

**Morphology**

- Adult: Similar (only slightly different) with adults of other opisthorchids
- Eggs are:
  - Short and broad
  - Average length: **26.7 microns**
  - Average breadth: **15 microns**

**Life Cycle**

- Same with *Clonorchis sinensis* (see above)

**Treatment**

- **Praziquantel**
  - Single dose (most effective)
    - 40 mg/kg
  - Three doses
    - 75mg/kg, for 3 days, 1x a day

**H. Opisthorchis felineus**

- Parasitizes: Cats
- Found in: Central and Eastern Europe, Siberia, East Prussia, Poland, Philippines, Korea, Japan, North Vietnam, and India
- They enter the biliary tree by passing through the **ampulla of vater** and ascending the **CBD**
Inhabits the bile ducts and the clinical features of infection by this parasite resembles clonorchiasis

Morphology

- Adult:
  - Almost the same with *C. sinensis*
- Eggs:
  - Narrower than those of *C. sinensis*
    - 30 microns by 11-12 microns

Treatment

- Praziquantel
  - 25mg/kg, 3x daily for 1-2 days

1. *Dicrocoelium dendriticum*

- A common parasite of the biliary tree of herbivores
- Size and shape is similar to *Clonorchis*

Morphology

- Different from *Clonorchis* in that its testes are slightly lobed and situated in the anterior 1/3 of the body
  - In *Clonorchis*, the testes are highly branched and are situated in the posterior 1/3
- Eggs:
  - The eggs that are passed are dark brown in color
  - Have a thick shell
  - Have a large operculum
  - Length: 38-45 microns
  - Breadth: 22-30 microns

Life Cycle

- Present an unusual life cycle
- 1—Embryonated eggs (Diagnostic stage) are passed out in the feces of the infected animal
- 2—Eggs become ingested by a land snail
  - The eggs undergo development within the snail
- 3—Cercariae are liberated from the snails during rainy periods and become massed in “slime balls”
- 4—The slime balls are eaten by ants
  - Within the ant, the cercariae become metacercariae
    - Therefore, for the human to become infected, the person must eat an infected ant
5—The ants then become “zombified” and behavioral modifications happen to them so much so that they stay on top of the leaves and wait to be eaten by a herbivore.
6—Herbivores eat leafy vegetation with zombified ants on top of the leaf.
7—Ulit sa #1

Symptoms and Pathogenesis:
Humans can also occur via the consumption of infected raw liver.
After ingestion of infective metacercariae, they excyst in the duodenum and pass through the CBD to invade the biliary system.
Human infections are usually light and often asymptomatic.
- With heavy infection, there can be:
  - Enlargement of bile ducts
  - Hyperplasia of biliary epithelium
    - With:
      a. Periductal fibrosis
      b. And eventually, Portal Cirrhosis

Biliary and colic disturbances have also been reported.

Treatment:
Praziquantel
- 20 mg/kg, 3x/day, for 1 day

J. Fasciola hepatica
A common parasite of herbivores.
Human infections are seen usually in: South America (Bolivia, Peru, Argentina, Chile), Cuba, France, and Algeria.

Morphology:
Fasciola hepatica is a large fluke
- Length: 3 cm
- Width: 1.5 cm
Possesses a cephalic cone located at the anterior end.
Eggs:
- Found in the feces but can NOT readily be differentiated from those of Fasciolopsis and echinostomes.
- The eggs are operculated.
- Measurements:
  - Length: 130-150 microns
  - Breadth: 63-90 microns

Life Cycle:
1—Eggs passed in feces hatches after maturing in water to release miracidium.
2—Miracidium invades lymnaeid snail that is aquatic.
Within the snail, the miracidium undergoes development to become cercariae.

1. Cercariae leave the snail host.
2. Cercariae encyst on aquatic vegetation as metacercariae.
3. Aquatic plants with the metacercariae are ingested by humans making ulit #1.

**Diagnosis**

- EnterTest
- The adult worms may be visualized in the liver by means of ultrasonography.
- CT scans may demonstrate the burrow tracts made by worms migrating in the liver parenchyma, and the dilation of the bile ducts that they have caused.
- Endoscopic retrograde cholangiopancreatography can show the worms inside the pancreatic duct.

**Pathogenesis**

- In human infections, symptoms are occasionally seen that suggest that there may be local irritation during the migration of the young worms to the liver.
  - In sheep, migration of the worms causes intense tissue damage—“liver rot.”
- *Fasciola* metacercariae burrow into and through the duodenal wall, migrate actively across the peritoneal cavity, and enter the bile ducts by way of the Glisson’s capsule and liver parenchyma.
  - During the migration, some metacercariae are lost on the way and occasionally develop in the:
    - Peritoneal cavity
    - Other ectopic foci
- Once established in the bile ducts, the worms may produce both mechanical and toxic effects.
  - Such effects are unique to *Fasciola* and differ from opisthorchids or *Dicrocoelium* as *Fasciola* is larger and a more powerful worm.
  - The effects:
    - Mechanical irritation
    - Toxic metabolites of worm to the host tissue
    - Mechanical obstruction
      1. May bring about hyperplasia of biliary epithelium
      2. May cause proliferation of connective tissue around the ducts AKA PERIDUCTAL FIBROSIS
      3. Partial/Total Biliary Obstruction
- The adult worm may erode through the walls of the bile ducts to invade once again the liver parenchyma.
- Secondary bacterial infection may occur.
- Portal Cirrhosis is seen as the final outcome of severe infections.

**Symptoms**
Because of the size of the worms, even light infections may produce signs and symptoms of:

- Biliary obstruction
- Cholangitis

Appearance of the following can confuse the clinician UNLESS the eggs are found in the stool or through the biliary aspirate:

- Fever
- Chills
- RUQ Pain that radiates to the scapula
- Jaundice
- Hepatomegaly + Hepatic tenderness
- Eosinophilia

Halzoun—A pharyngeal form of the parasitic disease caused by the ingestion of raw liver infected by *Fasciola*

- In Halzoun, the young adult worms attach to the pharyngeal mucosa causing:
  - Pain
  - Bleeding
  - Edema
  - Interference with the respiratory process

Treatment

- Bithionol
  - Administered orally at the rate of 30-50mg/kg every other day for 10-15 doses is the recommended treatment for fascioliasis

- Praziquantel, Dehydroemetine, and Albendazole yield unsatisfactory results

Control

- Infection follows consumption of aquatic vegetation upon which metacercariae of *Fasciola* have become encysted.
  - Human cases have been traced to infected watercress (a plant), which should never be grown for human use in water to which herbivores have access

**K. Fasciola gigantica**

- Common name: Giant Liver Fluke
- A parasite of herbivores:
  - Camels
  - Cattles
  - Water buffalos

- Human cases: Usually in Hawaii but occur in other areas
- Life cycle is very similar to *Fasciola hepatica* and so is the clinical picture
Morphology
- May attain a length of 7.4cm
- It has a more attenuated shape than *F. hepatica* from which it is also differs in some details of structure
- Egg:
  - Measurements: **150-190 microns by 70-90 microns**

**THE INTESTINAL FLUKES**

*L. Fasciolaripsis buski*
- Common name: Giant Intestinal Fluke
- Found in: China, Taiwan, Vietnam, Thailand, Indonesia, Malaysia, and India
- Life span: 6 months or less
- Prevalence: 10 million infections/year
- Reservoir host: Rabbits, Pigs, and Dogs

**Morphology**
- Adults:
  - Seen only after purgation by use of an anti-helminthic treatment
  - Color: Fleshy
  - Length: 2-7.5cm (ayyy ang haba!!)
  - Width: 0.8-2cm (ayyy ang taba!!)
- Eggs:
  - Shape: Ellipsoid
  - Color: Yellow brown
  - Shell: Transparent
  - Size: **130-140 microns** by **80-85 microns**
  - With an operculum at the more pointed ends

**Life Cycle**
1—Eggs are passed out in feces, slowly matures in water to liberate *miracidia*
2—Miracidia invade *planorbis snail* (aquatic)
   - Within the snail, the miracidia undergo larval development and multiplication
3—The now *cercarialia* leave the snail host
4—The cercariae attach themselves and excyst onto an aquatic plant, the water chestnut and become *metacercariae*
5—Metacercariae become ingested by the host when the water chestnut is eaten raw or is peeled with teeth
6—Ulil #1

**Symptoms and Pathogenesis**
- Adult worms live attached to the duodenal/jejunal wall
  - In heavy infections, they may be found in the entire GIT
Attachment of these large worms to the intestinal mucosa causes:
  - Local inflammation
  - Ulceration
  - Sometimes, hemorrhage

In light infections, the patient is usually asymptomatic
  - However, in heavy infections, there may be:
    - Abdominal pain
      1. At times suggestive of duodenal ulcer disease
    - Diarrhea

In heavy infections, the stools are described to be:
  - Profuse
  - Light yellow in color
  - Contain much undigested food
    - Suggestive of a malabsorptive process which can be seen in giardiasis
  - VitB12 absorption is seen to be impaired
  - Intestinal obstruction can be seen to occur

The worm has toxins and these toxins can be absorbed in the gut causing:
  - Edema
    - The edema may also result from the fact that Fascioloopsis buski impairs absorption therefore producing hypoalbuminemia
      1. Low serum albumin = E D E M A (physiowww)
  - Ascites
    - There is also protein-wasting enteropathy + marked eosinophilia

Treatment
  - Drug of choice: Praziquantel (Biltricide)
    - An isoquino-linepyrazine derivative
    - Administration: Oral
      1. 25 mg/kg 3x for 1 day
    - Mechanism of Action (MOA):
      - Alters the cell membrane permeability to mono- and divalent cations, especially to Ca$^{2+}$ causing massive calcium influx thereby initiating a tetanic contractile process on the worms
      - Leads to disruption and vacuolization of the tegument of the worm with subsequent eosinophil attachment
      - The human host metabolizes the drug quickly and tolerates it well
      - Side effects are minimal and disappear within 48 hours:
        1. Epigastric pain
        2. Dizziness
        3. Drowsiness
      - Studies have failed to show praziquantel's teratogenicity, mutagenicity, and other toxicities
As per the US FDA approval though, the drug is recommended for:

- Clonorchiasis
- Opisthorchiasis
- Schistosomiasis

The Echinostomes

*M. Echinostoma ilocanum*

- Medium-sized intestinal flukes
- Found in: Japan, the Philippines, Malaysia, Sumatra, Java, Sulawesi, India, and in some other parts of Asia

Morphology

- Adult—can only be seen after treatment
  - Size:
    - Length: **Less than 1cm**
    - Width: 0.2 cm
  - Distinguished by a **collarette spines** on a disk surrounding the **oral sucker**
- Eggs:
  - The unembryonated eggs are similar in shape to the eggs of *Fasciolopsis buski* and vary in the size
    - However, some species of echinostomes are of the same size of the eggs of *Fasciolopsis* and therefore, an exact identification can NOT be made from examination of eggs

Life Cycle

- 1—Mature fluke attaches to small intestinal wall and eggs are passed out in the feces
- 2—Eggs that come in contact to water will hatch and liberate **miracidia**
- 3—Miracidia invade **planorbid snail** (aquatic)
  - Within the snail, the miracidia undergo larval development and multiplication
- 4—The now **cercariae** leave the planorbid snail host and **encyst** as **metacercariae** in **ANY freshwater snails** (2\textsuperscript{nd} intermediate host)
- 5—Humans acquire the infection by eating the 2\textsuperscript{nd} intermediate host snail raw
- 6—Uliti sa#1

Diagnosis

- History of eating raw snails
Symptoms and Pathogenesis

➤ Habitat: Small intestine, and in heavy infections, they can produce:
   - Inflammatory reaction
   - Ulceration
   - Diarrhea

➤ Light infections are usually asymptomatic

Treatment

➤ The drug of choice is Praziquantel
   - 25 mg/kg, 3x/day

➤ Tetrachloroethylene (TCE) can also be used at 0.1mL/kg
   - Take on an empty stomach after a light meal the preceding night
     - Max dose: 5mL ONLY
   - Fats and alcohol should be avoided 24 hours before and after TCE
   - Only water can be taken 3 hours after ingestion of medication

THE LUNG FLUKES

There are at least 8 species of lung flukes all belonging to the genus Paragonimus that are known to infect humans.

➤ Although there are 28 species of Paragonimus worldwide
   - The other 20 are primarily parasites of:
     - wild felines such as tigers, lions, leopards, and civet cats
     - canines such as dogs, foxes, and wolves
     - other mammals such as pigs, badgers, mongooses, opossums, raccoons, minks, and others the eat freshwater crabs/crayfish

➤ Humans are ACCIDENTAL HOSTS

➤ Found in: Japan, Korea, Manchuria, China, Taiwan, Southeast Asia, Papua New Guinea, Solomons, Samoa, India, Sri Lanki, Congo, Nigeria, and the Cameroon

➤ Parasitic species:
   - Paragonimus mexicanus—occurs in Mexico, South America, Ecuador, Peru
   - Paragonimus kellicotti—occurs in USA
   - Paragonimus westermani—most common Paragonimus species infecting humans

N. Paragonimus westermani

➤ Most common lung fluke that parasitize humans

➤ Causative agent for: Paragonimiasis

Morphology

➤ Adult:
   - Color: Reddish brown
   - Body: Thick (0.3-0.5cm thickness)
   - Length: 0.8-1.6 cm
Lecture 5: Trematodes 2
Parasitology: Liver, Intestinal, and Lung Flukes + Heterophyids

- Width: **0.4-0.8 cm**

- **Eggs:**
  - Color: **Dark Golden-Brown**
    - Can be found in the *sputum* or *feces*
  - Shape: **Ovoid**
  - Have **flattened operculum** that is distinctly set off from the rest of the shell as it is raised by the *opercular shoulders*
  - Measurement: **80-120 microns** by **48-60 microns**

**Life Cycle**

- **1**—Adult fluke encysts in the lungs after penetration as a *metacercaria* through wall of small intestine and diaphragm
  - The adults produce eggs that can be:
    - **Expectorated** in the *sputum*
    - Or if the sputum is swallowed, it can be seen in the *feces*
- **2**—The eggs are passed out in the *sputum* or *feces*
- **3**—Miracidium is released from the egg after several weeks of development in water
- **4**—The miracidia enter the *Semisulcospira* snails (aquatic)
  - Within the snail, the miracidia undergo larval development and multiplication
- **5**—As the miracidia leave the snail, they become *cercariae* and enter crabs/crayfishes
  - In the crabs or crayfishes, they encyst as *metacercariae*
- **6**—The crab/crayfish containing metacercariae are eaten raw by humans completing the life cycle back to #1

**Diagnosis**

- The Chest X-ray (CXR) may show a **patchy infiltrate** with **nodular cystic shadows** or **calcification**
  - The **calcification** is also a feature of lung infection by *Mycobacterium tuberculosis*
    - This can confuse the clinician when diagnosis is being made
- **Pleural effusion** may be seen
- **Cerebral calcifications** may also occur
- **Eosinophilia** is generally present

**Pathogenesis**

- Migration of larval *Paragonimus* through the intestinal wall and into the pleural cavity is generally established
Some young flukes can wander in the peritoneal cavity, grow there, and penetrate various organs.

- When these ectopic flukes reach sexual maturity in ectopic sites, they remain there.
- Thus, there are extrapulmonary sites:
  1. **CNS (Brain and Spinal Cord)**
     - Worms that reach the brain do so by way of the soft tissues of the neck and the cranial foramina (jugular foramen) giving rise to Cerebral Paragonimiasis—a form of neurocysticercosis.
     - Neurocysticercosis—Medical condition where there is worm in the brain (i.e., neocysticercosis).
  2. **Abdominal Cavity**
  3. **Subcutaneous Tissue**

Migration of the worms through the tissues produces:

- Local hemorrhage
- Transitory leukocytic infiltration
  - Both are without clinical symptoms
    - However, if the worms wander subcutaneously, obvious skin manifestations can occur.

> When the worms settle down, either in the lungs or in ectopic regions, more pronounced tissue reactions occur:

- In the lungs:
  - **Leukocytic infiltration** forms around the parasite and fibrous tissue surrounds the infiltrate to form a cyst wall.
    - Communication of the cyst with the respiratory tree may result from inclusion of a bronchiolar branch within the cyst or from the erosion of the cyst into the adjacent bronchioles.

- In the peritoneal cavity (or other extrapulmonary sites):
  - Worm cysts are still similar to pulmonary cysts.
  - **Peritonitis** and abdominal adhesions resulting from infection can occur.
    - Although there is usually little to no inflammation in these areas and suppurative and ulcerative lesions are NOT common.
      - Suppurative lesions—lesions that discharge pus.

- In the brain:
  - Lesions may occur in both white and gray matter and sometimes, they are connected by passageways.
    - **Gray matter lesions**
      - May cause:
        - Thickening of pia matter
        - Arachnoiditis
Although trematodes are most often found in the liver, intestinal, and lung tissues, they can also infect the brain. The eggs of these parasites can be carried into the circulation and evok

### Symptoms

- **Cysts**
  - If the worms die or escape, the cysts gradually shrink as their contents are absorbed.
  - This will leave a fibrotic tissue nodule and eggs which may calcify.

- **Granulomatous reaction** similar to that of schistosome eggs in tissues.
  - Such lesions have been observed in many organs including the peri- and myocardium.
    - But eggs in blood do not reach the CNS because of the blood-brain barrier.
      1. The blood-brain barrier (Histow, neurow)
  - Since the majority of worms migrate to the lungs, and since most infections are light, extrapulmonary paragonimiasis is rare.

- **Charcot-Leyden crystals**
  - If the worms die or escape, the cysts gradually shrink as their contents are absorbed.
  - This will leave a fibrotic tissue nodule and eggs which may calcify.

- **Granulomatous reaction** similar to that of schistosome eggs in tissues.
  - Such lesions have been observed in many organs including the peri- and myocardium.
    - But eggs in blood do not reach the CNS because of the blood-brain barrier.
      1. The blood-brain barrier (Histow, neurow)
    - Which is formed by the perivascular foot processes of the astrocytes.

- **Cysts**, in whatever location, contain:
  - Living or dead worms
  - Yellowish to Brownish, thick fluid that is sometimes hemorrhagic
  - Eggs
  - Charcot-Leyden crystals

- **Symptoms**
  - No recognizable symptoms attend the migration of the parasites.
  - As the parasites grow in the lungs, there is an inflammatory reaction that can produce a fever.
    - When the cysts in the lungs rupture, coughing develops, and there may be increased sputum production.
      1. The sputum:
        1. Blood tinged
        2. And may contain:
          - Dark brown eggs
          - Charcot-Leyden Crystals
      - Chronic coughing can lead to hemoptysis.

- There may be severe chest pain.
  - The severity and progression of symptoms depend on the number of parasites present and on whether or not the infection is treated successfully, but as time goes on there is:
    - Worsening dyspnea
    - Chronic bronchitis
      1. If untreated, there can be bronchiectasis and pleural effusion is sometimes seen:
        a. Bronchiectasis—chronic dilation of main stem bronchi or bronchioles.

- Increasing fibrosis of the lungs occur with longstanding infection as the cavitary lesions become worse.
Thus, pulmonary paragonimiasis mimics the clinical picture of pulmonary tuberculosis

The usual *Paragonimus* that wander extrapulmonarily is usually NOT *P. westermani*

The extrapulmonary migration is attributed to the fact that these *Paragonimus* species has not adapted to the human hosts

- That is why for *Paragonimus* infections, humans are only accidental hosts

If the *Paragonimus* enters the cranial cavity via the jugular foramen and invades the brain parenchyma, the symptoms are:

- Fever
- Headache
- Nausea
- Vomiting
- Visual disturbances
- Motor weakness

  1. All these symptoms will advance to:
     - Convulsive (Jacksonian) seizures
     - Meningeal symptoms
     - Altered sensorium
     - Motor dysfunction

*Cutaneous paragonimiasis* is usually attributed to *Paragonimus skrjabini* (o diba, ang hirap basahin pero sabi ng book it is synonymous with: *Paragonimus szechuanensis*)

- This parasite can also invade and severely damage the liver

**Treatment**

**Praziquantel**

- For *Pulmonary Paragonimiasis*: 25mg/kg, 3x daily, for 2 days
  - Smaller doses given in longer periods to achieve the cumulative dose have been found ineffective

- In *Cerebral Paragonimiasis*
  - Praziquantel is administered over an extended period

**Bithionol**

- Alternative treatment for *Pulmonary Paragonimiasis*
- Orally administered
- 15-25mg/kg, 2x/day, every other day, for 10-15 days
- Side effects:
  - Skin rashes
  - Urticaria
  - Abdominal cramping
  - Nausea
  - Vomiting
- Diarrhea
- Dizziness
- Headache
- Hepatic and Renal Involvement can be present but transient

Epidemiology
- In some areas, human paragonimiasis may be common enough that human-to-human transmission (via appropriate snail and crab intermediate hosts) occurs
- Many different species of crabs and crayfish may be infected in various parts of the world, and only very few of these crabs are part of the human diet
  - Thus, endemicity of the disease rests on:
    - Dietary habits
    - Methods of food preparation
    - Presence of appropriate snail hosts (*Semisulcospira* spp.)
    - Freshwater crustaceans
    - Reservoir hosts (other mammals that eat infected crab/crayfish)
    - Paratenic hosts and their associated with vulnerable hosts

THE HETEROPHYIDS
- Two minute flukes: *O. Heterophyes heterophyes* and *P. Metagonimus yokogawai*
- Occurs in: Japan, Korea, China, Taiwan, Philippines, and western India
  - *Heterophyes* has also been reported from Egypt and Israel
  - *Metagonimus* has also been reported from the Balkans, Spain, Israel, the former USSR, and Indonesia
- The life cycle is similar to that of *Opisthorchis*

Morphology
- Adults—only seen in the feces following an anthelminthic treatment
  - *Metagonimus* is larger than *Heterophyes*
    - However, it does NOT exceed 2.5mm in length by 0.75mm in width
  - *Heterophyes* has a 3rd sucker that surrounds the genital pore
    - This structure is NOT present in *Metagonimus*
- Eggs:
  - Contain miracidia (of course)
  - Possess prominent opercular shoulders
  - Color: Brownish Yellow
  - Eggs of *Heterophyes* are slightly larger than those of *Metagonimus*
  - Size range for eggs of both species: 26.5-30 microns by 15-17 microns
  - Eggs of both species closely resemble (in terms of size and shape) those of *Opisthorchis* and *Clonorchis*
*In modern day taxonomy, *Clonorchis* is a synonym of *Opisthorchis*. However, *Clonorchis* is very much entrenched in the medical literature, and we refer to the Chinese liver fluke as *Clonorchis sinensis*.

**Life Cycle**
1. Embryonated eggs (diagnostic stage) each with a miracidium are passed out in feces.
2. Snail hosts ingest the eggs, miracidia emerge from the eggs, and penetrate the snail’s intestine.
   - Within the snail, the miracidia develops to become cercariae.
3. Cercariae leave the snail host.
4. Cercariae penetrate the skin of freshwater/brackish water fish and encyst as a metacercariae in the fish tissue.
5. Host becomes infected by ingesting undercooked/raw fish containing metacercariae.
   - Fish-eating mammals can be infected as well making these mammals reservoir host.
6. Ulit sa #1

**Symptoms and Pathogenesis**
- The parasites live attached to the small intestinal wall.
  - Light infections are, as a rule, asymptomatic.
  - If present in heavy infections, they can cause:
    - Chronic intermittent diarrhea
    - Nausea
    - Vague abdominal complaints
- Occasionally, the worms invade the mucosa and their eggs deposited in the tissues may gain access to the circulation to cause embolus to the:
  - Brain
  - Spinal Cord
  - Heart
    - Embolus—an abnormal particle circulating in the blood.
The eggs that have embolized the CNS and the heart can cause the following as granulomas can form around these eggs:

- Seizures
- Neurologic deficits
- Cardiac insufficiency

Treatment:
- Praziquantel
- Tetrachloroethylene

-end-

References

1. Markell and Voge’s Medical Parasitology (9th edition)
2. Lecture notes by RAsturiano from the lecturer

Downloadable for free at: www.theelusivedoktora.wordpress.com

For any corrections you may find, content or otherwise, email me at: ram.ustmedicine@gmail.com

-THE THANKS-

AsturiaNOTES
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