Dictyocaulus

Respiratory Trichostrongyles

Dictyocaulus spp.

Take Homes

Dictyocaulus spp.

- Pasture-borne (ingest L3s while grazing), Lungworm of livestock
- Lives in the bronchi, causes inflammation with exudate.
- Bronchi are blocked by worms, inflammation, exudate.
- General CS: Couching, dyspnea
- Larvae (L1s) are coughed up and passed in the feces, use Baermann technique to find active nematode larvae.
- Failure of antibiotics → lungworms

Dictyocaulus viviparus

- Lungworm of Cattle (sporadic in US, more common in Europe)
- DZ & CS worse in cattle (especially calves) than the lungworms of sheep & goats and horses
- Blocks airways, causes verminous pneumonia and partial lung collapse, may lead to bacterial pneumonia
- Coughing, dyspnea, tachypnea, air hunger (bronchial sounds & crepitations), multiple calves in herd are coughing
- CS 1-week after turnout; continually worsens to week 5 when non-sterile immunity catches up, kills worms and CS improve.
- Non-Sterile immunity => requires continual exposure. ??Treat older asymptomatic cattle or not?? (Europe has vaccine)
- Clues: CS, calves' first grazing season, an issue every year (i.e. endemic on farm), new stock introduced

Dictyocaulus arnfieldi

- Lungworm of horses & donkeys
- Donkeys: non-pathogenic but patent; Horses: pathogenic (cough, tachypnea, unthrifty) but non-patent => hard to diagnose (bronchial lavage)
- In Endemic areas, don't co-graze horses & donkeys

Dictyocaulus filaria

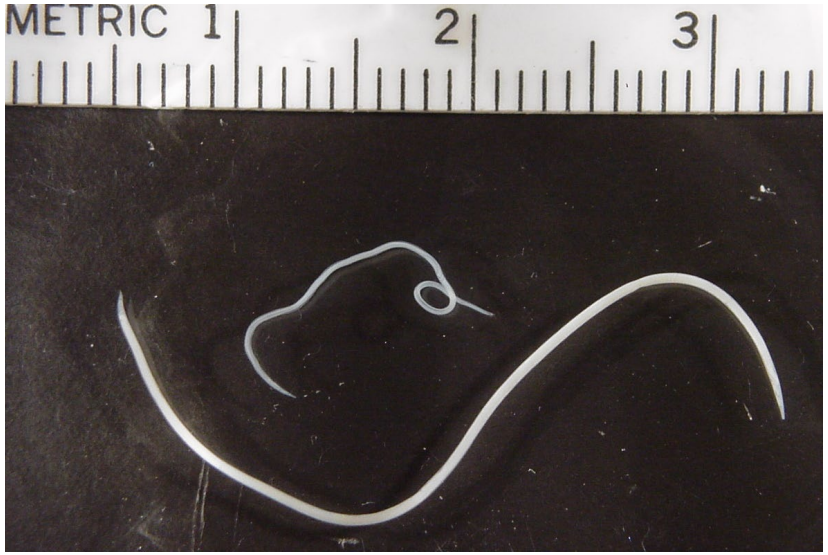
- Lungworm of sheep, goats, camelids
- Asymptomatic unless very heavy infection

Dictyocaulus spp.

Lungworms of livestock

General

- High Host Specificity
  - *Dictyocaulus viviparus* – cattle
  - *Dictyocaulus filaria* – sheep, goats & camelids
  - *Dictyocaulus arnfieldi* – donkeys & horses
- Verminous Bronchitis
- Range
  - Areas of high rainfall
  - Widespread in Europe
  - **Very Sporadic in USA**
    - Check with Extension agent.
    - 1st diagnostic questions
      - **Is it an endemic area?**
      - **Have new animals been introduced?**

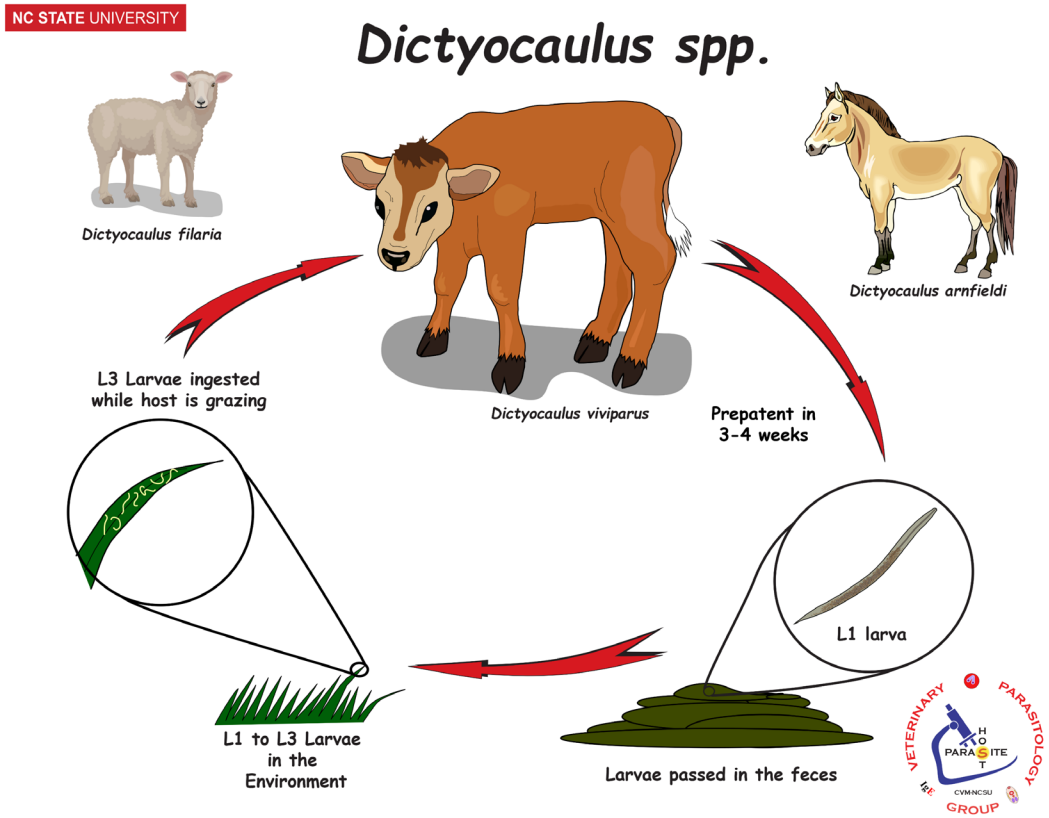


Dictyocaulus spp.

Lungworms of livestock

Life Cycle

- Typical Pasture-borne Nematode Life Cycle
  - Ingestion of L3 on-pasture while grazing
- PPP: 4 weeks
- LC specifics
  - Adult worms in Bronchi
  - Eggs, coughed up, swallowed; then hatch in GI
  - L1 in feces – diagnostic stage
  - On pasture: L1 → L3 from 5 days to 3 weeks
  - Infective L3 on pasture
    - Very susceptible to desiccation
      - ➔ Control: quick to die-off, so rest pastures & avoid wet, low-lying areas
    - Over-winter well
      - ➔ Transmission: source of early spring infections
  - Ingested L3 to Lungs – 5 days
    - ➔ Diagnosis: CS (coughing) 1 week after letting out on contaminated pastures
    - ➔ Diagnosis: however, PPP is 4 weeks, so CS w/o diagnostic stage in feces.

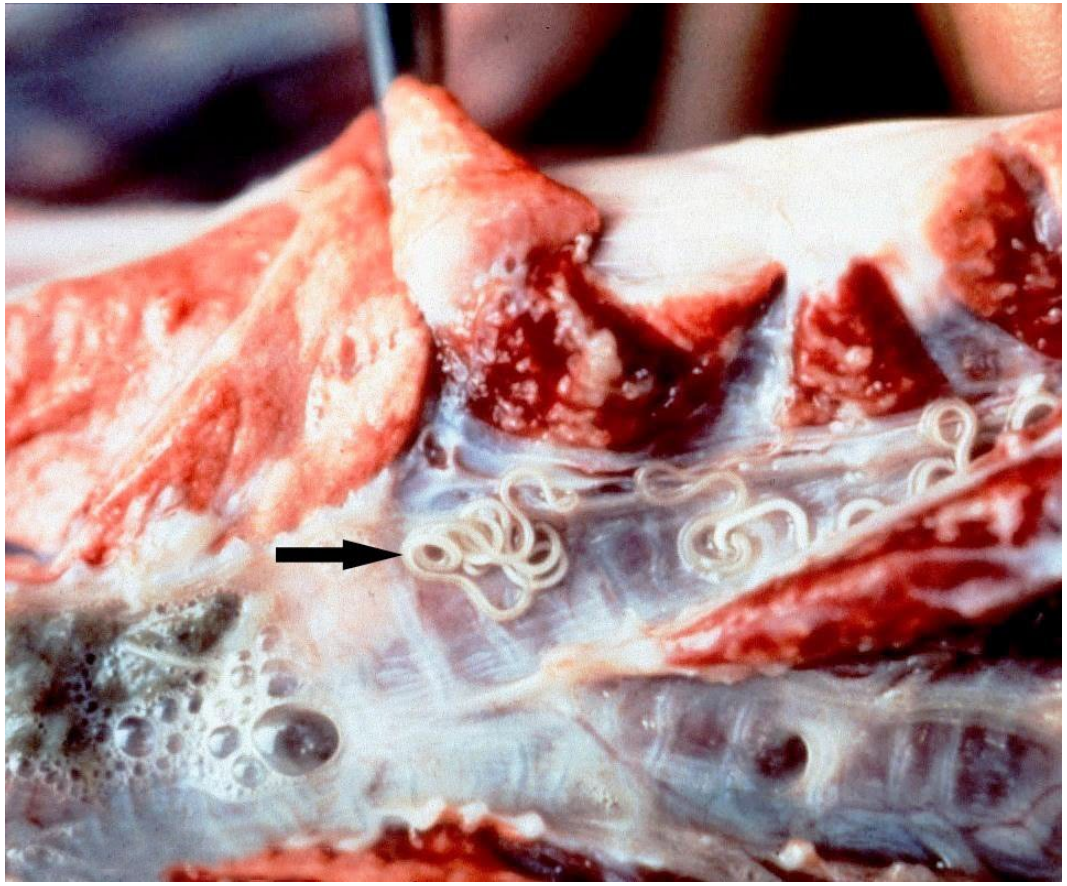


Dictyocaulus spp.

Lungworms of livestock

Pathology

- Inflammatory DZ of Lower Respiratory Tract
- Pathology proportional to infection Load
  - ⇑ # of Worms ⇒ ⇑ Pathology
- Bronchial Inflammation + Exudate + Worms ⇒ Blocked airways
- Aspiration of eggs, larvae & exudate into alveoli ⇒ verminous pneumonia + segments of collapsed lung.
- May promote 2° bacterial infection ⇒ bacterial pneumonia
- Subclinical older animals are sources of pasture contamination



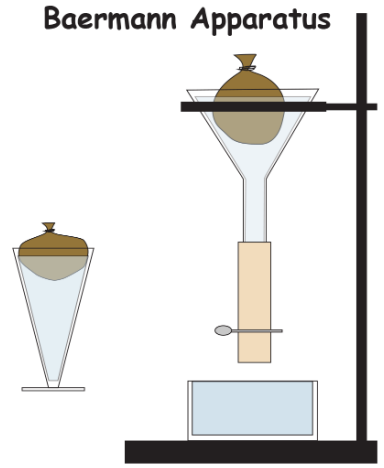
CALF

Dictyocaulus spp.

Lungworms of livestock

Diagnosis

- Clinical Signs
  - Coughing, tachypnea, dyspnea
  - Multiple coughing animals
- Pasture History
  - Calves' first grazing season
  - Coughing starts 1 week after turn-out
- DZ History (Endemic on the farm?)
  - Outbreaks in previous years or new stock
- Diagnostics
  - Failure of antibiotic therapy
  - Baermann or fecal float
    - Larvae with dark food granules
    - 4 weeks PI and 3 weeks post-CS
  - Necropsy
    - Collapsed caudal lobes
    - Worms & frothy mucus in Bronchi
    - Inflamed bronchi with eosinophilic exudate.



Treatment

- Most anthelminthics are effective
  - Long-acting macrocyclic lactones preferred
    - Ivermectin, moxidectin, doramectin, eprinomectin
  - But removes natural challenge for continuous immunity
  - ➔ Control: Vet must balance deworming asymptomatic older stock v/s natural exposure immunity.

Dictyocaulus viviparus

Lungworm of Cattle

Details are FYI

Clinical DZ of Heavy infection

- 1st week after put-out on pasture
  - Coughing begins
- 2nd week
  - Tachypnea + occasional cough
- 3rd Week
  - Coughing, forced respirations, tachypnea @ 100 resps/min
  - Harsh bronchial sounds and occasional crepitation
  - Dyspnea
- 4th week
  - Frequent coughing, tachypnea > 100 resps/min
  - Lung sounds prominent
    - Harsh bronchial sounds + obvious crepitation
  - Air-hunger is acute
    - Extended neck, mouth breathing, not eating
- 5th Week
  - Survivors begin to recover due to Immune RXN
- 2-3 months PI
  - Adult worms expelled
    - But dead worm material may cause inflammatory RXN in alveoli => pneumonia may be persistent.
  - Eventual Resolution of Clinical Signs

Take Home:
Clinical Signs begin 1 week after turnout and worsen until week 5, when non-sterile acquired immunity begins to eliminate worms and clinical signs improve.

Immunity

- Host Immune RXN ➔ Acquired Non-Sterile Immunity
  - Expels Adult worms & minimizes future incoming L3's and disease
  - But requires continued exposure in endemic areas
    - ➔ Control: Natural immunity v/s deworming
  - Attenuated L3 Vaccine has been developed
    - Used in Europe, not in USA due to limited demand

Details are FYI

Dictyocaulus spp.
Other Lungworms of Livestock

Dictyocaulus arnfieldi – donkey & horses

- Hosts:
  - Donkeys
    - usually asymptomatic carriers, w/ patent infections
    - Little Immune RXN ⇒ ⇓ Pathology, but worms patent
  - Horses (older)
    - can be symptomatic, with severe coughing, tachypnea, unthriftiness
    - ⇑ Immune RXN ⇒ ⇑ Pathology, but ⇓ worm patency
    - usually non-patent
      - ➔ Diagnosis: difficult to diagnose in horses
      - ➔ Diagnostics: Bronchial lavage may be helpful
    - ➔ Control: In endemic areas, don't co-graze horses w/ donkeys
      - Check with local extension agents

Dictyocaulus filaria – sheep, goats, camelids

- PPP: 4 weeks
- Pathology
  - Most cases are asymptomatic
  - Heavy infections symptomatic
    - Verminous bronchitis and pneumonia
    - Unthriftiness, coughing, dyspnea

Dictyocaulus spp.

Parasite (Host)	Transmission	Pathology	Clinical Signs	Diagnostics	Treatment & Control	Notes
Dictyocaulus viviparus (cattle) bronchi	Pasture-borne	verminous bronchitis (worms, exudate, inflammation block airways)	Coughing, tachypnea, dyspnea, air-hunger.	CS, Baermann for L1s, necropsy Multiple calves, failure of antibiotics, endemic on farm, recurs each year	Deworm @ 1st sign ---------- Keep off wet pastures, Quarantine new animals	Progression of CS: cough 1st week on pasture, progressively worse until week 5, then improvement Non-sterile immunity To deworm or not to deworm asymptomatic adult cattle? Vaccine in Europe, not USA
Dictyocaulus arnfieldi (donkey, horse) bronchi	Pasture-borne	Horse: verminous bronchitis (worms, exudate, inflammation block airways) Donkey: non-pathogenic	Horse: Coughing, dyspnea, unthrifty Donkey: usually asymptomatic	Horse: Difficult to diagnose. Bronchial Lavage? Donkey: Baermann for L1s Recurs each year	Deworm @ 1st sign ---------- Keep off wet pastures, Don't co-graze donkeys & horses (if endemic on farm)	----------
Dictyocaulus filaria (sheep, goat, camelids) bronchi	Pasture-borne	Usually Non-Pathogenic	Usually asymptomatic	Baermann for L1s	Deworm based on Baermann ---------- Keep off wet pastures	----------

Syngamus tracheae

Tracheal worm of Poultry

Syngamus trachea

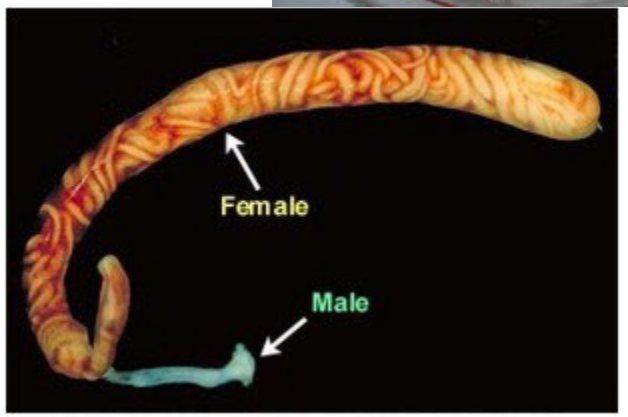
Take Homes

Syngamus trachea

- Gapeworm of Poultry
- Ingest infective eggs, infective larvae, or paratenic hosts (earthworms)
- Lives in the trachea, causes inflammation with exudate.
- Trachea is blocked by worms, inflammation, exudate. (patrial or full blockage)
- CS: Respiratory distress, Coughing, Gape (mouth breathing), head shaking.
- CSs, eggs in feces
- Move chicken yard

Syngamus tracheae
General

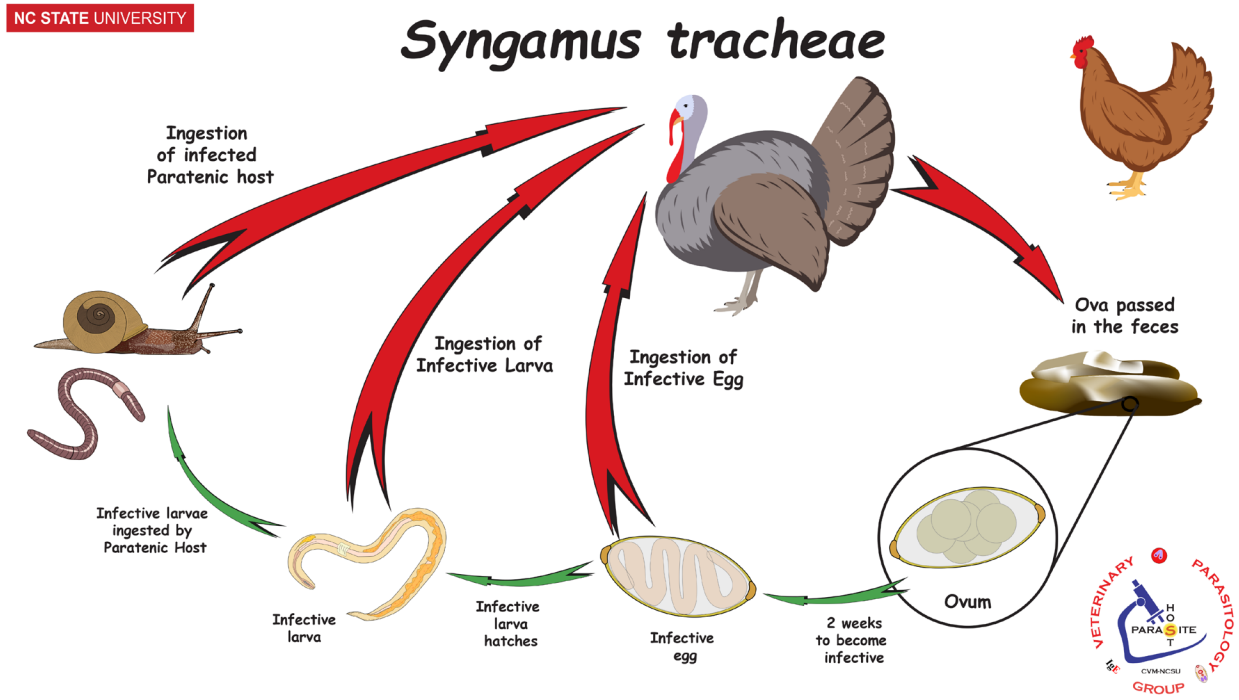
- Gapeworm of Birds (Chickens, Turkeys, Pheasants, Guinea Fowl)
- Parasites of the trachea
- Male & Female worms in permanent copula.



Syngamus tracheae
Life Cycle

Life Cycle

- Direct:
  - Ingest hatched or unhatched Infective L3
- Paratenic hosts:
  - Earthworms, Snails, slugs
- PPP: 17-20 days
- LC specifics
  - Ingested L3 (direct or in paratenic host) migrate from GI lumen into blood stream to lungs and up to trachea.
  - Double operculated eggs coughed up, swallowed & passed in feces



Syngamus tracheae

Pathology

- Partial or complete trachea obstruction
- Respiratory distress

Clinical signs

- Coughing, mouth-breathing (gape), convulsive head shaking

Hen with Gapeworm: https://www.youtube.com/watch?v=HO6R5o2PwOY

Treatment

- Extended (7 days) in-feed dewormers.

Diagnostics

- Clinical Signs
- Eggs in feces
- Necropsy
  - Adult worms in trachea

Control

- Avoid Infective L3's
- Rotate range area
- Avoid / eliminate paratenic hosts (unlikely)

Metastrongylus spp.

Lung Nematode of Swine

Metastrongylus spp.

Take Homes

Metastrongylus spp.

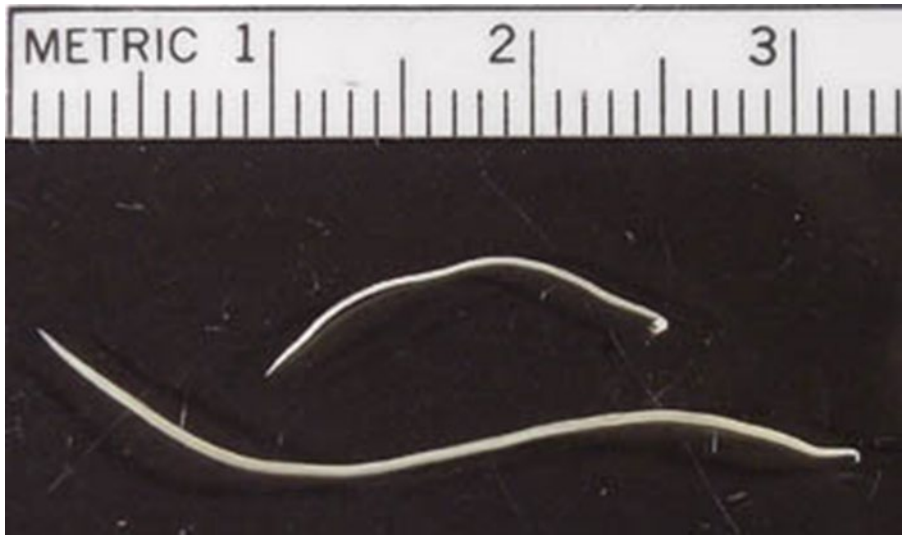
- Lungworm of Swine (pastured swine)
- Requires Earthworm Intermediate Host
- In Bronchi: Blocks airways, causes verminous pneumonia and partial lung collapse, may lead to bacterial pneumonia
- Coughing (especially when exercised or stressed), dyspnea, "thumps".
- CS, eggs in feces, worms in bronchi during necropsy

Metastrongylus spp.

Lungworms of Swine

General

- Lungworms of Swine
  - In primary & secondary bronchi
- 3 species
  - *Metastrongylus elongatus (syn. M. apri)*
  - *Metastrongylus pudendotectus*
  - *Metastrongylus salmi*
- Parasite of Pastured Swine
- Requires Earthworm Intermediate Host

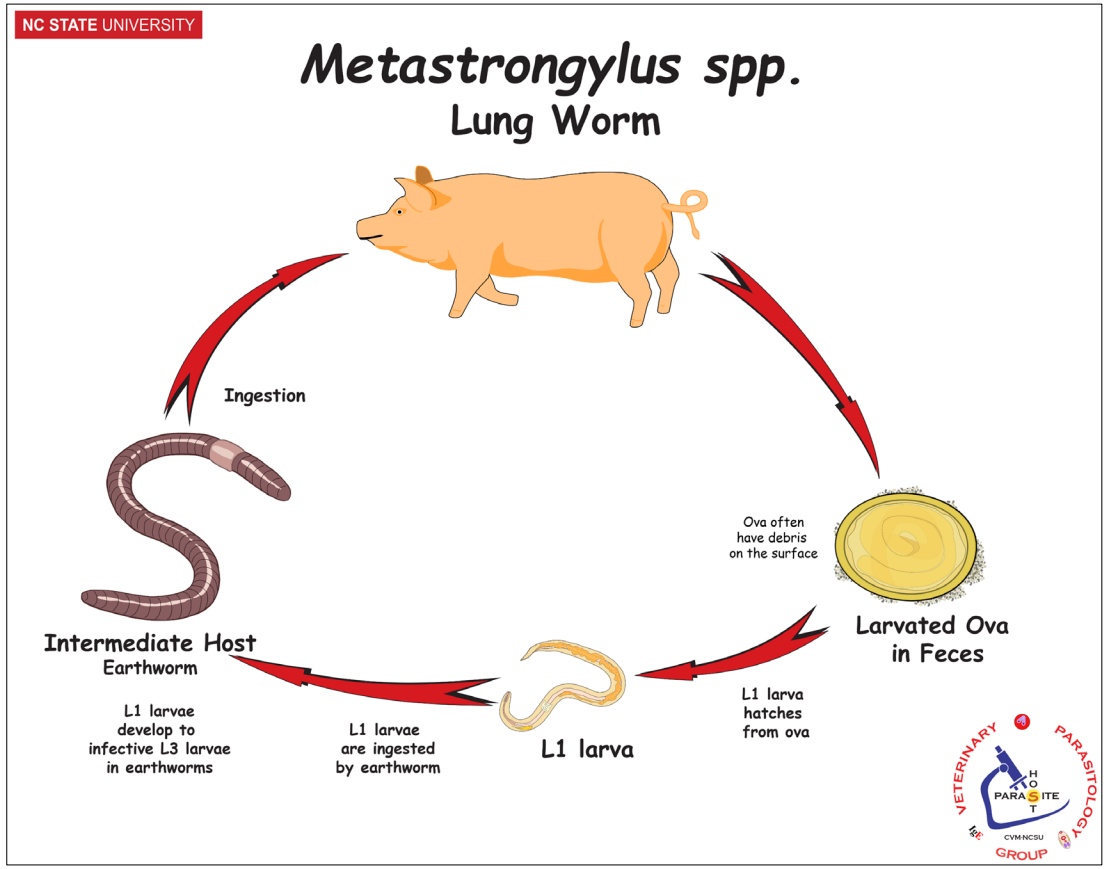


https://vetmed.iastate.edu/vdpam/FSVD/swine/index-diseases
https://vetmed.iastate.edu/vdpam/FSVD/swine/index-diseases/metastrongylosis

Metastrongylus spp.
Life Cycle

Life Cycle

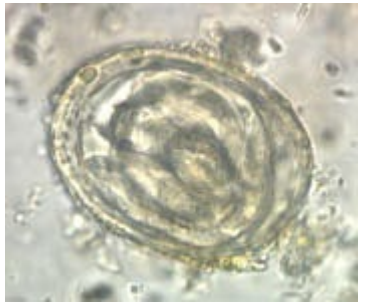
- Indirect LC w/ required Intermediate hosts:
  - Earthworms
- LC specifics
  - L1s hatch from eggs; are ingested by earthworms; and develop to infective L3s in the earthworm.
  - Ingestion of L3 infected earthworms (intermediate hosts) → migrate from GI lumen into lymphatics and blood stream to lungs and up to bronchi.
  - Larvated thick-shelled eggs coughed up, swallowed & passed in feces
  - PPP = about 25 days



Metastrongylus spp.
Pathology, Diagnosis

Pathology
- Worms and inflammatory exudate may obstruct airways
  - Alveolitis / bronchiolitis
  - Alveolar emphysema and atelectasis
  - May lead to secondary bronchopneumonia
- Unthriftiness and poor weight gain

Clinical signs
- Heavy infections
  - Coughing when exercised or stressed
  - Dyspnea
  - Abdominal breathing = "Thumps"



Diagnostics
- Clinical Signs
- Larvated thick-shelled eggs in fresh feces
- Necropsy
  - Adult worms in bronchi

Deworming
- Various dewormers are effective.

Avoid Infective L3's
- Move to confinement production
- Or rotate pasture area
- Avoid / eliminate paratenic hosts (unlikely)

Respiratory Nematodes of Poultry & Swine

Parasite (Host)	Transmission	Pathology	Clinical Signs	Diagnostics	Treatment & Control
Syngamus trachea [Gapeworm] (poultry – turkey, chicken, pheasant) Trachea	Ingest infective L3 (unhatched or hatched) Or Paratenic snail/slug/earthworm	worms, exudate, inflammation block trachea	Coughing, dyspnea, shaking head frequently, open mouth breathing (gaping)	CS, Fecal float for eggs, worms on necropsy	Extended in-feed dewormers ---------- Avoid infected poultry runs or/and rotate runs
Metastrongylus spp. (pigs) Bronchi	Ingestion of required earthworm intermediate host infected with L3s	worms, exudate, inflammation block bronchi	Coughing, dyspnea, "thumps", unthrifty, poor weight gain	CS, Fecal float for eggs, worms on necropsy	Various dewormers, In-feed dewormers

Aelurostrongylus abstrusus

Lungworm of Cats

Respiratory Nematodes of Pets

Take Homes

Aelurostrongylus

- Lungworm of Cats (sporadic in US)
- Requires Snail/ Slug Intermediate Host, may include bird/rodent Paratenic Host
- Ingest infective larvae in IH or PH
- "Nests" of worms, eggs and larvae nodules in the lung parenchyma.
- Disseminated nodules in the lungs cause granulomatous pneumonia
- Coughing, Dyspnea, abdominal breathing
- Motile larvae (L1s) in coughed-up sputum or feces – Baermann technique
- Deworm, supportive respiratory care, avoid IH & PH

Eucoleus (Capillaria) spp.

General

- Respiratory worms of dogs & cats
- Wildlife Reservoirs; more severe in fox
- Asymptomatic to mild pathology in pets
- Life cycle is speculative: maybe direct ingestion of infective eggs or earthworms as IH or PH
- Eggs in feces, must distinguish b/w *Capillaria* & *Trichuris* eggs. Use CS as clue.

E. (C.) aerophilus

- In the Bronchi of cats and dogs, cough

E. (C.) boehmi

- In the nasal sinuses of dogs, sneeze, rub nose
- Distinguish b/w rhinitis caused by allergies
- Often diagnosed thru endoscopy

Aelurostrongylus abstrusus

Lungworm of Cats

General

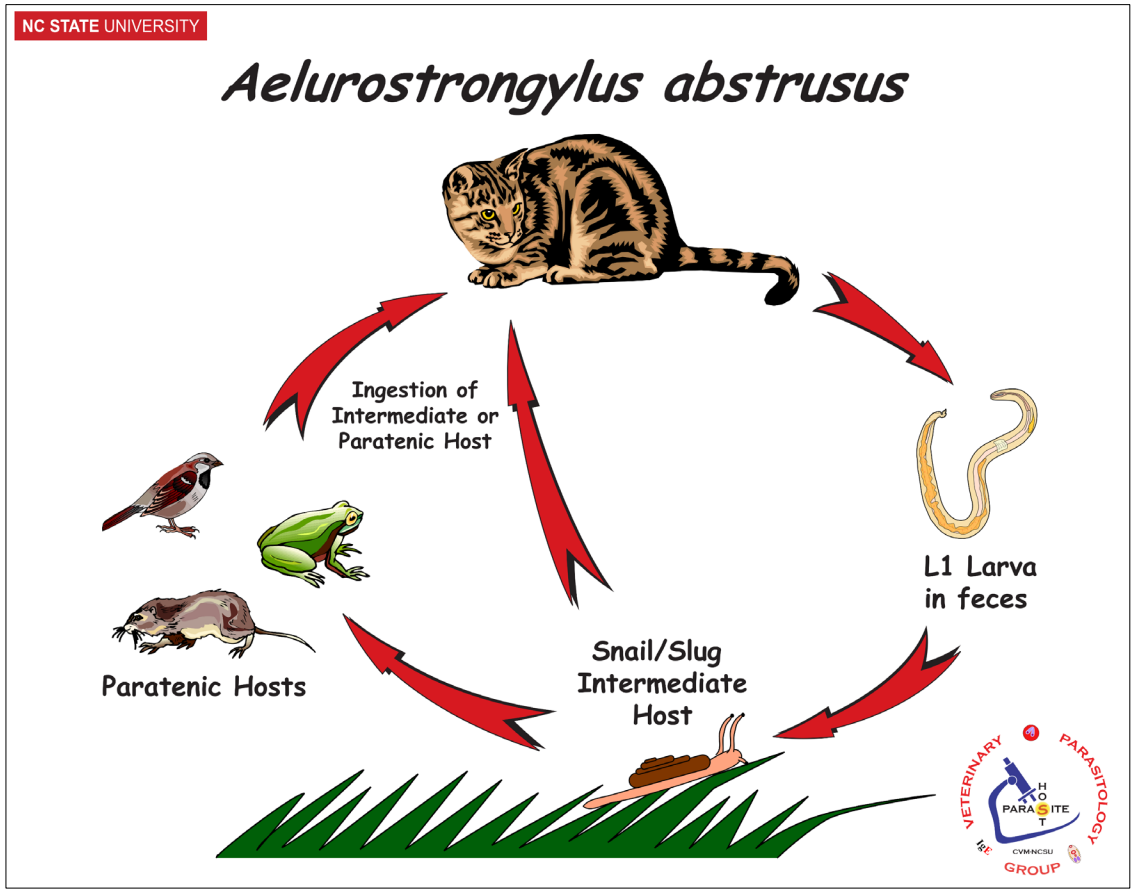
- Lungworm of Cats (Lung Nematode of Cats)
  - Small (up to 1 cm)
  - Adults in lung parenchyma, eggs in subpleural nodules ("nests")
- Requires Slug / Snail Intermediate Host, but likely infection via paratenic host (rodent or bird)
- Sporadic in US, but mostly Northeast, Great Lakes, and West Coast
  - Sporadic cases in North Carolina

Aelurostrongylus abstrusus

Life Cycle

Life Cycle

- Indirect w/ required Intermediate hosts:
  - Intermediate Hosts: slugs & snails
  - Paratenic Hosts: rodents & birds
- PPP: 5-6 weeks
- LC specifics
  - L1 larvae in lung "nests" are coughed-up, swallowed & passed in the feces.
  - L1's are ingested by snails & slugs (intermediate hosts) & develop to infective L3's
  - Snails & slugs are in-turn ingested by birds & rodents (paratenic hosts).
  - Once cats ingest an infected paratenic host (bird / rodent) the L3's migrate from GI lumen into lymphatics and blood stream to lungs and into the lung parenchyma.

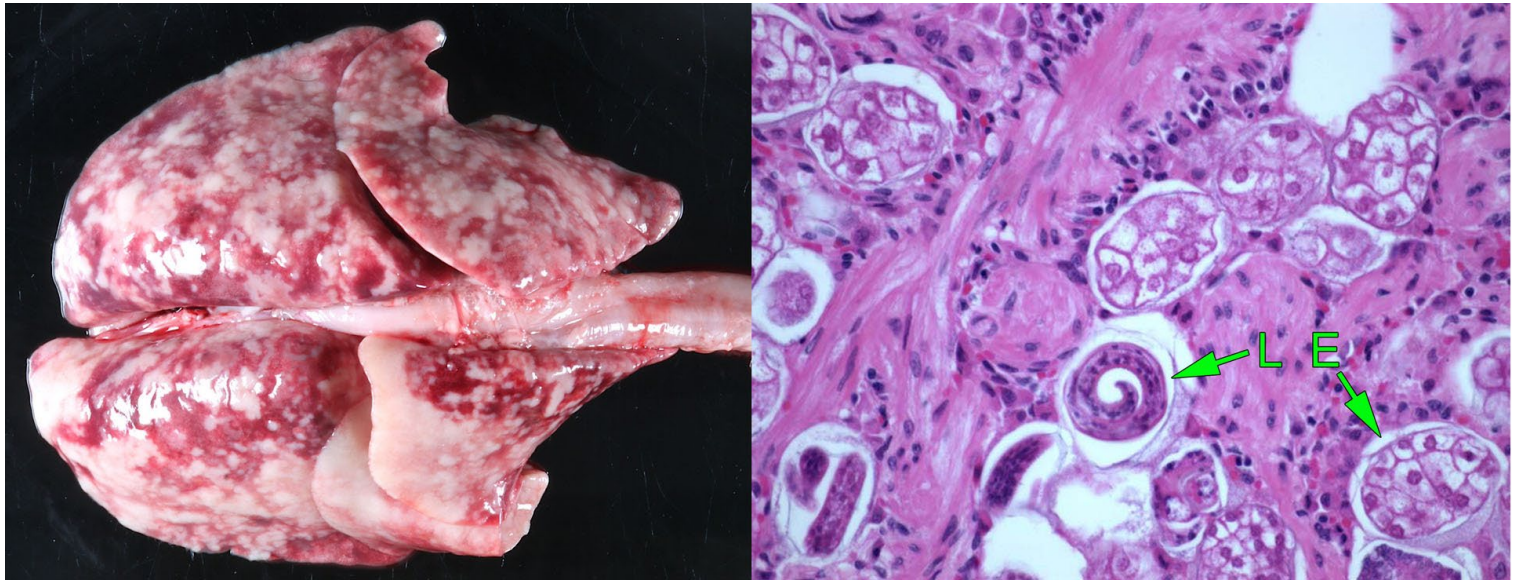


Aelurostrongylus abstrusus

Pathology

Pathology

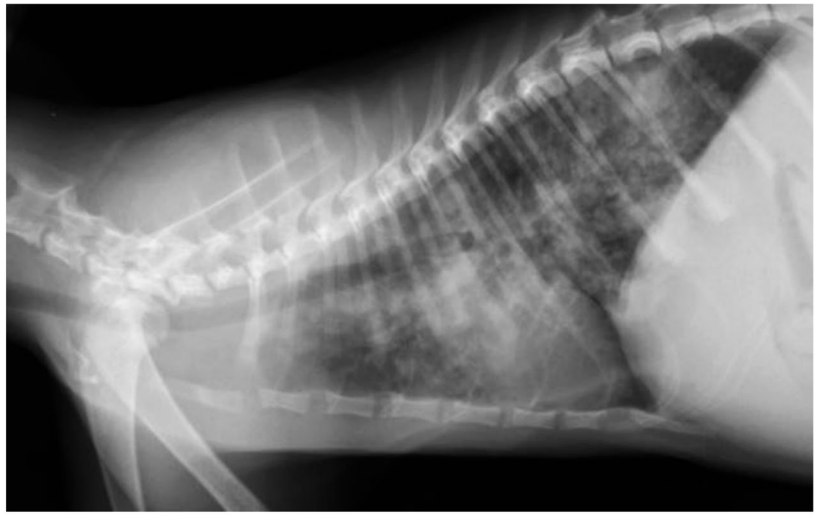
- Worms and egg nests produces **nodular areas of granulomatous pneumonia**
- Heavy infections with nodules disseminated throughout the lungs can be fatal. Especially if exasperated by anesthesia



https://ecampusontario.pressbooks.pub/pathologyoftherespiratorysystem/chapter/respiratory-diseases-of-cats/

Aelurostrongylus abstrusus

Treatment & Control



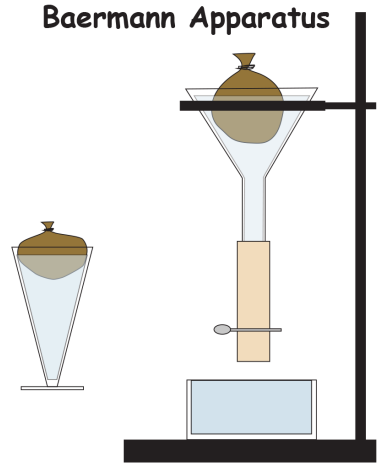
https://www.mdpi.com/2076-0817/12/2/273

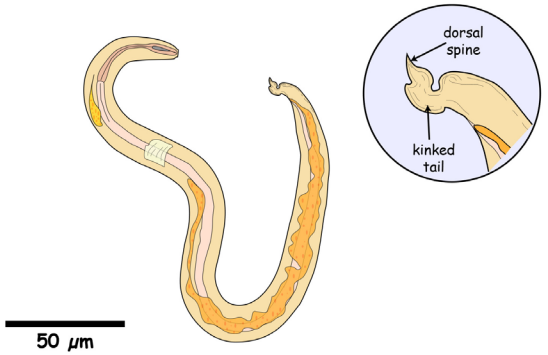
Clinical signs

- Coughing, Dyspnea
- Abdominal breathing

Diagnostics

- Clinical Signs
- Thoracic Radiographs
  - Parenchymal densities
- Failure of antimicrobial treatment, which is usually the 1st suspect.
- Outdoor cat more likely
- Fecal analysis
  - Use Baermann
    - For motile nematode larvae
  - L1 larvae in feces
    - Larvae with distinct tail spine





Aelurostrongylus abstrusus

Treatment & Control

Treatment

- Various dewormers are effective.
  - Topical formulations containing moxidectin, selamectin, or emodepside and oral fenbendazole have been used successfully
- May need supportive care to manage respiratory distress.

Control

- Avoid intermediate hosts
- Avoid paratenic hosts

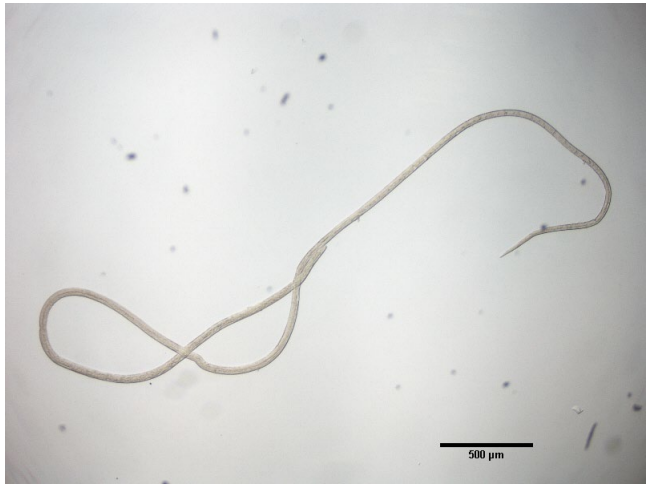
Capillarids

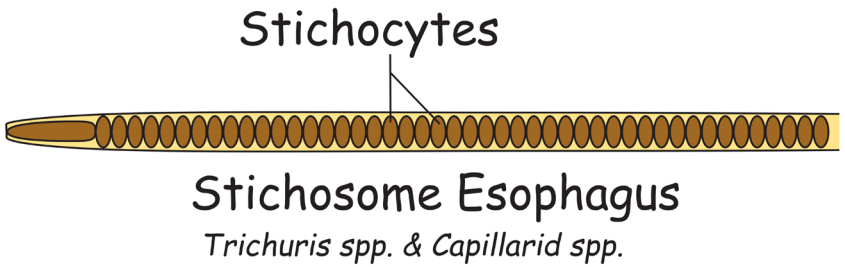
Of the Respiratory System

Capillarids

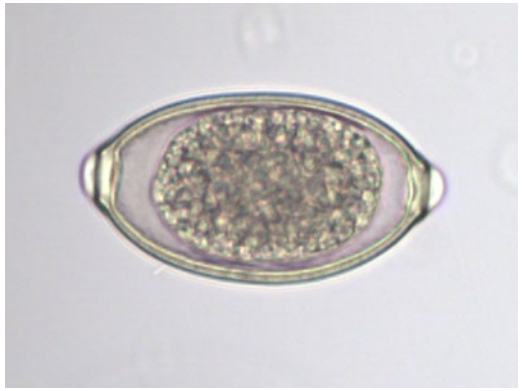
General

- Closely related to the whipworms (*Trichuris spp.*)
- A multitude of species that are site specific and somewhat host specific.
  - Ruminants & Birds with GI Capillarids
  - Dogs & Cats with Respiratory and Urinary Capillarids
- All have a stichosome esophagus and are hair-like.
- Females produce bipolar eggs that must be differentiated from *Trichuris* eggs.



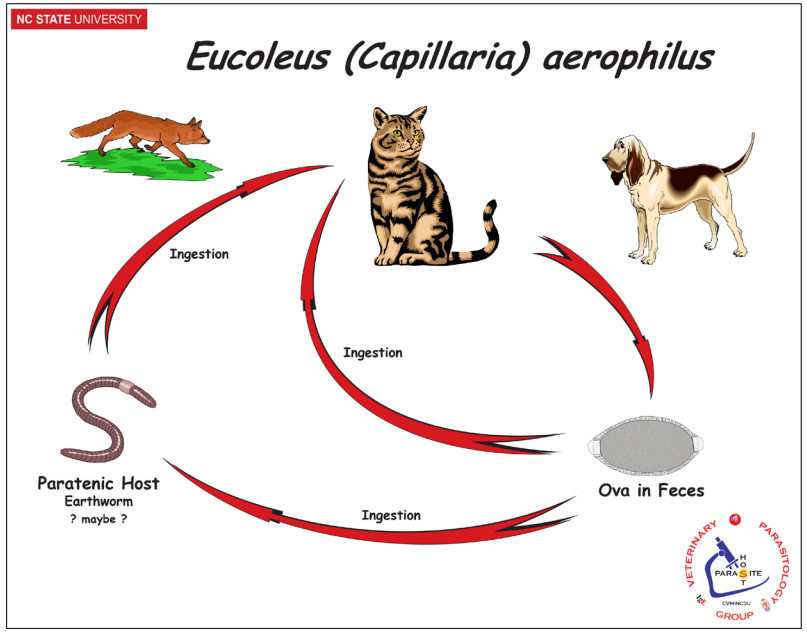


Trichuris spp. & Capillarid spp.



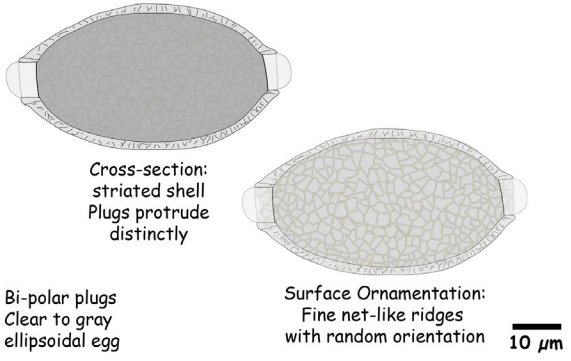
Eucoleus (Capillaria) aerophilus

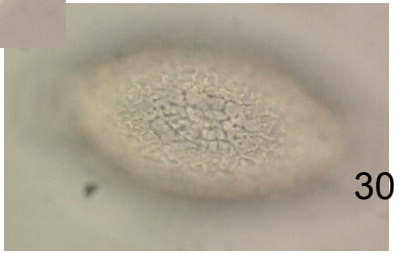
Bronchial capillarid



General

- LC incompletely studied
  - Direct or earthworm intermediate host
  - Wildlife reservoir hosts
  - Dogs & Cats definitive hosts
    - Rare cases in NC
- Pathology
  - Severe bronchitis in Fox
  - Asymptomatic to mild cough in dogs & cats
- Diagnosis
  - Clinical Signs: Cough
  - Fecal float centrifugation
    - Capillarids v/s *Trichuris* eggs (also use CS)
- Treatment
  - Topical Moxidectin has been successful in cats.



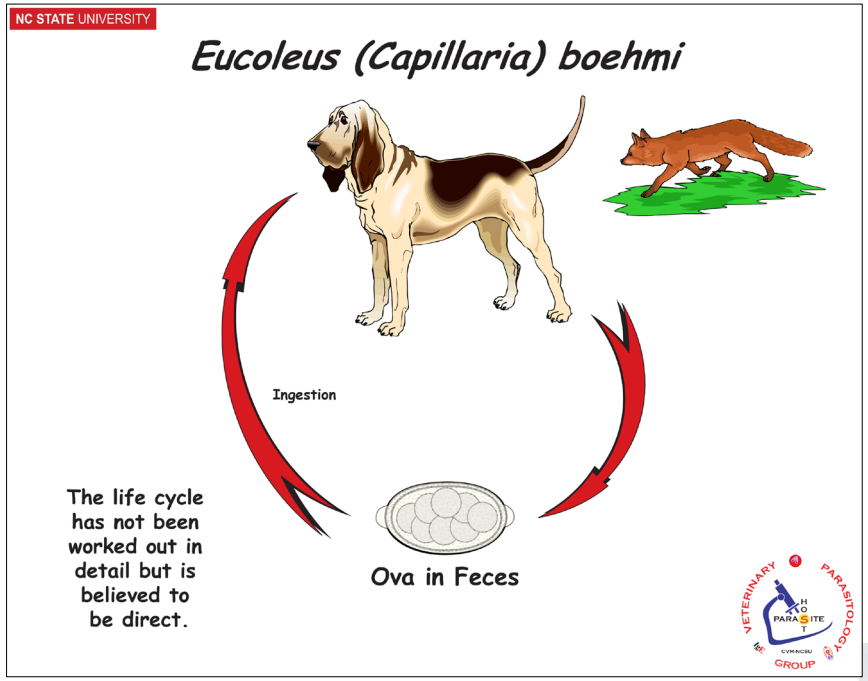


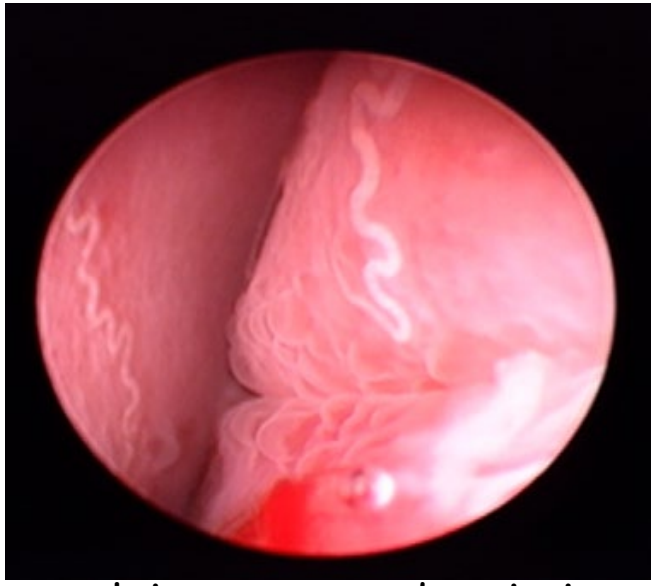
Eucoleus (Capillaria) boehmi

Nasal capillarid

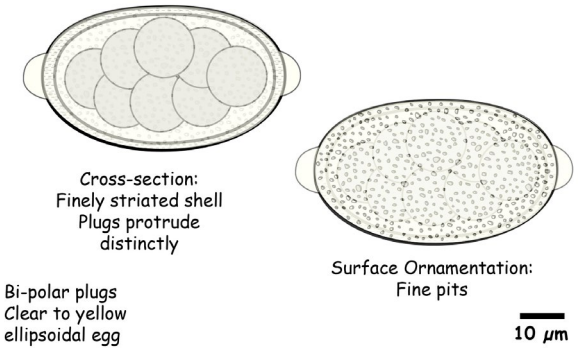
General

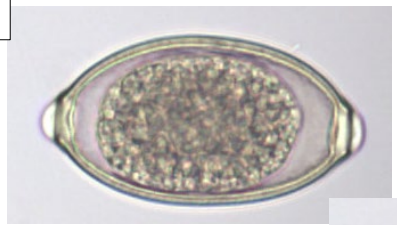
- LC incompletely studied
  - Direct or earthworm intermediate host
  - Fox are Wildlife reservoir hosts
  - Dogs are definitive hosts
    - Common in NC
- Pathology
  - Appears to be rhinitis due to allergies
- Diagnosis
  - Clinical Signs: Sneezing, rubbing nose
  - Nasal endoscopy
  - Fecal float centrifugation
    - Capillarids v/s *Trichuris* eggs (also use CS)
- Treatment
  - Ivermectin, Fenbendazole, Milbemycin, Topical Moxidectin

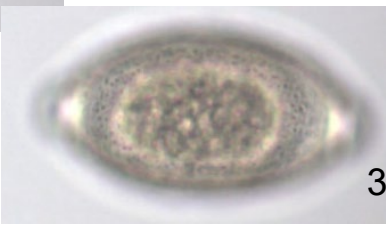




nasal sinus mucosa – endoscopic view







Respiratory Nematodes of Pets

Parasite (Host)	Transmission	Pathology	Clinical Signs	Diagnostics	Treatment & Control	Notes
Aelurostrongylus abstrusus (Cat) Lung parenchyma	Ingest snail/slug required intermediate host OR Bird/ rodent paratenic host	Disseminated nodules cause granulomatous pneumonia	Coughing, dyspnea, abdominal breathing	CS, Baermann, thoracic radiographs, failure of antibiotics	Various topical & oral dewormers. Maybe supportive care --- Avoid intermediate / paratenic hosts. Avoid outdoor access	----------
Eucoleus (Capillaria) aerophilus (fox, dogs, cats) Bronchi	Direct ingestion of infective eggs. Maybe ingestion of earthworm paratenic host infected with L3s	Fox: severe bronchitis Dog & Cat: usually asymptomatic	Coughing	CS, Fecal float for eggs	Off-label v/s Capillarids: Topical Moxidectin has been successful --- Avoid outdoor access	Capillaria v/s Trichuris eggs
Eucoleus (Capillaria) boehmi (fox, dogs) Nasal sinuses	Direct ingestion of infective eggs.	Rhinitis	Sneezing, rubbing nose	CS, Fecal float for eggs, Nasal Endoscopy	Off-label v/s Capillarids: various dewormers --- Avoid outdoor access	Capillaria v/s Trichuris eggs Don't assume allergies

Paragonimus kellicotti

Lung Fluke of Pets

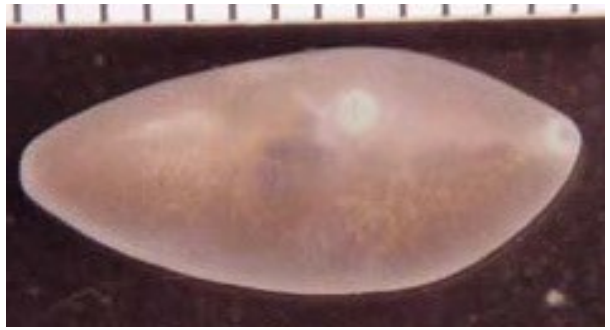
Lung Fluke of Pets & Wildlife

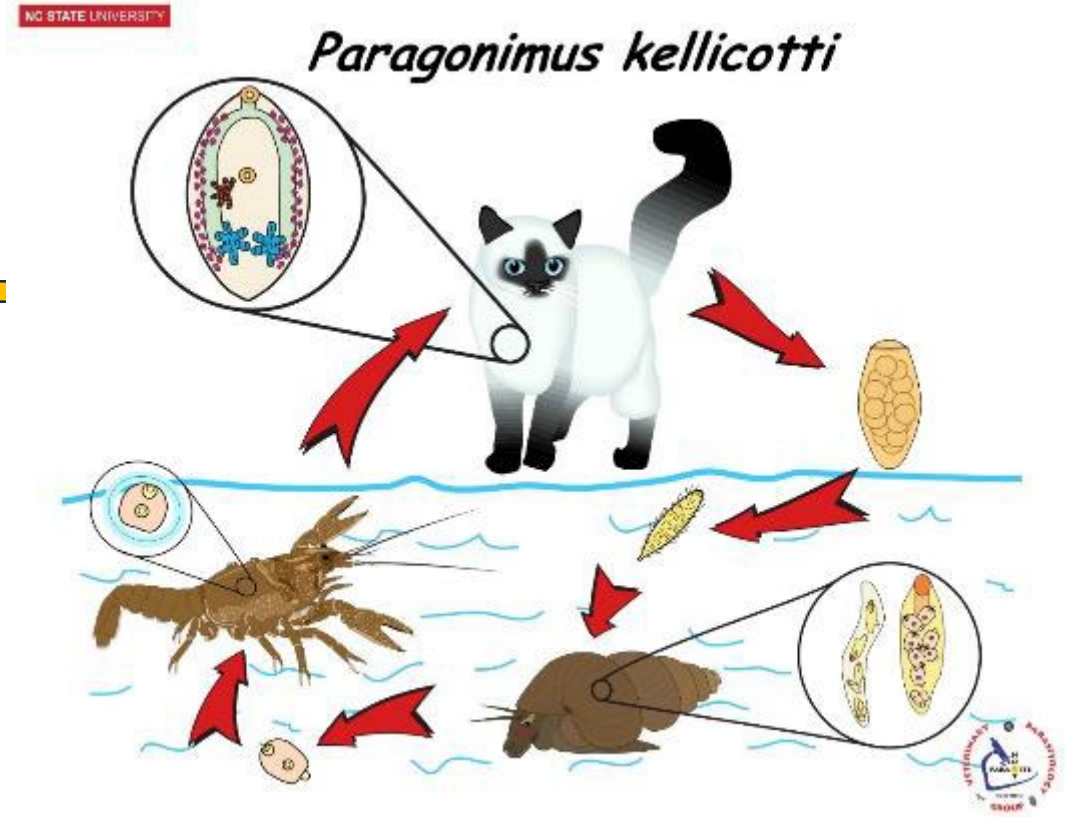
Take Homes

Paragonimus kellicotti

- This Worm is a Fluke, previous worms in this lecture are Nematodes
- Throughout the US but uncommon, cases in NC, rarely zoonotic
- Lung Fluke of Pets (dogs & cats) and Wildlife (Raccoon, Bobcat, Fox, Mink, etc.)
- Aquatic Life Cycle: 1st IH - River snail & 2nd IH - Crayfish
- Ingest infective larvae in Crayfish
- Worms in cysts in lung parenchyma.
- Bronchiolar inflammation, with eosinophilic granulomas in the lung parenchyma. Can lead to pneumothorax.
- Chronic cough, Lethargy, "rusty sputum"
- Sedimentation, Radiology (x-ray, CT scan)
- Deworm, supportive respiratory care, avoid Crayfish IH

Paragonimus kellicotti
Lung Fluke of Pets





Life Cycle HIGHLIGHTS

- Aquatic
- Definitive Hosts -- Dogs & Cats (Pigs, Raccoon, Mink, etc.)
  - Lung Parenchyma
- River snails
- 2nd Intermediate Host -- Crayfish

Geographic Distribution

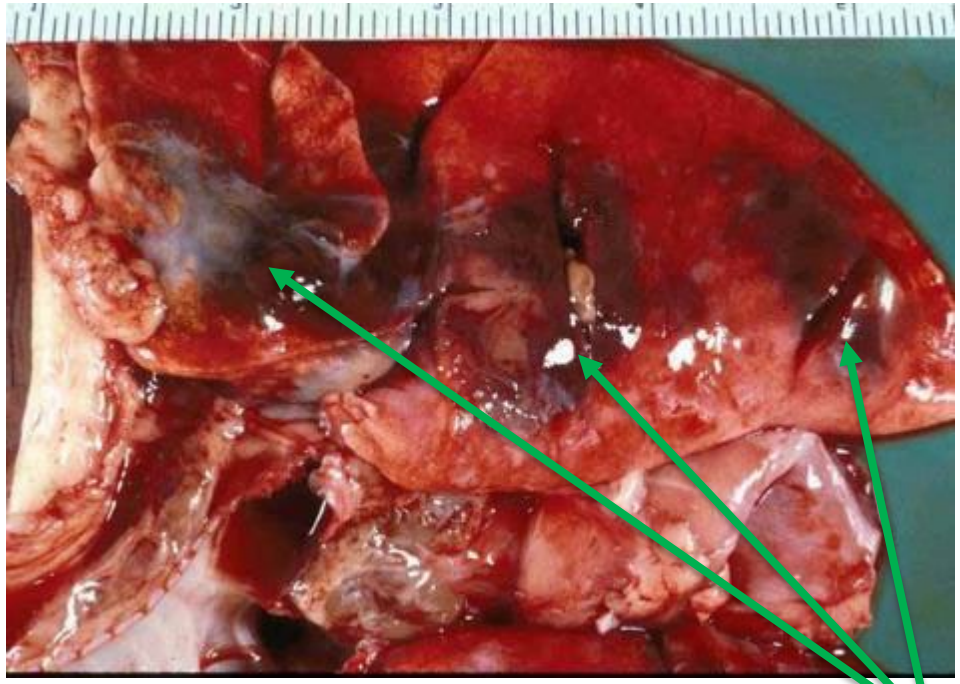
- Throughout North America
- Cases in North Carolina (dogs, cats, mink, raccoons, bobcats)

Zoonosis

- *Paragonimus kellicotti*
  - Wildlife lung fluke in North America
  - Zoonosis has been reported.
    - Human infection from eating raw or undercooked crayfish
- *Paragonimus westermani*
  - human lung fluke in orient

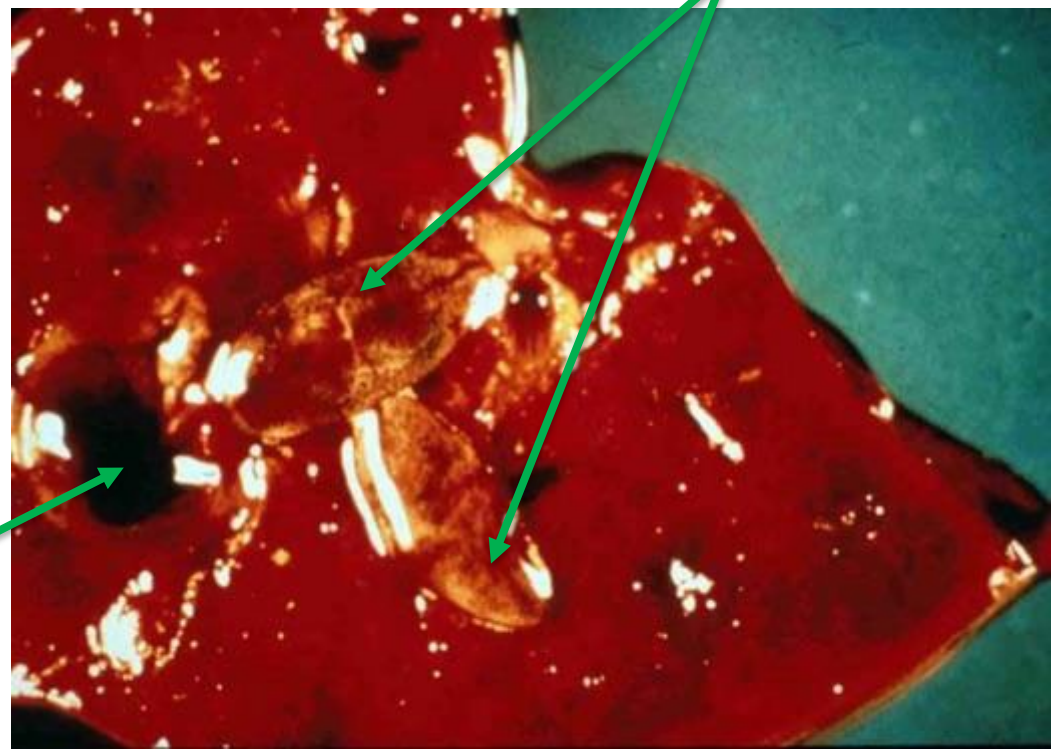
Paragonimus kellicotti
Pathology

- Bronchiolar inflammation
- Eosinophilic granulomas in the lung parenchyma.
- Rare instances of acute Pneumothorax & sudden death



Fluke Cysts

2 Adult flukes

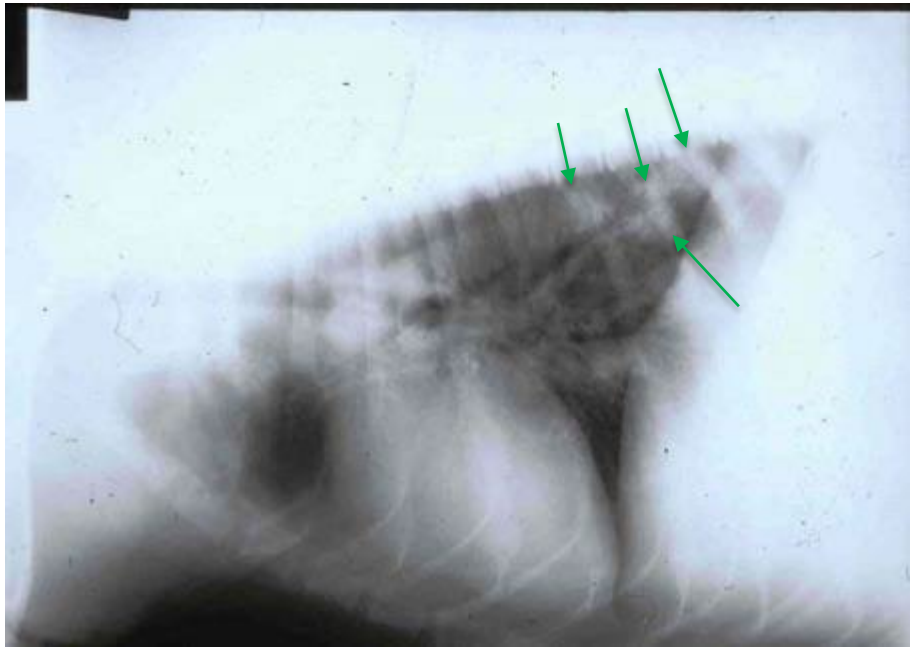


Paragonimus kellicotti
Diagnosis

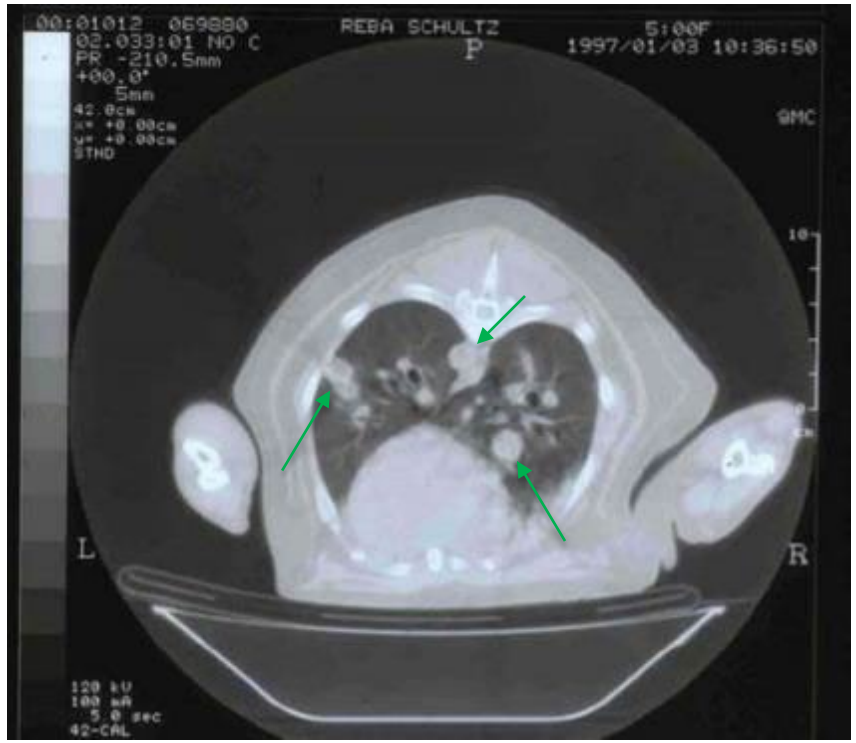
- Clinical signs: lethargy, chronic intermittent cough, "rusty" sputum.
- Fecal Sedimentation
- Sputum Smear
- Radiology: radiographs; CT scan
- History of possible access to crayfish

Sedimentation

Rim around operculum



Radiograph



CT scan

[Cysts indicated by arrows]

Paragonimus kellicotti
Treatment & Control

- **Praziquantel *(Droncit)***
  - 23 mg/kg TID for 3 days
- **Fenbendazole *(Panacur)***
  - 50 mg/kg daily for 10-14 days
- **Albendazole**
  - 25 mg/kg BID for 10 days

- **Snail Control** (unrealistic)
  - Molluscicides: check government restrictions
- **Environmental Control**
  - Restrict access to crayfish (streams, creeks, rivers)

Class Discussion

A cat owner, from Hillsborough has brought in her 5-year-old cat to your clinic. She has noticed that her cat has developed a cough and lately has become significantly less rambunctious. The cat is indoor / outdoor and has access to the Eno River.

Respiratory Worms?

Diagnostics?

LUNG FLUKE Table

Parasite	Definitive Host	1st Intermediate Host	2nd Intermediate Host	Pathology	Diagnostics	Control	Zoonotic ?
Paragonimus kellicotti Throughout US	Dog & Cats Raccoons, Mink, other wildlife Lungs	Aquatic snails (river)	Crayfish	1. Pulmonary inflammation --- Respiratory signs 2. Pneumothorax / sudden death	Sedimentation	Dx Snails Dx access to crayfish (rivers, ponds, streams)	Yes


VETERINARY
PARASITOLOGY
HOST
PARASITE
IgE
CVM-NCSU
GROUP