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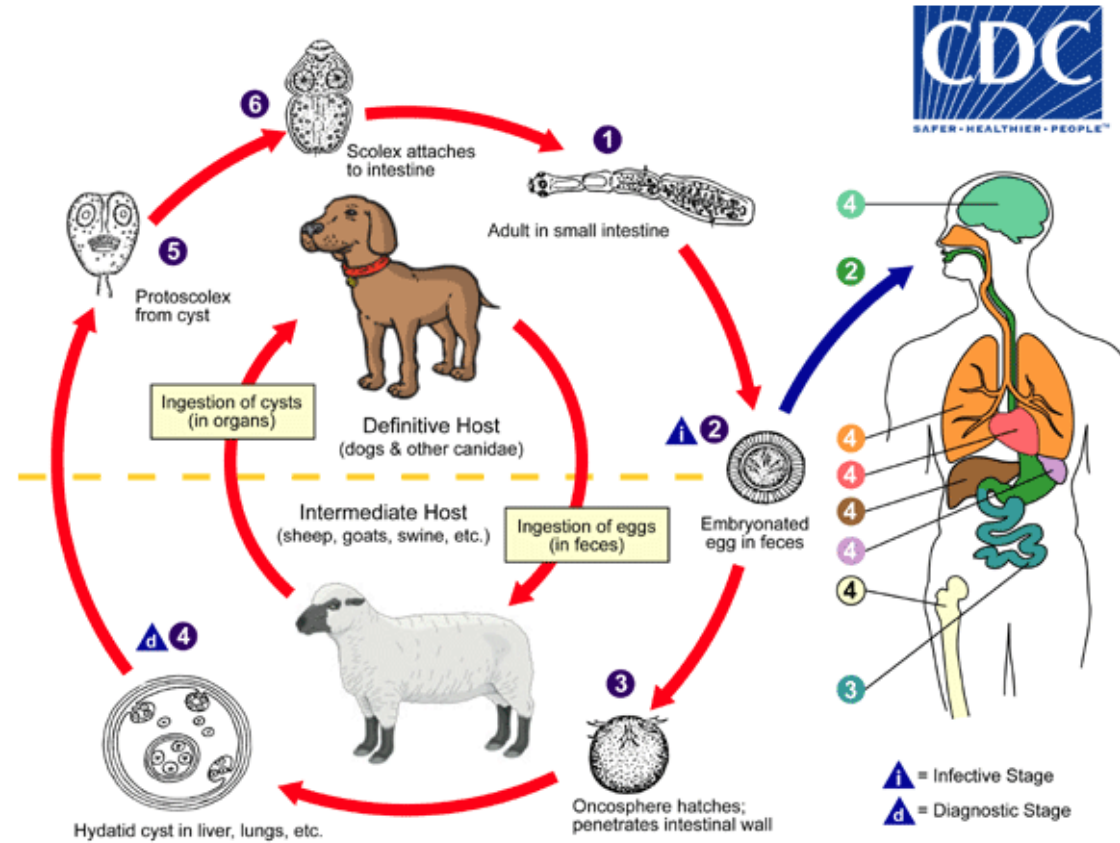


Past and present status of taeniid cestodes in Icelandic dogs

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Introduction



Life cycle of *Echinococcus granulosus*



Background

- Cestode infestations in humans, sheep and cattle known for centuries
 - \approx 22% of adults born 1861-1870 had hydatidosis
 - 12,4% of sheep from 6 slaughterhouses in 1924 with cysts in liver or lungs
 - Cattle believed to be almost as frequently infested as sheep in 1901
- 1863 – Dr. Harald Krabbe
 - Searched for cestodes in husbandry animals, cats, dogs, rats and a fox
 - Found 7 cestode species in total
 - Later became main advisor for the government in the eradication campaign



Dr. Harald Krabbe (1831-1917)



Cestodes in Icelandic dogs

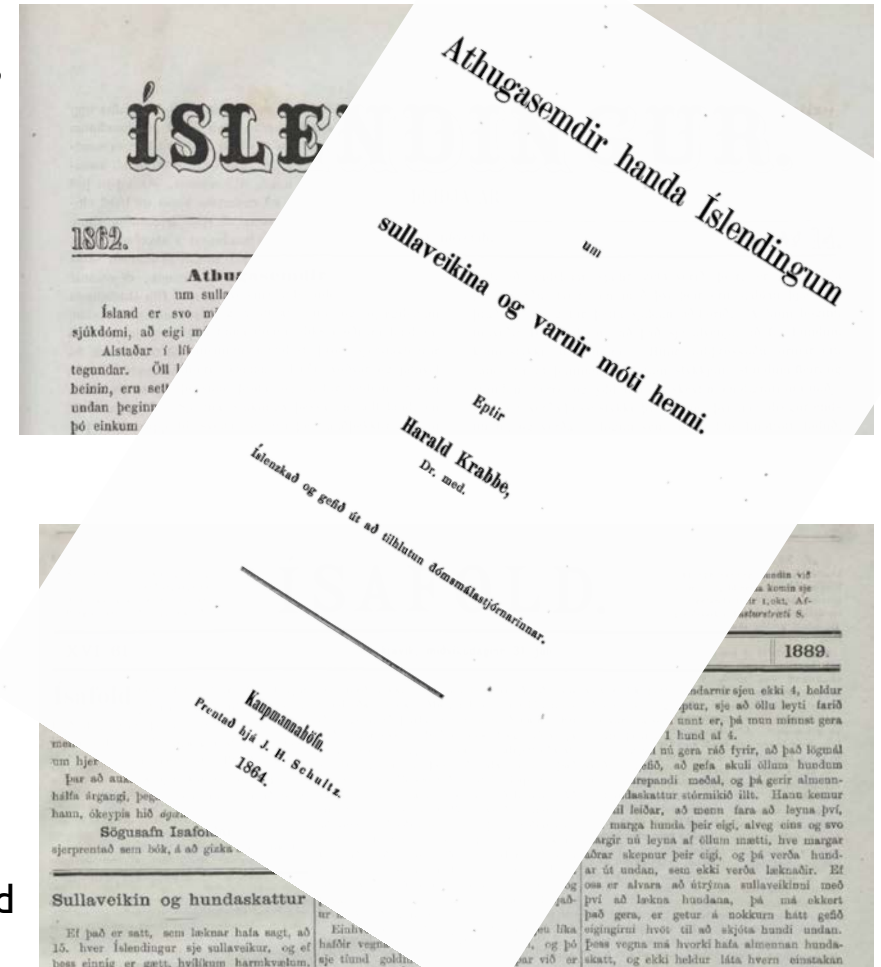
- *Mesocestoides canislagopodis*
- *Diphyllobothrium dendriticum*
- *Diphyllobothrium ditremum*
- *Diphylidium caninum*
- *Taenia multiceps*
- *Echinococcus granulosus*
- *Taenia hydatigena*
- *Taenia ovis*

Landlægir bandormar	Lokahýslar	Millihýslar
<i>Mesocestoides canislagopodis</i> – <i>refabandormur</i>	  	  
Útdauðar tegundir	Lokahýslar	Millihýslar
<i>Echinococcus granulosus</i> – <i>ígulbandormur</i>		  
<i>Taenia hydatigena</i> – <i>netjusullusbandormur</i>		 
<i>Taenia multiceps</i> –		 
Landlægir bandormar	Lokahýslar	Millihýslar
Nýr landnemi ^{3,4}		
<i>Taenia ovis</i> – <i>Vöðvasullsbandormur</i>		



Eradication campaign

- Public education program
 - Reliable information and preventive measures presented (1862, 1863, 1884, 1891)
- Change in husbandry practices
 - Dogs kept from raw offal
 - Slaughter on farm reduced
 - Regular anthelmintic treatment (regulation from 1890)
 - Ineffective medicine used up until 1989 (PZQ)
- Reduction of the dog population
 - Tax on dogs not needed for farming (1869)
 - Import of dogs prohibited (1909-1989)
 - Ban on keeping dogs in urban areas (1924)
- Improved housing for humans and animals
- Meat inspection
 - Gradually introduced (1900-1920)
- Accidental factors
 - Canine distemper outbreaks decimated the dog population (1870, 1888 and 1890)
 - Trade in adult sheep on the hoof in the last third of the century





Taenia multiceps (*Taenia coenurus*, *Coenurus cerebralis*)

- **Definitive host:** Dog (18% 1865)
- **Intermediate host:** Sheep
 - Occasionally found in cattle
 - No reported incidents in humans
- Cysts usually found in the brain and spinal cord
 - Changes in behaviour: Circling, altered head position, incoordination etc.
- Damage for the farmer
 - All infected sheep died
- **First to be eradicated**
 - Probably before Second World War

Cysts up to 100 mm in diameter

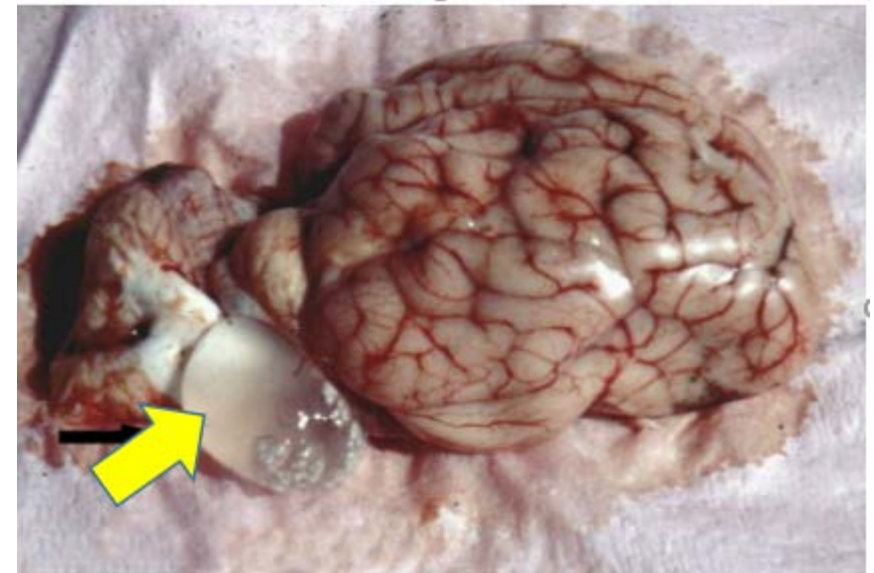


Photo: Wikipedia commons



Echinococcus granulosus (*Taenia echinococcus*)

- **Definitive host:** Dog (28% 1865)
- **Intermediate host:** Sheep, cattle and humans
 - Also found in pigs
 - Never in horses or reindeers
- Cysts commonly found in visceral tissues
 - Liver, lungs etc.
- **Second to be eradicated**
 - Few infestations in humans occurred after 1900
 - Last infected sheep found in 1979
 - Last infected human found in 1988
 - Probably acquired infection around mid century

Cysts 50 -100+ mm in diameter
Icelandic record: 500 mm in diameter (16L) !



Hydatid cyst from sheep liver. 40 mm in diameter
Photo: Karl Skírnisson



Taenia hydatigena (*Taenia marginata*, *Cysticercus tenuicollis*)

- **Definitive host:** Dog (75% in 1865)
- **Intermediate host:** Sheep and cattle
- Cysts normally found on the peritoneum
 - Infections usually asymptomatic
- **Last to be eradicated**
 - Last known infected sheep found in 2008

Cyst often 30 – 40 mm in diameter, can become up to 60 mm

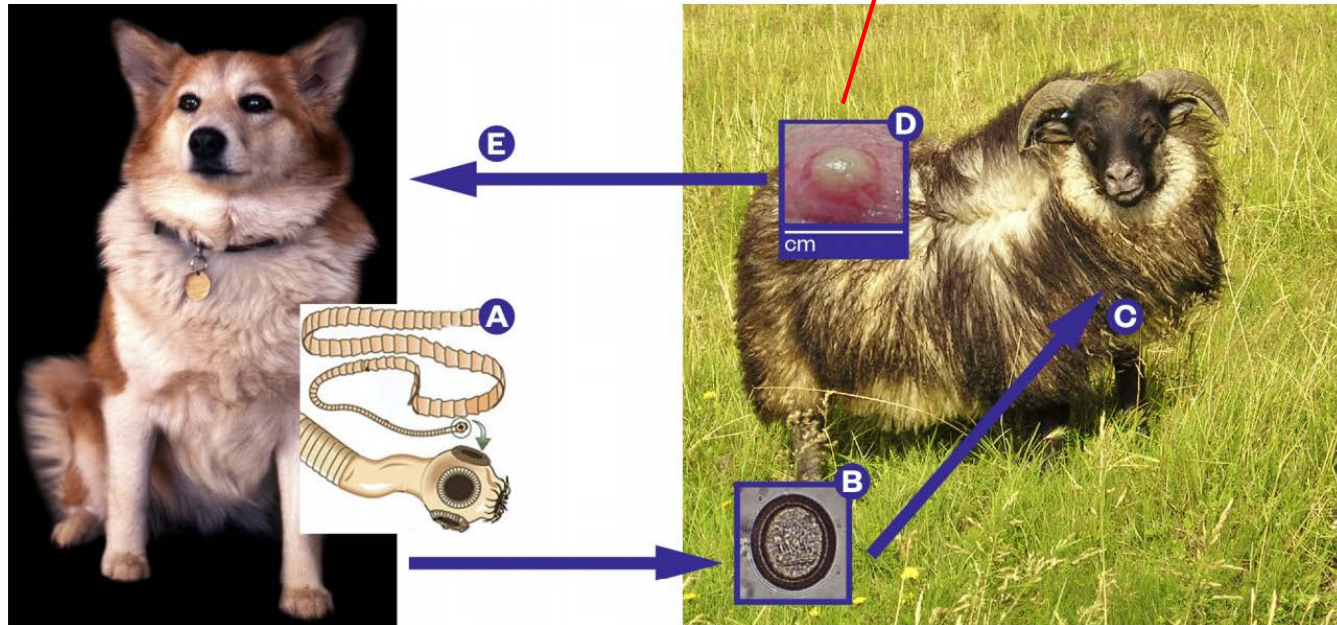


T. hydatigena, 50 x 40 mm with neck and head from the mesentery of a sheep.
Photo: Karl Skírnisson



Taenia ovis

Cyst size: 3-7mm



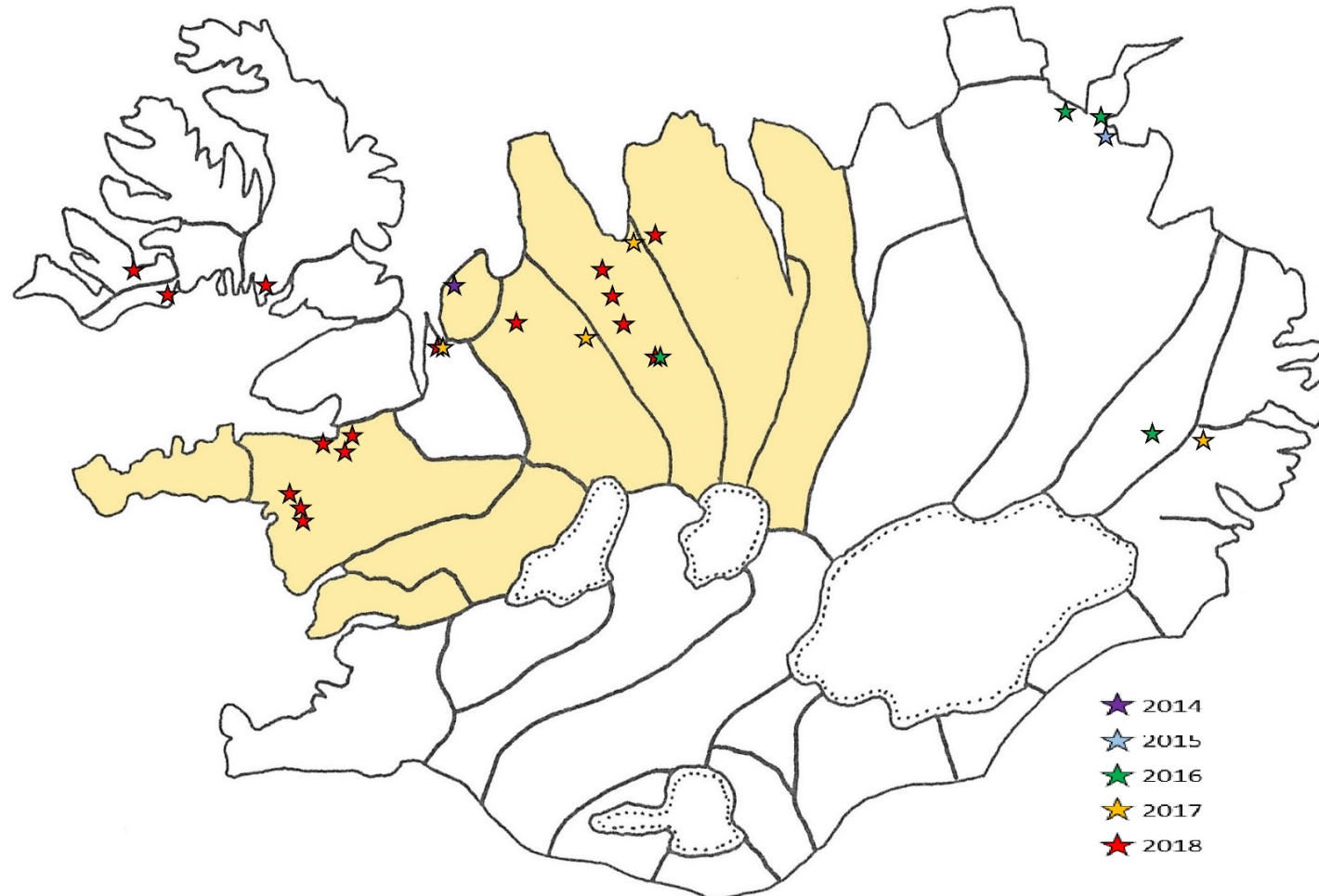
- **Definitive host: Dog**
 - Still not found in foxes but cannot be ruled out
- **Intermediate host: Sheep**
- Possibly imported with platinum foxes (*Vulpes lagopus*) from N-America (1939-1941)
 - Could have been earlier!

5. mynd. Lífsferill vöðvasullsbandormsins *Taenia ovis*. A. Fullorðinn bandormur. B. Egg ($31 \times 28 \mu\text{m}$) úr hundaskít á íslenskum sveitabæ. C. Sauðkind, millihýsill í lífsferlinum; D. Stakur vöðvasullur ($7 \times 4 \text{ mm}$) í þind kindar. E. Hundur, lokahýsill í lífsferlinum. – A. Adult *Taenia ovis*. B. Egg ($31 \times 28 \mu\text{m}$) from feces of an Icelandic farm dog. C. Sheep, intermediate host in the life cycle. D. Single *Cysticercus ovis* cyst ($7 \times 4 \text{ mm}$) in sheep diaphragm. E. Dog, definitive host in the life cycle. Ljósmynd. / Photos: B. Matthías Eydal & Karl Skírnisson; D. Ólöf Guðrún Sigurðardóttir; C. & E. Karl Skírnisson.



Distribution of infected farms

Based on unpublished data from Keldur and Mast – ME, GRP, EJ and ÓGS 2018)





The ball has been thrown!

- Deworming dogs is mandatory in Iceland (Regulation: 837/1999)
 - „Dog owner or caretaker is bound to deworm their dog every year and bear all the cost of the procedure“
- Each municipality is responsible to enforce the legislation and to do a follow-up in their area
- The increased distribution of *T. ovis* in Iceland clearly shows that the legislation is obviously not always thoroughly followed
- This stresses the importance of deworming dogs and prevent them from accessing / feeding them raw offal and raw pet food diets

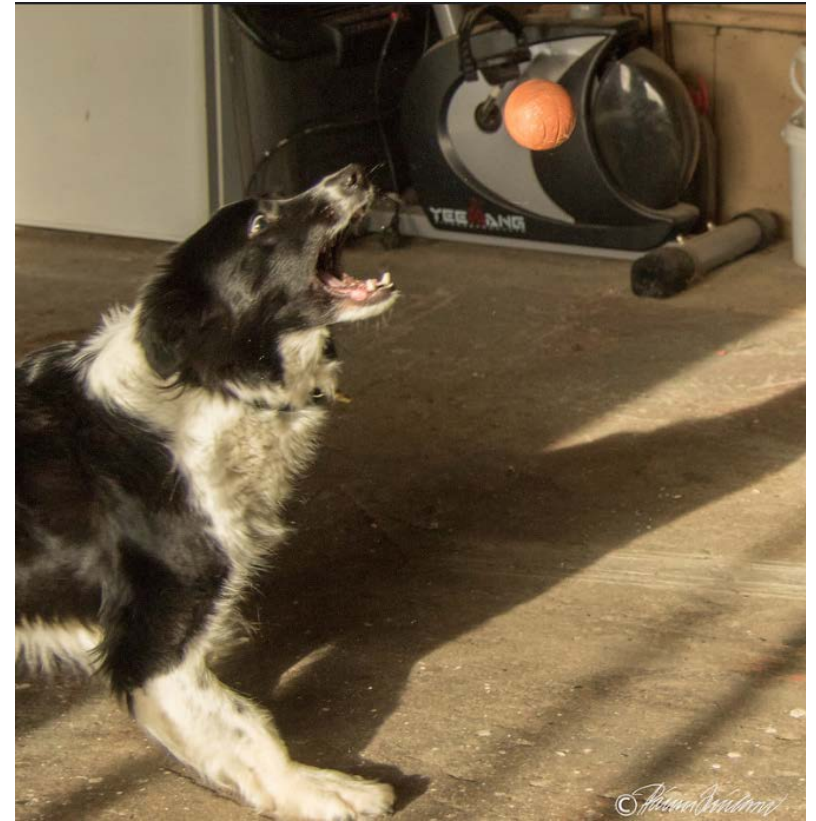


Photo: Páll M. Skúlason



Thank you for your attention



Photo: bbl.is

1. tafla. Sjö tegundir bandorma sem Harald Krabbe greindi við rannsóknir sínar á hundum, köttum, ref og brúnrottum á Íslandi árið 1863.⁴ Getið er um þáverandi smittíðni (%) sem og núverandi stöðu bandormanna. – Seven cestode species identified by Harald Krabbe⁴ from Icelandic dogs, cats, arctic fox and brown rats with information on their prevalence of infection in 1863, and their present status.

Tegund / hýsill <i>Species / host</i>	Hundur <i>Dog</i>	Köttur <i>Cat</i>	Refur <i>Arctic Fox</i>	Staða í dag <i>Present status</i>
Fjöldi krufinna hýsla / Numbers examined	100	31	1	
<i>Echinococcus granulosus</i> – ígulbandormur (<i>Taenia Echinococcus</i> ^A)	28%	-	-	útdauður / <i>extinct</i>
<i>Taenia hydatigena</i> – netjussullbandormur (<i>Taenia marginata</i> , ^A <i>Cysticercus tenuicollis</i> ^B)	75%	-	-	útdauður / <i>extinct</i>
<i>Taenia multiceps</i> – höfuðsóttarbandormur (<i>Taenia coenurus</i> , ^A <i>Coenurus cerebralis</i> ^B)	18%	-	-	útdauður / <i>extinct</i>
<i>Taenia taeniaformis</i> – kattabandormur (<i>Taenia crassicollis</i> , <i>Cysticercus fasciolaris</i> ^C)	-	23%	-	landlægur / <i>indigenous</i>
<i>Dipylidium caninum</i> – flóarbandormur (<i>Taenia cucumerina</i> ^A)	57%	-	-	útdauður / <i>extinct</i>
<i>Mesocestoides canislagopodis</i> – refabandormur (<i>Taenia Canis Lagopodis</i> ^A)	21%	35%	100%	algengur / <i>common</i>
<i>Diphyllobothrium</i> sp.^D – fugla- og rándýrabandormur (<i>Bothriocephalus fuscus</i> ^A)	5%	-	-	algengur / <i>common</i>

A Eldra heiti tegundarinnar. – Old name of the species.

B Heiti lírfu- eða sullstigsins. – Name of the larval stage.

C Harald Krabbe⁴ fann lírfustigið í brúnrottum, *Rattus norvegicus*, í Reykjavík 1863. – Krabbe⁴ detected the larval stage in brown rats, *Rattus norvegicus*, in Reykjavík in 1863.

D Tvær þekktar tegundir nú: – At present two species are known: *D. dendriticum* og/and *D. ditremum*.^{16,17}