

# Základy humánní parazitologie

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VII INTERNATIONAL CONGRESS OF PROTOZOOLOGY  
NAIROBI 22-29 JUNE 1985



7-KENYA

R.P. ROMINA



1954



MALAYSIA 25c



INSTITUT PENYELIDIKAN PERKANTARA



2R.

SWAZILAND



7½c



4,00



POLSKA 600

VII INTERNATIONAL CONGRESS OF PROTOZOOLOGY  
NAIROBI 22-29 JUNE 1985



5-KENYA



Sir Arnold Theiler (1867-1936)  
Viererbühnige Mücke



البريد  
2,00

المؤتمر الدولي الثاني عشر لمرض الأيكس المائيتية



\$1.00

URUGUAY



20



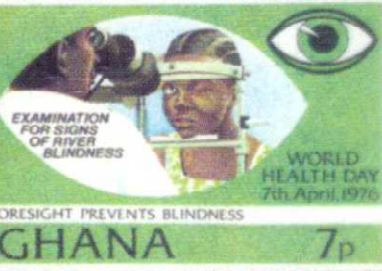
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BRASIL  
CORREIO  
L.5 2,50



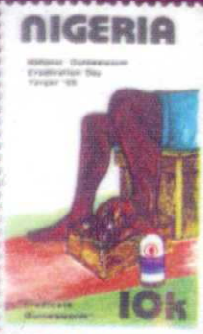
50



WORLD HEALTH DAY  
7th April, 1976  
GHANA 7p



40F



10k



DESARROLLO MEDICINA VETERINARIA



DESARROLLO MEDICINA VETERINARIA

# Základy humánní parazitologie

Základní údaje o předmětu:

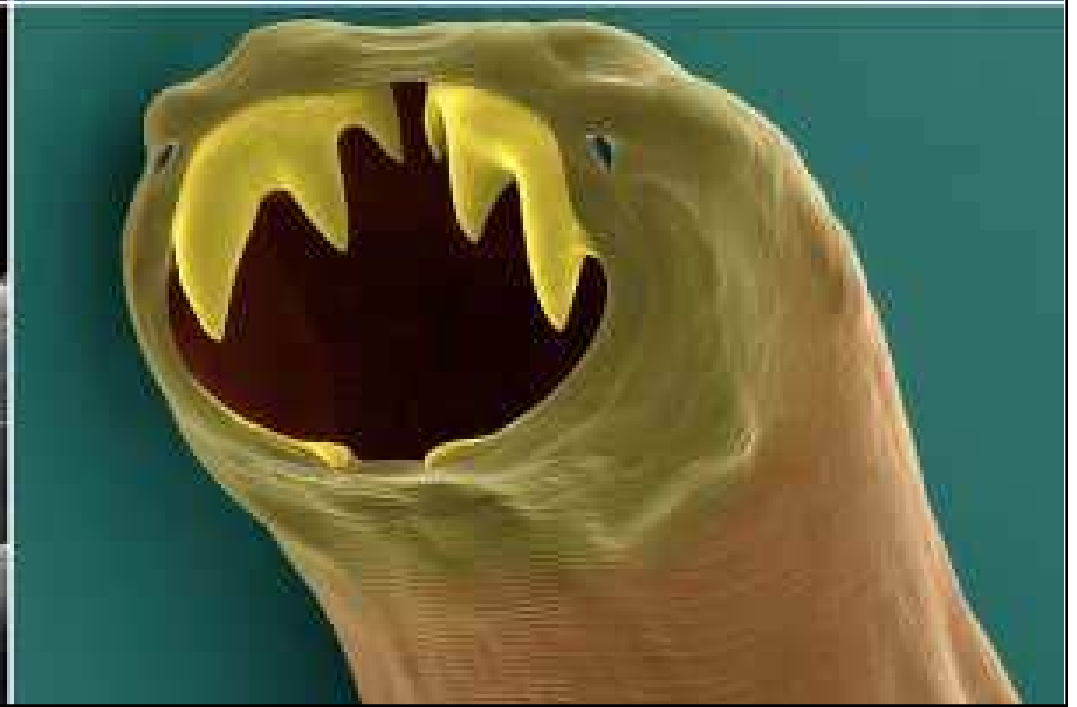
přednáška: úterý, od 9 do 11.50 hodin,

budova A11, místnost 306

zkouška (ústní/písemná) se bude konat v kampusu MU Bohunicích v pavilonu Ústavu botaniky a zoologie A31 v místnosti 332 – bude info mailem ???

studijní materiály na IS – prezentace a nahrávky

# Paraziti mezi námi a všude kolem



# Základy humánní parazitologie

- Struktura přednášky:
- Úvodní část přednášky, základní parazitologické pojmy
- Protozoologie
- Helmintologie
- Arachnoentomologie
- Kombinace orgánového přístupu a systematiky

# Starověký Egypt



# Z historie parazitologie I

Egypt: (1250 – 1000)

Schistosoma hematobium

Taeniarhynchus saginatus

Ascaris lumbricoides

Dracunculus medinensis

Řecko a Řím:

Plinius starší

Aristoteles

Galén

Hippocrates

# Starověký Řím a Řecko





# Starověká Čína



# Z historie parazitologie II

- Čína *Ascaris lumbricoides*
- Amerika  
helmini  
*Tunga penetrans*  
*Pediculus humanus*  
Malárie (*Plasmodium*)  
Leishmanióza (*Leishmania*)

# Předkolumbovská amerika



# Evropa - historie a současnost



# Z historie parazitologie III

- Evropa (1200 – 1650)
  - 1379: Fasciola hepatica
  - 1592: Diphylobothrium latum
  - 1674: Eimeria
  - 1681: Giardia intestinalis
  
  - 2. pol. 17.stol – Francesco Redi – „otec parazitologie“ - redie

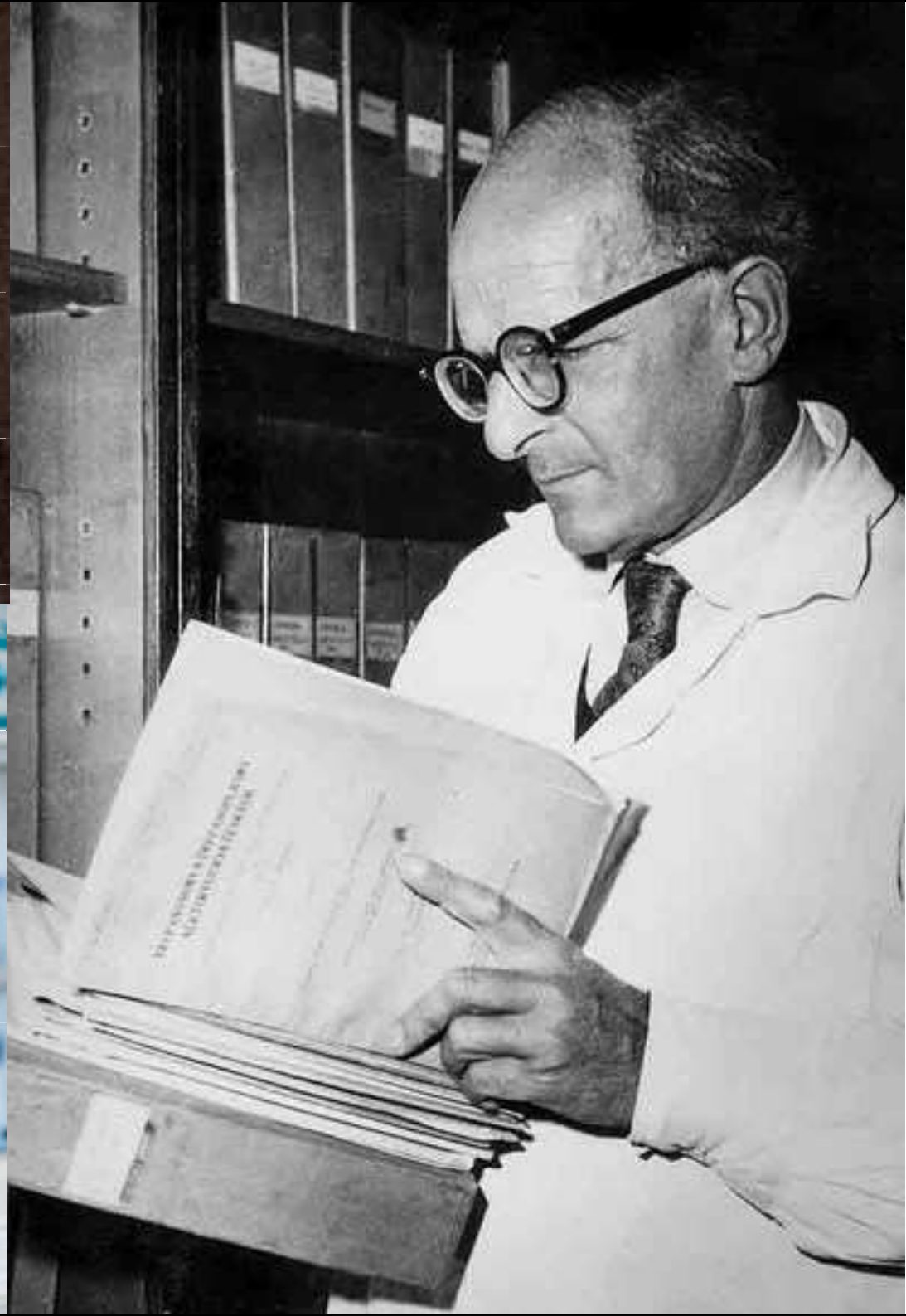
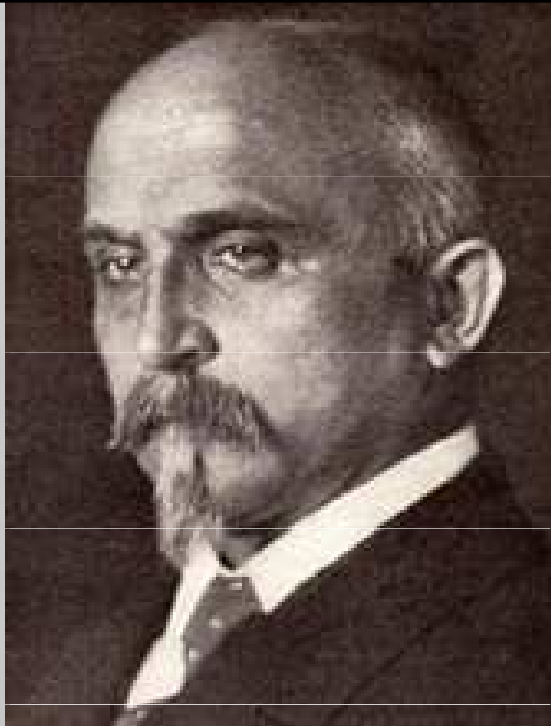
# Z historie parazitologie IV

- Středověk – mnoho falešných představ o cizopasnících
- Rudolphi:
  - Nematoidea
  - Acanthocephala
  - Nematoda
  - Cestoda
  - Cystica
- 1773: cerkarie (Muller)
- 1816: cercarie – motolice (Nitzsch)
- 1842: životní cyklus motolice (Thomas, Leucard)
- 19. století – parazitologie jako věda (Zeder, Rudolphi, Frolich, Butschli, Dolfein, Dujarden, von Siebold, Schaudin, Loos aj.)



0077

Prof. MUDr. VILÉM D. LAMBL.  
Zemfel ve Várlavě dne 26. února 1895.  
Převodit reprodukce dle fotografie.



# Parazitologie v České republice

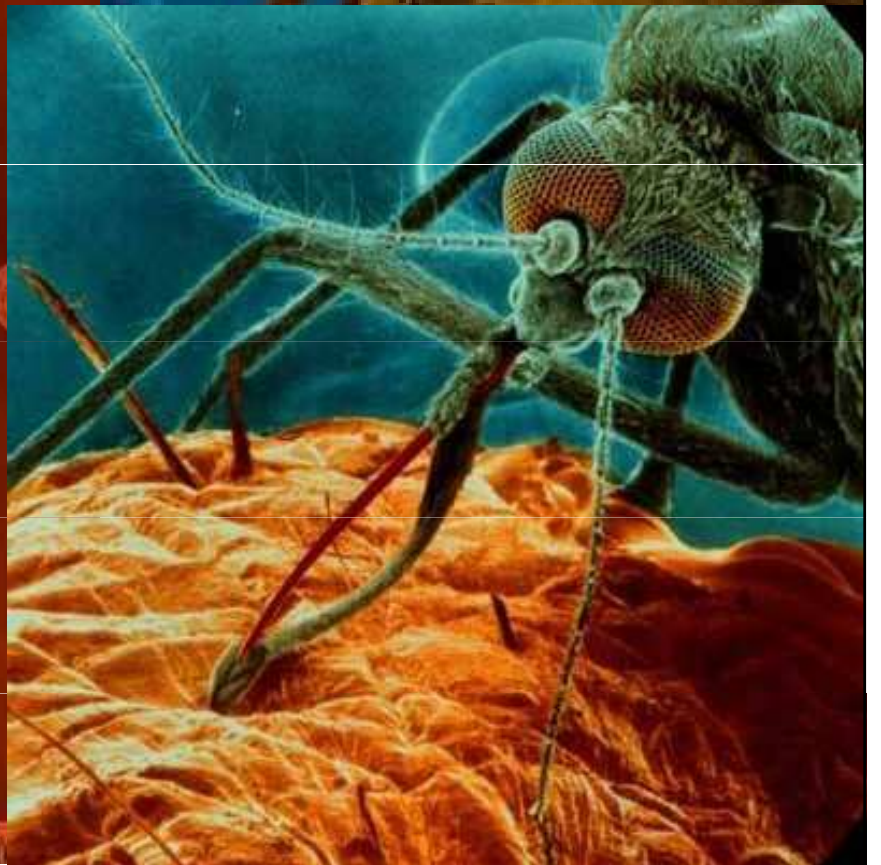
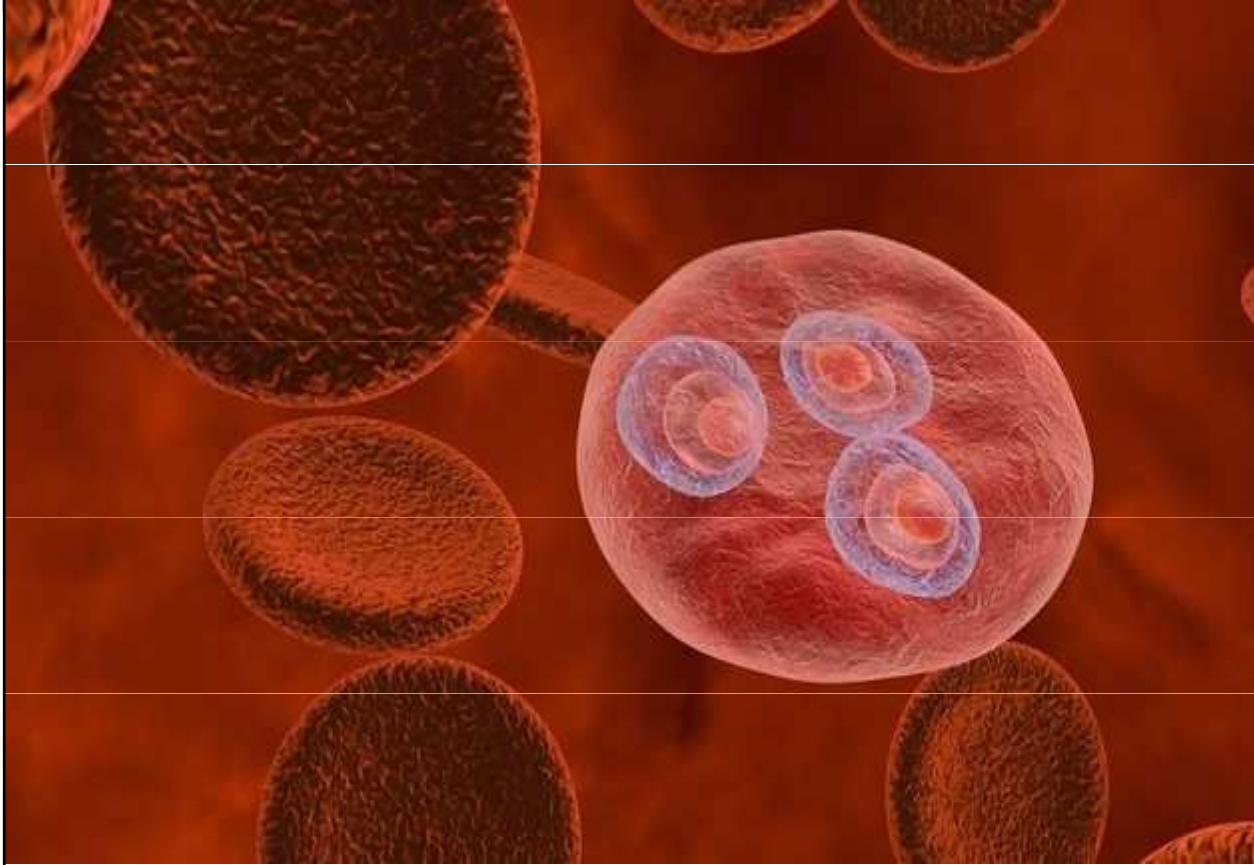
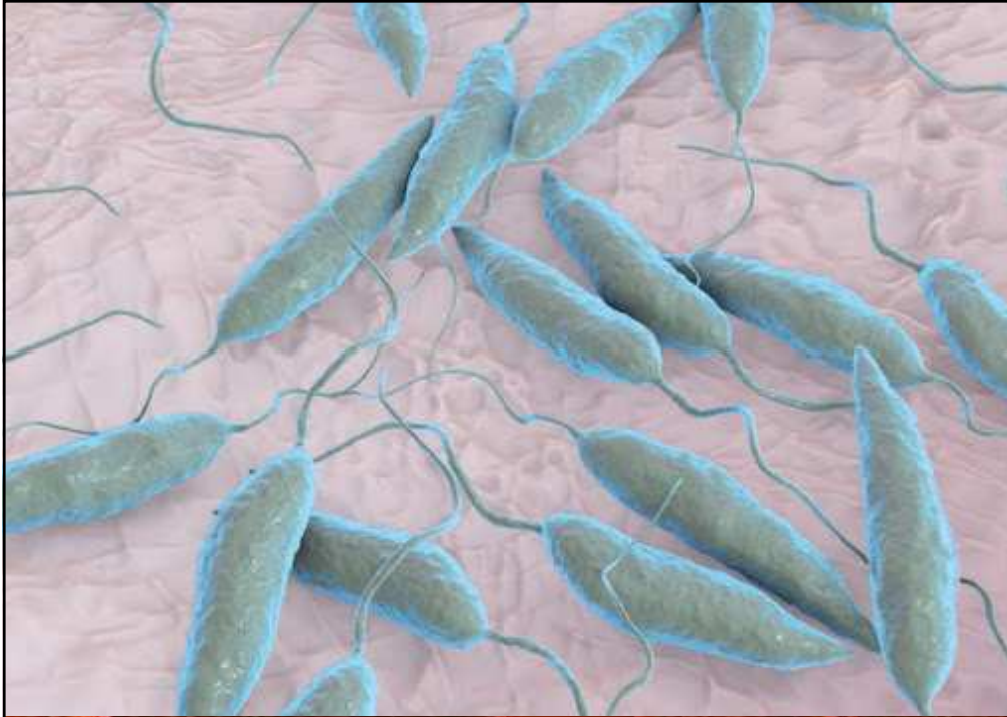
- Univerzita Karlova, Praha
- Masarykova univerzita, Brno
- Veterinární univerzita, Brno,
- Jihočeská univerzita a Biologické centrum AV ČR v Českých Budějovicích - Parazitologický ústav AV ČR - %Č. Budějovice











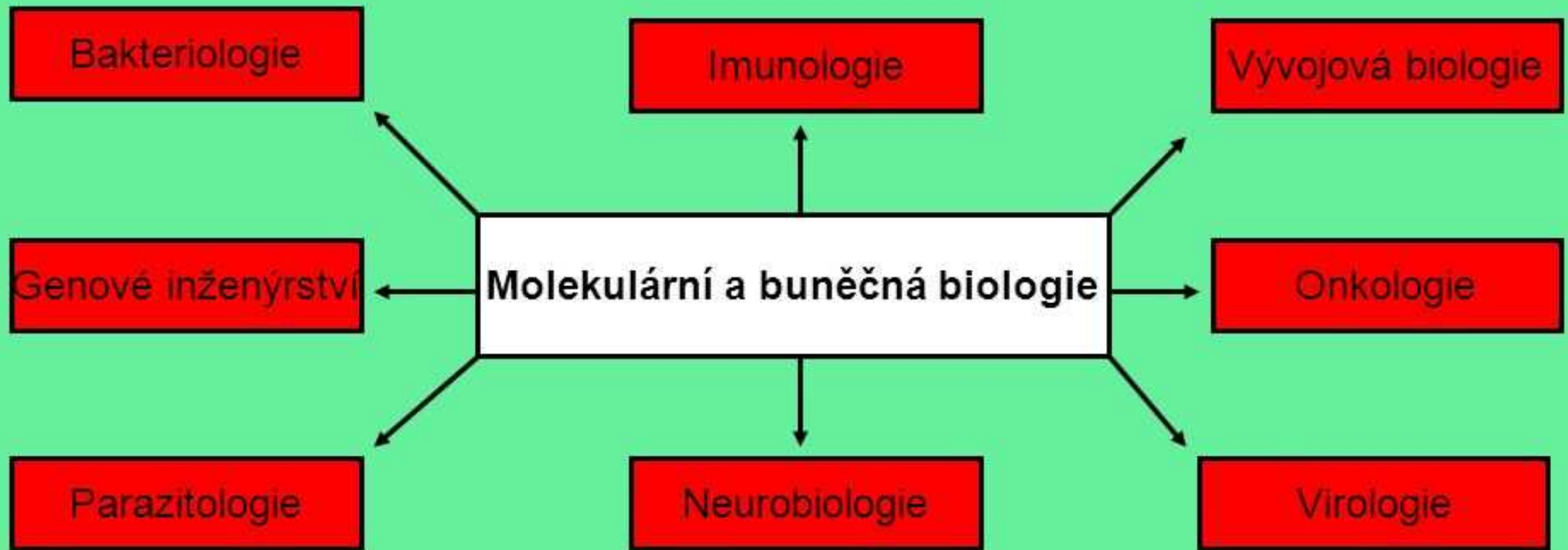
# Z historie parazitologie VI

- 20. století – parazitologie vyhraněná vědní disciplína
- Fauna cizopasníků
- Morfologie, taxonomie a systematika
- Životní a vývojové cykly
- Biologie a ekologie
- Fyziologie, biochemie, imunologie
- Epidemiologie a matematické modelování
- Genetika a molekulární biologie
- Evoluční biologie a fylogenetika
- Genomika a transkriptomika
  
- Histologie, histochemie, imunohistochemie
- Ultrastruktura a anatomie
- SCAN, TEM, CLSM

# Moderní parazitologická laboratoř



# Rozvoj molekulární biologie



## Rozvoj molekulární parazitologie

# Základ – kvalitní mikroskopická technika



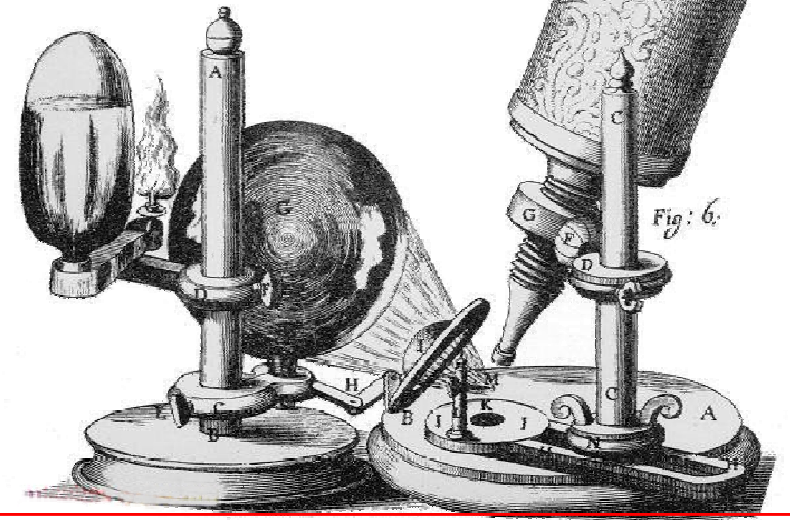
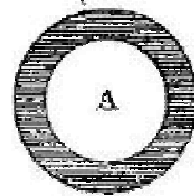
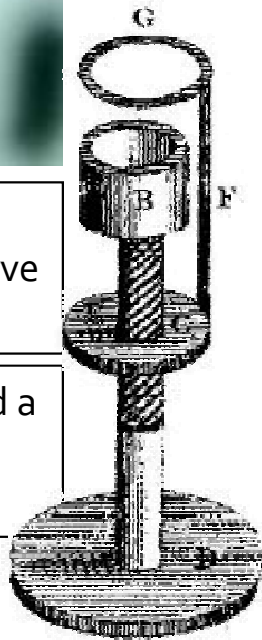
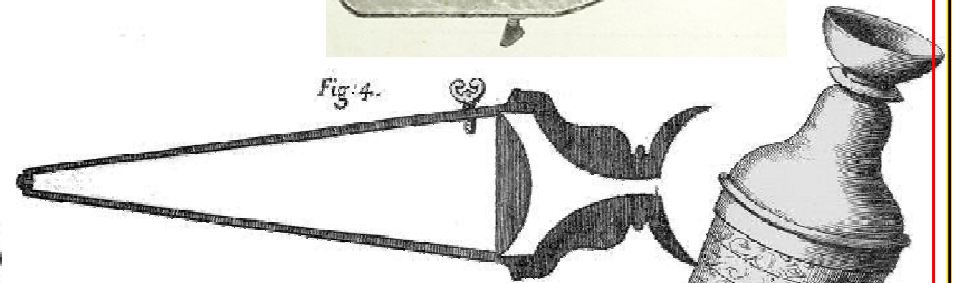
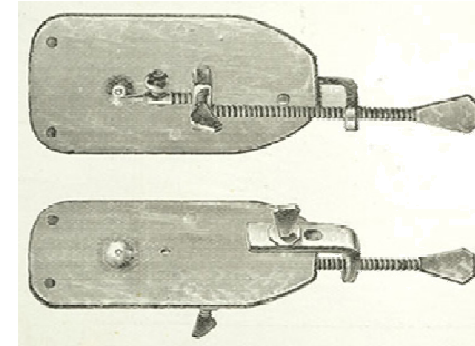


# Přehled základních mikroskopických technik

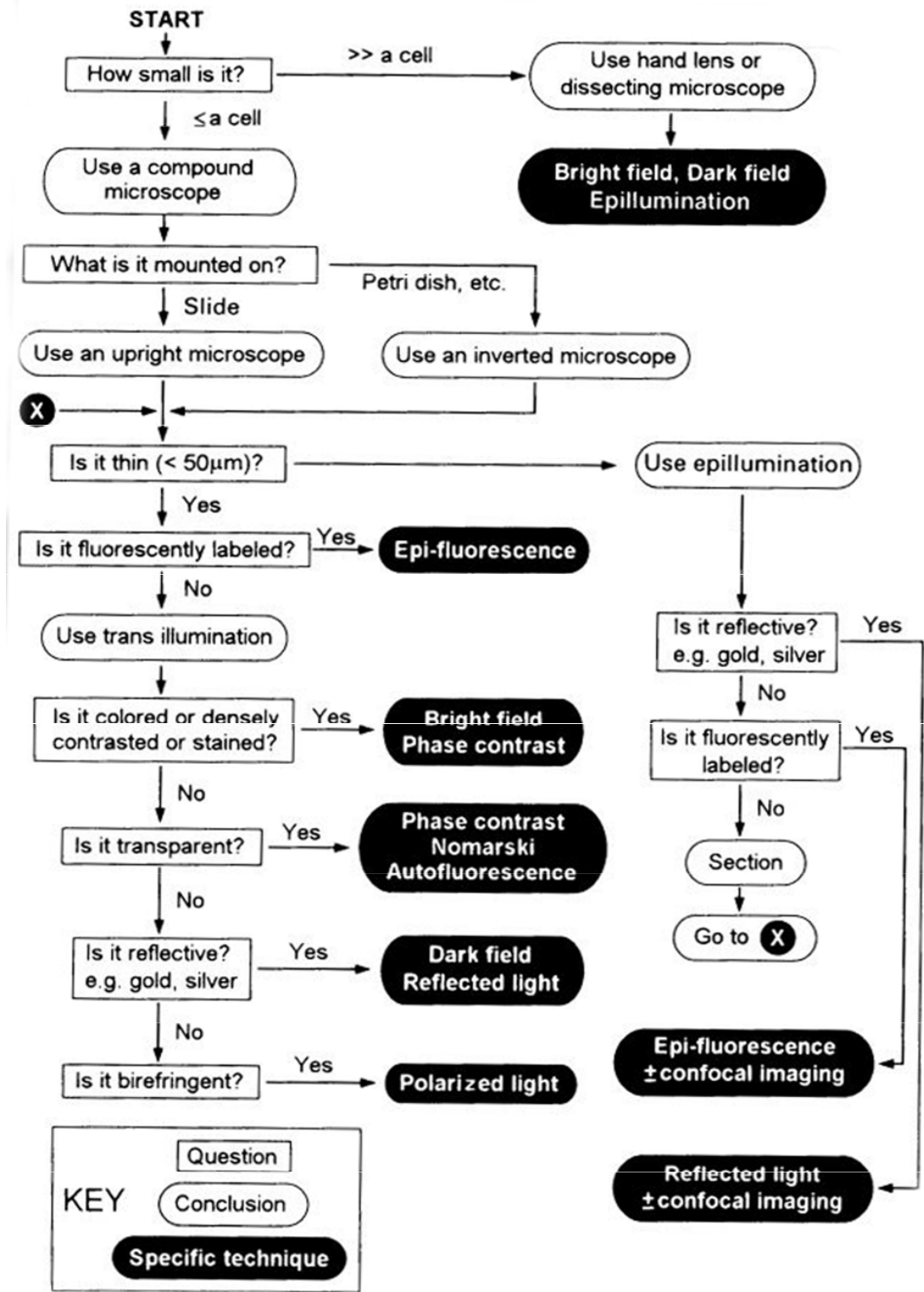


Small drop has a nearly perfect spherical shape, and so it can serve as a lens.

17th century - Stephen Gray used a water drop as a lens for a microscope he built



# Jak vybrat správnou mikroskopickou techniku ?



Parasitic crustacea



**ECTOPARASITES**  
Parasitic crustaceans,  
leeches - found  
externally:  
usage of hand lens or  
dissecting microscope



## Oddělení parazitologie - infrastruktura

### Laboratoř speciální mikroskopie



Mikroskop  
Olympus BX51 s fázovým  
kontrastem a analýzou obrazu

# Bright field

*Eudiplozoon nipponicum*



- Acetylcholine visualised with 5-bromo-chloro-indolyl acetate

(Zurawski T.H. et al., 2001)

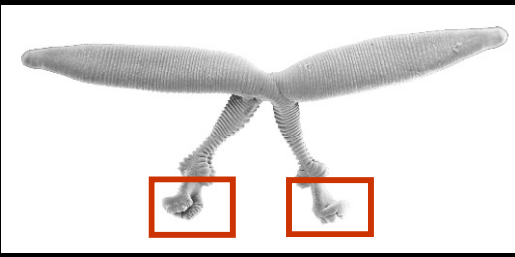
# Gomori Trichrom Staining

*E. nipponicum*



*P. homoion*

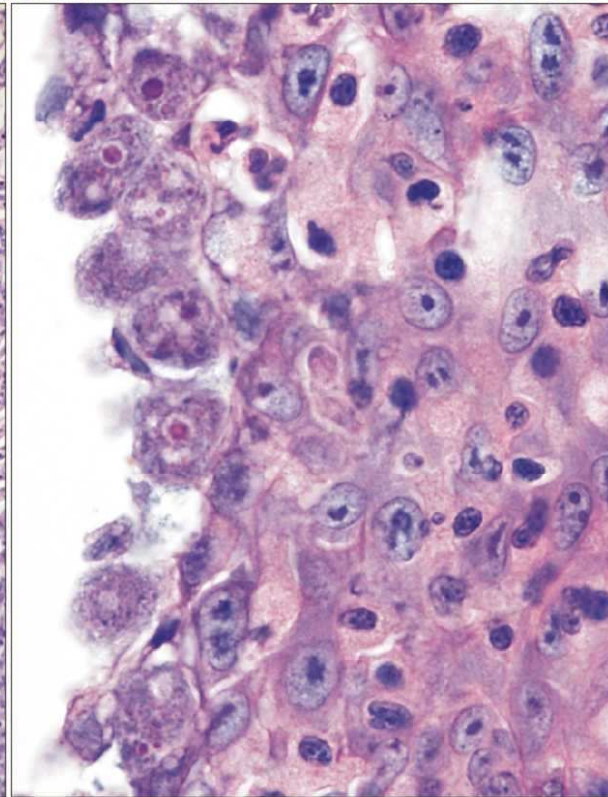
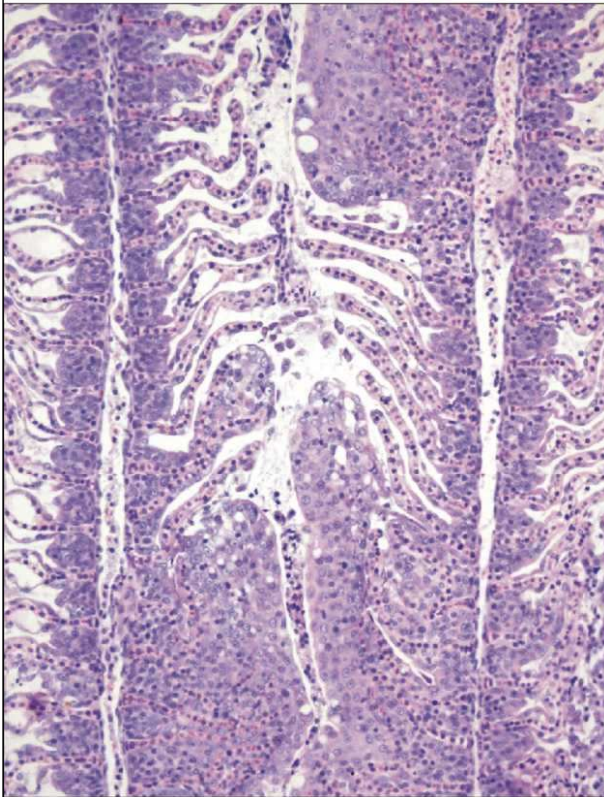
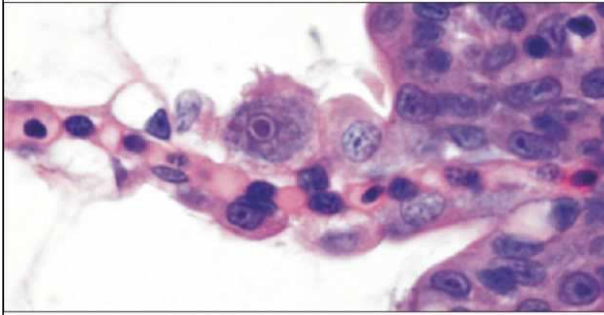
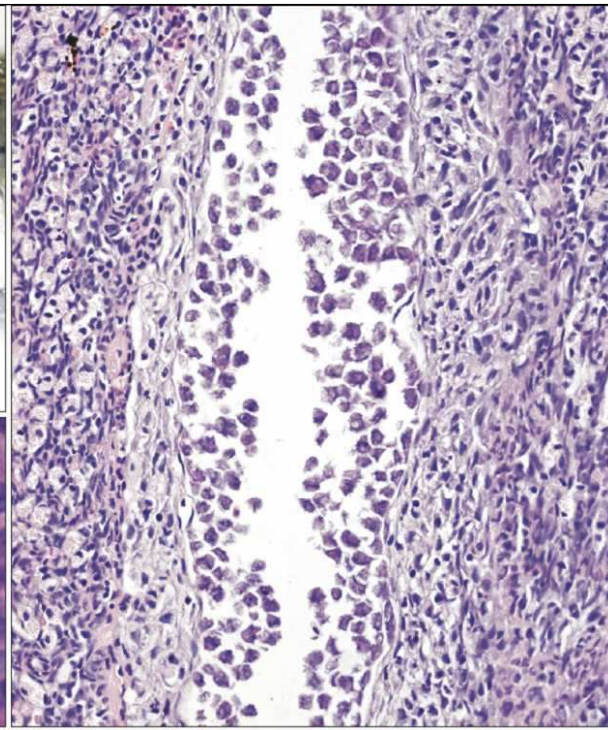
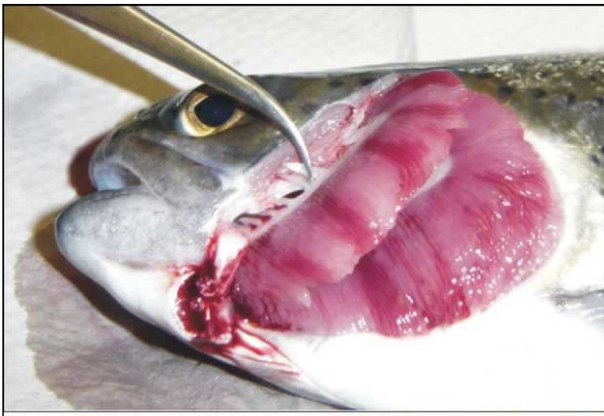




# *E. nipponicum* - histology



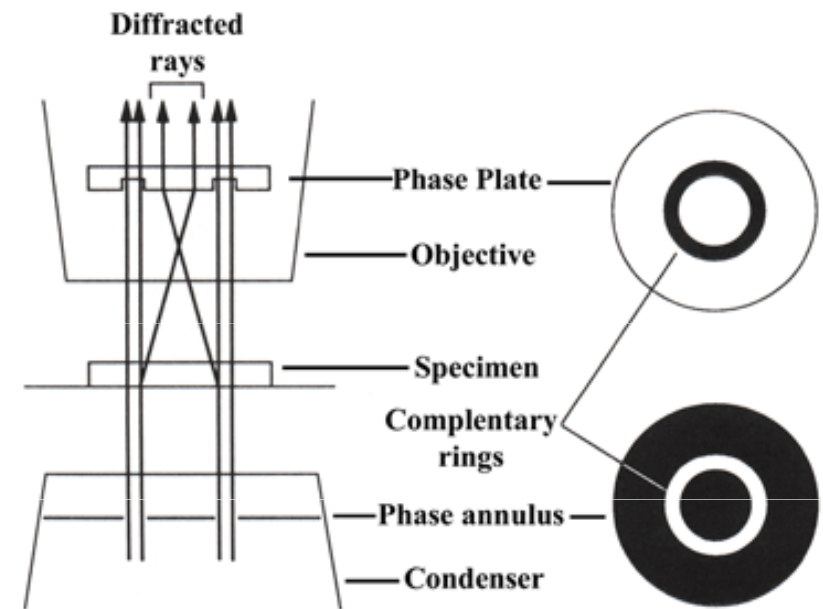
LM (Histological sections, Masson's trichrome)



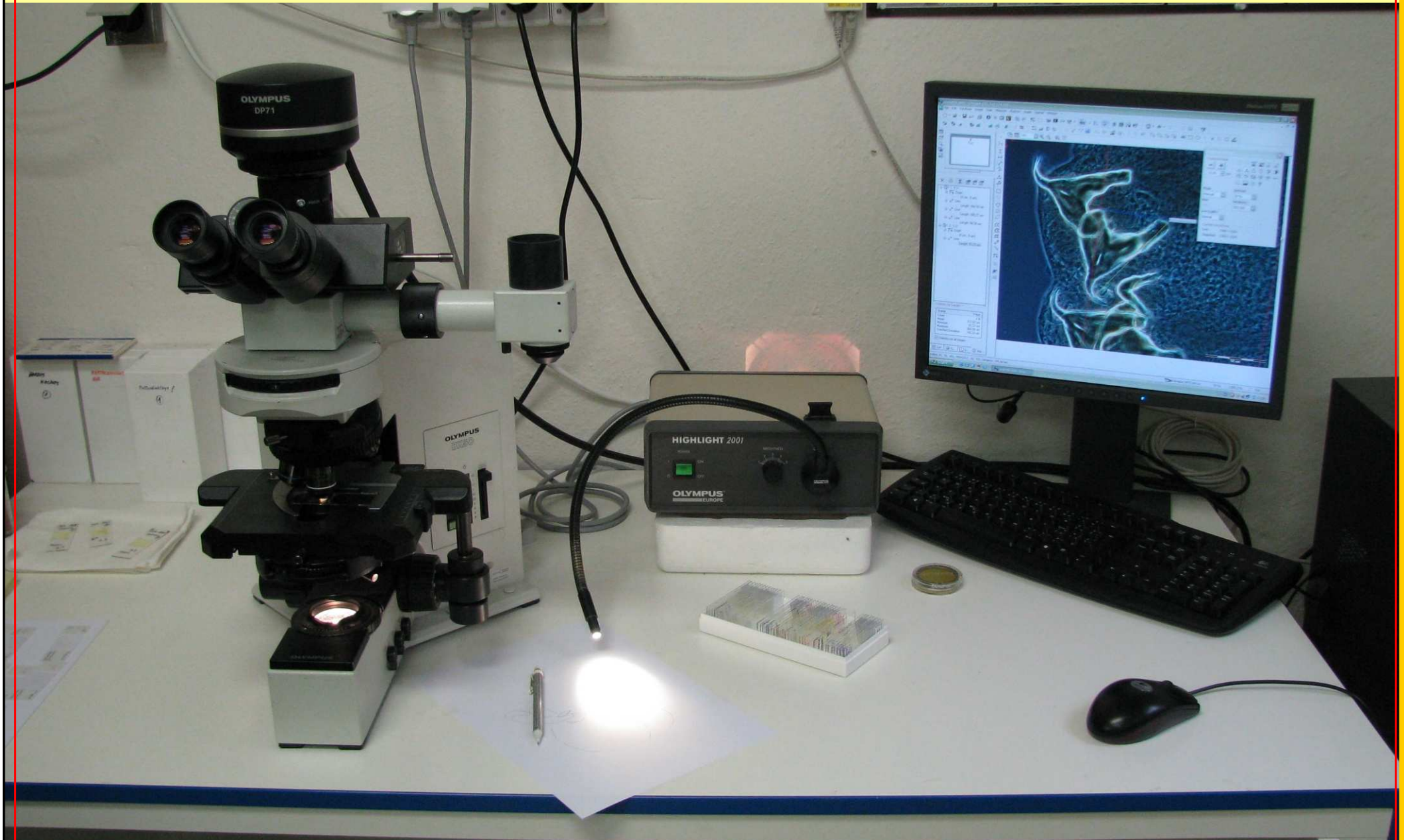


# Phase contrast (PC)

- PC enhances contrasts of transparent and colorless objects by influencing the optical path of light
- Light passing through a transparent part of the specimen travels slower and, due to this is shifted compared to the uninfluenced light
- Difference in phase is not visible to the human eye → change in phase can be increased to half a wavelength by a transparent phase-plate in the microscope and thereby causing a difference in brightness
- Transparent object becomes shining out in contrast to its surroundings

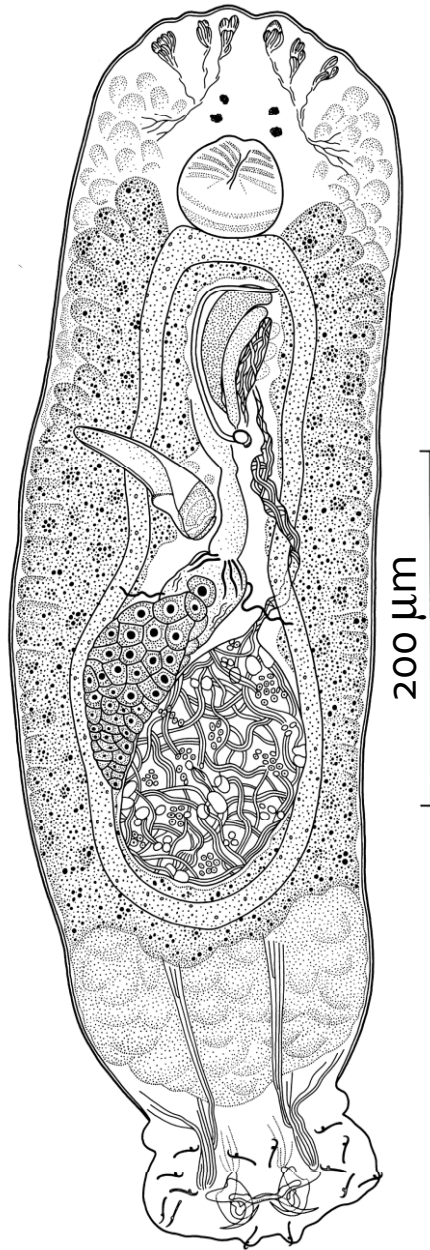


# I. Organismal and structural diversity - species identification

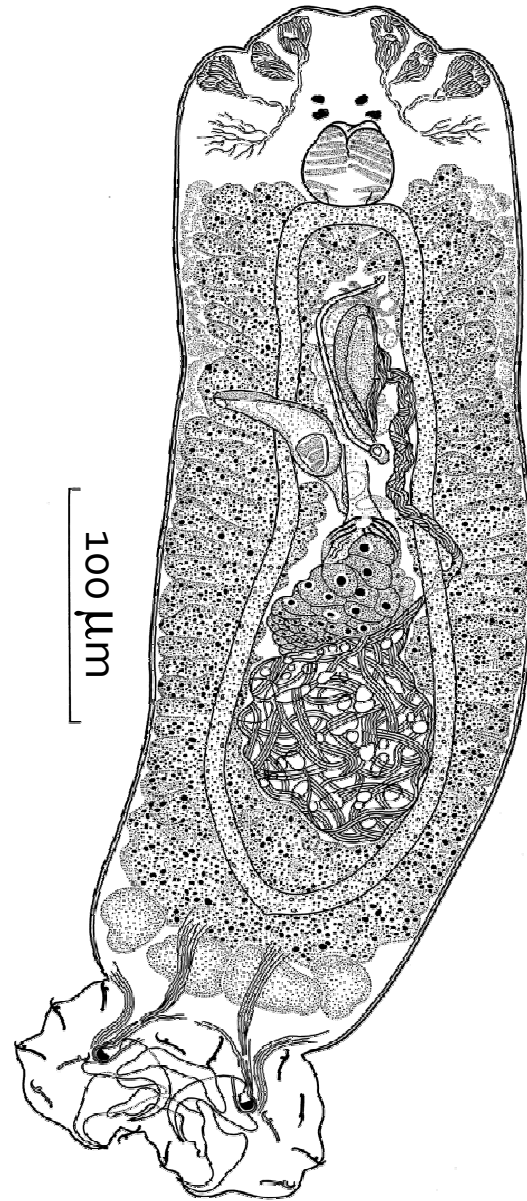


**Drawings:** microscope Olympus BX 50 equipped with a phase contrast optics and drawing tube; **Measurements:** Digital Image Analysis

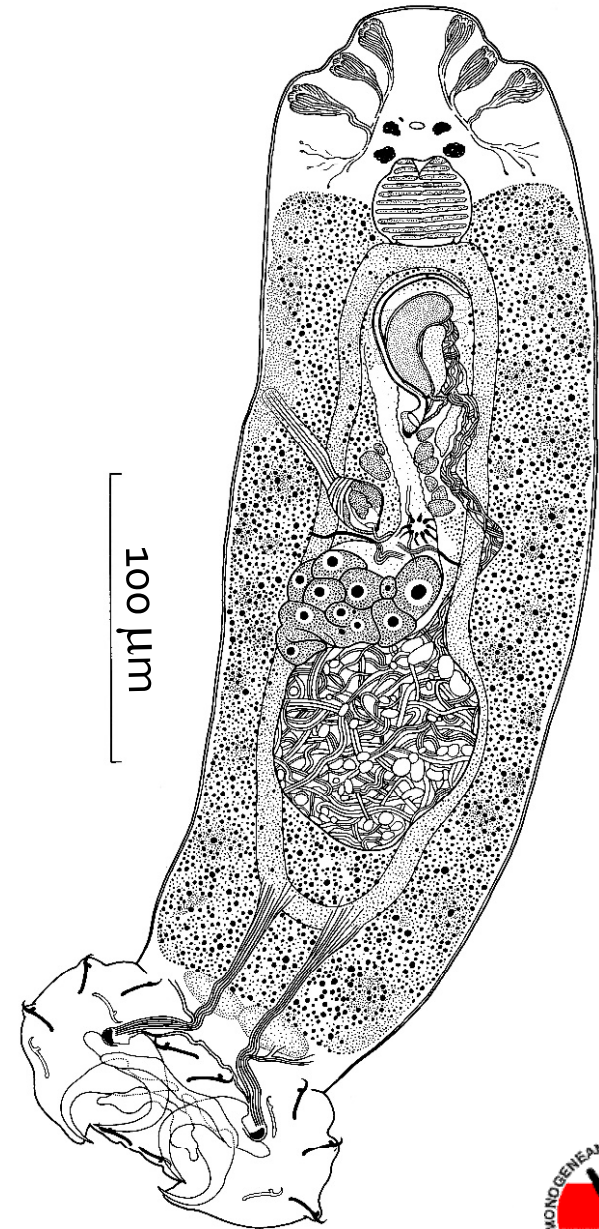
*Thylacicleidus serendipitus*



*Thylacicleidus*  
sp. 1

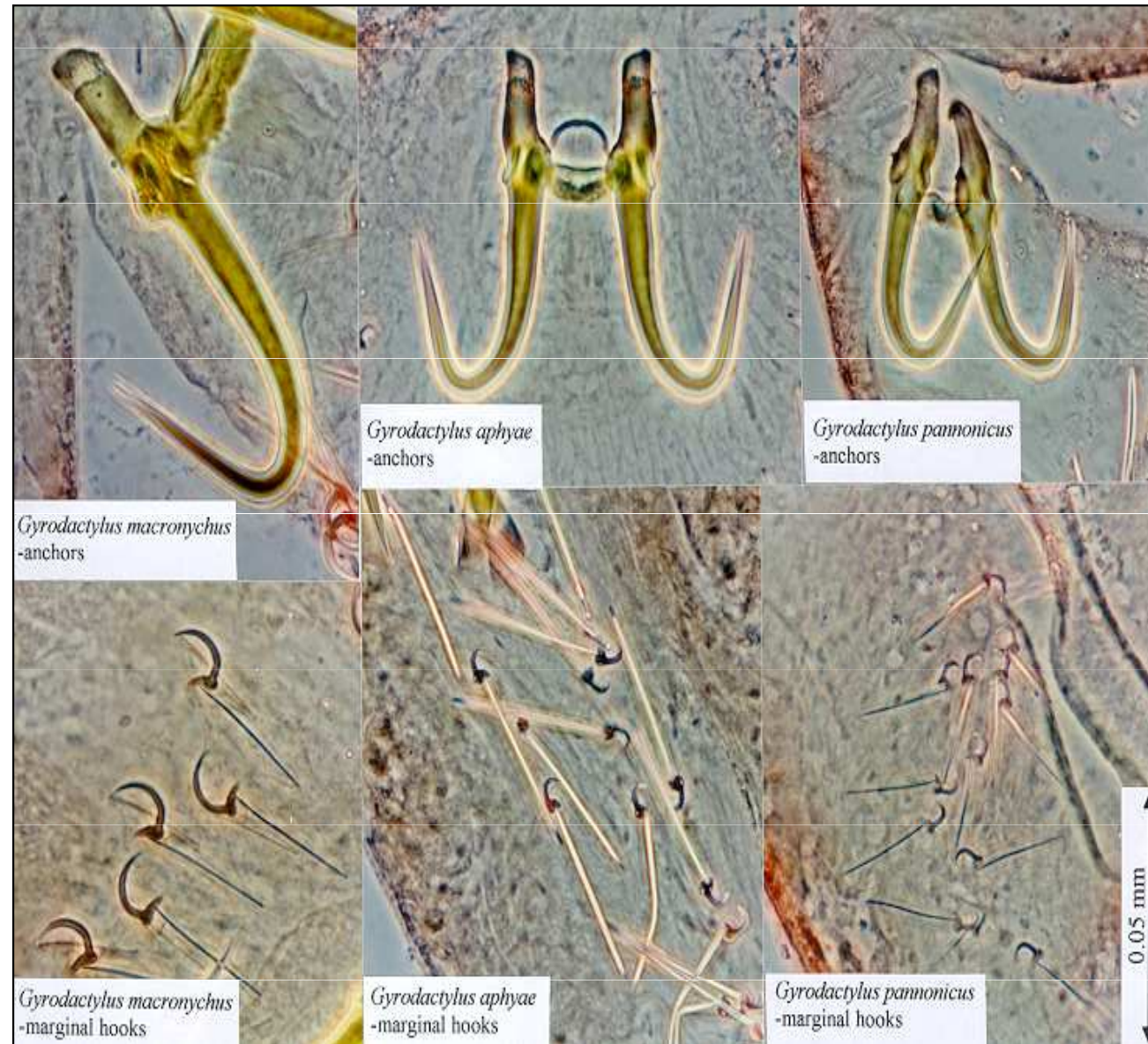


*Thylacicleidus*  
sp. 2



# Laboratoř speciální mikroskopie

## Fázová mikroskopie



**Thylacicleidus  
serendipitus**



**Thylacicleidus  
sp. 1**



**Thylacicleidus  
sp. 2**



# Nomarski differential interference contrast

- DIC Nomarski
- mid-1950s - Georges Nomarski modified the Wollaston prism
- Living or stained specimens, which often yield poor images when viewed in brightfield illumination, are made clearly visible by optical rather than chemical means

Differential Interference Contrast Schematic

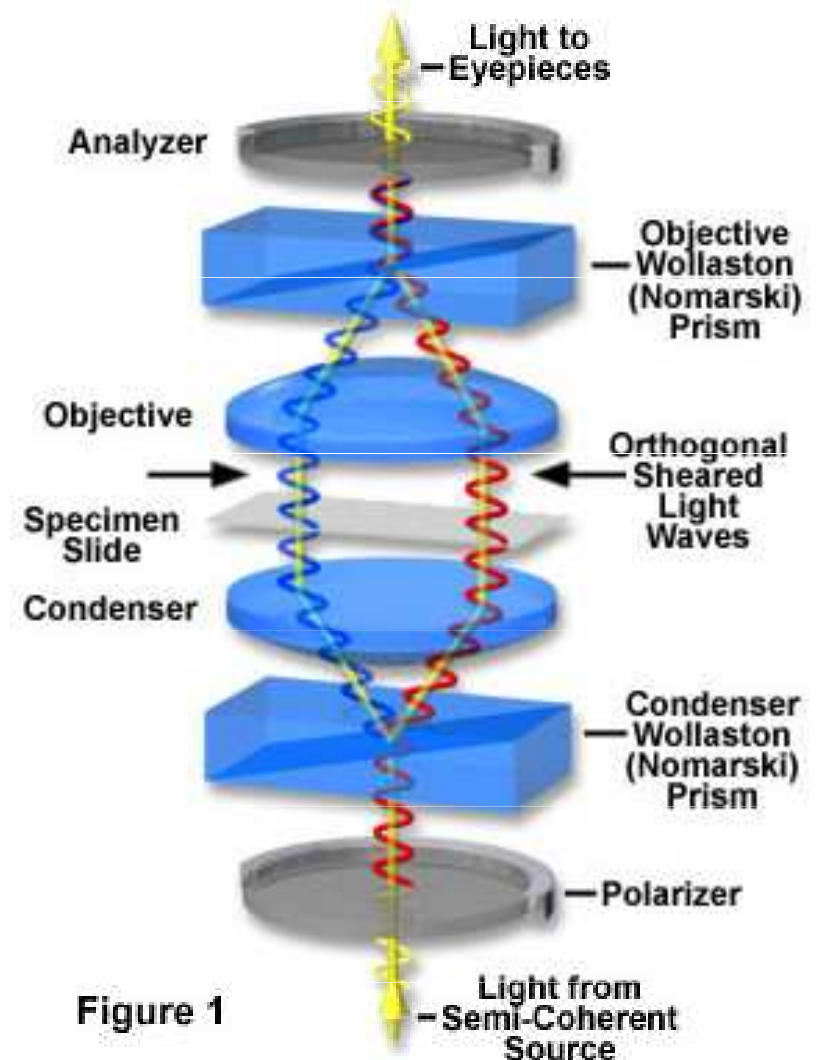
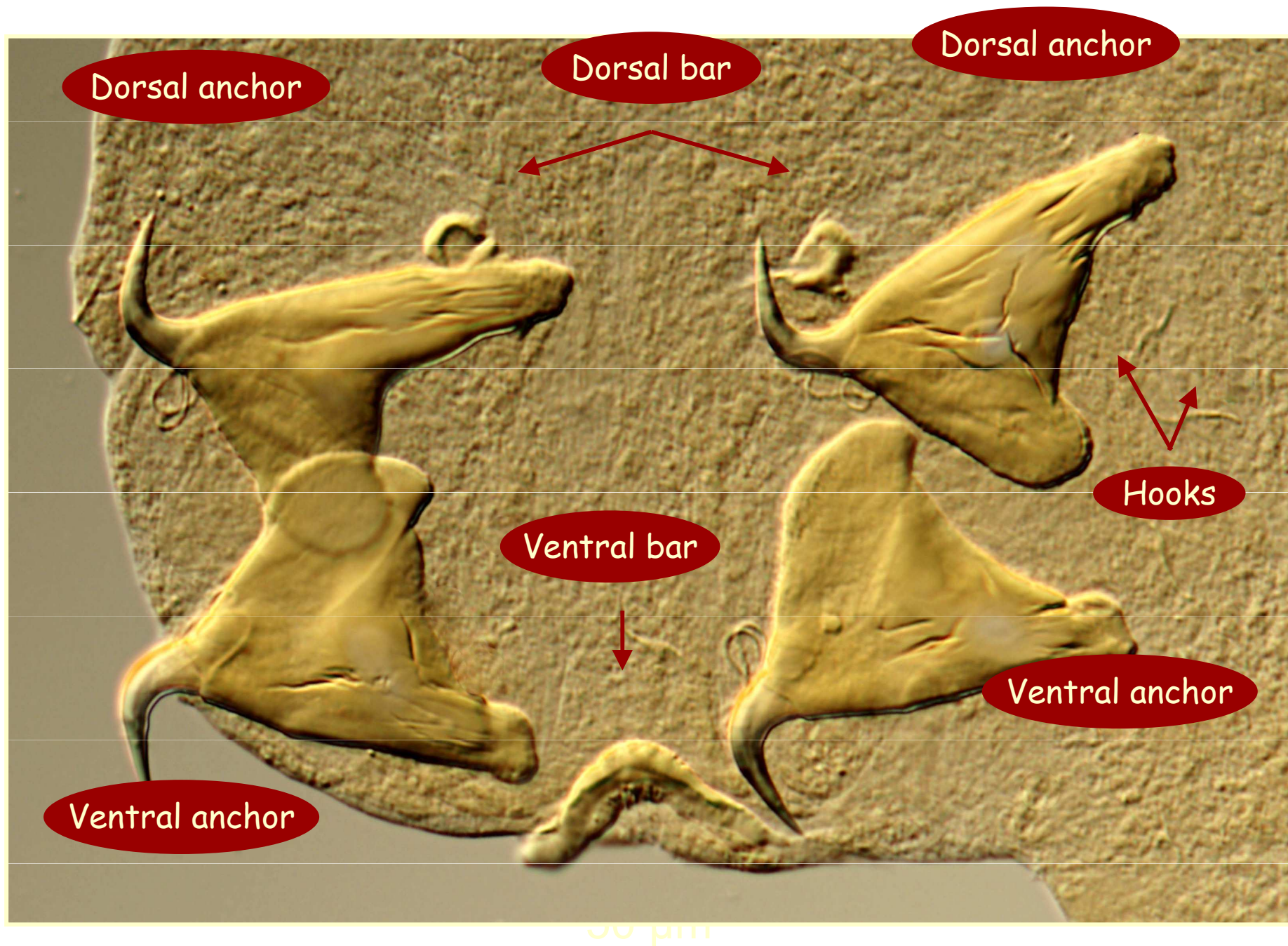


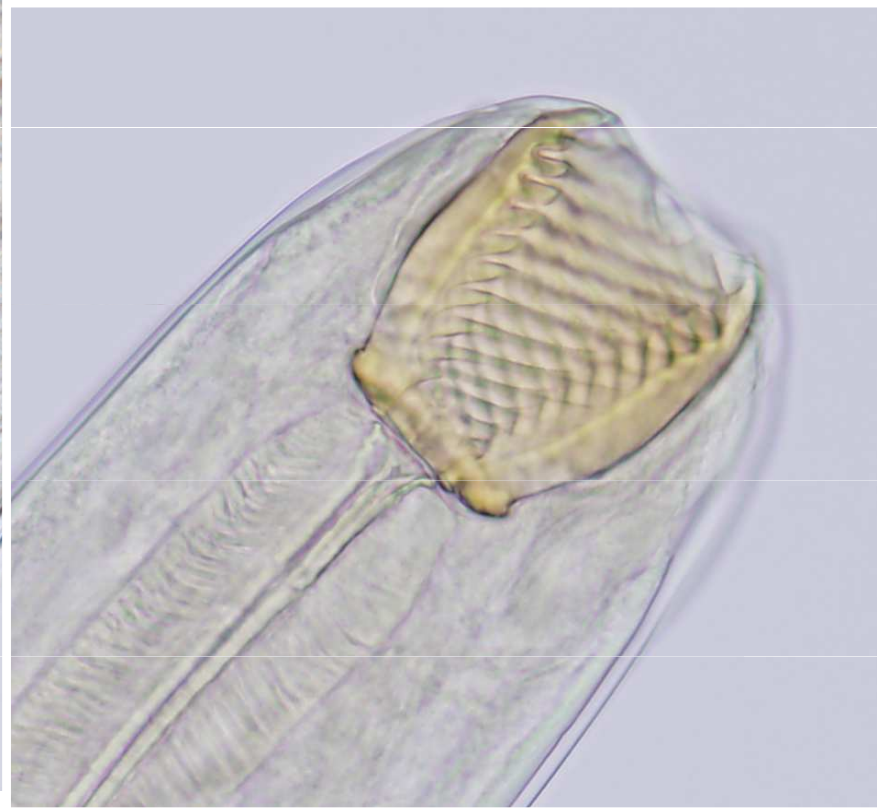
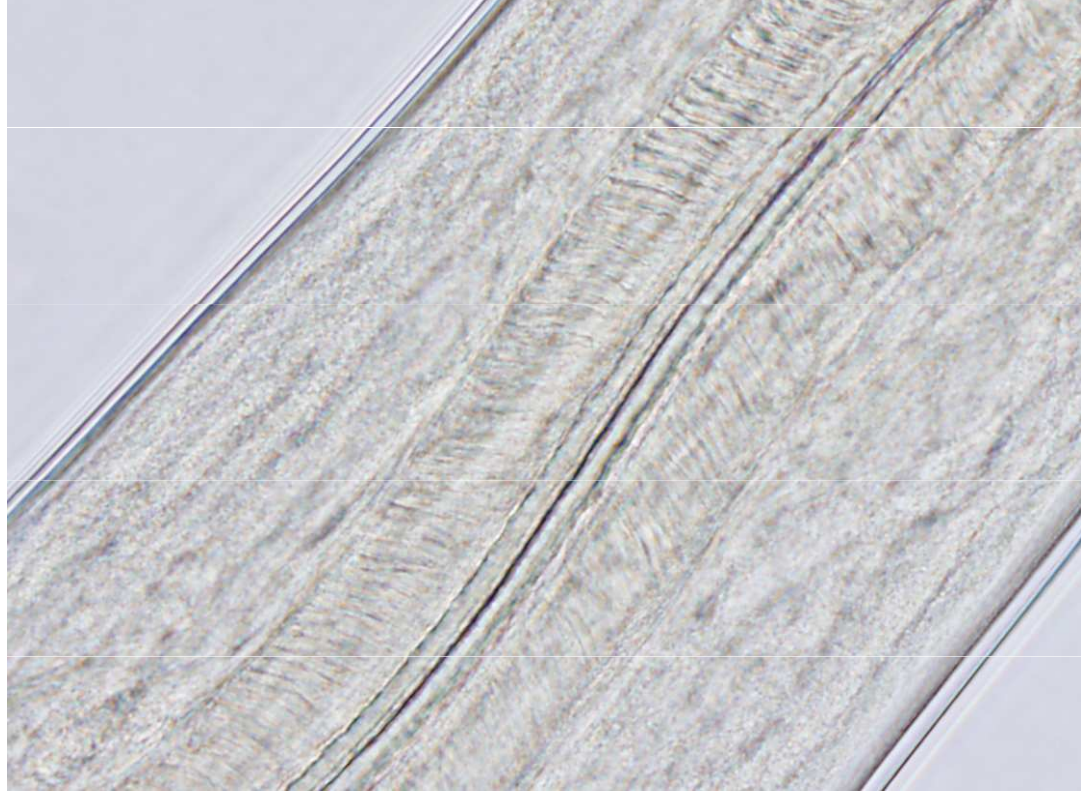
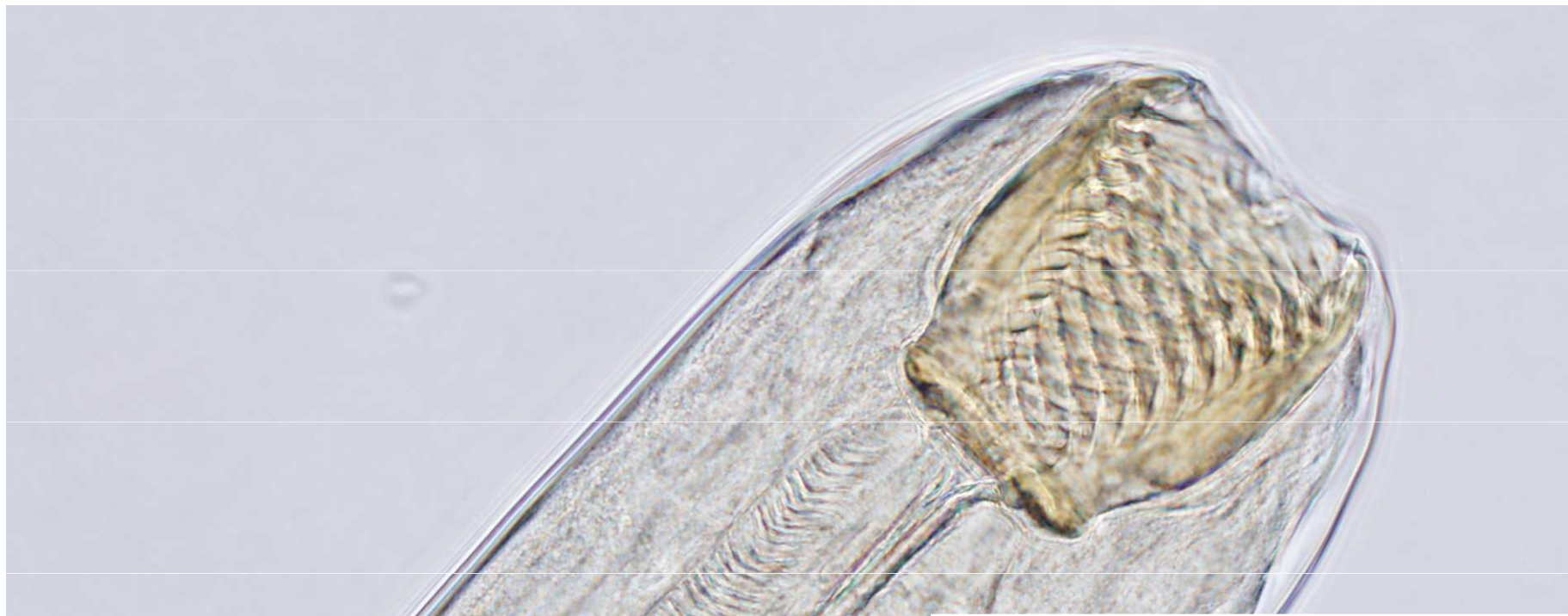
Figure 1

# Laboratoř speciální mikroskopie (DIC Nomarski)

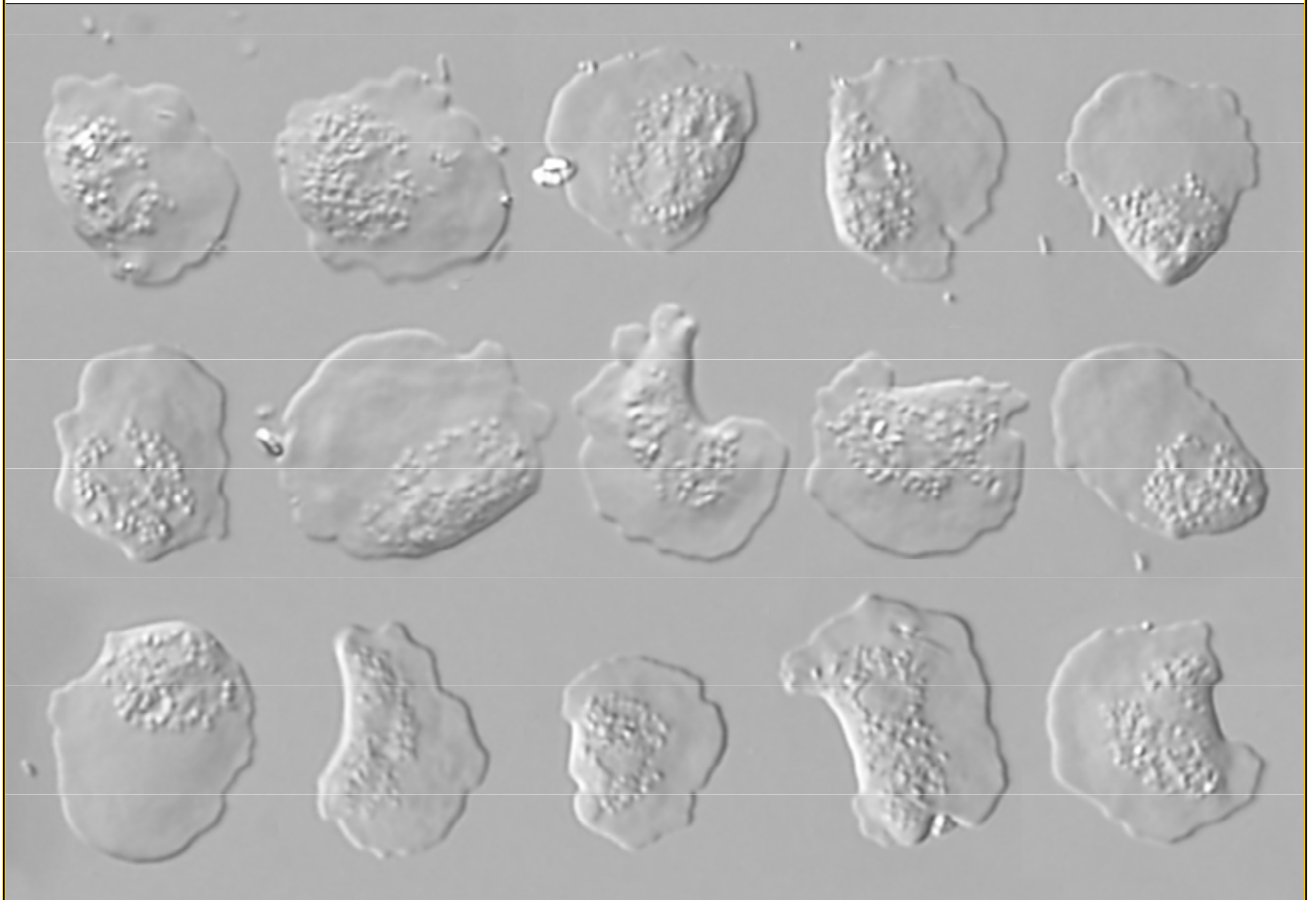






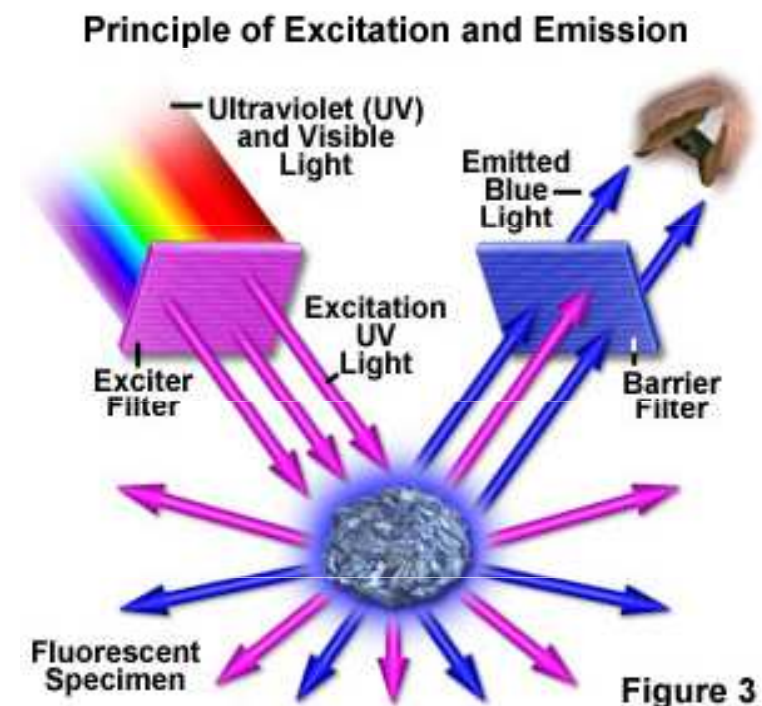


Model parasites group: free living amoebae



# Fluorescent illumination

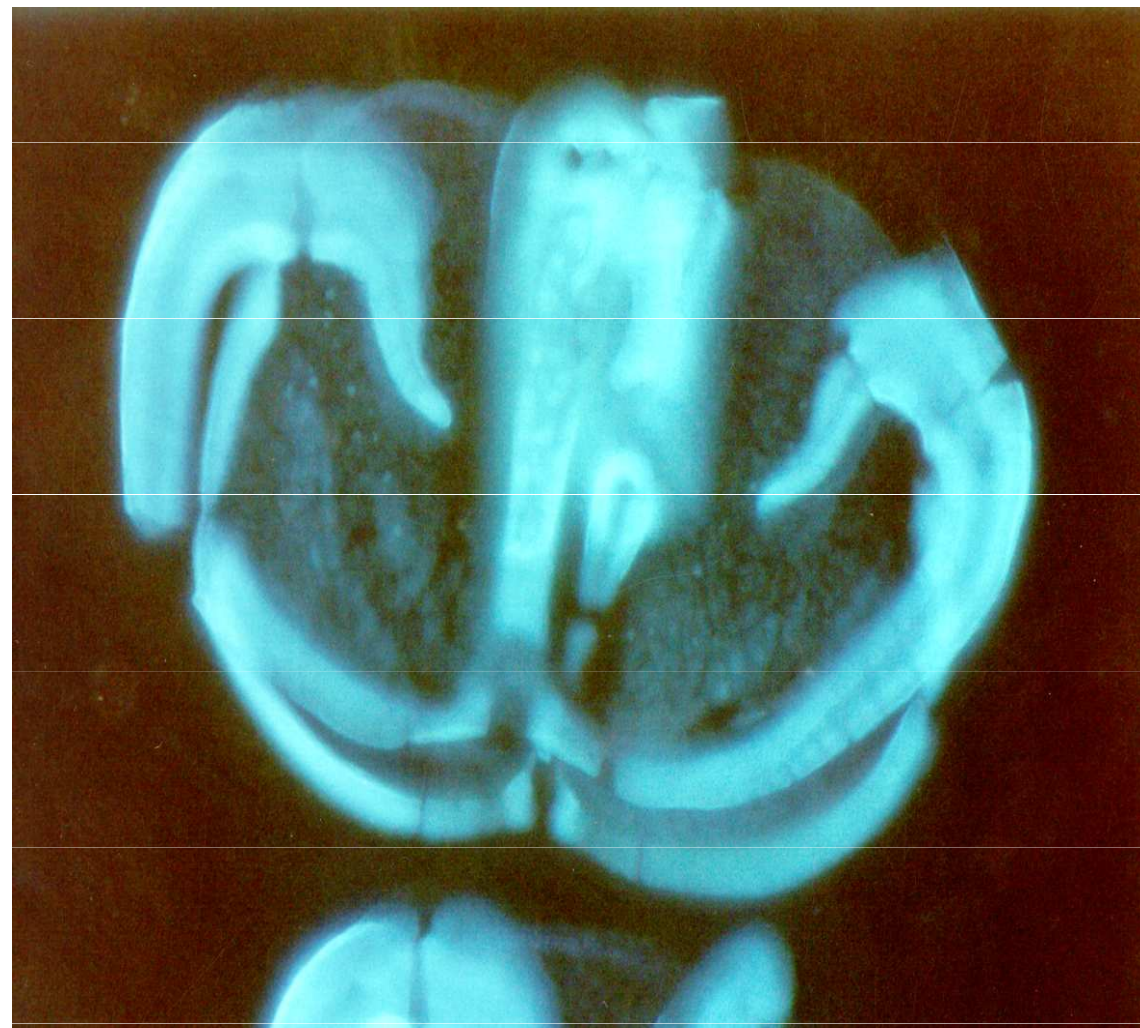
- emission of light by a substance that has absorbed light or other electromagnetic radiation of a different wavelength
- emitted light has:
  - longer wavelength
  - lower energy



# Fluorescenční mikroskopie

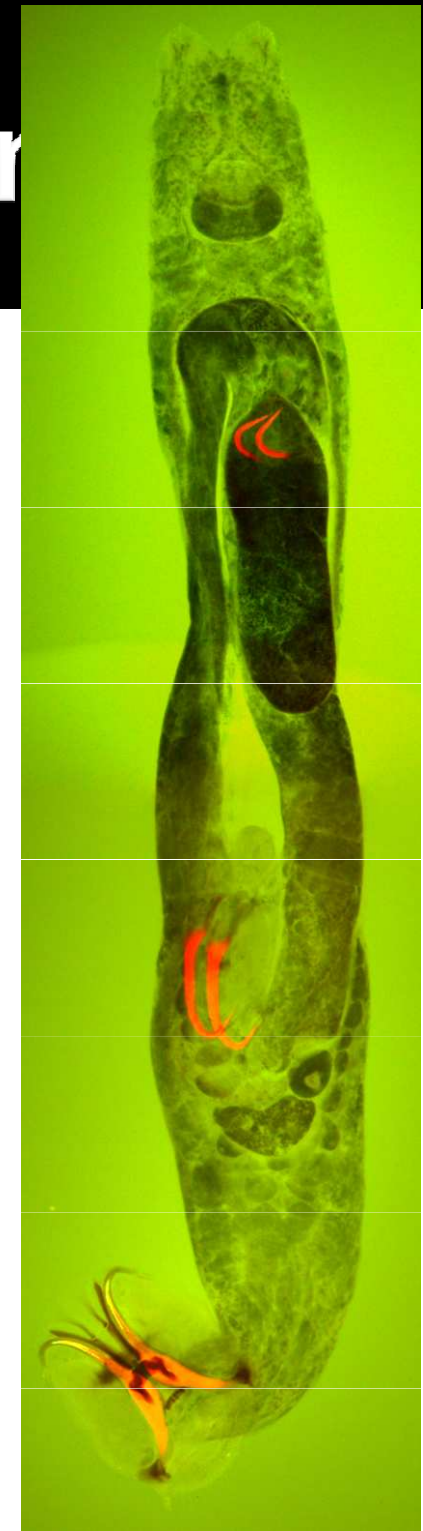
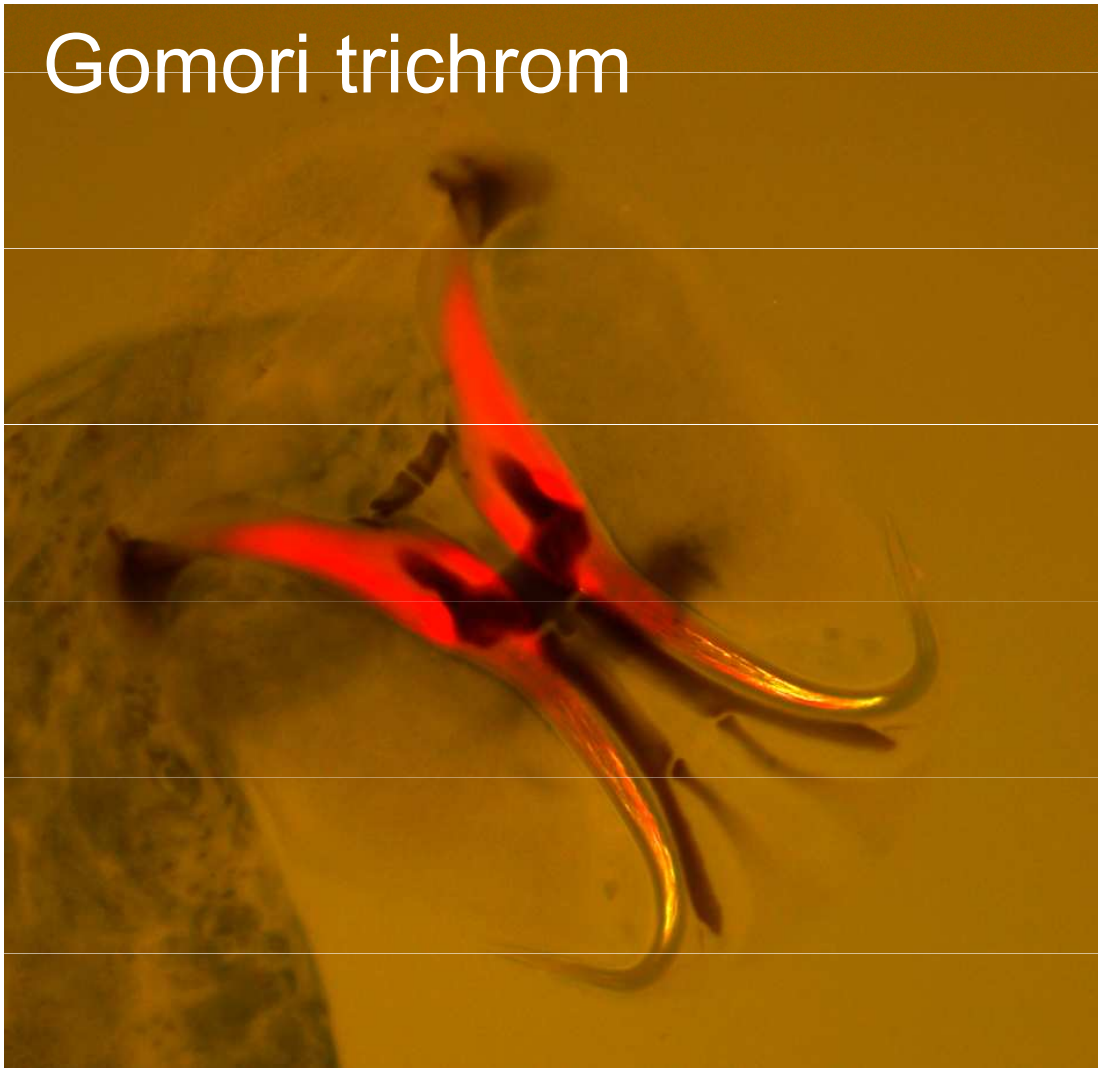


# Fluorescent illumination



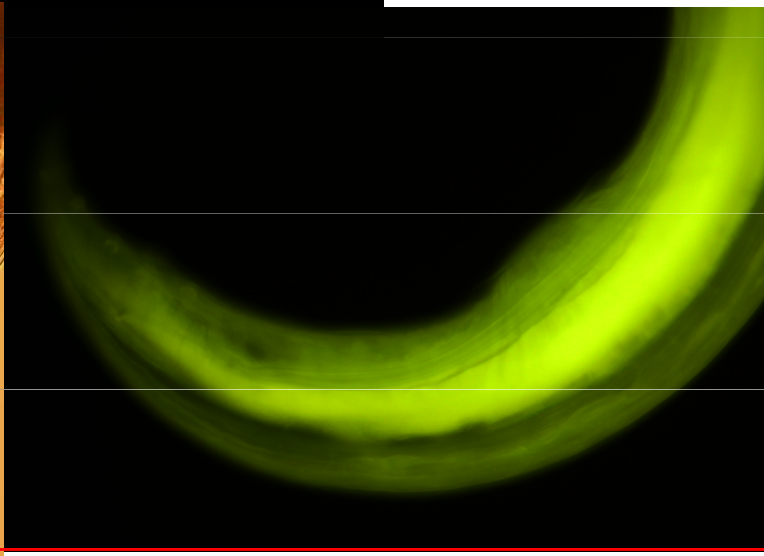
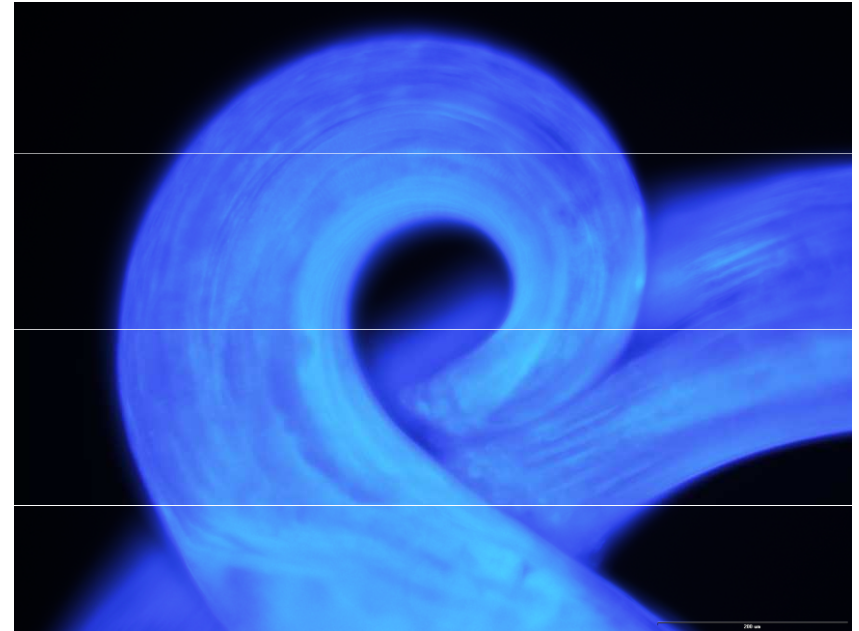
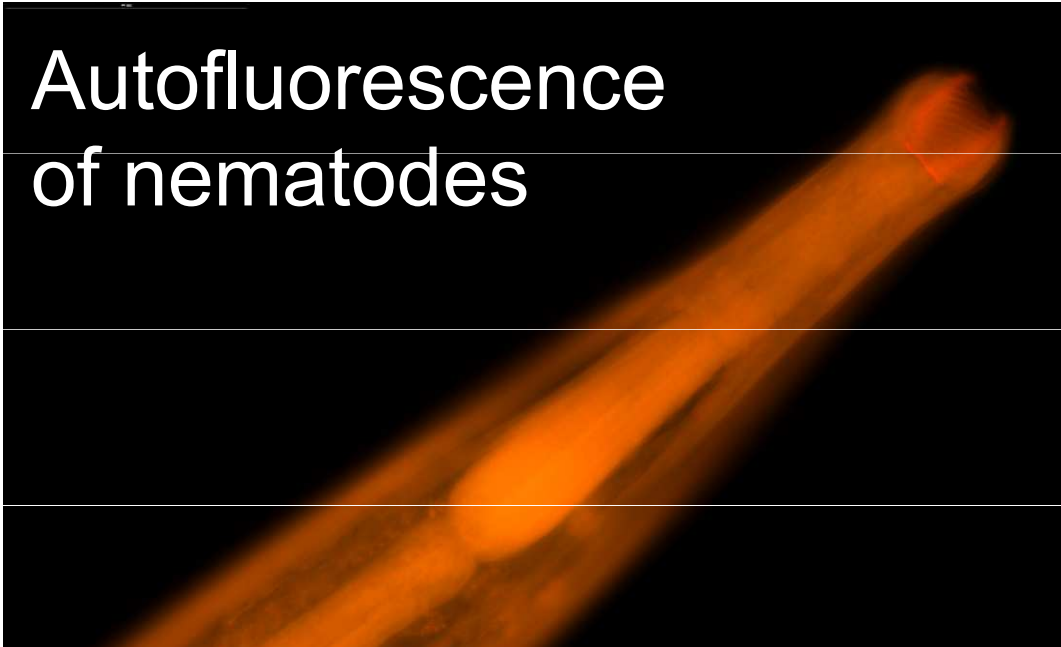
# Fluorescent illumination

Gomori trichrom

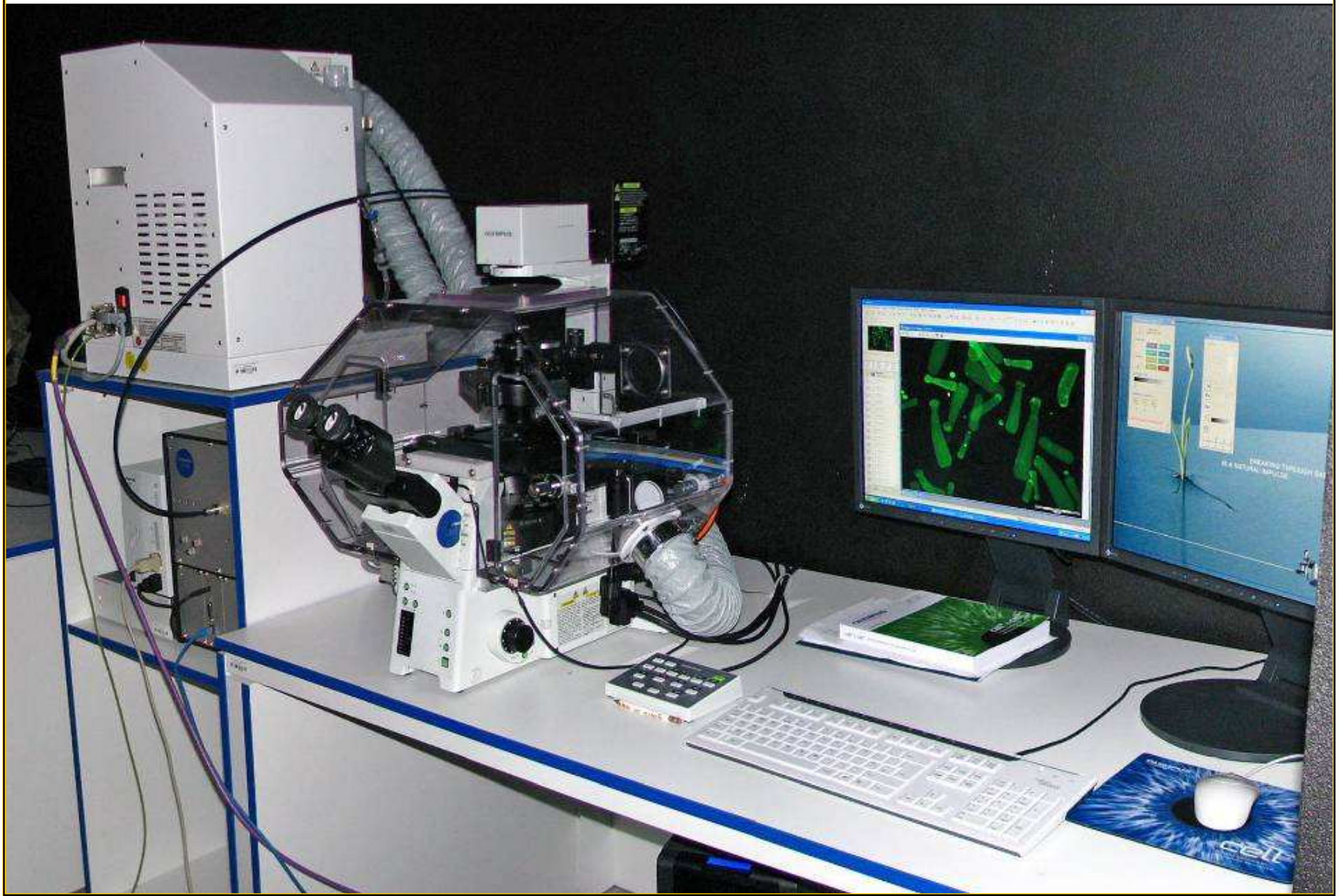


# Fluorescent illumination

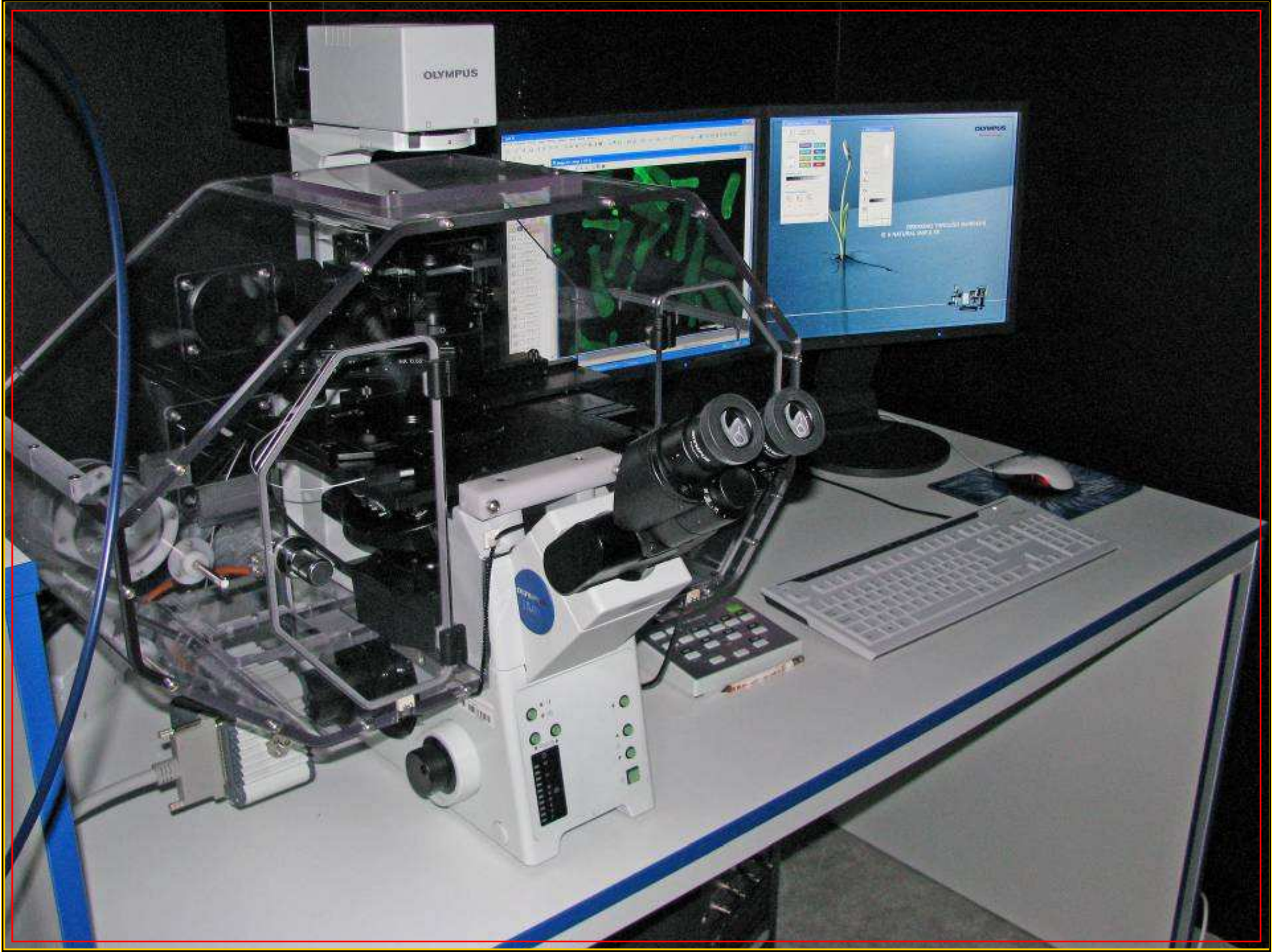
Autofluorescence  
of nematodes



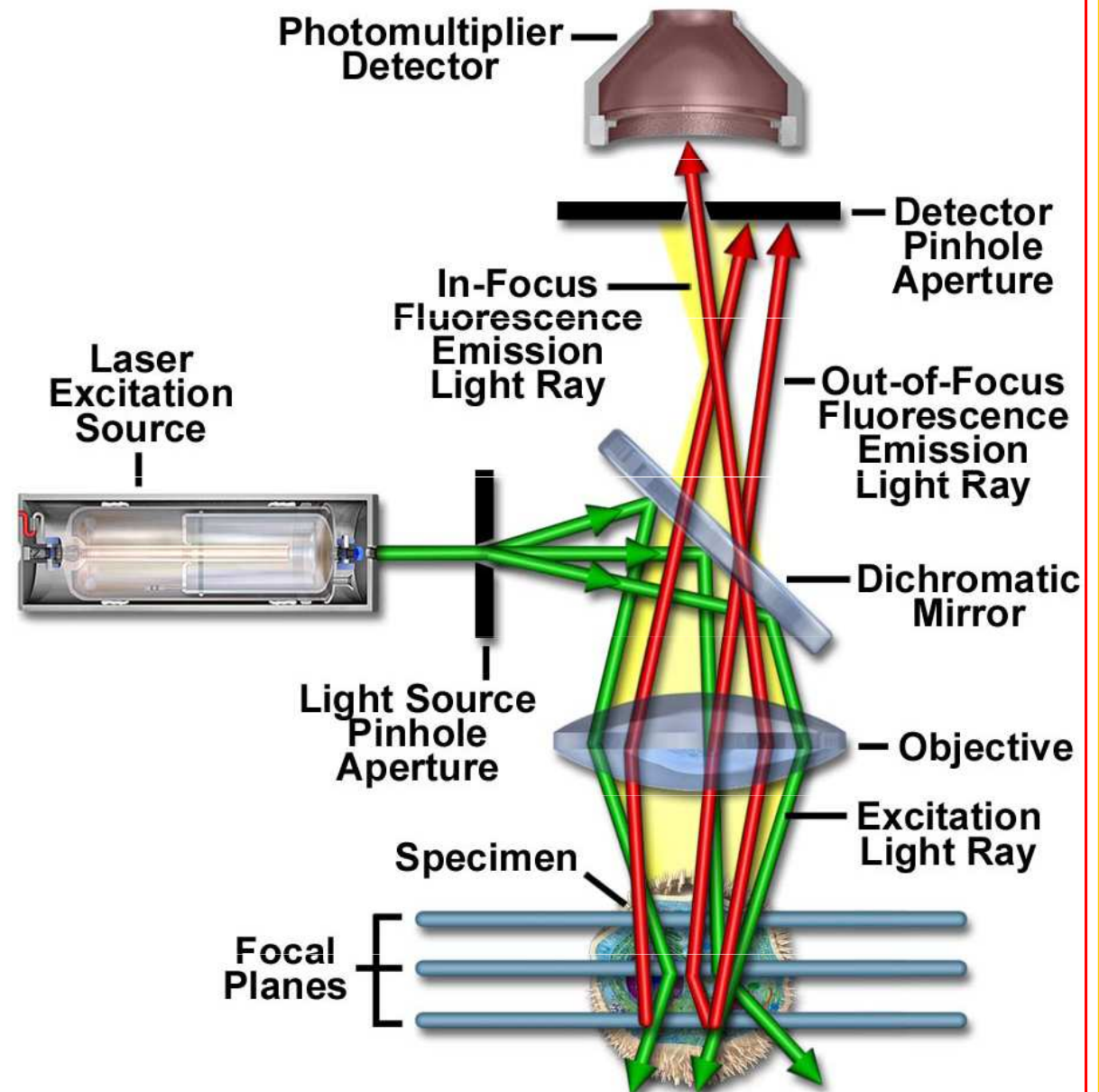
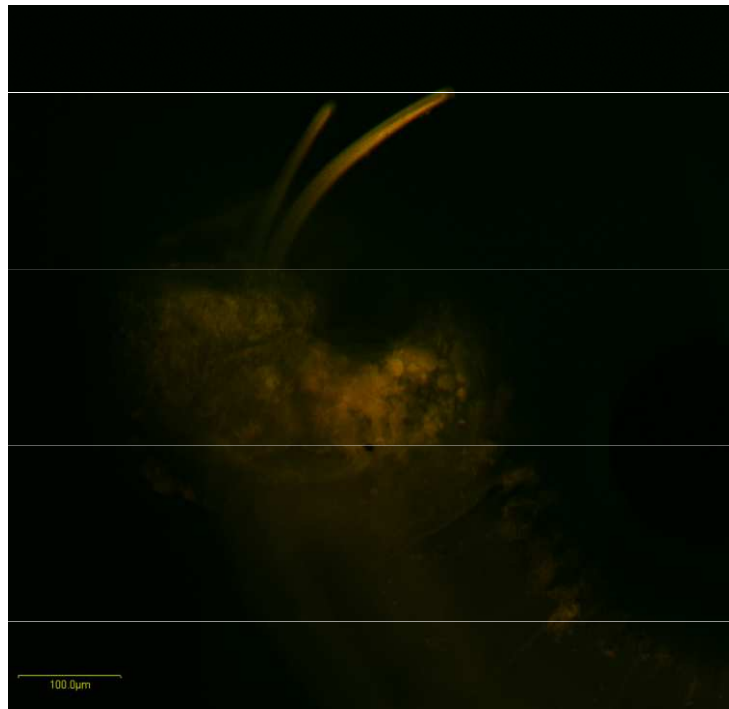
# Olympus Cell<sup>R</sup> - motorizovaný invertovaný mikroskop se systémem rychlé fluorescence pro sledování procesů v živých buňkách







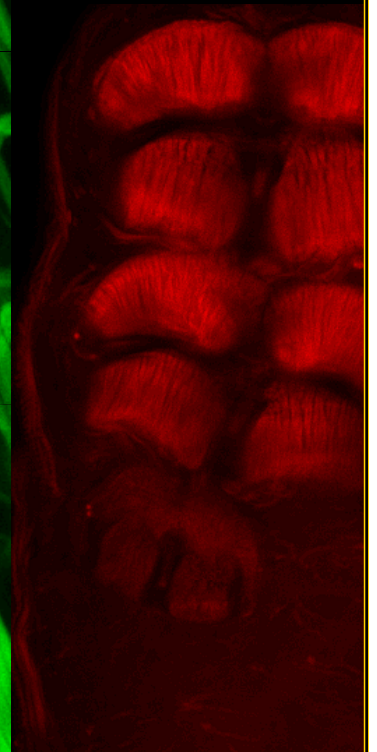
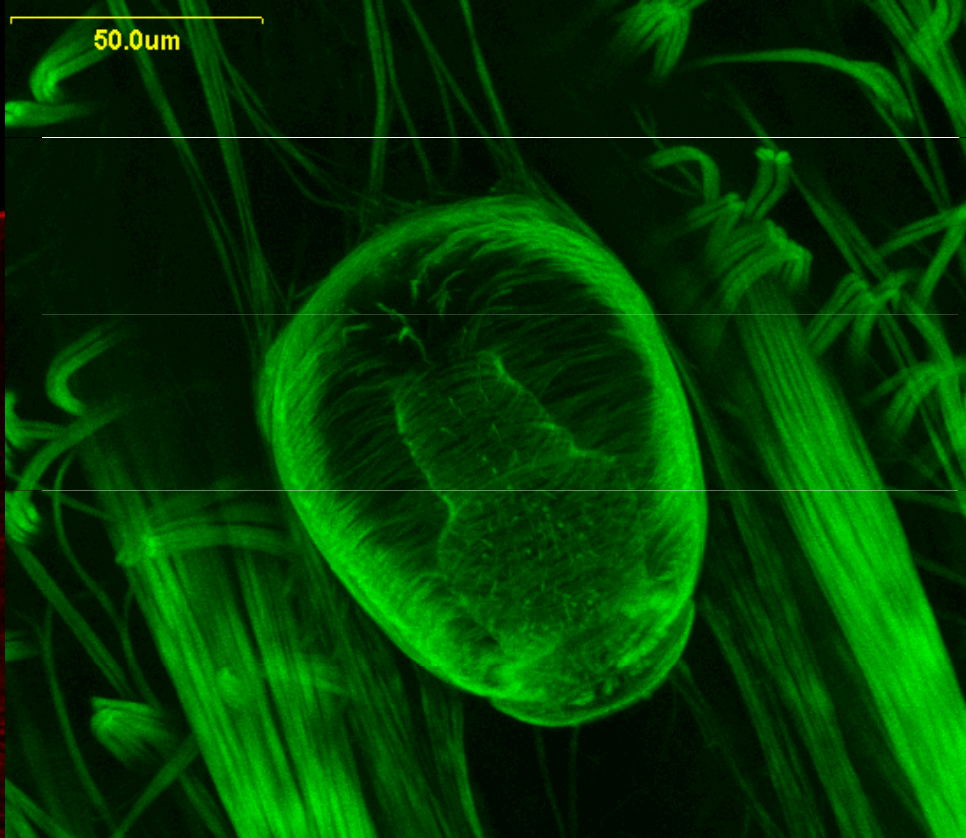
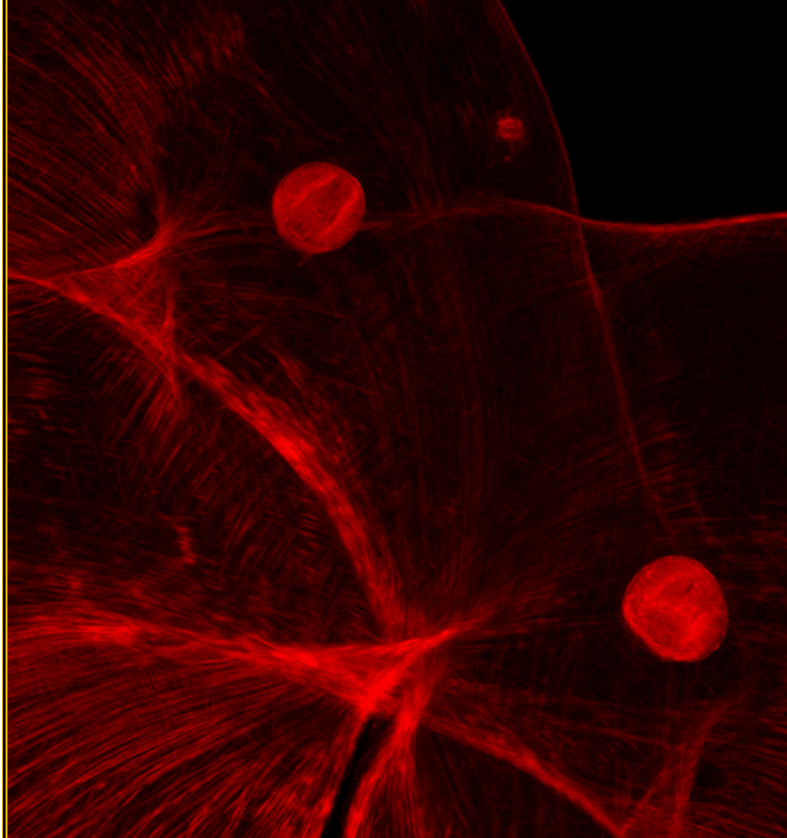
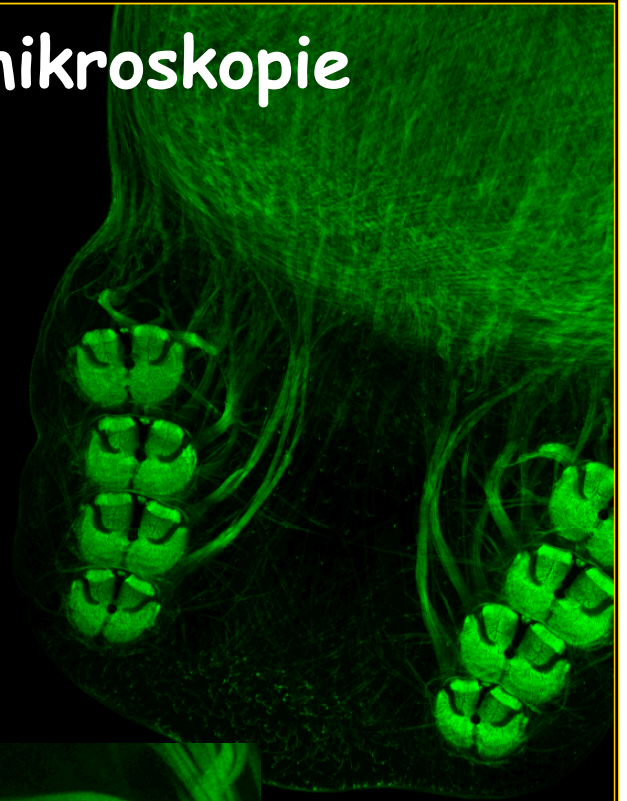
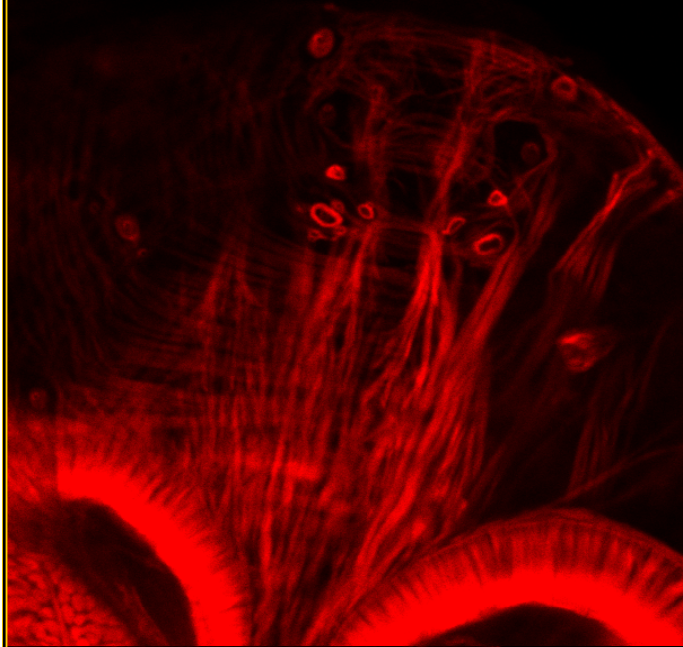
# Confocal Laser Scanning Microscopy



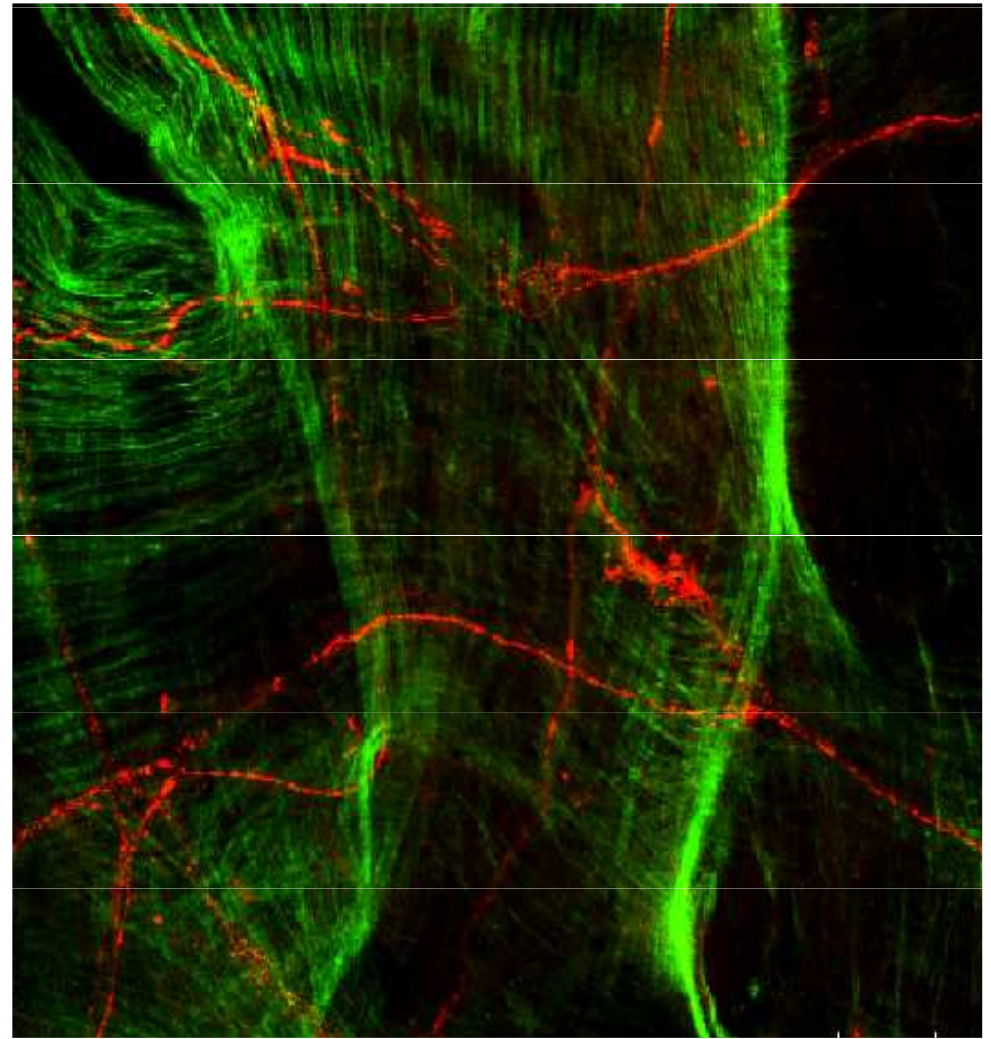
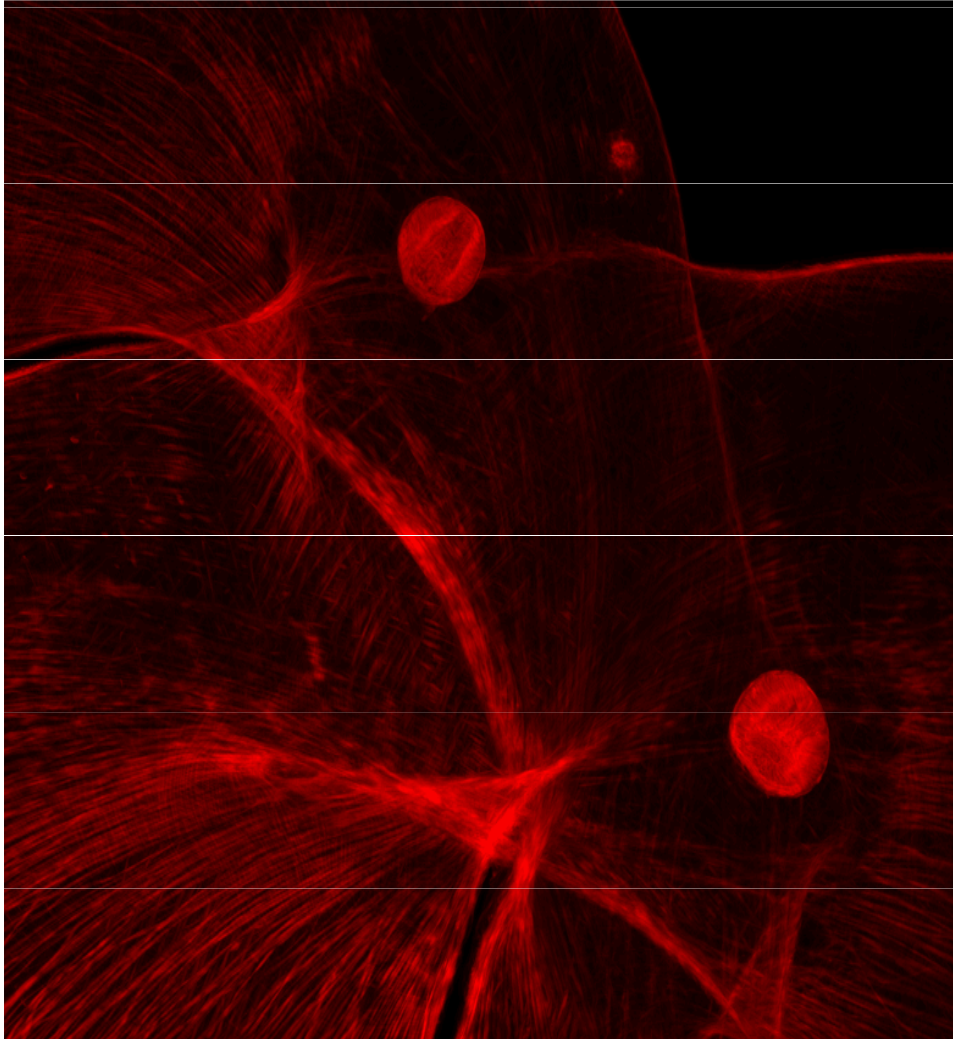
**CLSM**



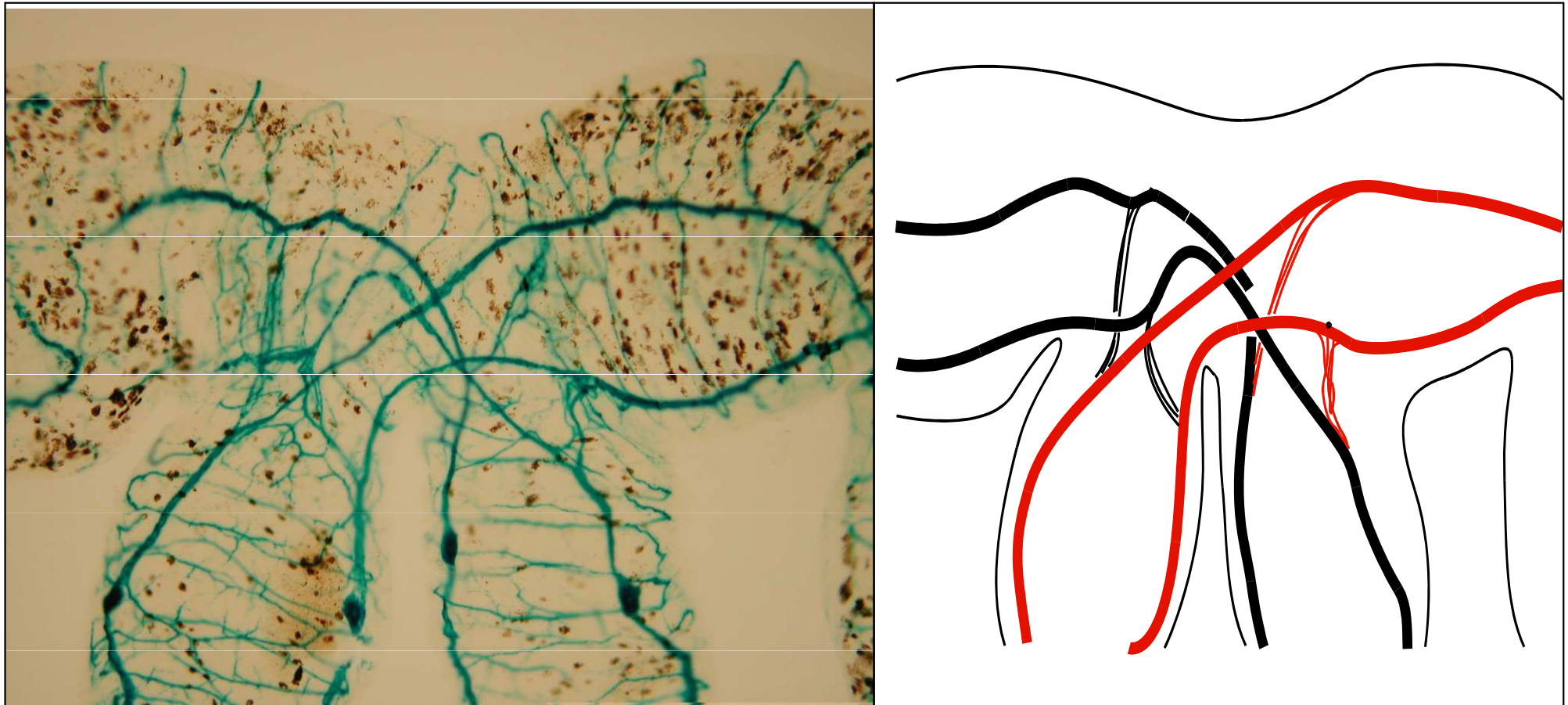
# CLSM - Konfokální laserová skanovací mikroskopie



# Možnost kombinace barvicích technik



# Schematic illustration of neuronal interspecific connectivity between 2 heterogenic CNS

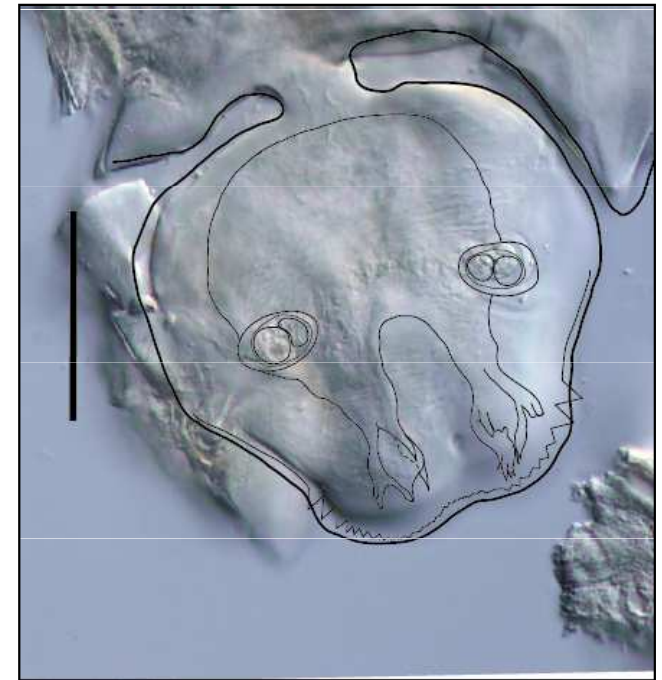
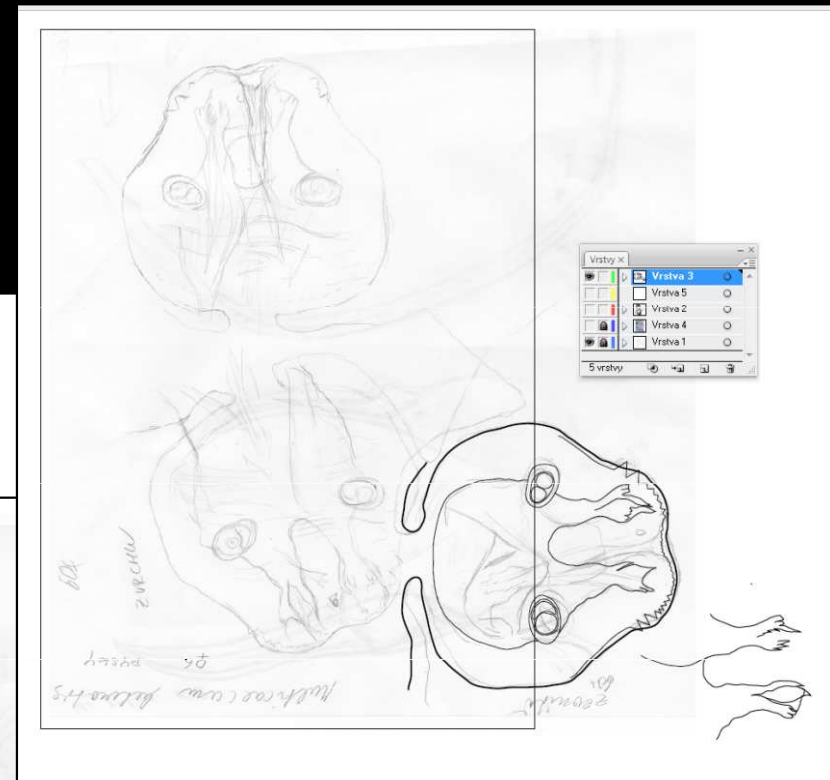
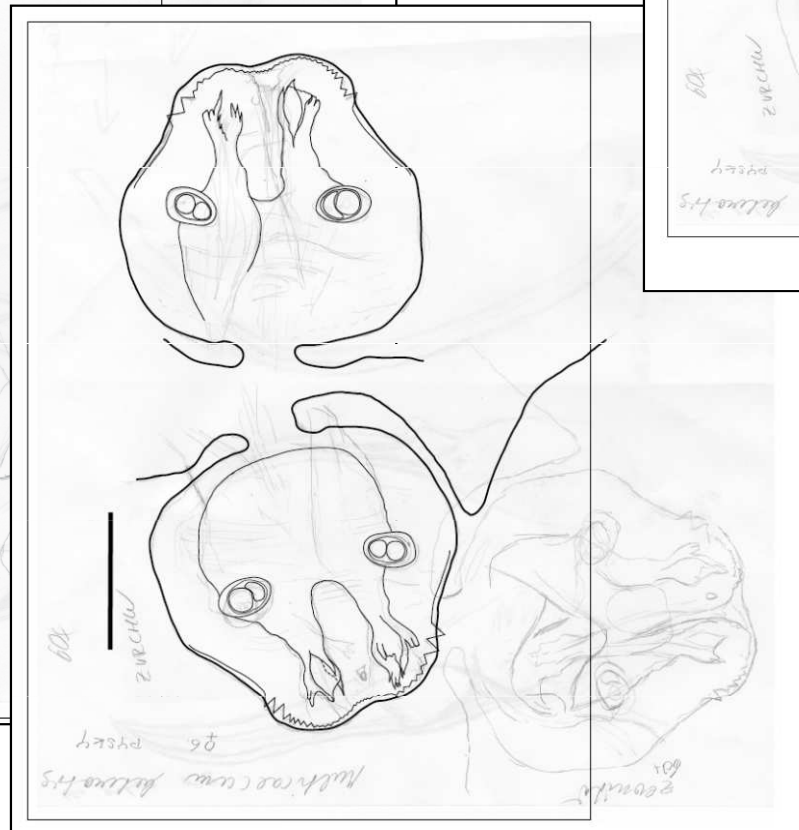
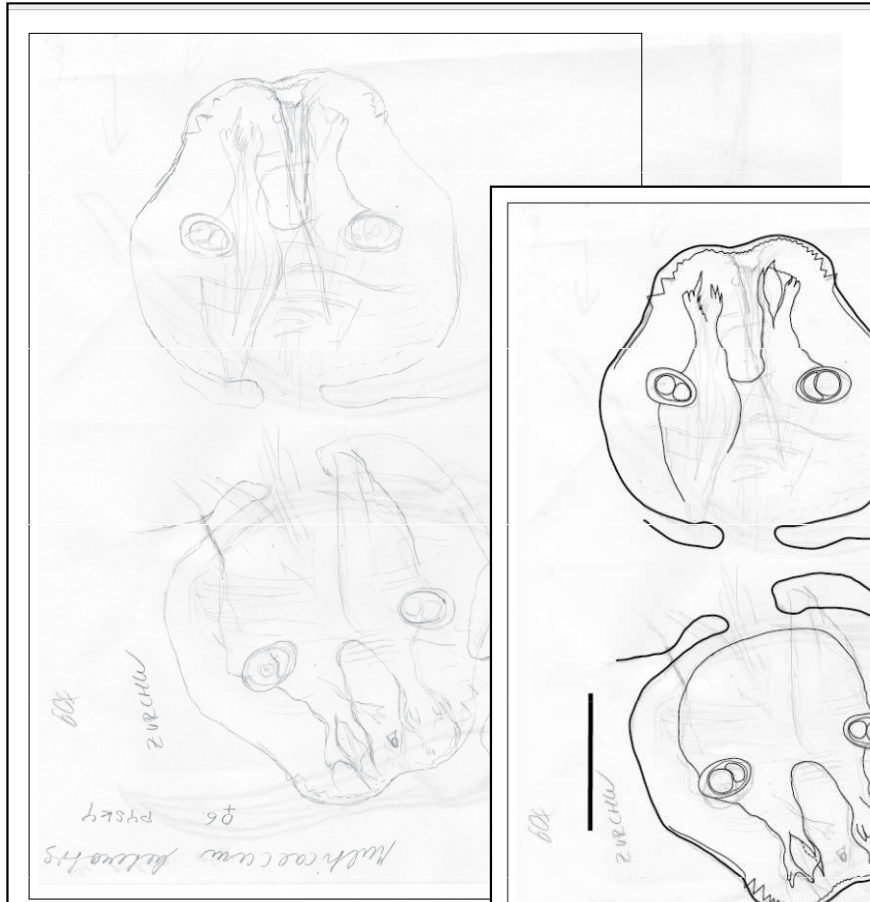


Zurawski T.H. et al., 2003: Microscopic evaluation of neural connectivity between paired stages of *Eudiplozoon nipponicum*. J. Parasitol 89:198-200

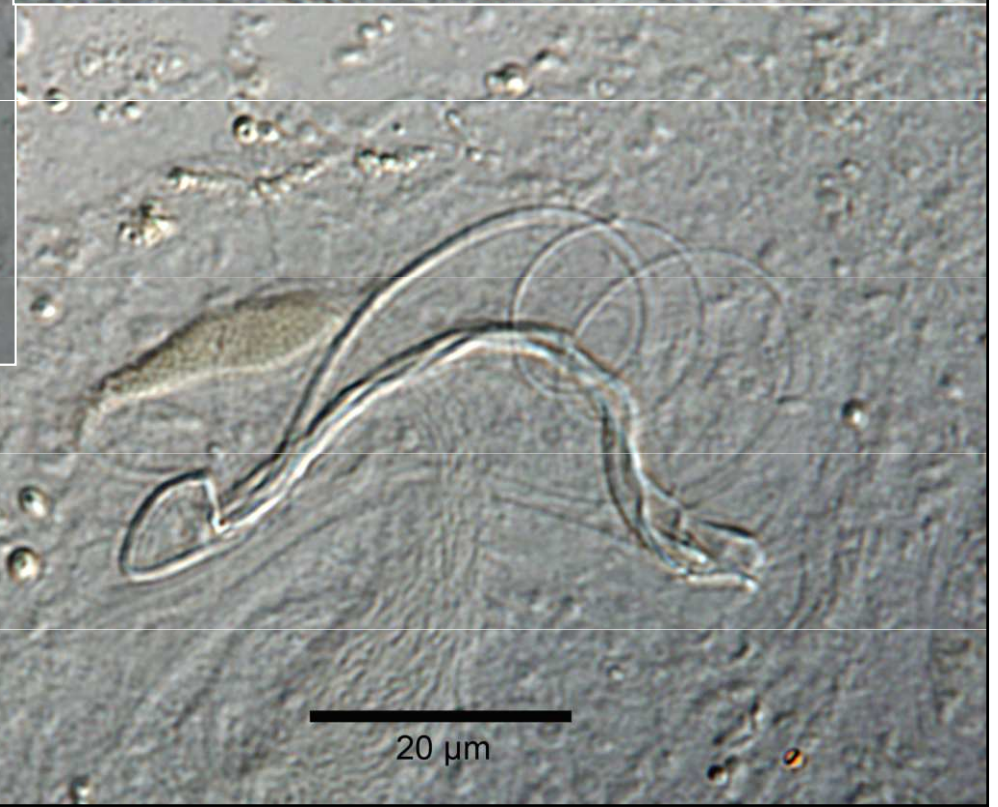
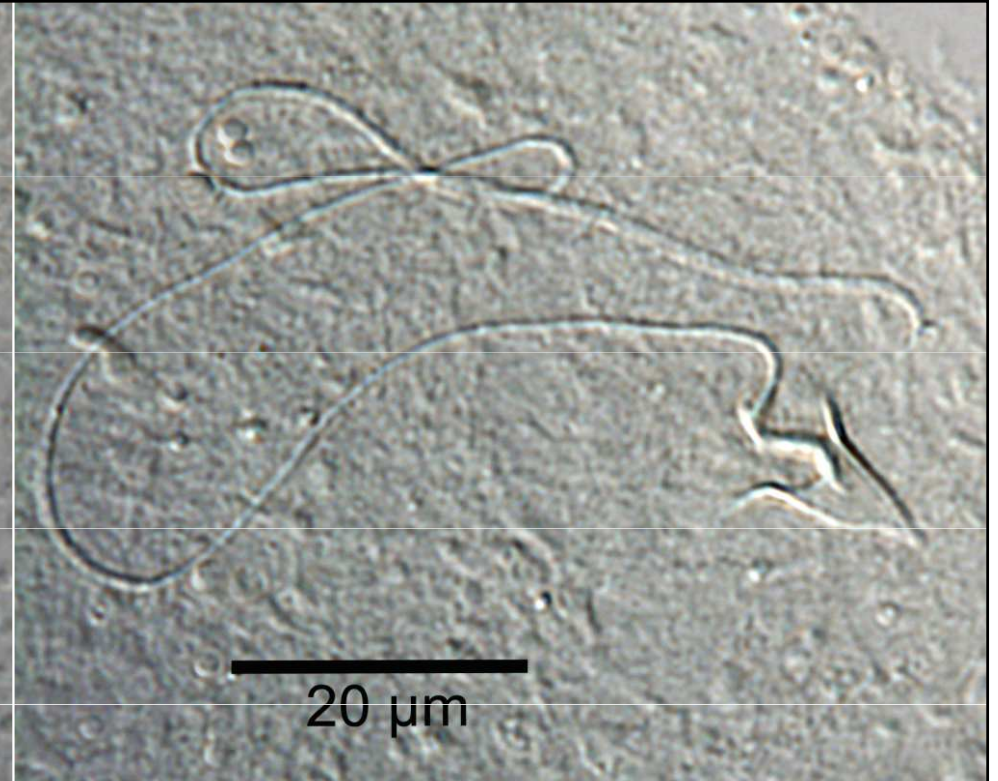
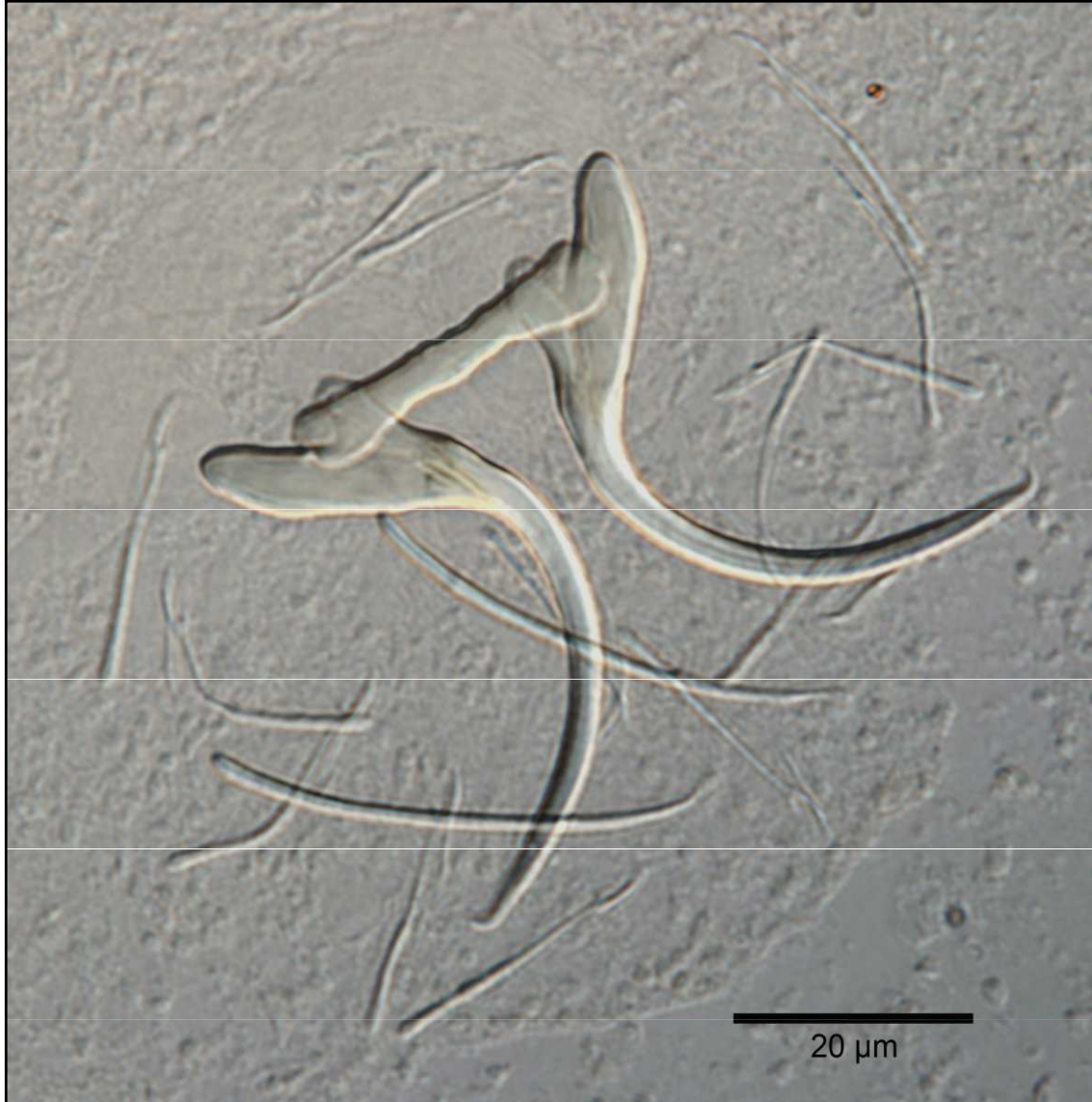
# Line-drawings



# Line-drawings



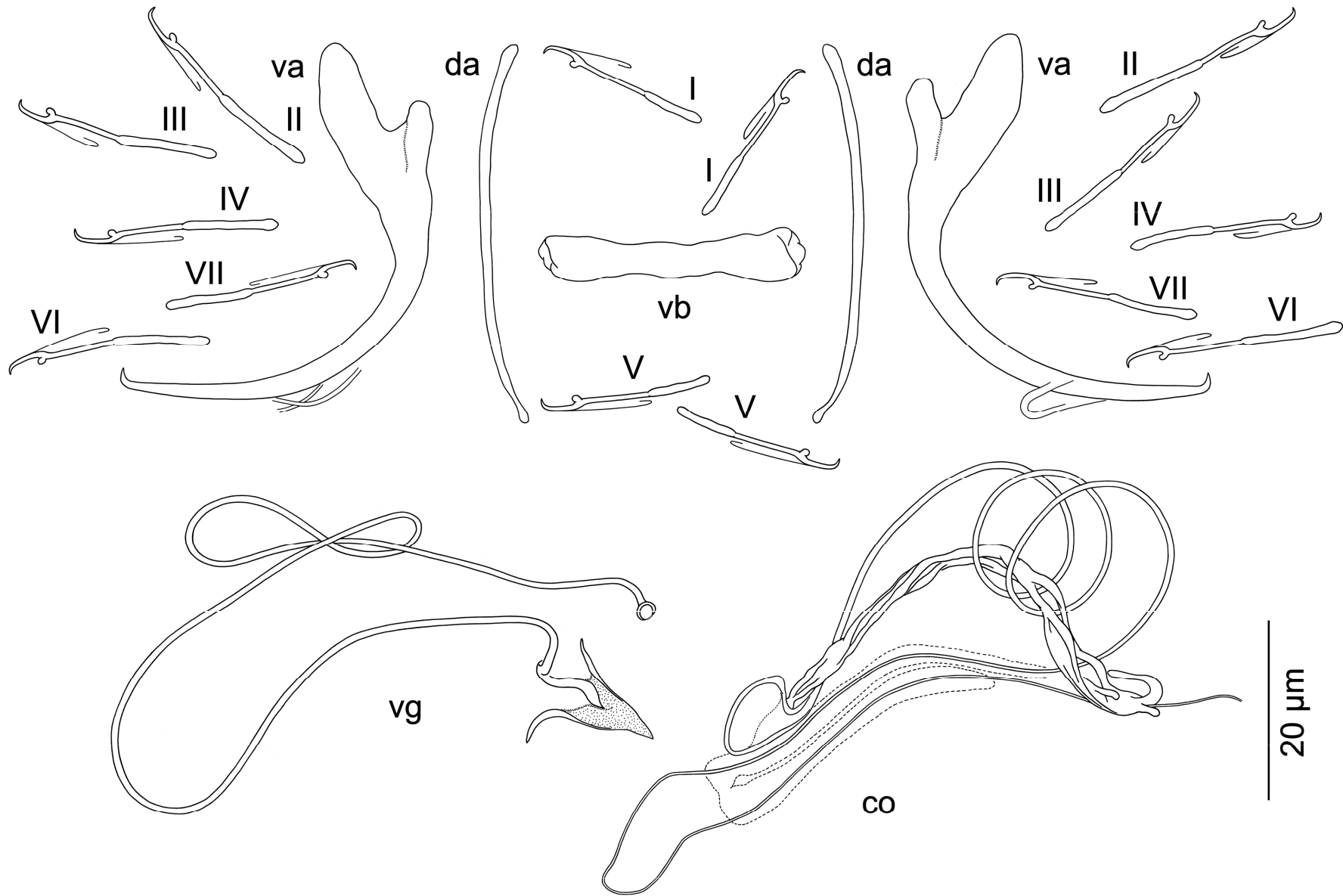




*Nanotrema niokoloensis* n.sp.

**Host:** *Citharinus citharus citharus*

**Locality:** Niokolo Koba River near Pont  
Suspendu Niokolo-Koba National Park,  
Senegal

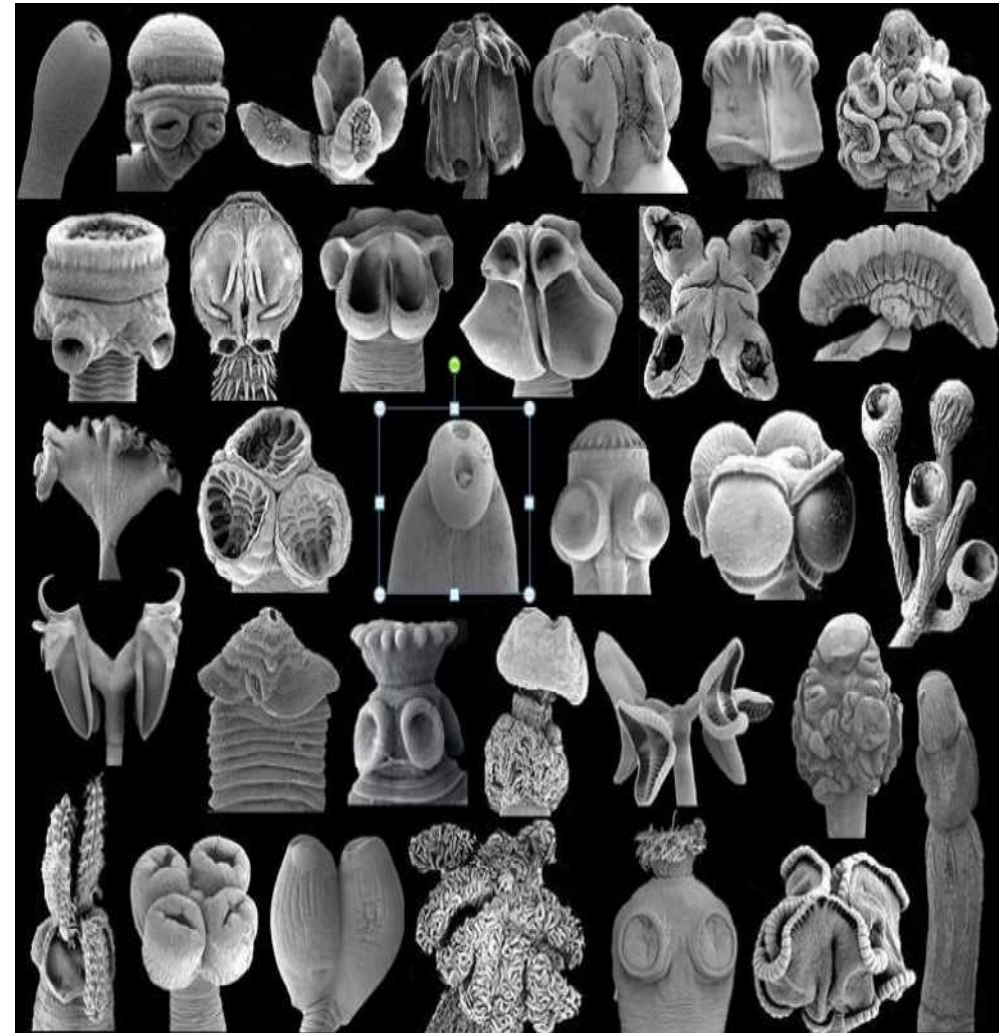
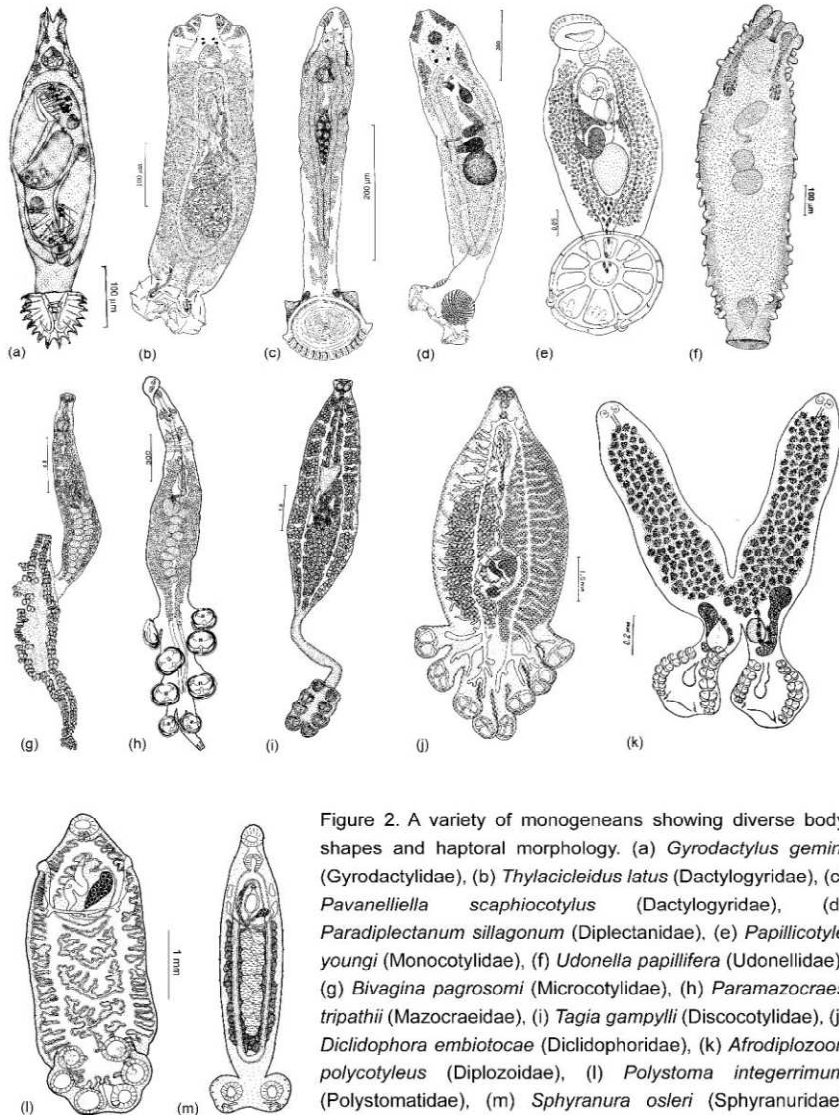


*Sclerotised structures of Nanotrema niokoloensis* sp.nov.: va = ventral anchor, vb = ventral bar, da = dorsal anchor, I-VII = pairs of hooks, co = copulatory organ, vg = vagina

# Sampling of parasite individual

Variety of monogenean body shapes and haptor morphology

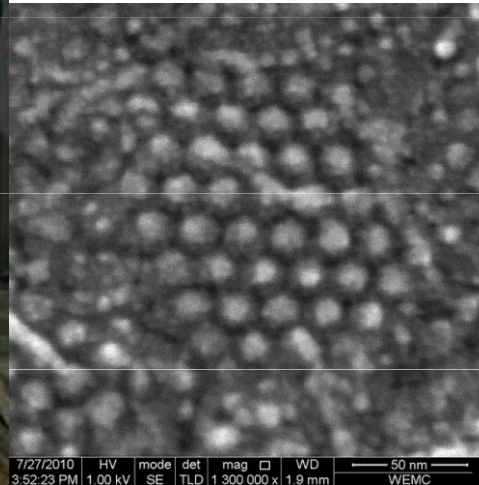
Variety of types of scolexes of cestodes



# Ultra High Resolution SEM



Magellan (FEI).



resolutions  
below one  
nanometer

7/27/2010 HV mode det mag □ WD 50 nm  
3:52:23 PM 1.00 kV SE TLD 1 300 000 x 1.9 mm WEMC www.fei.com

# AFM



Example of AFM image is shown below where the shape of single DNA and protein molecules are seen. (<http://nano.uib.no/AFM.php>)

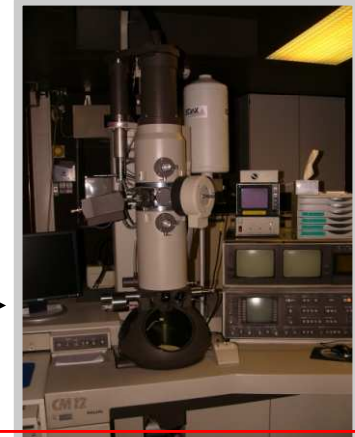
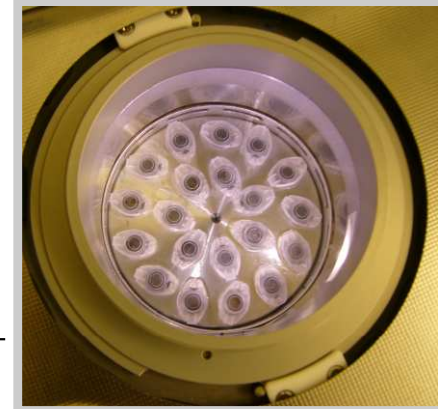
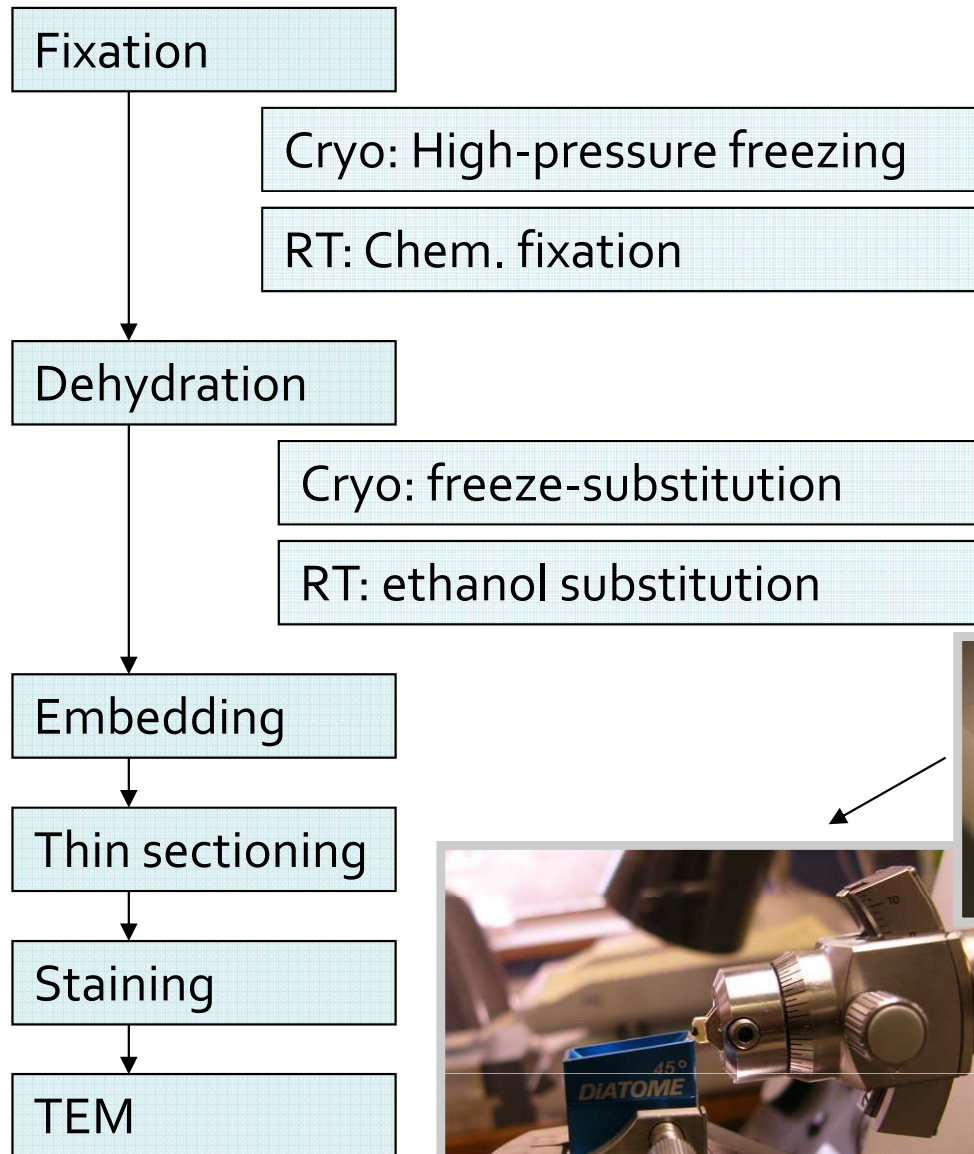


AFM determines the topology of a surface with a resolution down to 0.8 nm.

# Electron microscopy

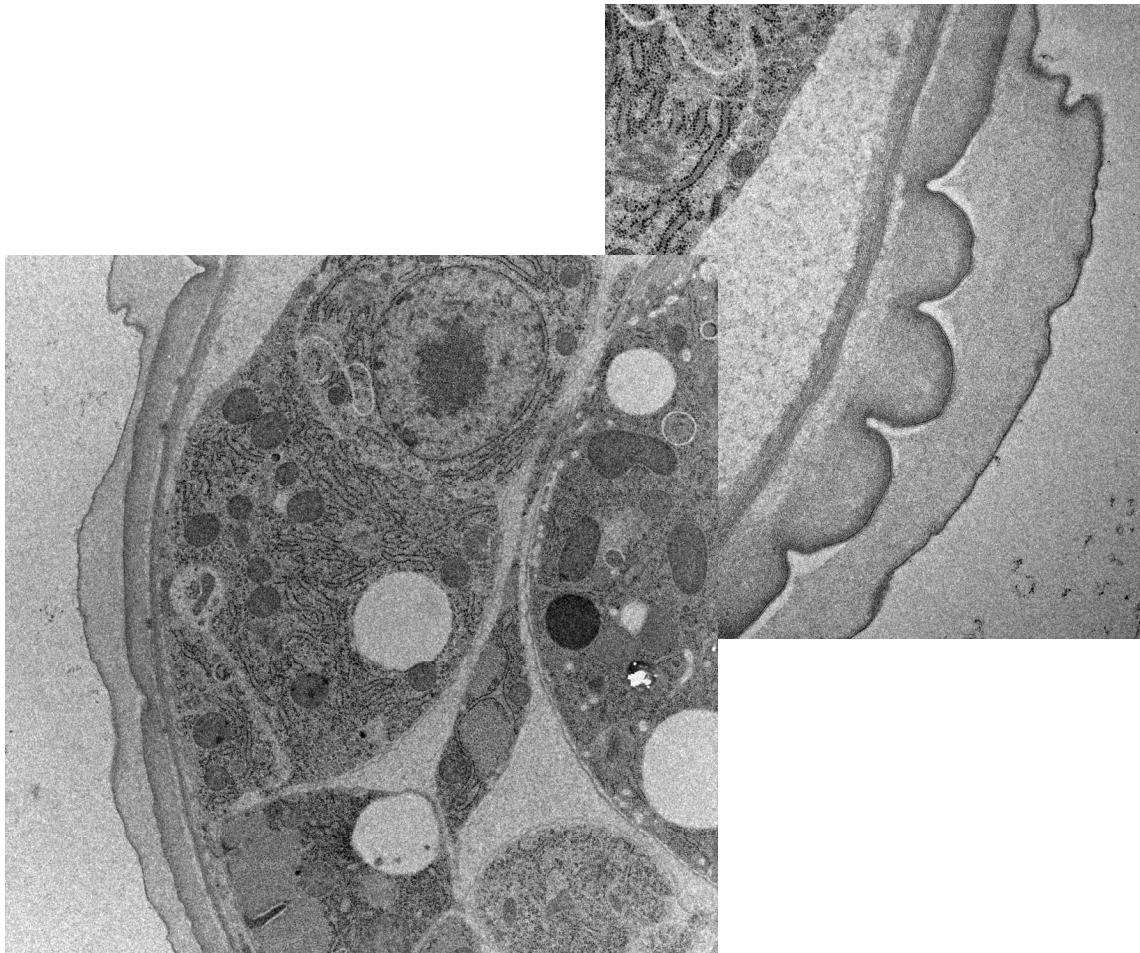
- Transmission electron microscopy (TEM)
- Scanning electron microscopy (SEM)
- Environmental scanning electron microscopy (ESEM)

# TEM - Sample preparation

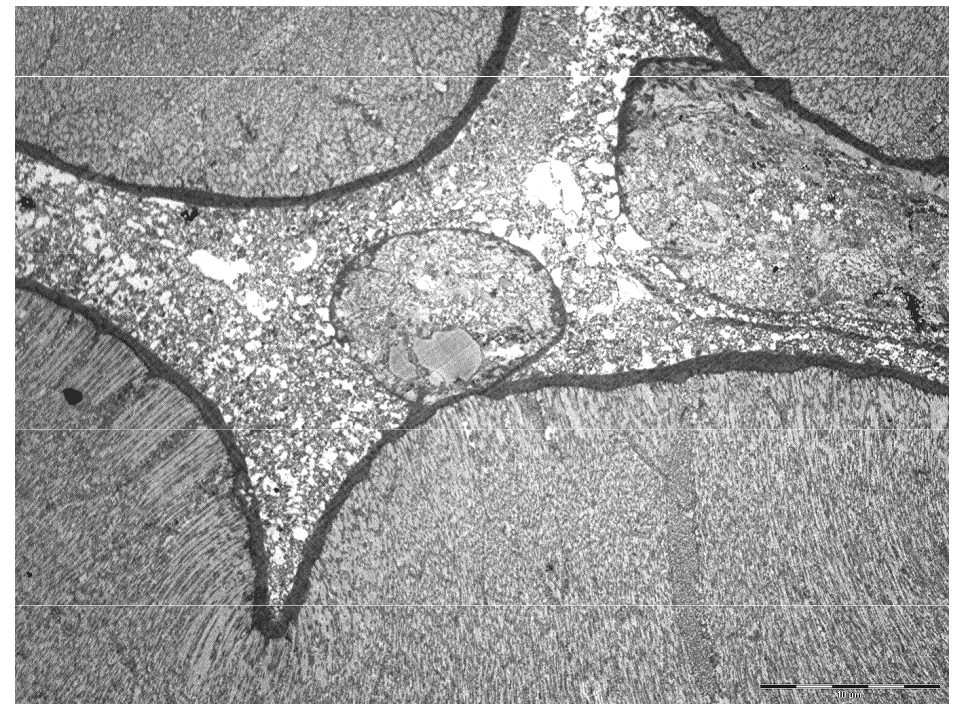
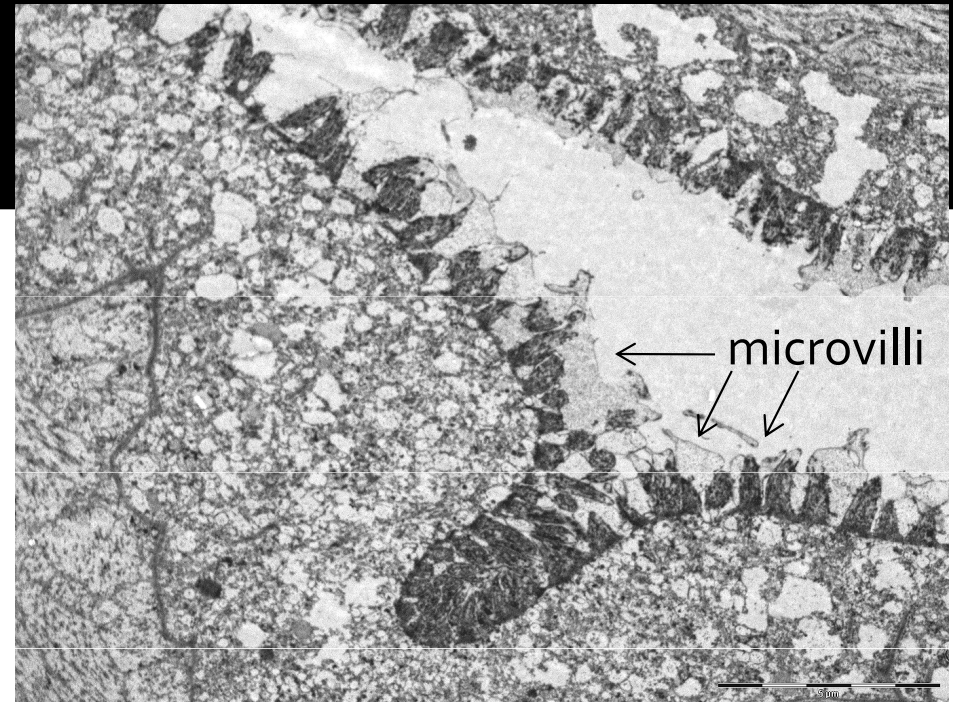
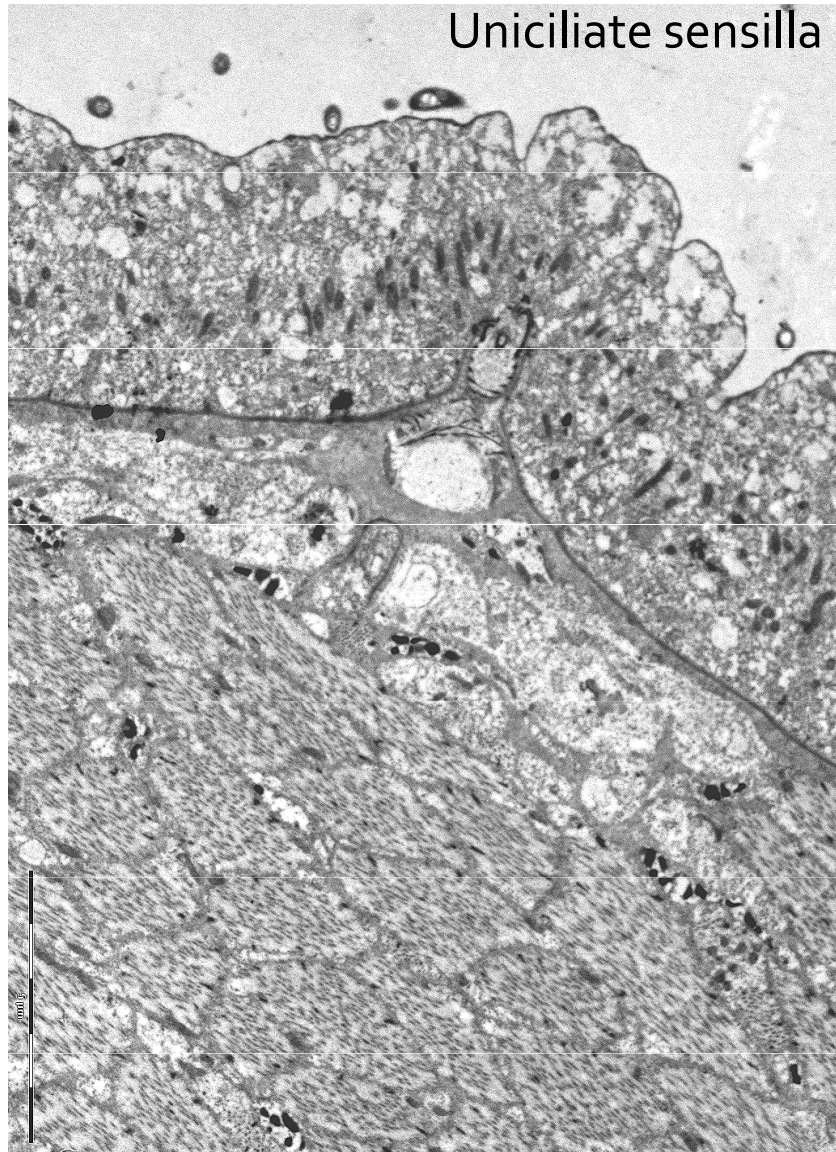


# TEM

- Philips Morgagni



# TEM – *E. nipponicum*

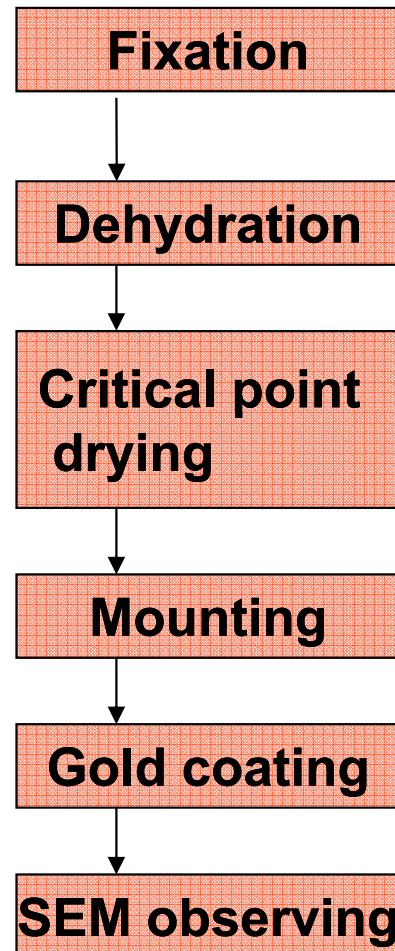


Muscle tissue



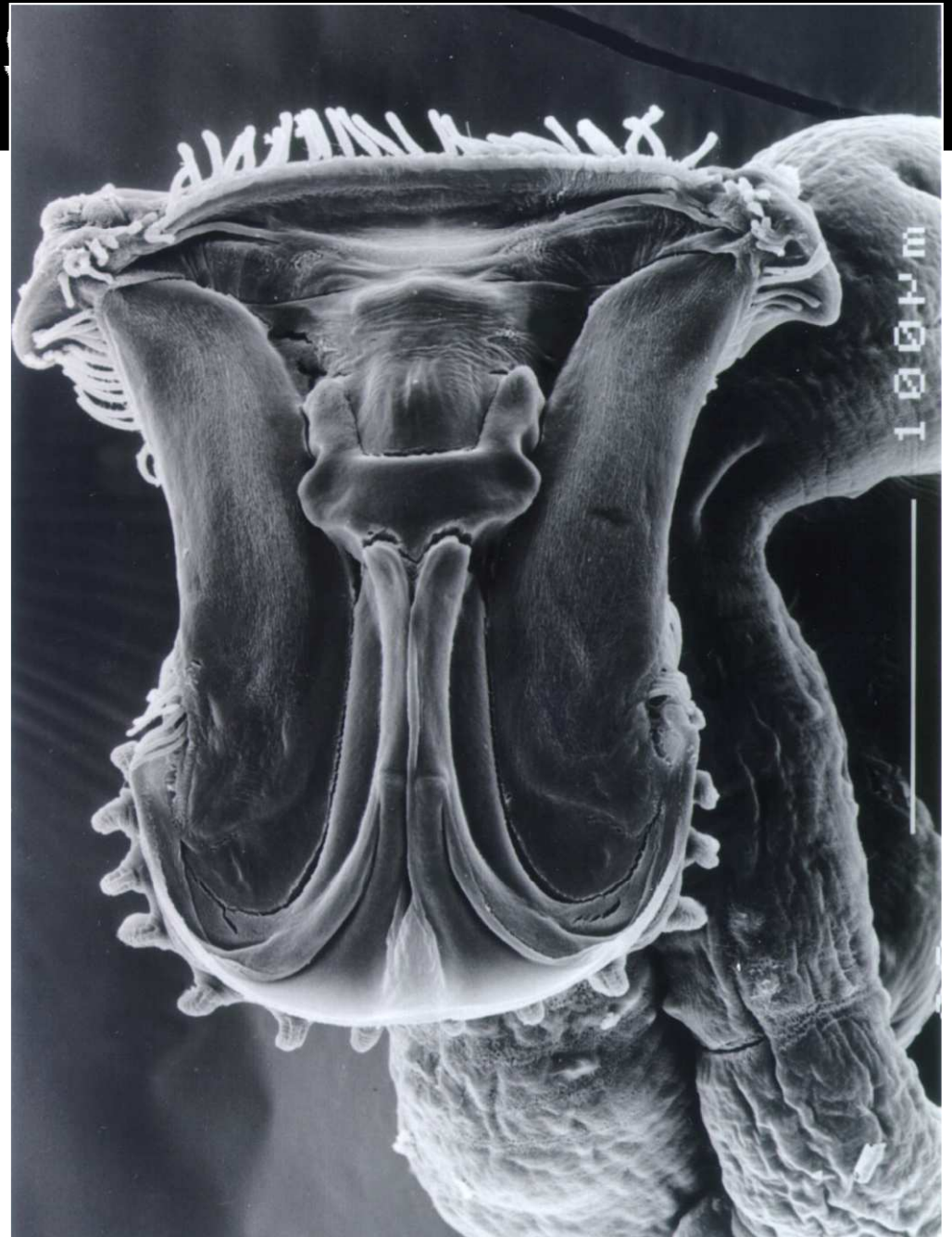
# SEM

- FEI Quanta™ 3D FEG

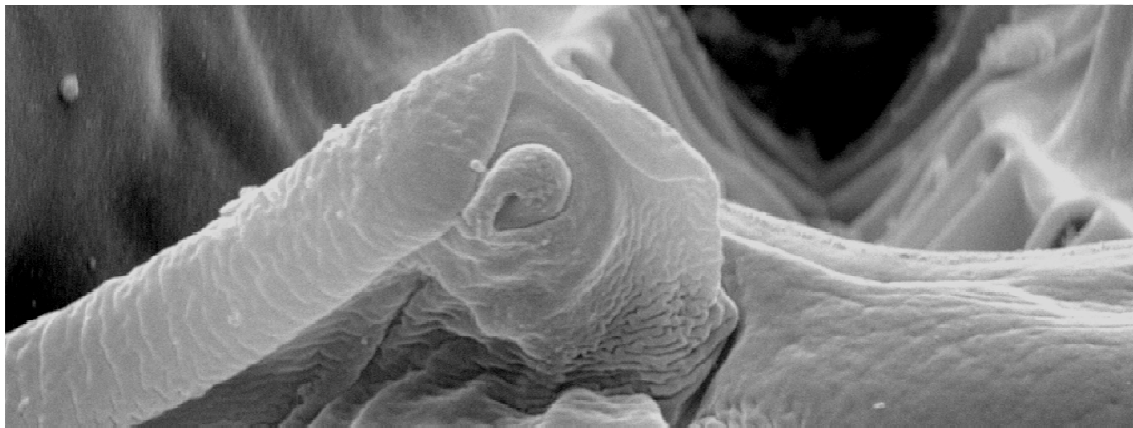
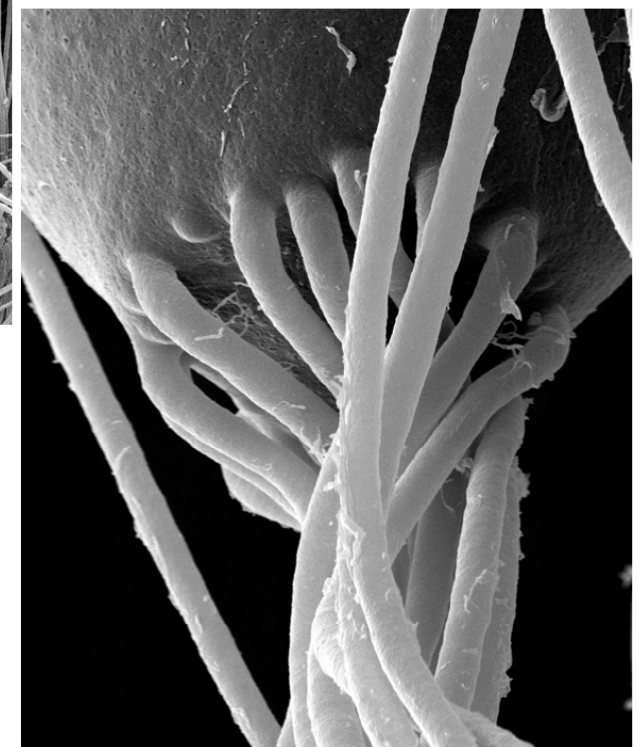
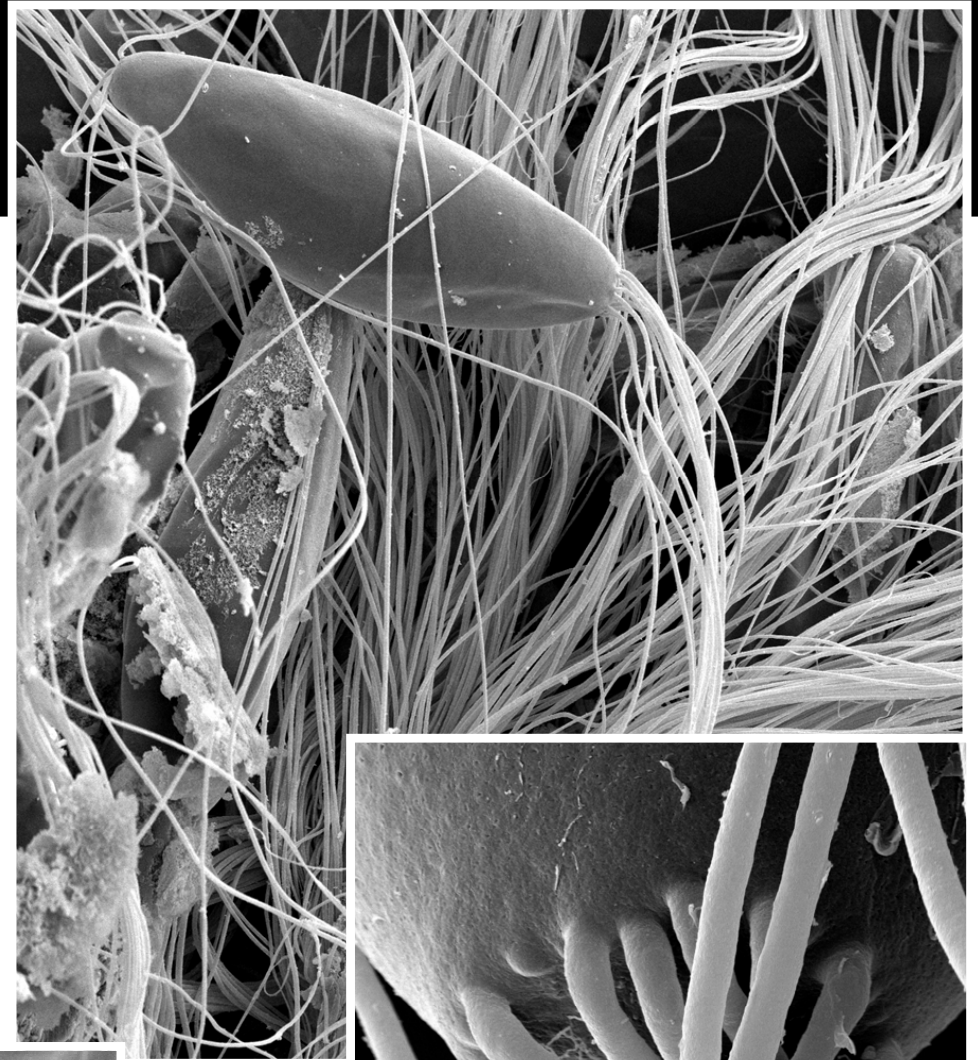
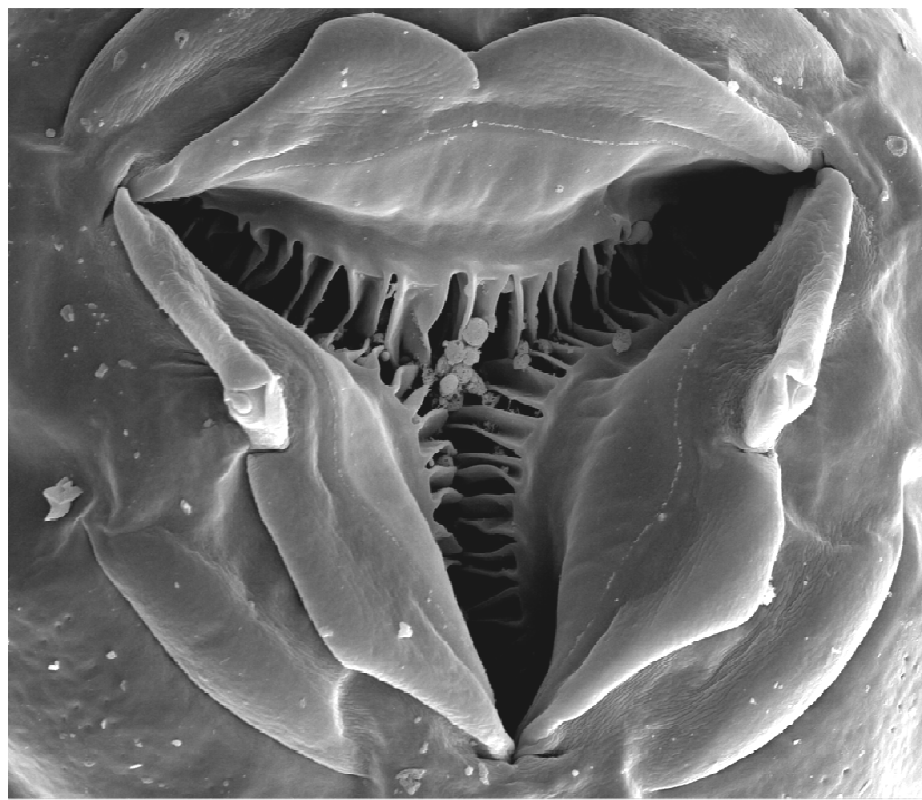


■ Tescan Vega and Mira

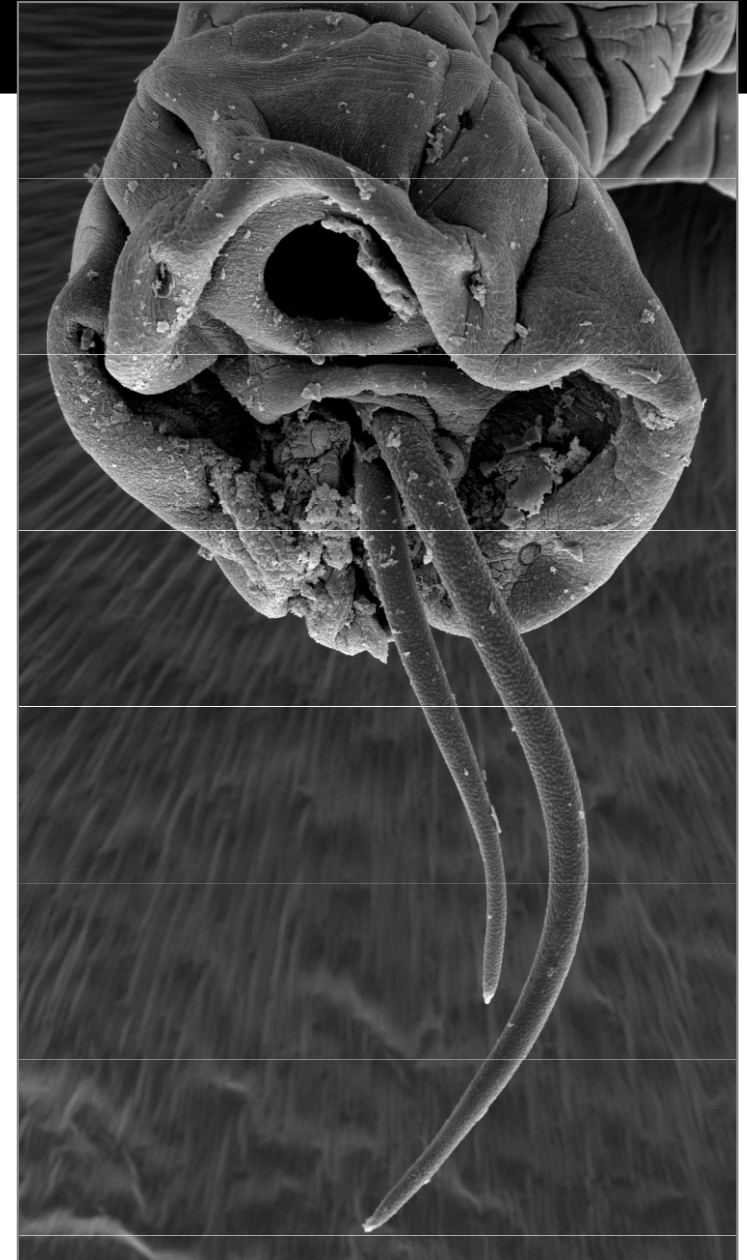
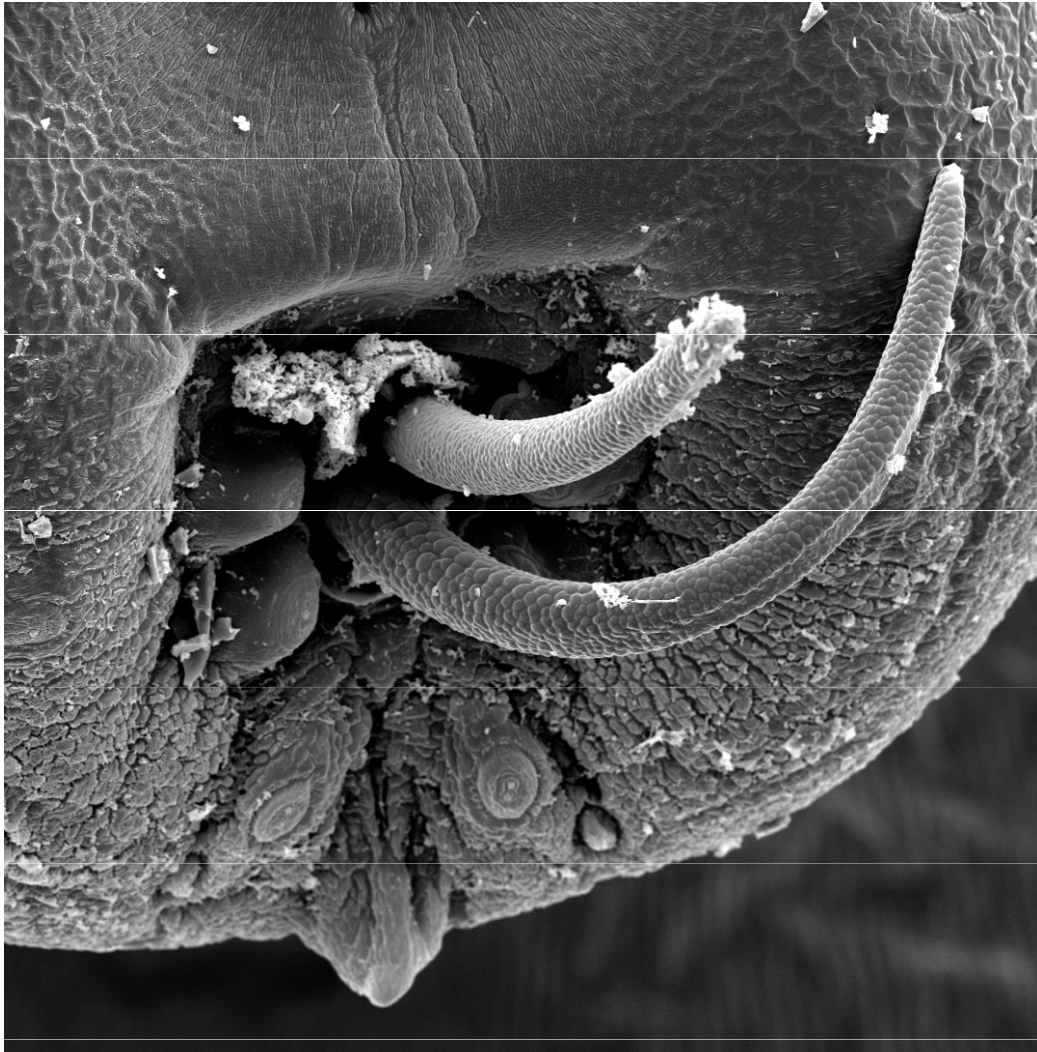
# SEM - example



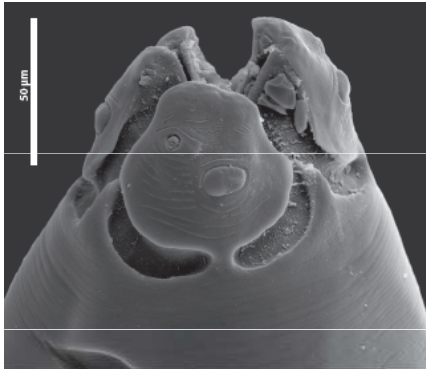
***Cithariniella*  
*khalili***



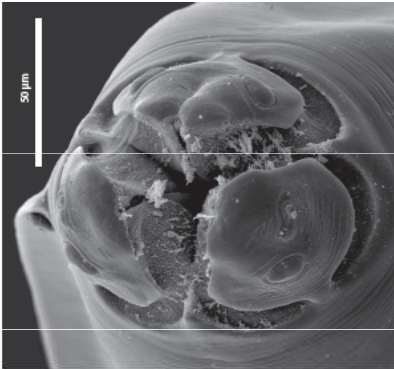
# *Strongyluris brevicaudata*



# ESEM



SEM, lateral view, cephalic end



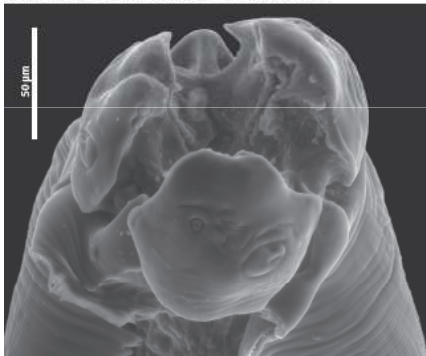
SEM, apical view, cephalic end



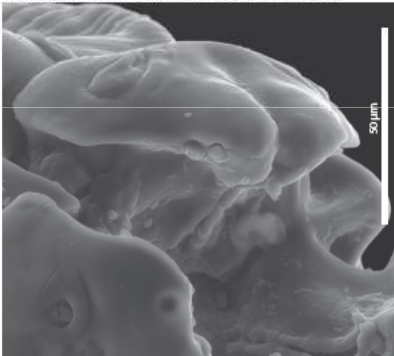
ESEM, lateral view, cephalic end with remains of water



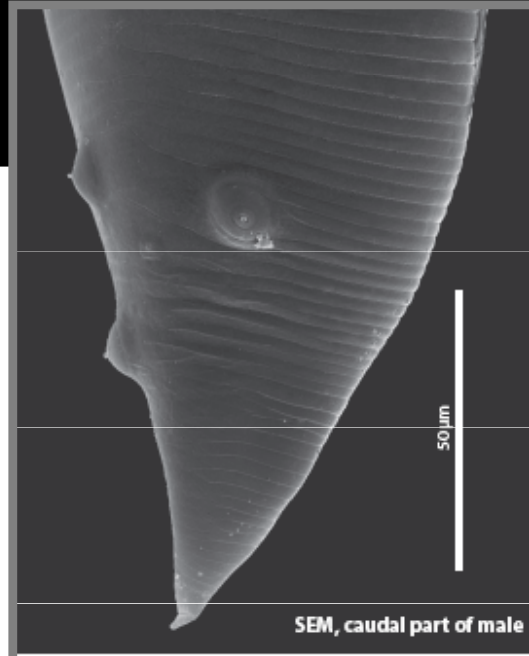
ESEM, lateral view, cephalic end submerged in the water



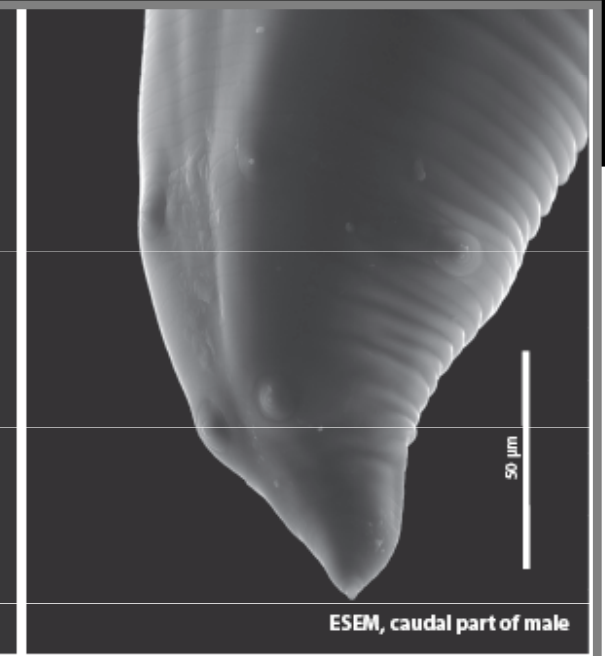
ESEM, cephalic end



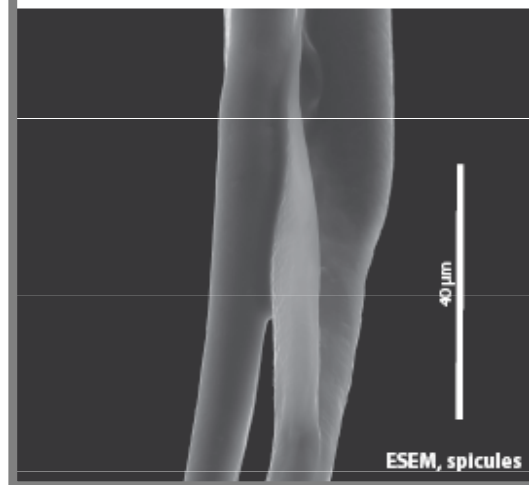
ESEM, dorsal lip with denticles



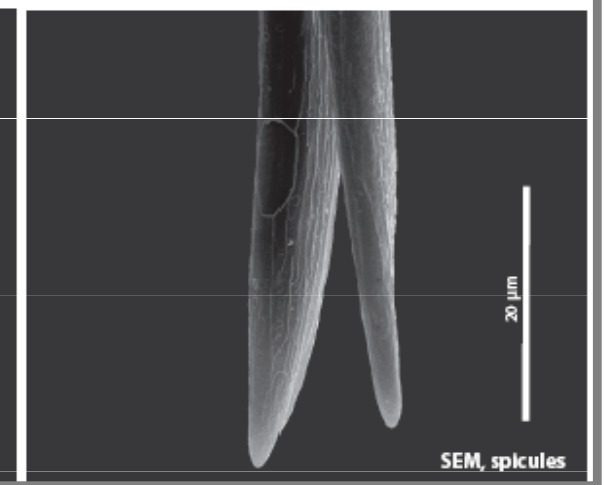
SEM, caudal part of male



ESEM, caudal part of male



ESEM, spicules

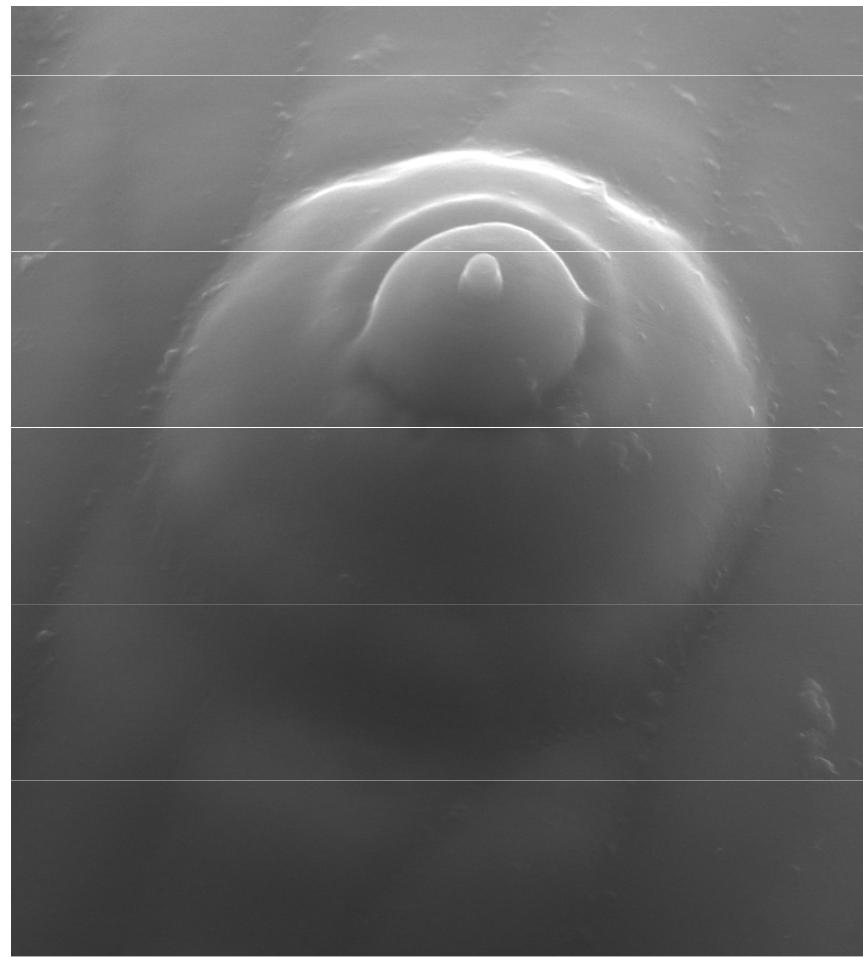
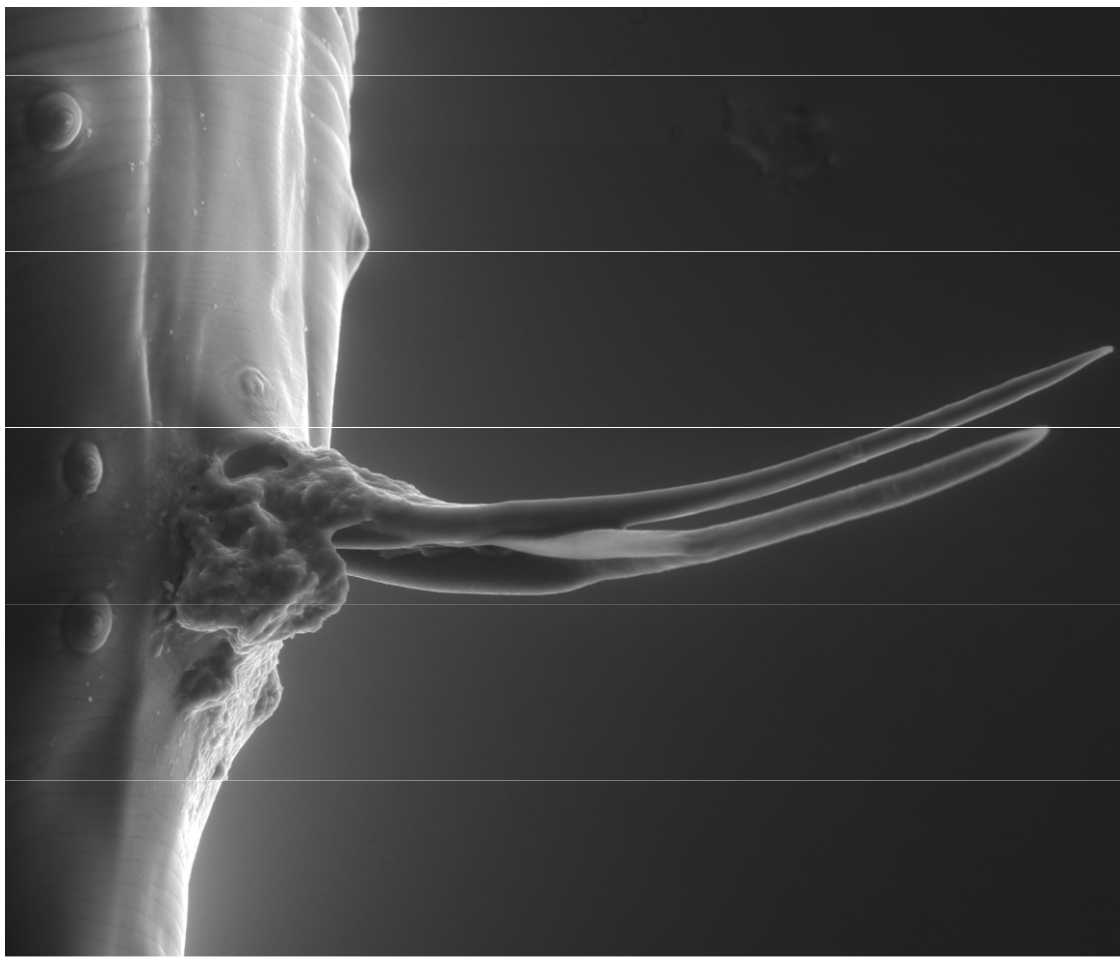


SEM, spicules

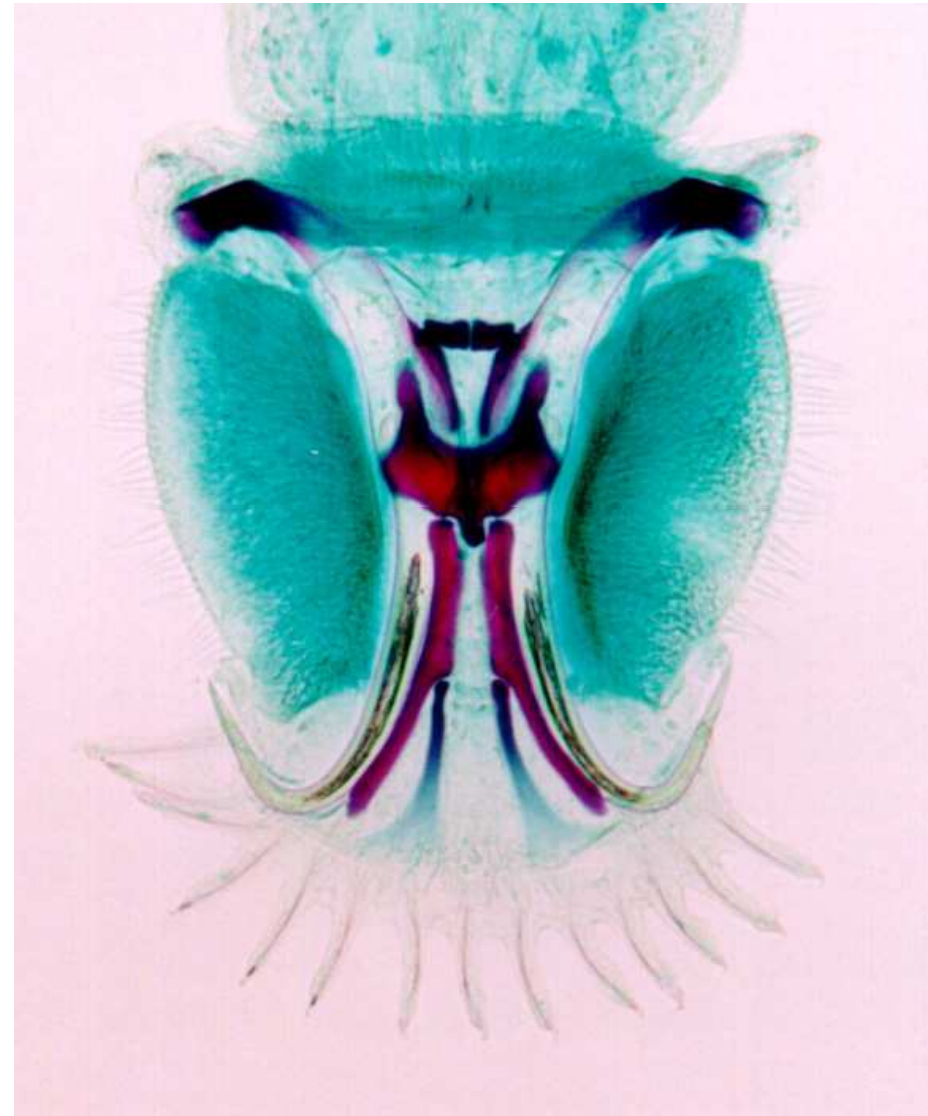
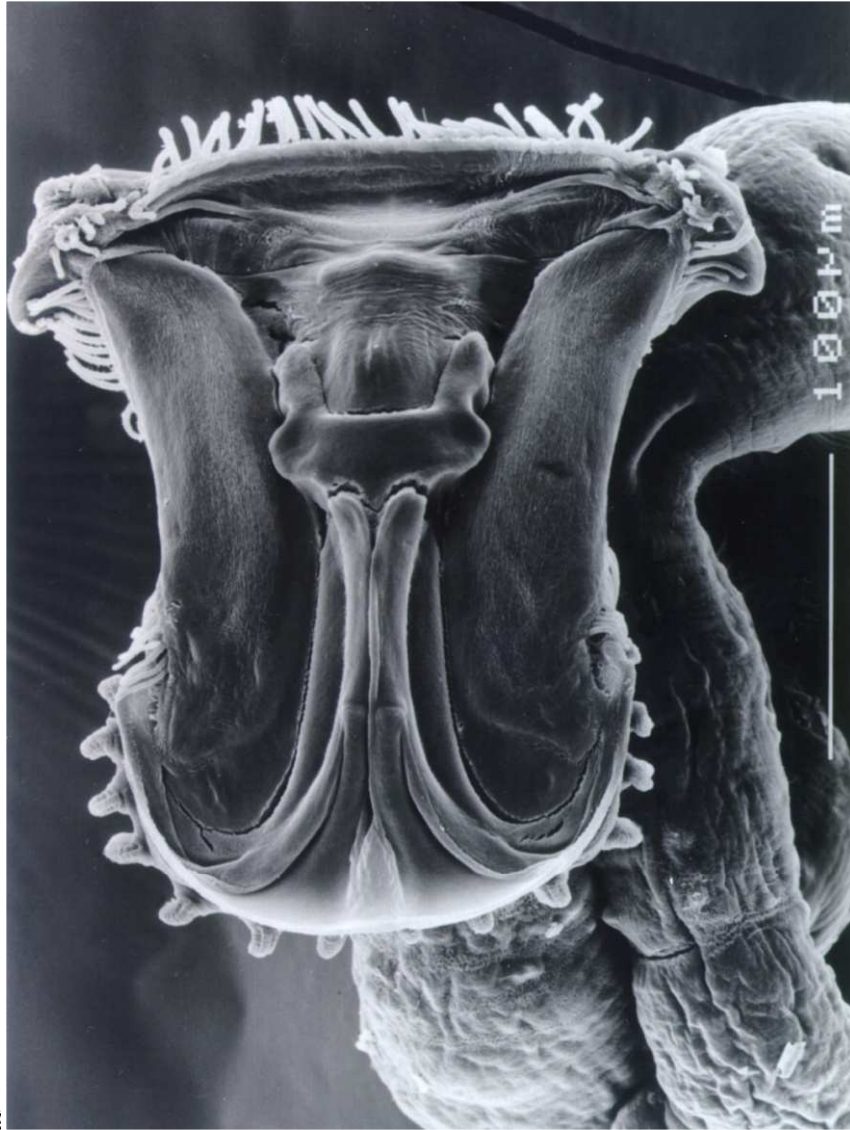
ESEM & SEM  
comparison

***Multicaecum heterotis***

# ESEM -examples



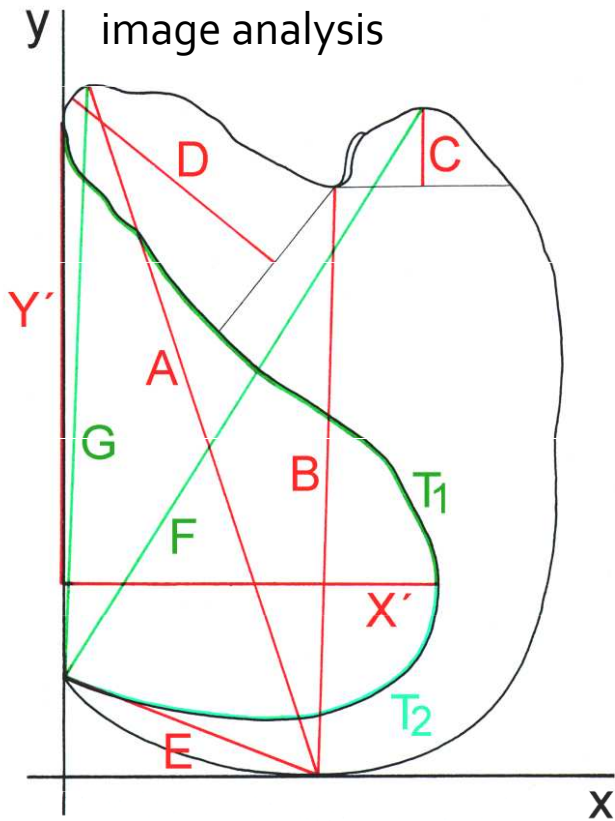
# Combinations of techniques



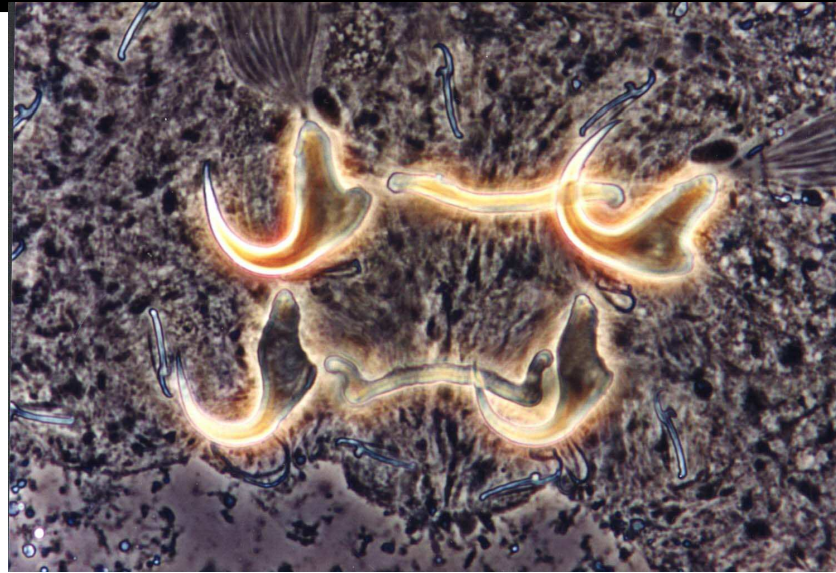
# Dokumentace monogeneí

## Phase contrast

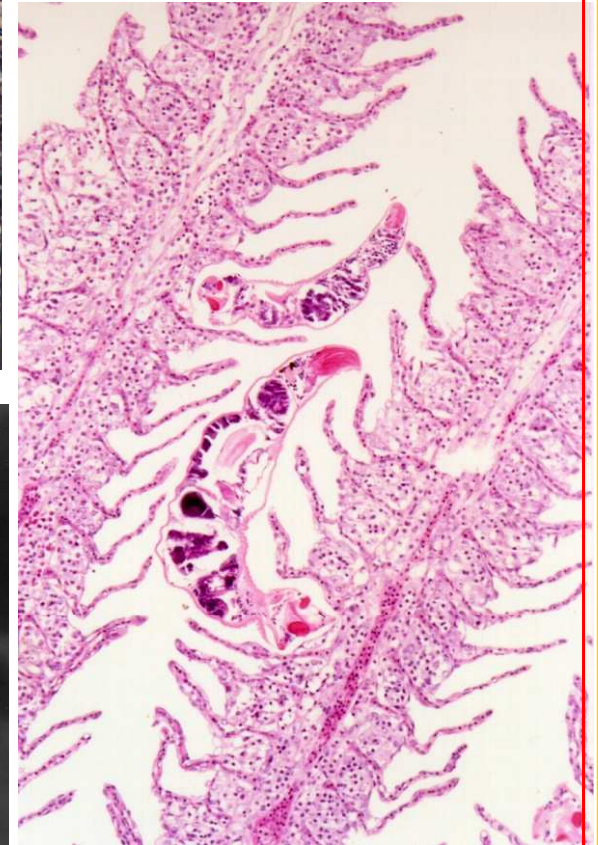
Morphometry- digital  
image analysis



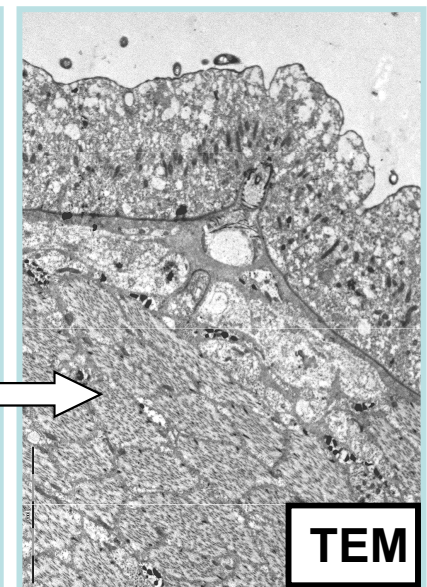
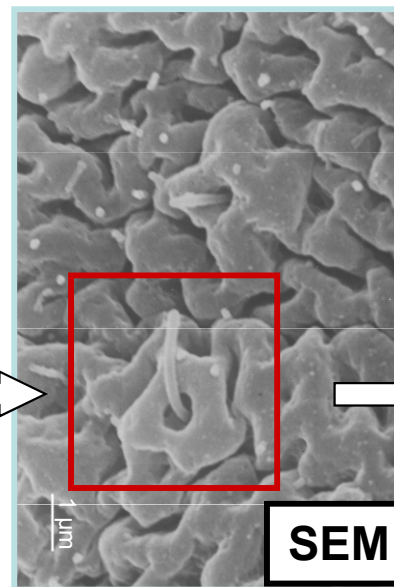
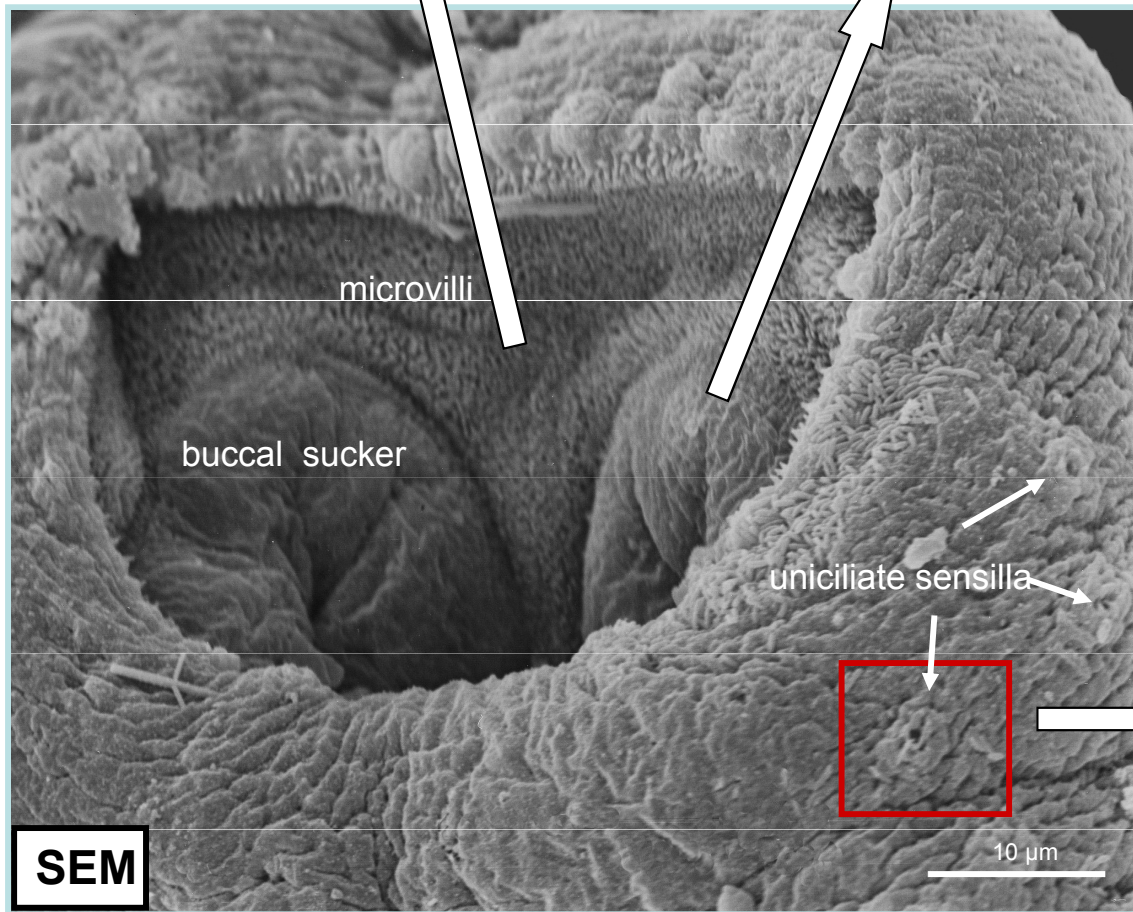
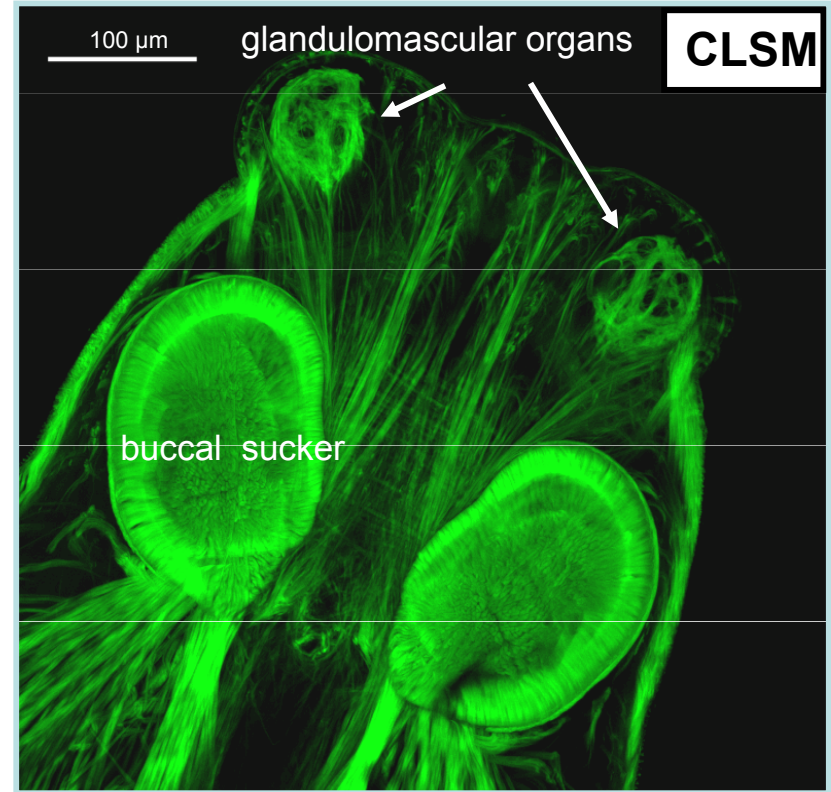
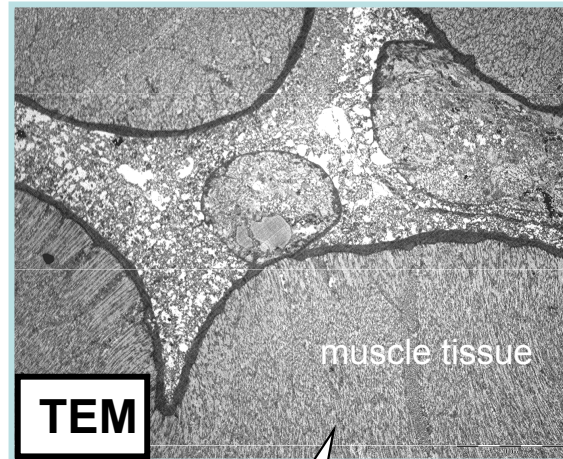
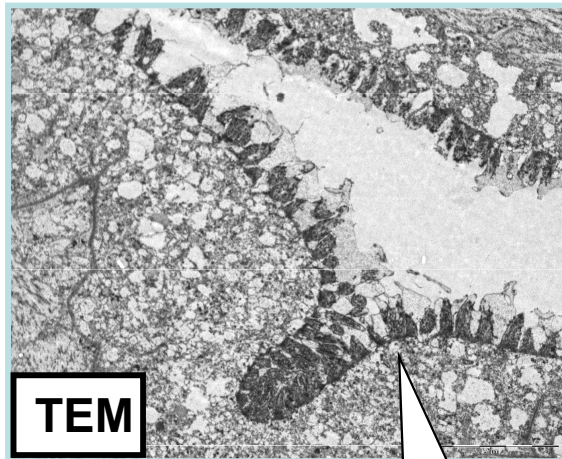
SEM

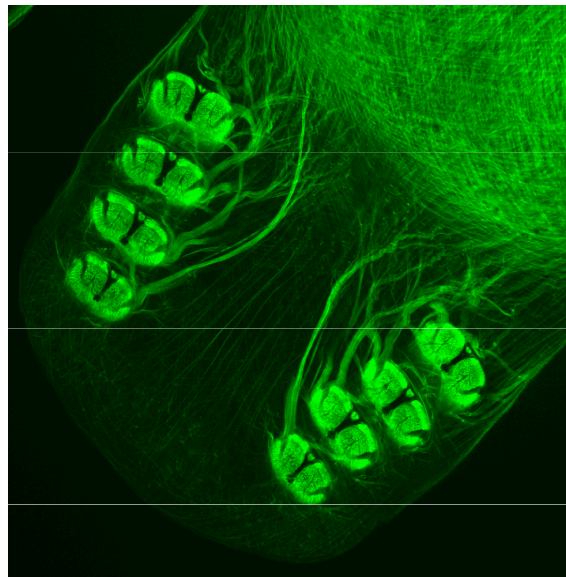
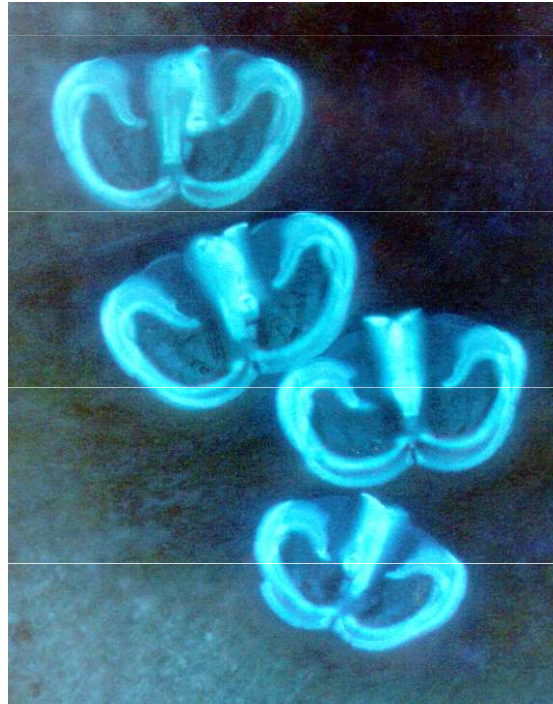
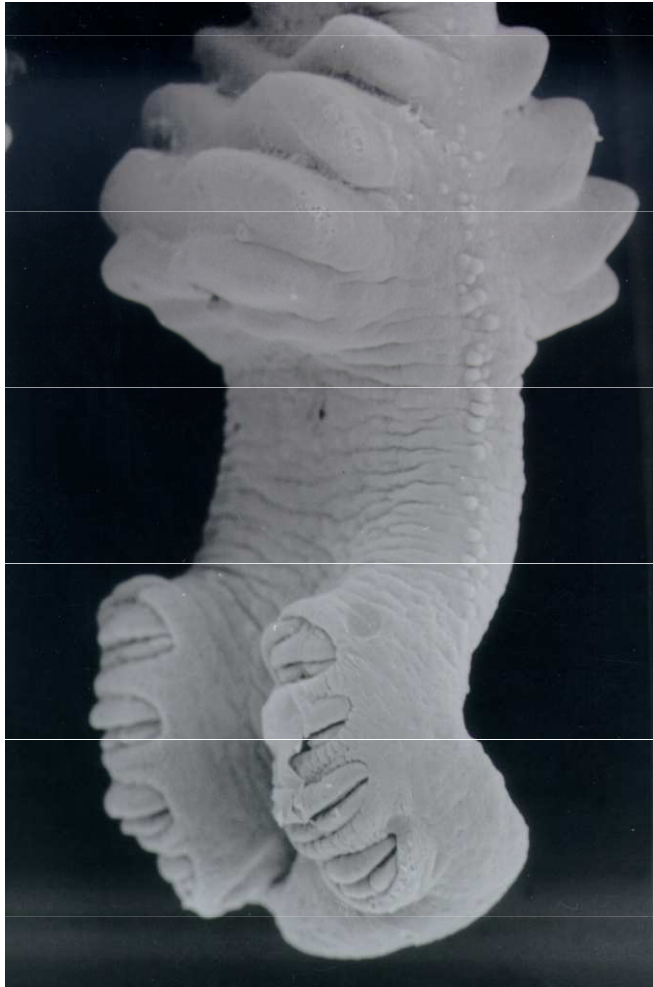


Histology (BF)









*Eudiplozoon nipponicum*

# Úvod do přednášky – základní pojmy

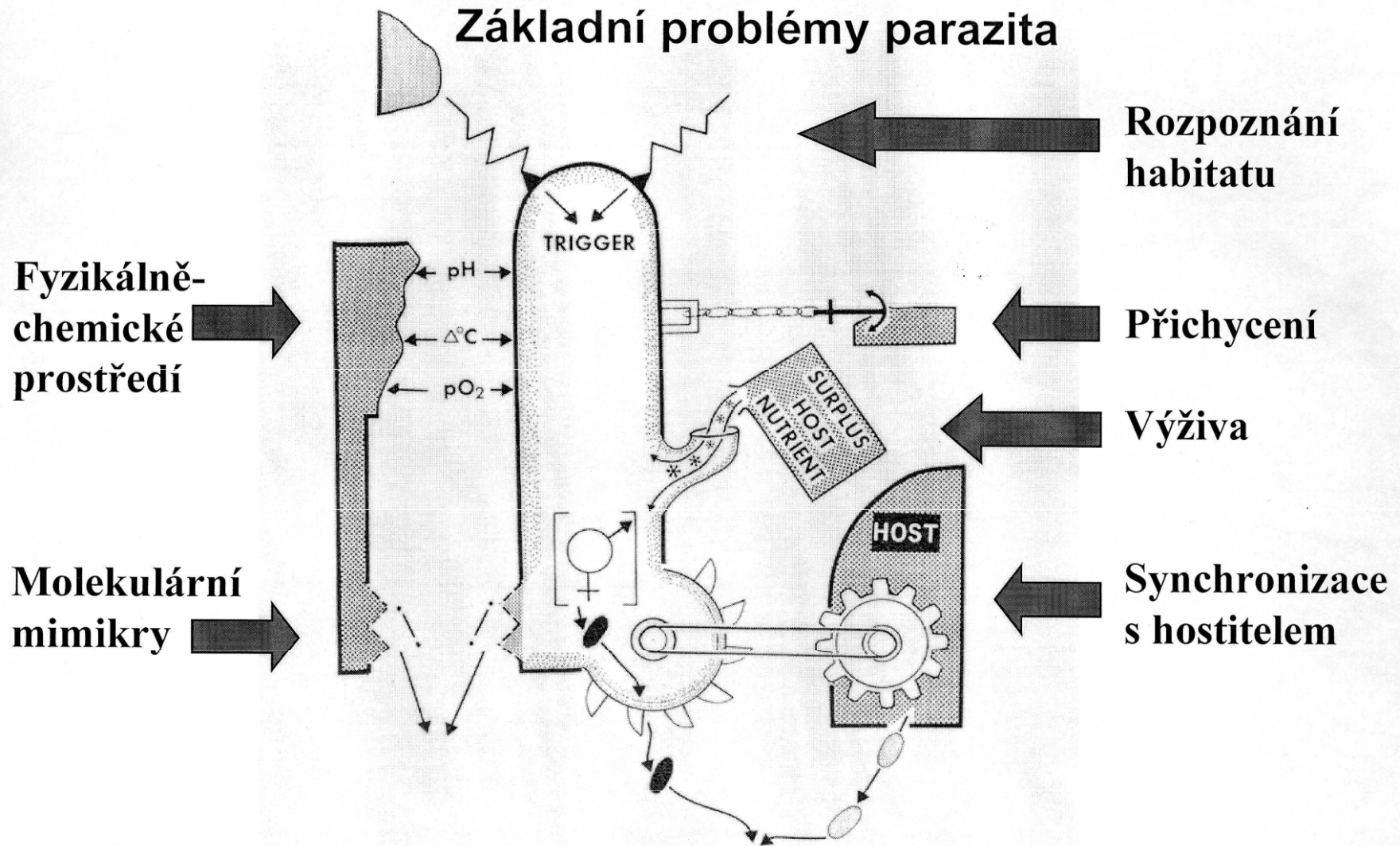
**Typy prostředí:** Voda  
Půda  
Atmosféra

**Organismy** → **Paraziti**

**Co je to parazit ?**

**Raison d'etre for parasitologists.**

# Základní problémy parazita



(upraveno podle Smytha 1994)

# Jak se stát úspěšným parazitem ?

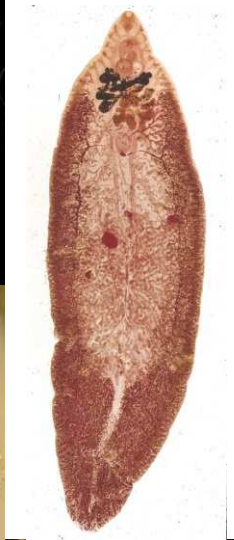
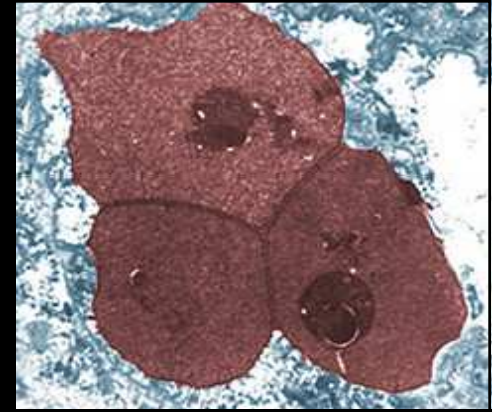
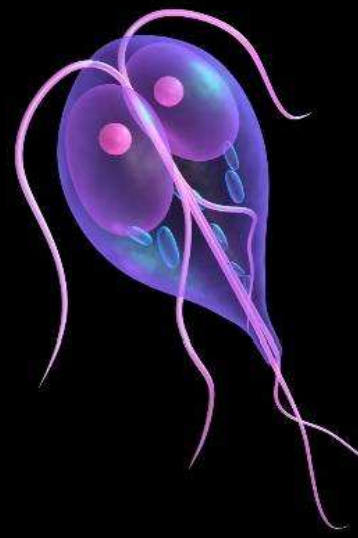
## Co je potřeba umět ?

- ▶ Musí mít strategii vyhledávání hostitele
- ▶ Způsob jak proniknout do hostitele a přichytit se na/uvnitř jeho těla
- ▶ Schopnost se adaptovat na fyzikálně-chemické podmínky uvnitř organismu hostitele
- ▶ Schopnost se v těle hostitele uživit
- ▶ Schopnost se bránit vůči obranným mechanismům organismu hostitele (imunita)
- ▶ Schopnost se množit a šířit na další hostitelské organismy

**Být parazitem není jednoduché !**

**Je to ale terno !!!**

# Rozmanitost parazitů



# Výhody parazitismu

- ▶ (1) Po dosažení hostitele není nutno vyhledávat dalšího
- ▶ (2) Stálá dostupnost potravy
- ▶ (3) Redukovaná nezbytnost složitého získávání a zpracovávání potravy
- ▶ (4) Ochrana proti extrémům vnějšího prostředí
- ▶ (5) Ochrana proti predátorům a nemocem
- ▶ (6) Redukované mechanismy sloužící k pohybu (zajišťuje hostitel)
- ▶ (7) Vyvinutější pohlavní orgány ve srovnání s volně žijícím příbuznými (obrovská plodnost cizopasníků)



# Nevýhody parazitismu

- ▶ 1) Extrémní hostitelská specifčnost zvyšuje riziko vyhynutí parazita
- ▶ 2) Nezbytnost vyhledávání optimálního habitatu na/v hostiteli – často složité ontogenetické migrace cizopasníků
- ▶ 3) Nezbytnost být adaptován na podmínky uvnitř organismu hostitele
- ▶ 4) Nezbytnost se bránit vůči imunitnímu systému hostitele
- ▶ 5) Distribuce cizopasníka je limitovaná rozšířením jeho hostitele
- ▶ 6) Riskantní šíření tj. mnoho cizopasníků zahyne ještě před dosažením vhodného hostitele

# Fenomén parazitismu

<b>Typy vztahů mezi organismy</b>	<b>A</b>	<b>B</b>
<b>Parazitismus</b>	<b>+</b>	<b>-</b>
<b>Predace</b>	<b>+</b>	<b>-</b>
<b>Kompetice</b>	<b>-</b>	<b>-</b>
<b>Protokooperace</b>	<b>+</b>	<b>+</b>
<b>Mutualismus</b>	<b>+</b>	<b>+</b>
<b>Komensalismus</b>	<b>+</b>	<b>0</b>
<b>Amensalismus</b>	<b>-</b>	<b>0</b>
<b>Neutralismus</b>	<b>0</b>	<b>0</b>

**Parazitismus = forma symbiosy**

# Co je to parazitismus ?

- Parazitismus – vzájemný vztah, při kterém jeden organismus (druh) získává výhodu, zatímco druhý je tímto vztahem poškozován.
- Je parazitismus symbiosa ?

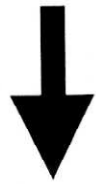
# Co je to symbiosa ?

- Symbióza – jakýkoliv vztah nebo soužití dvou nebo více druhů organismů, ať prospěšné nebo neprospěšné.

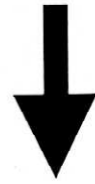
# Typy symbiósy



**Forezie**



**Komenzalismus**



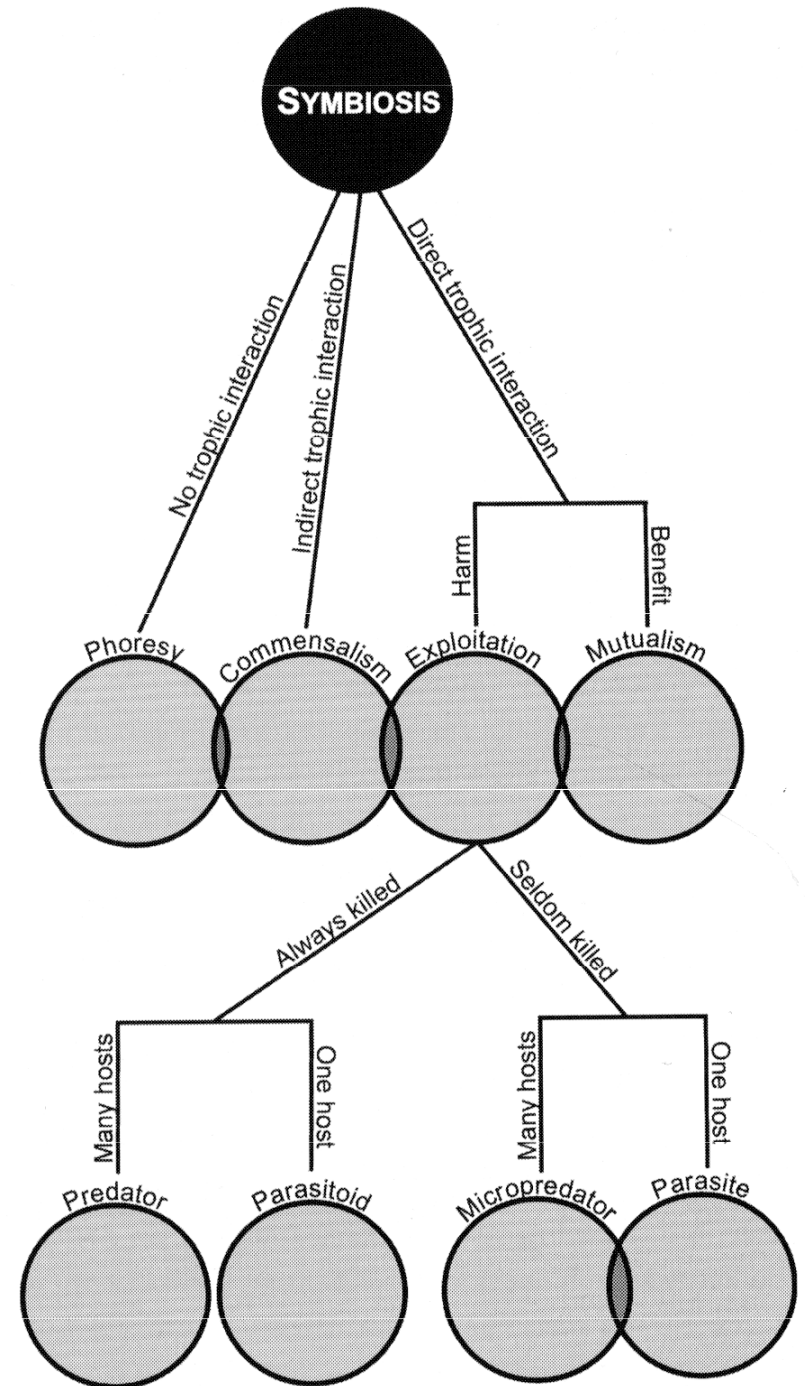
**Parazitismus**



**Mutualismus**

# Parazit - symbiosa

- ▶ Celý život nebo alespoň jeho část žije na povrchu nebo uvnitř těla svého hostitele
- ▶ Živí se na jeho úkor (exploatace) → tento efekt však může být i zcela zhoubný (pro jedince hostitele - patogenita)



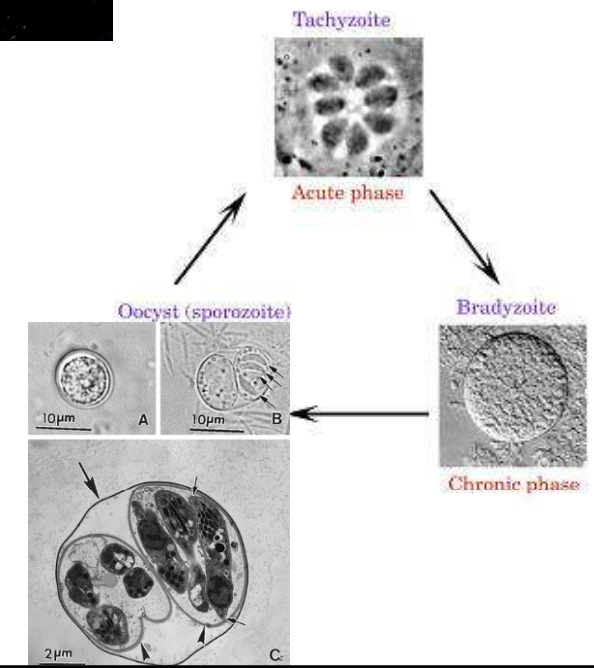
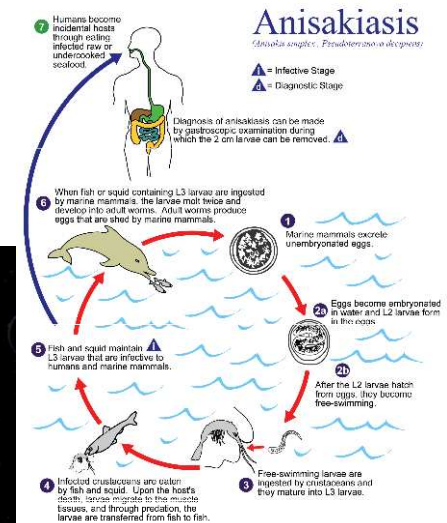
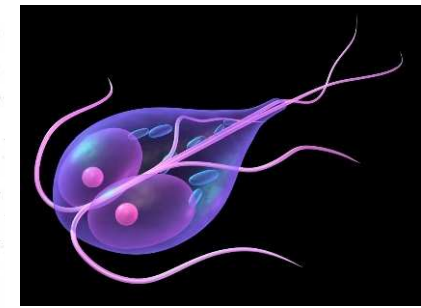
# Typy parazitismu

- Parazit
- Predátor
- Parazitoid
- Mikropredátor
- Parazitický kastrátor
- Parazitičtí obratlovci
- Parazitické rostliny
- Hnízdní parazitismus
- Sociální parazitismus u hmyzu

# Jak vypadá typický parazit ?

- ▶ Napadá jednoho hostitele a má slabé nebo žádné patogenní působení
- ▶ Hostitel přežívá
- ▶ Andreson & May (1979) :  
typický parazit – závislý na intenzitě infekce (makroparazit)  
patogen – nezávislý na intenzitě infekce (mikroparazit)

!!! Troficky přenosný typický parazit  
nebo patogen vyžaduje usmrcení hostitele  
- častá manipulace chováním hostitele





# Parazitoid

- ▶ Napadá jednoho hostitele
- ▶ Usmrcení hostitele je nezbytné
- ▶ Parazitické larvy hmyzu, např. Diptera (Tachinidae) a Hymenoptera (Chalcidoidea, Braconidae), fyziologické adaptace (endosymbiotické viry)
- ▶ Samičky kladou vajíčka do hostitele, kde se pak vyvíjí parazitická larva



# Parazitický kastrátor

- ▶ Energie původně určená pro reprodukci hostitele je využita ve prospěch parazita
- ▶ **Parazitický kastrátor** - zabíjí svého hostitele v evolučním smyslu
- ▶ **Částečný kastrátor** – přechod mezi typickým parazitem a parazitickým kastrátorem



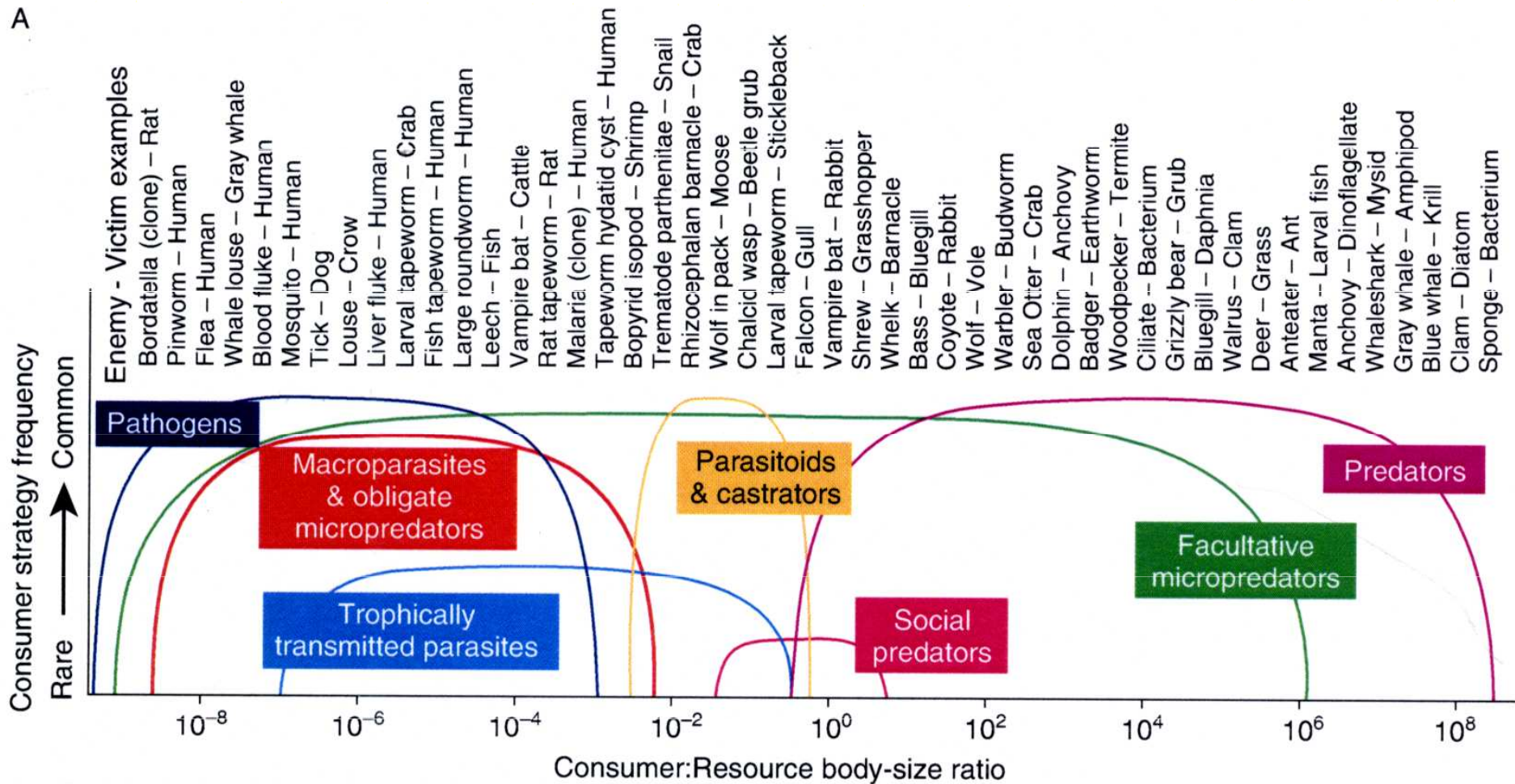
# Ekologické vymezení parazita I

Effect on fitness	Number of hosts/prey attacked		
	1 host		> 1host/prey
	Death of host not required	Death of host required	
< 100%	Typical parasite	Tropically transmitted typical parasite	Micropredator
100% (prey has 0 fitness)	Parasitic castrator	Parasitoid	Predator

# Ekologické vymezení parazitismu II

Effect on host fitness	Number of hosts/prey attacked		
	1 host		> 1 host/prey
	Death of host not required	Death of host required	
< 100%	typical parasite pathogen	trophically transmitted typical parasite trophic transmitted pathogen	micropredator harvest regeneration
100% (prey has 0 fitness)	partial castrator parasitic castrator	trophically transmitted castrator parasitoid	social predator predator

# Frekvence poměru relativní velikosti těla konzumenta a hostitele



# Ekologická klasifikace parazitů

- ▶ Podle spojení s hostitelem
  - obligátní** (Monogenea, Digenea, Cestoda)
  - fakultativní** (nematoda *Micronema*)
  - hyperparasitický** – *Udonella* on parasitic Crustacea
- ▶ Podle časového úseku kdy parazitují
  - permanentní** (*Plasmodium*, *Entamoeba*)
  - temporální** (*Argulus*, *Ixodes*)
  - periodický** – vývojová stádia (glochidie Mollusca, larvální Diptera), generační (*Rabdias bufonis*)

# Klasifikace hostitelů

- Hostitel definitivní
- Mezihostitel
- Vektor
- Rezervoárový hostitel
- Paratenický (transportní) hostitel