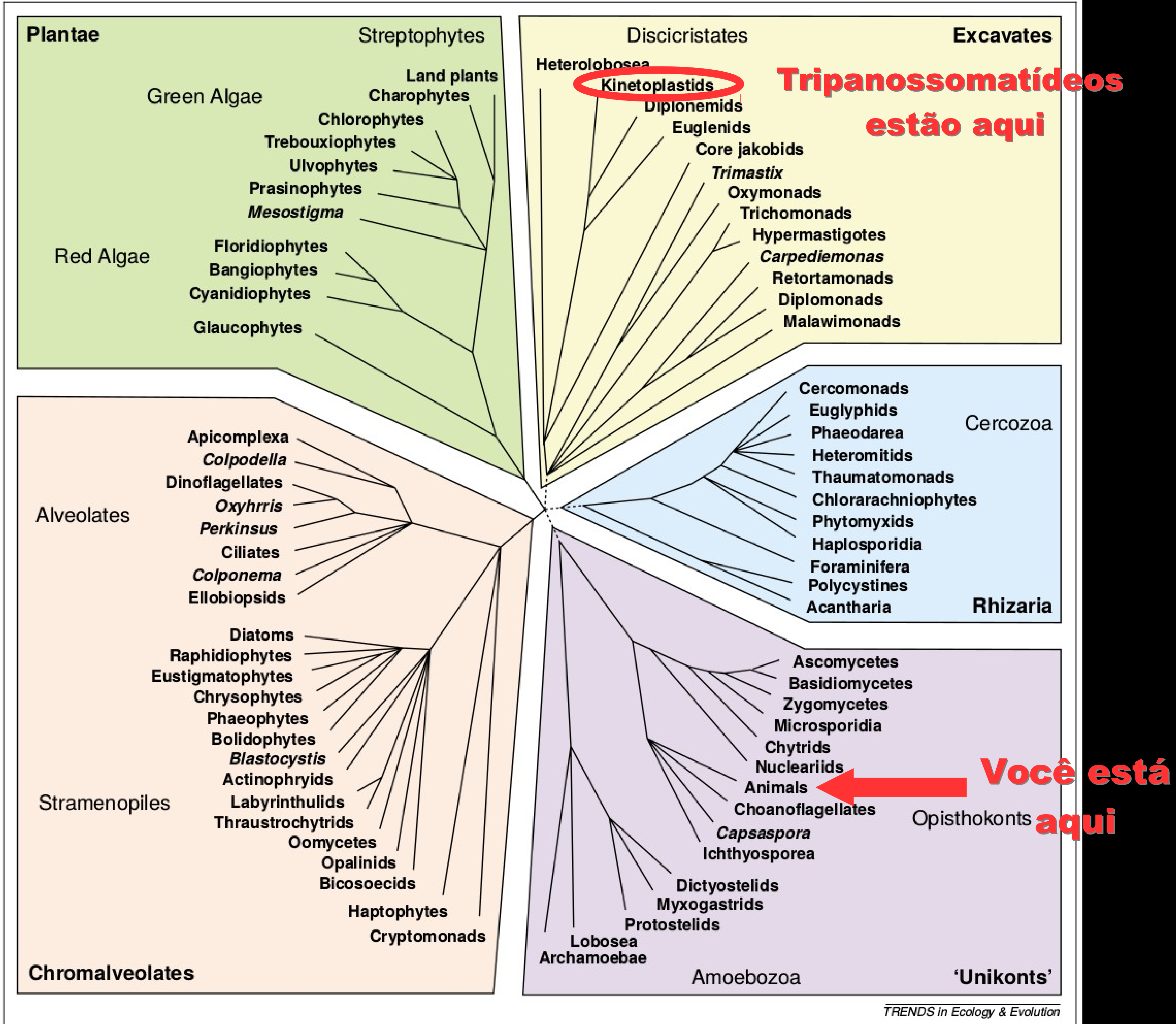
Filogenia de Tripanossomatídeos

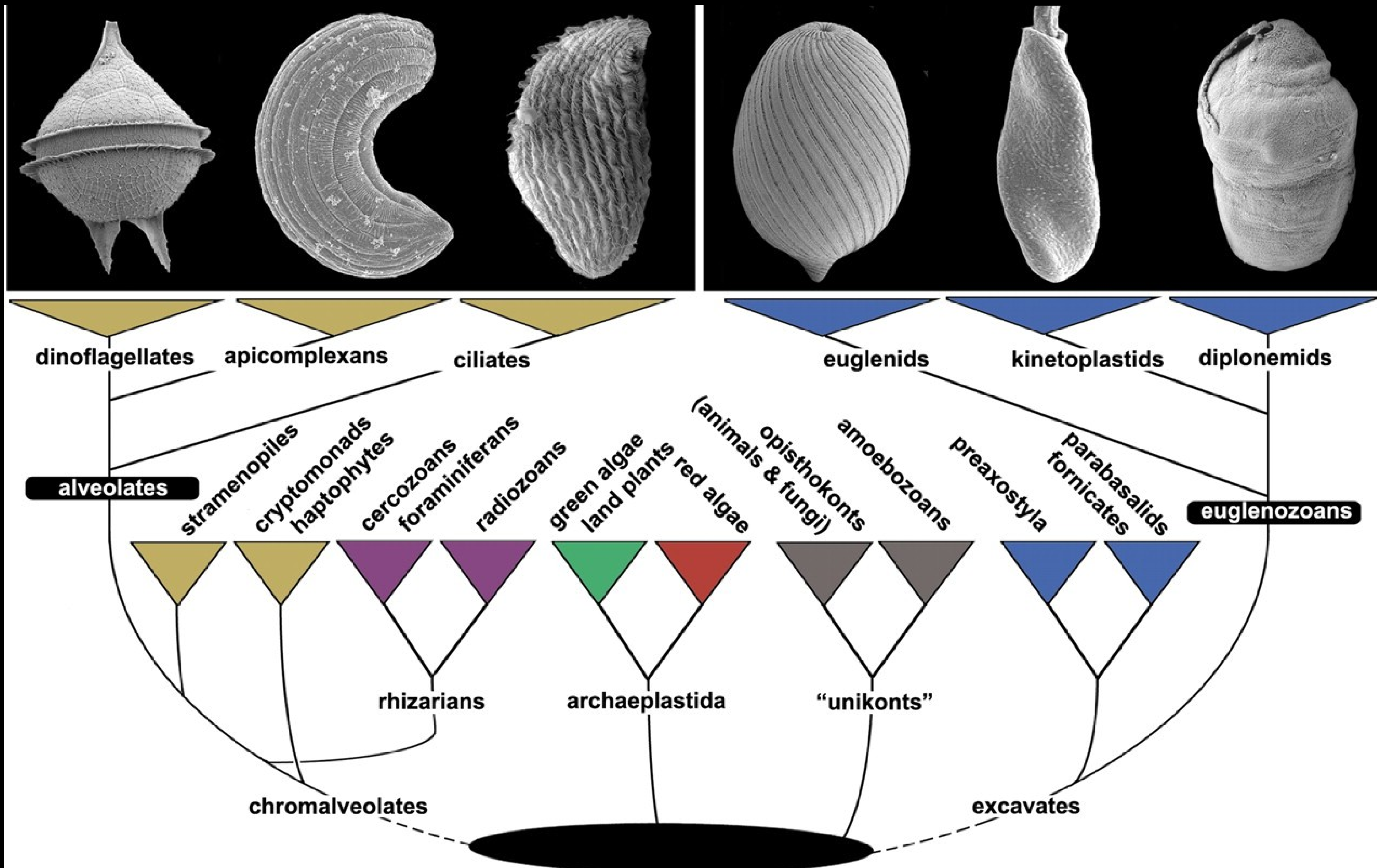


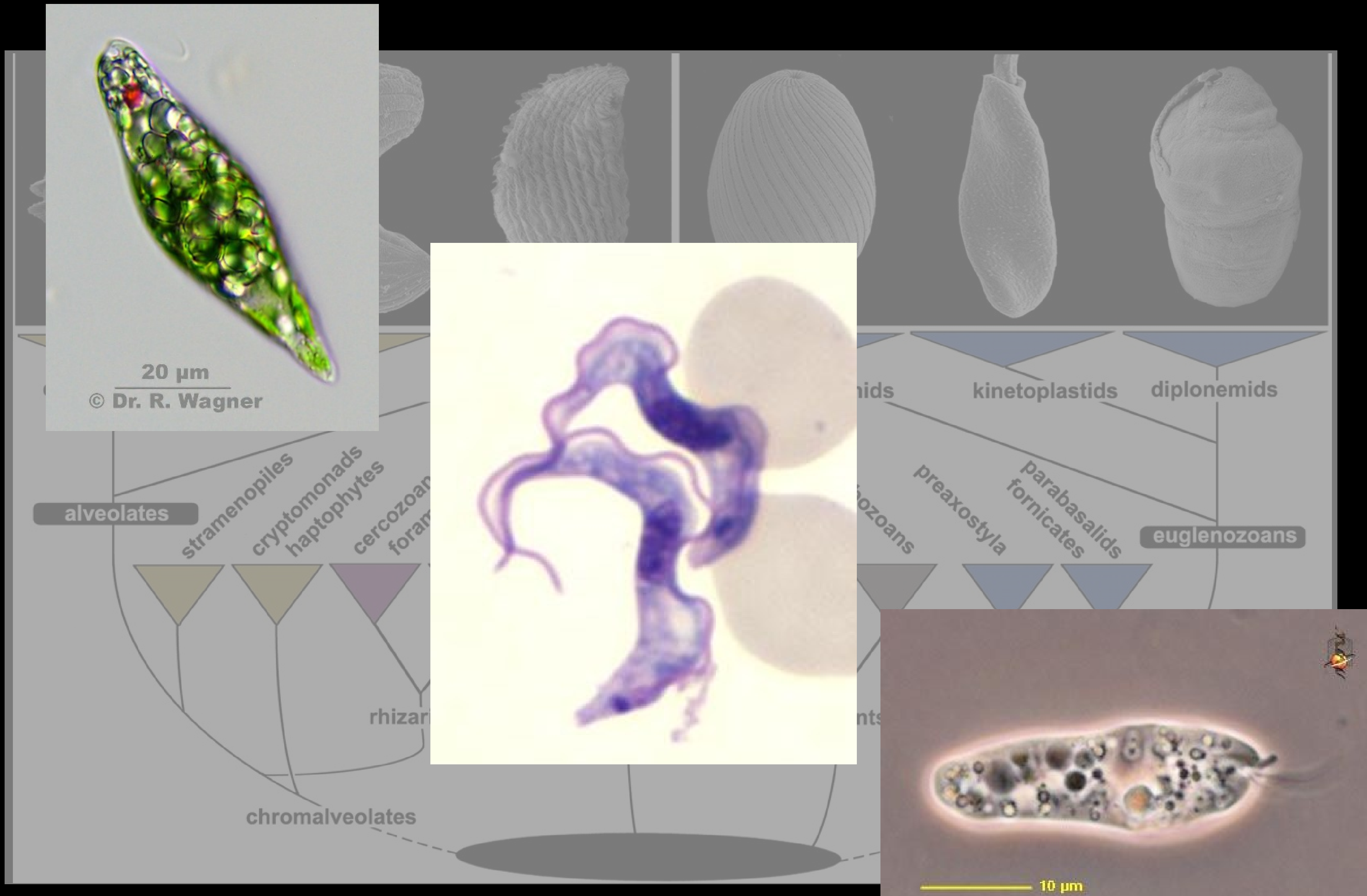
Plantae
Streptophytes
Land plants
Charophytes
Green Algae
Chlorophytes
Trebouxiophytes
Ulvophytes
Prasinophytes
Mesostigma
Red Algae
Floridiophytes
Bangiophytes
Cyanidiophytes
Glaucophytes
Discicristates
Excavates
Heterolobosea
Kinetoplastids
Tripanossomatídeos estão aqui
Diplonemids
Euglenids
Core jakobids
Trimastix
Oxymonads
Trichomonads
Hypermastigotes
Carpediemonas
Retortamonads
Diplomonads
Malawimonads
Cercomonads
Euglyphids
Cercozoa
Phaeodarea
Heteromitids
Thaumatomonads
Chlorarachniophytes
Phytomyxids
Haplosporidia
Foraminifera
Polycystines
Acantharia
Rhizaria
Apicomplexa
Colpodella
Dinoflagellates
Alveolates
Oxyhrris
Perkinsus
Ciliates
Colponema
Ellobiopsids
Diatoms
Raphidiophytes
Eustigmatophytes
Chrysophytes
Phaeophytes
Bolidophytes
Blastocystis
Actinophryids
Stramenopiles
Labyrinthulids
Thraustrochytrids
Oomycetes
Opalinids
Bicosoecids
Haptophytes
Cryptomonads
Chromalveolates
Ascomycetes
Basidiomycetes
Zygomycetes
Microsporidia
Chytrids
Nucleariids
Você está aqui
Animals
Choanoflagellates
Opisthokonts
Capsaspora
Ichthyosporea
Dictyostelids
Myxogastrids
Protostelids
Lobosea
Archamoebae
Amoebozoa
'Unikonts'
TRENDS in Ecology & Evolution

Excavata

T. Cavalier-Smith, 2002

Superfilo	Filo ou Classe	Exemplos
Discoba	Euglenozoa	*Euglena, Trypanosoma*
	Heterolobosea	*Naegleria*
	Jakobea	*Jakoba, Reclinomonas*
Metamonada	Preaxostyla	*Trimastix*
	Fornicata	*Giardia*
	Parabasalia	*Trichomonas*


dinoflagellates
apicomplexans
ciliates
euglenids
kinetoplastids
diplonemids
alveolates
stramenopiles
cryptomonads
haptophytes
cercozoans
foraminiferans
radiozoans
green algae
land plants
red algae
(animals & fungi)
opisthokonts
amoebozoans
preaxostyla
parabasalids
fornicates
euglenozoans
rhizarians
archaeplastida
"unikonts"
chromalveolates
excavates

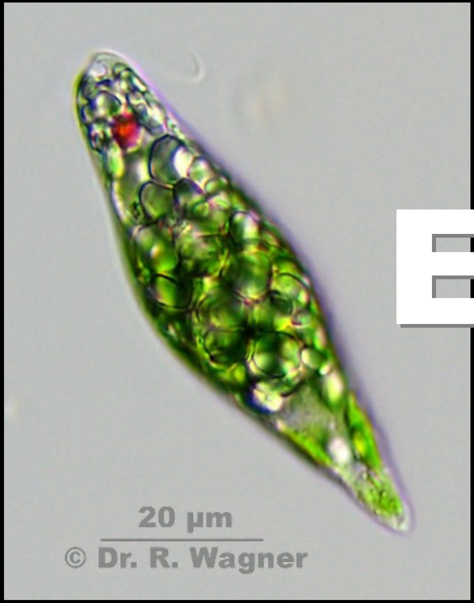

20 µm
© Dr. R. Wagner
kinetoplastids
diplonemids
alveolates
stramenopiles
cryptomonads
haptophytes
preaxostyla
parabasalids
fornicates
euglenozoans
chromalveolates
10 µm

Euglenozoa

T. Cavalier-Smith, 1981

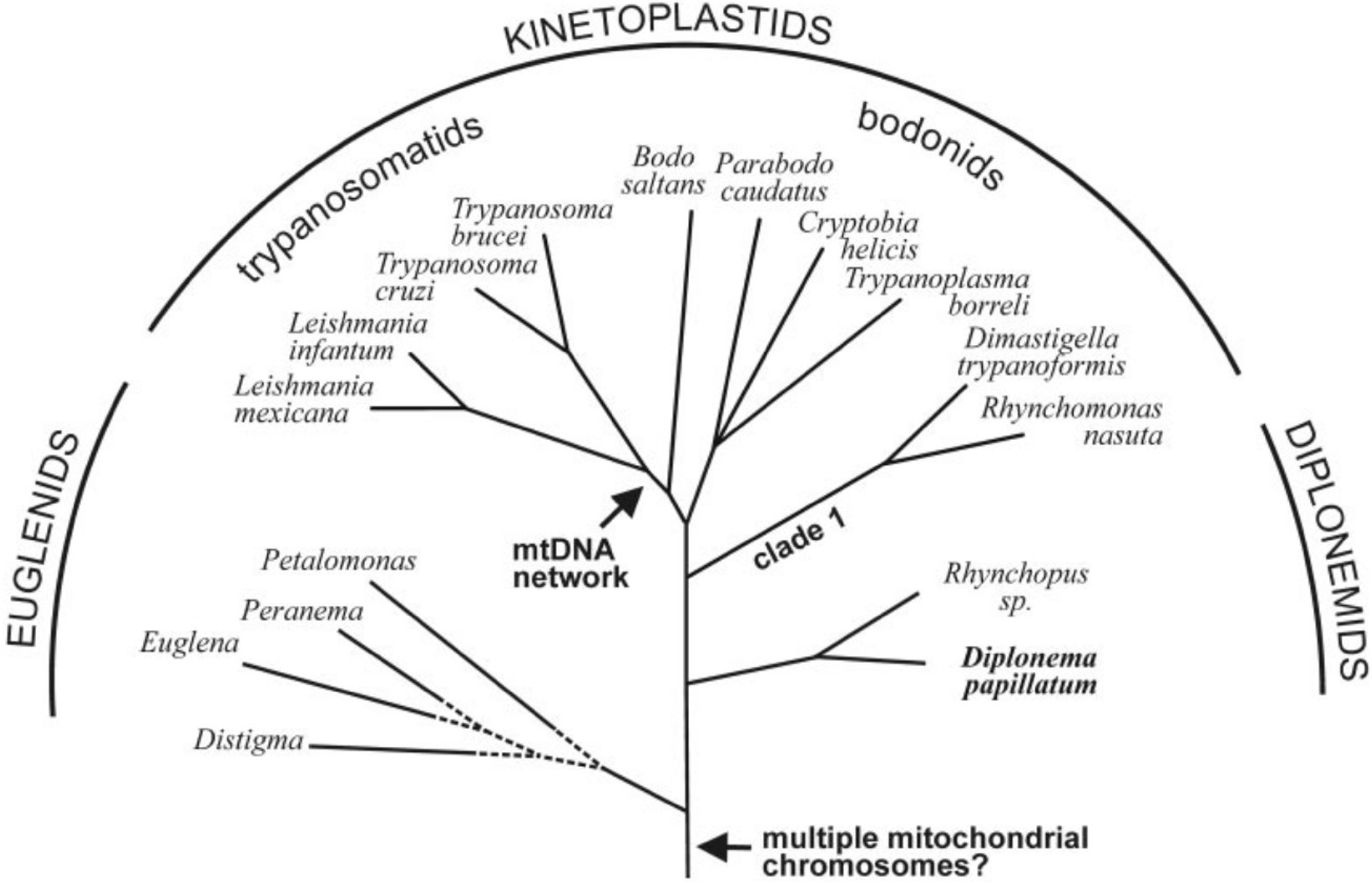
- unicelulares
- flagelados (geralmente dois flagelos)
- 15 – 500 µm de tamanho
- alguns: citóstoma (boca)
- três conjuntos de microtúbulos emergem da base flagelar
  - um suporta o citóstoma, os outros, as superfícies ventral e dorsal da célula
- modos de vida diversos
  - fagocitose (fagotrófos)
  - absorção (osmotrófos)
  - fotossíntese (autotrófos)
  - parasitas
  - (endo)simbiontes

Kinetoplastida



Euglenida

Diplonemida


KINETOPLASTIDS
trypanosomatids
bodonids
EUGLENIDS
DIPLONEMIDS
Bodo saltans
Parabodo caudatus
Trypanosoma brucei
Cryptobia helicis
Trypanosoma cruzi
Trypanoplasma borreli
Leishmania infantum
Dimastigella trypanoformis
Leishmania mexicana
Rhynchomonas nasuta
mtDNA network
clade 1
Petalomonas
Peranema
Euglena
Distigma
Rhynchopus sp.
Diplonema papillatum
multiple mitochondrial chromosomes?

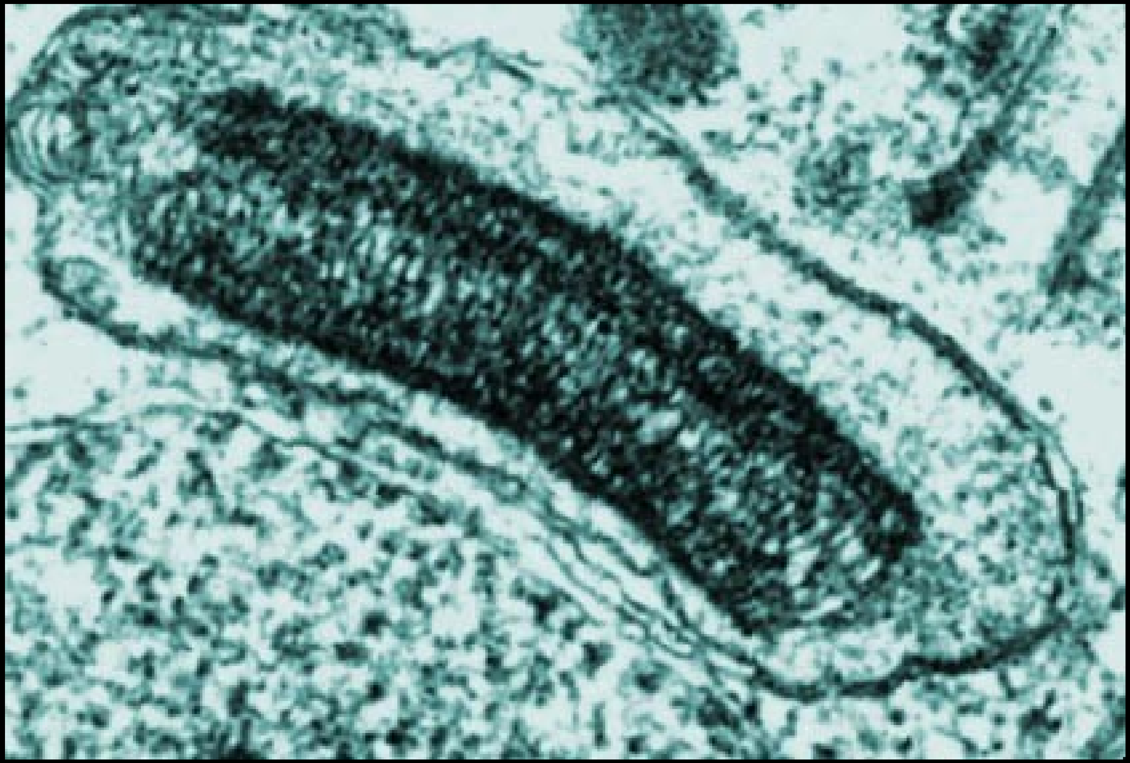
Kinetoplastida

Honigberg, 1963

- possuem cinetoplasto
  - estrutura de DNA mitocondrial concatenado em rede
  - condensado (estrutura escura em coloração)
  - localizado próximo à base flagelar
- uma mitocôndria grande, tubular e ramificada
- cristas mitocondriais podem ser poucas
- biflagelados (bodonídeos)...
- ...ou uniflagelados (tripanossomatídeos)
- possuem glicossomos
- fazem trans-splicing

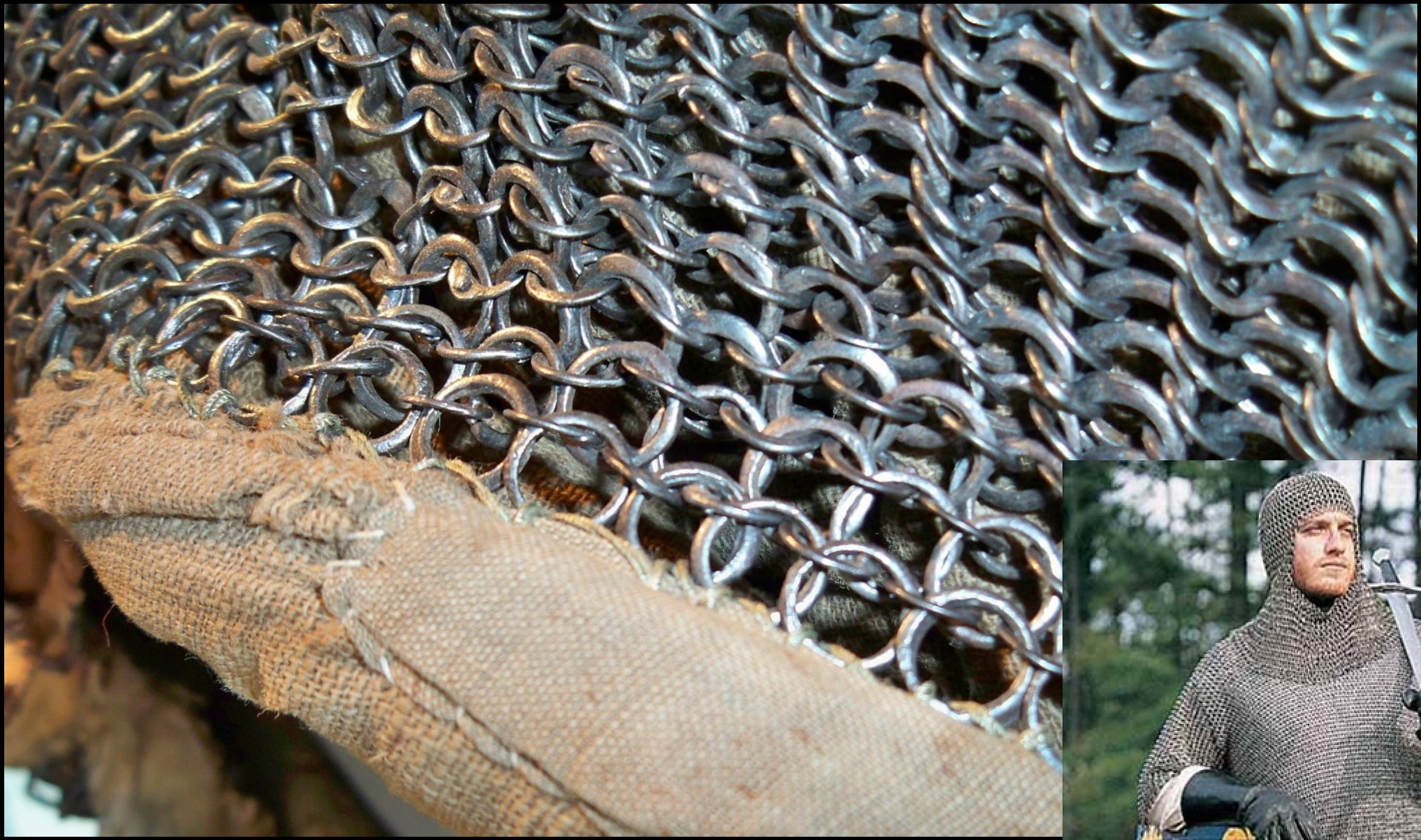
kDNA

DNA do cinetoplasto



kDNA

DNA do cinetoplasto



kDNA

DNA do cinetoplasto

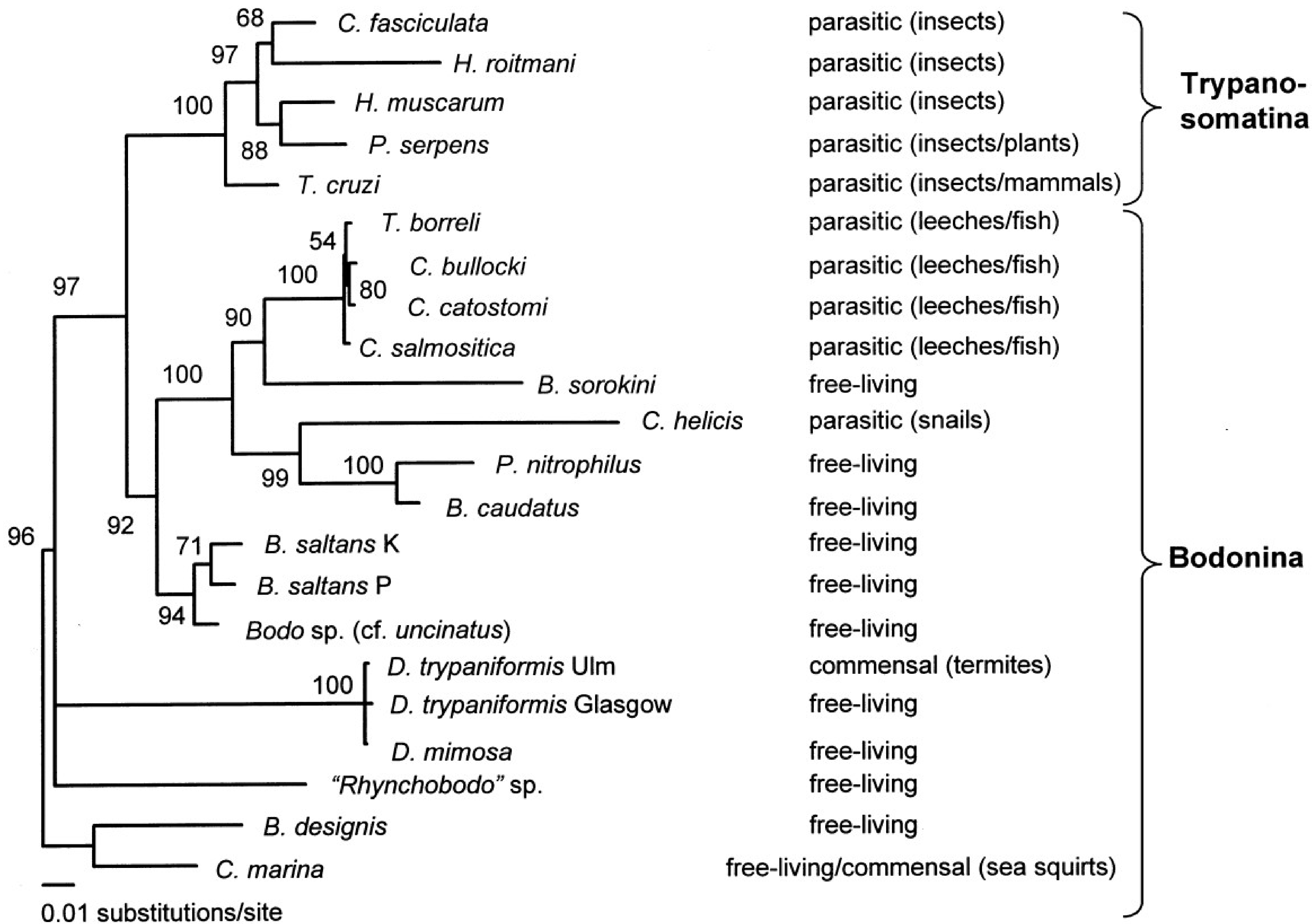
- 20 a 50 maxicírculos de 20 a 40 kbp
  - contém os genes mitocondriais
    - mRNAs, tRNAs, rRNAs
  - equivalente do nosso mtDNA
- 5 a 20 mil minicírculos de 0,5 a 1 kbp
  - genes de RNA-guia
  - usados para edição de RNA (inserção de U)

Bodonina

(dois flagelos)

Trypanosomatina

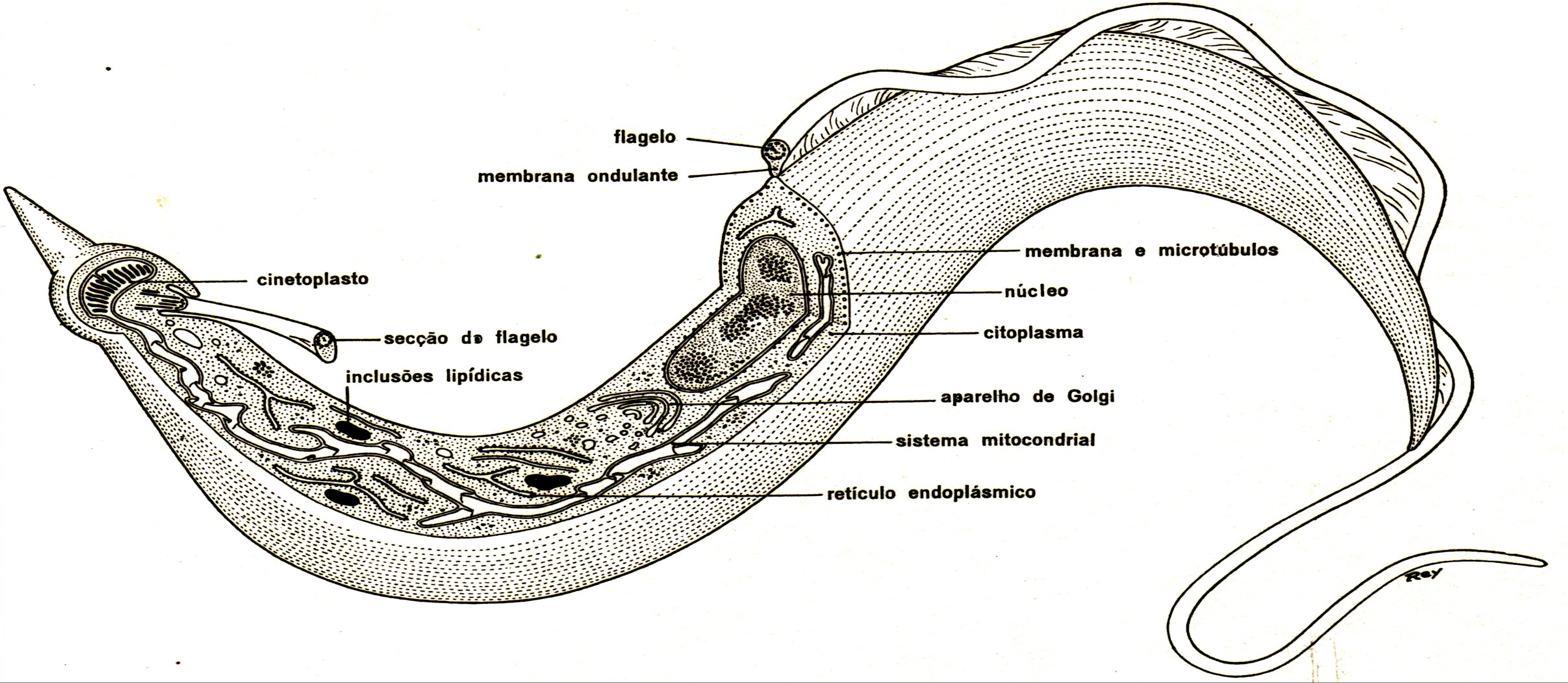
(um flagelo)



68
97
100
88
C. fasciculata
H. roitmani
H. muscarum
P. serpens
T. cruzi
parasitic (insects)
parasitic (insects)
parasitic (insects)
parasitic (insects/plants)
parasitic (insects/mammals)
Trypano-somatina
54
100
80
90
97
100
99
100
92
71
96
94
T. borreli
C. bullocki
C. catostomi
C. salmositica
B. sorokini
C. helicis
P. nitrophilus
B. caudatus
B. saltans K
B. saltans P
Bodo sp. (cf. uncinatus)
D. trypaniformis Ulm
D. trypaniformis Glasgow
D. mimosa
"Rhynchobodo" sp.
B. designis
C. marina
parasitic (leeches/fish)
parasitic (leeches/fish)
parasitic (leeches/fish)
parasitic (leeches/fish)
free-living
parasitic (snails)
free-living
free-living
free-living
free-living
free-living
commensal (termites)
free-living
free-living
free-living
free-living
free-living/commensal (sea squirts)
Bodonina
0.01 substitutions/site

Trypanosomatidae

- mais de uma dezena de gêneros
- todos parasitas
- um flagelo
    - emerge de um bolso anterior ou lateralmente
    - flagelo aderido ao corpo celular
- nutrição fagotrófica ou osmotrófica
- quando há citóstoma: simples e associado ao bolso flagelar


flagelo
membrana ondulante
membrana e microtúbulos
cinetoplasto
núcleo
citoplasma
secção da flagelo
inclusões lipídicas
aparelho de Golgi
sistema mitocondrial
retículo endoplásmico
Rey

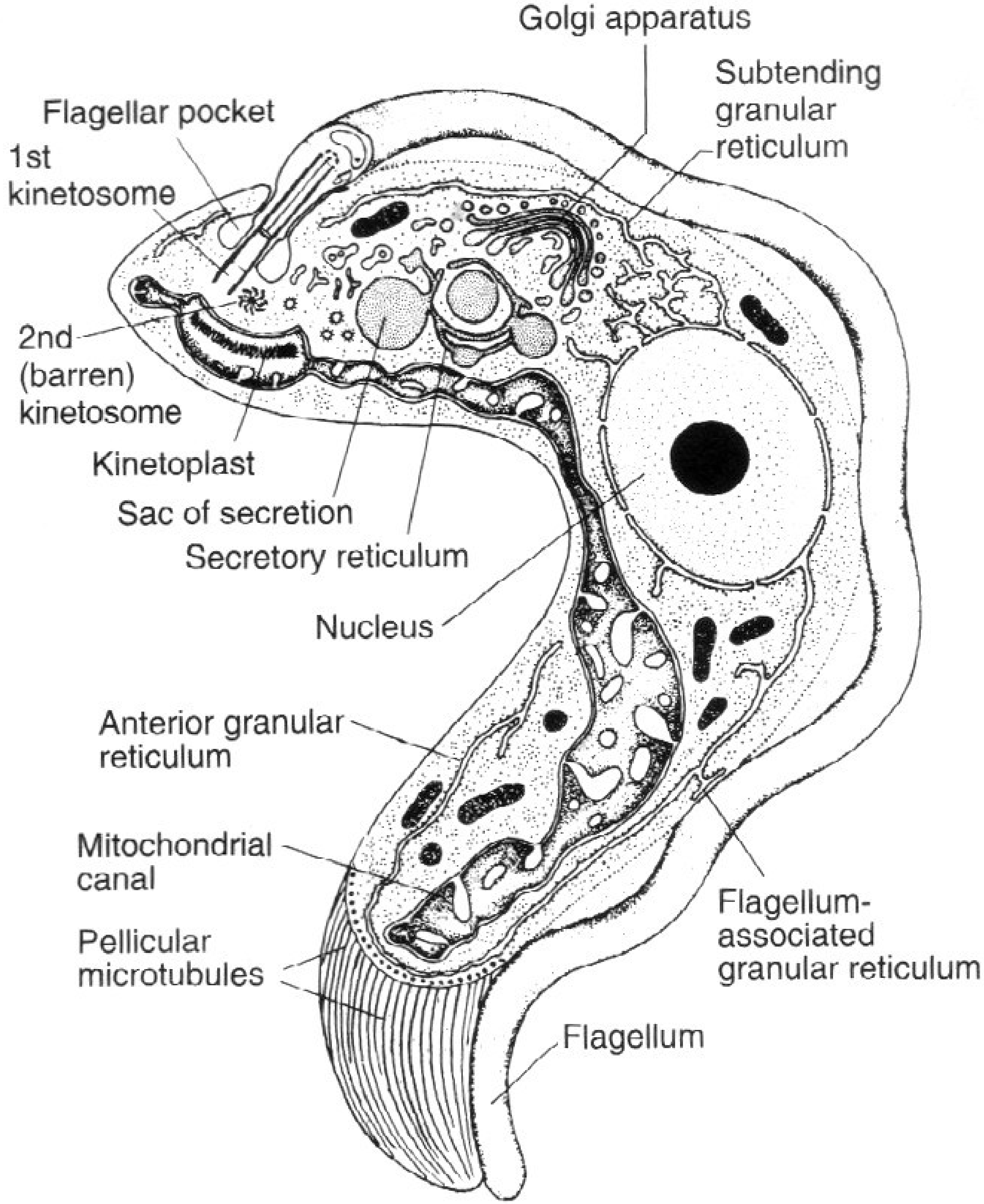
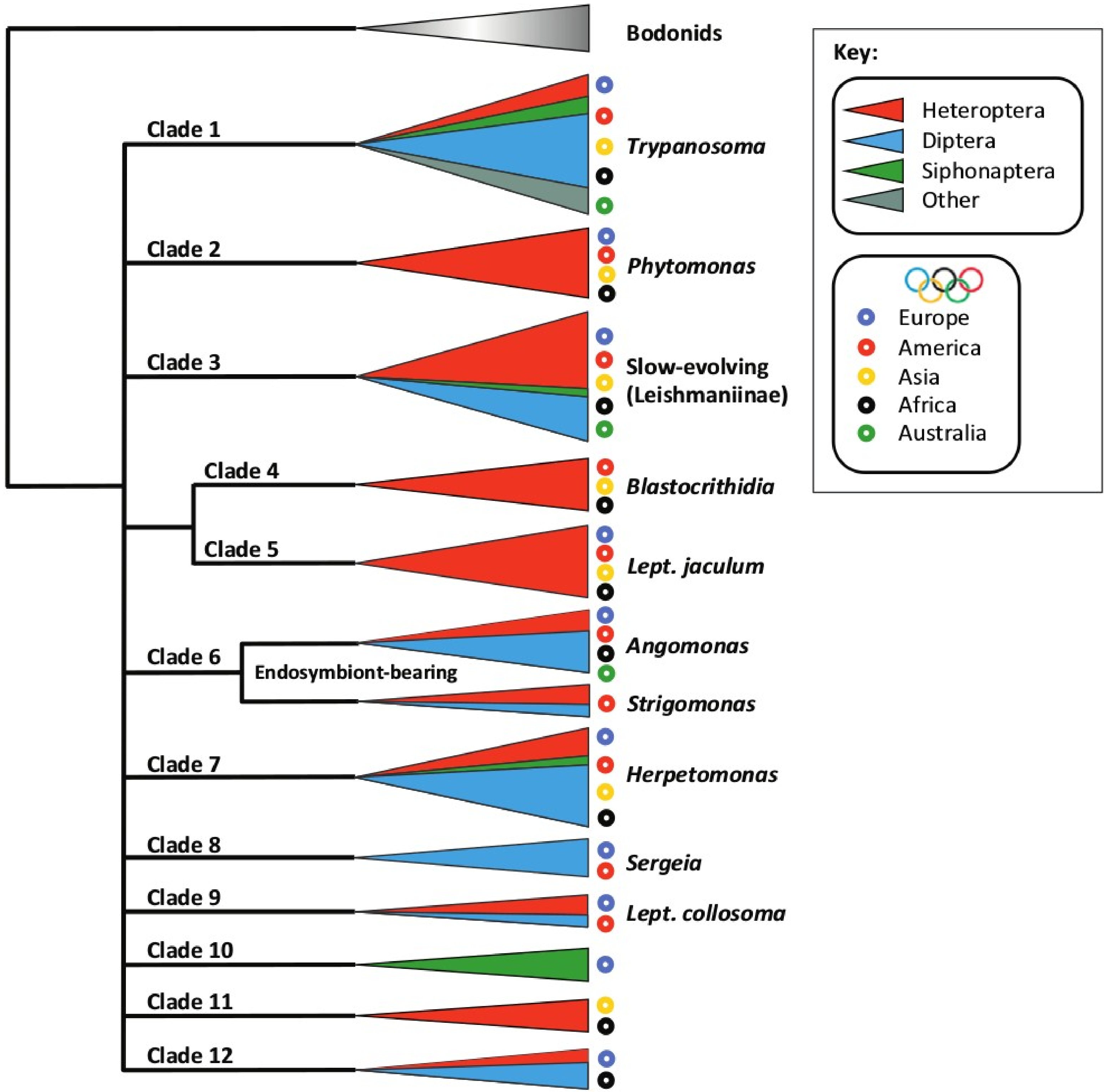


Figure 5.1 **Diagram to show principal structures revealed by electron microscopy in the bloodstream trypomastigote of a salivarian trypanosome, *Trypanosoma congolense*.**



TRENDS in Parasitology

Trypanosoma

David Gruby, 1843

- sempre heteroxênicos (exceto *T. equiperdum*)
- parasitas de todas as classes de vertebrados
- na maioria dos casos, transmitidos por vetores hematófagos
- geralmente vivem no sangue ou fluidos teciduais, mas podem ter fase intracelular (por exemplo, *T. cruzi*)

Seção Salivaria

T. brucei

T. congolense

T. vivax

T. evansi

T. equinum

T. equiperdum (doença venérea de cavalos, sem vetor)

Seção Stercoraria

T. cruzi

T. rangeli

T. lewisi

T. theileri

Outros

T. percae (perca)

T. granulosum (enguia)

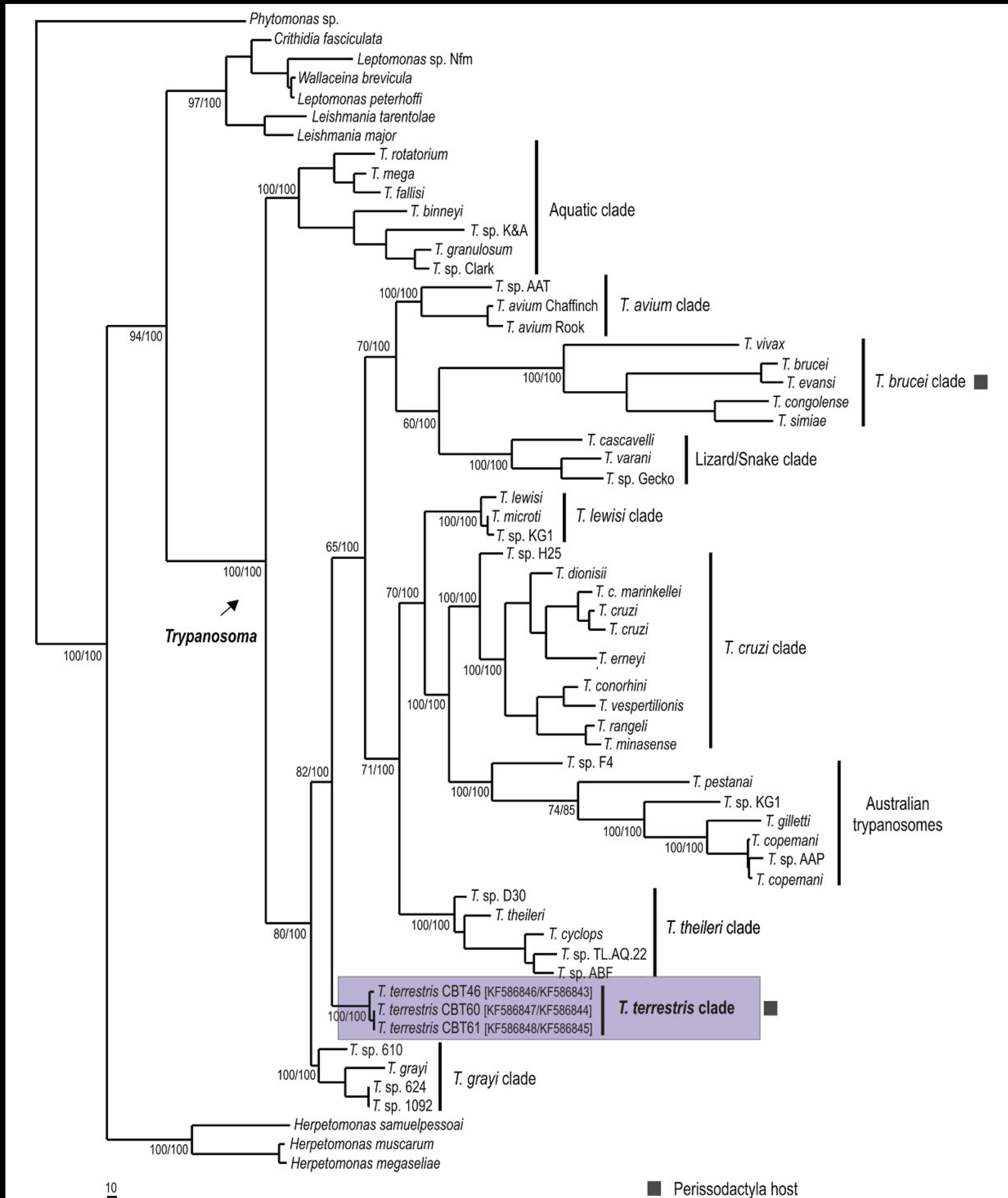
T. avium

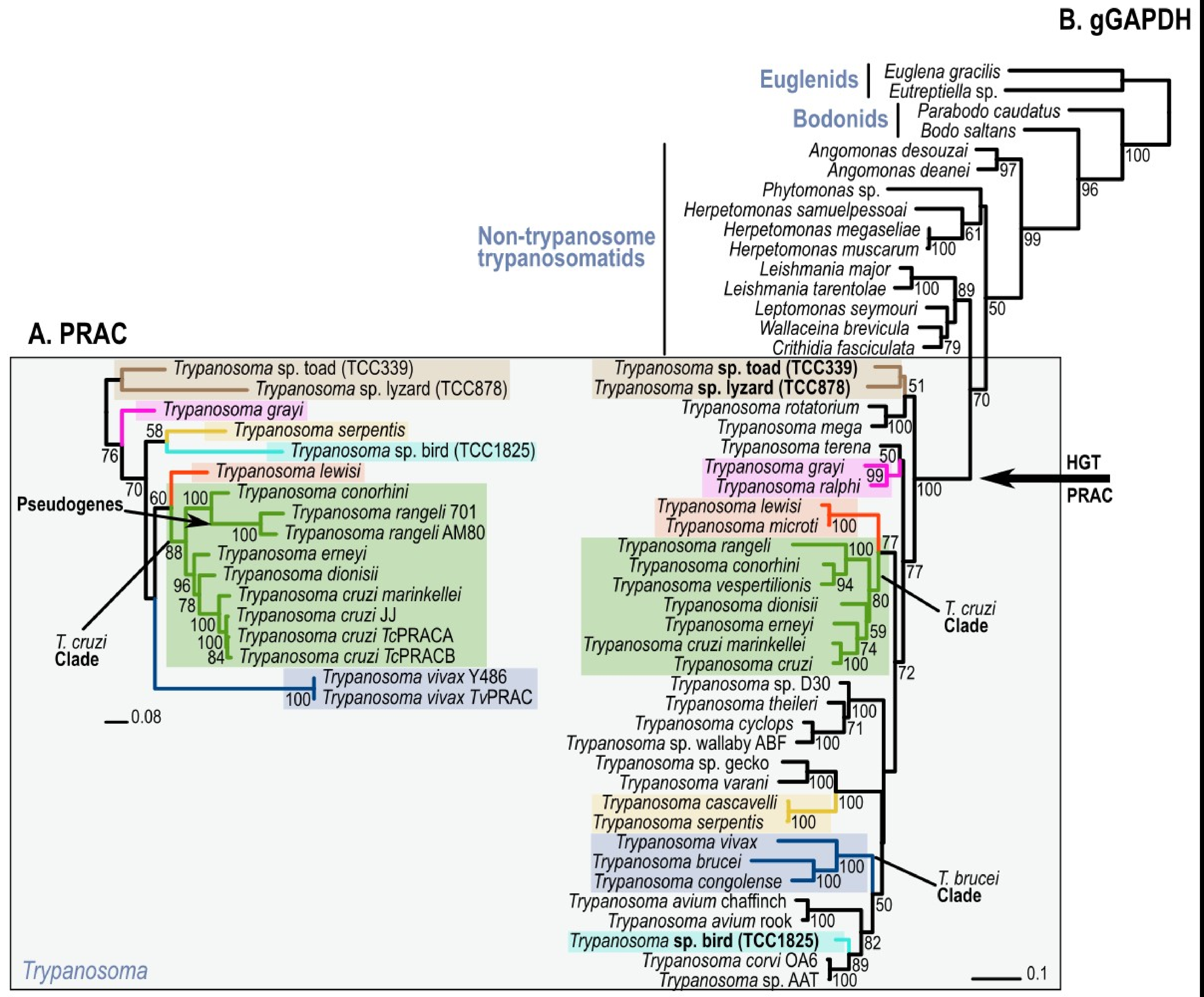
T. terrestris

T. grayi

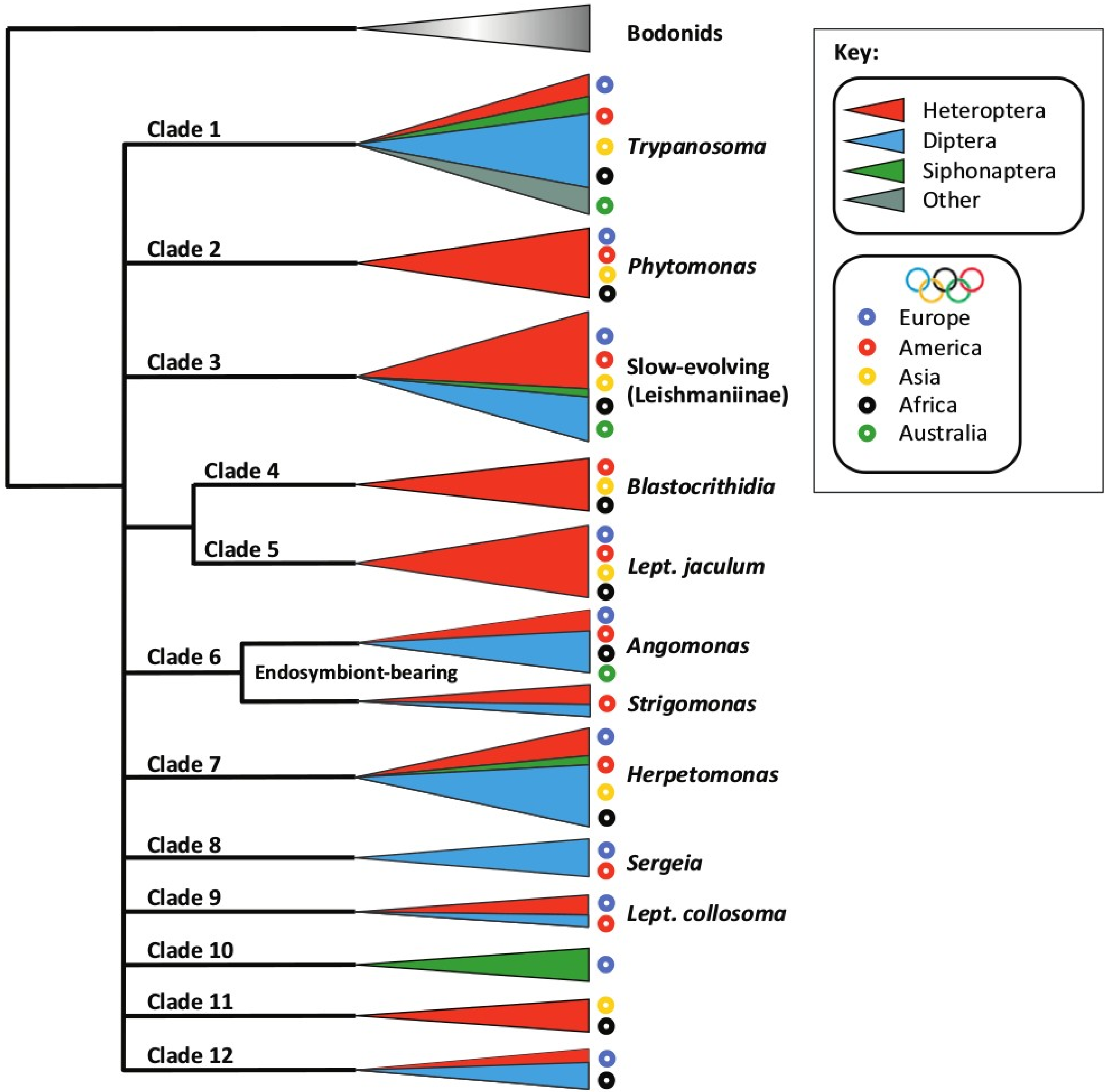
T. mega

etc. etc. etc.


Phytomonas sp.
Crithidia fasciculata
Leptomonas sp. Nfm
Wallaceina brevicula
Leptomonas peterhoffi
Leishmania tarentolae
Leishmania major
97/100
T. rotatorium
T. mega
T. fallisi
T. binneyi
T. sp. K&A
T. granulosum
T. sp. Clark
Aquatic clade
100/100
T. sp. AAT
T. avium Chaffinch
T. avium Rook
T. avium clade
100/100
94/100
70/100
T. vivax
T. brucei
T. evansi
T. congolense
T. simiae
T. brucei clade
100/100
60/100
T. cascavelli
T. varani
T. sp. Gecko
Lizard/Snake clade
100/100
T. lewisi
T. microti
T. sp. KG1
T. lewisi clade
100/100
65/100
T. sp. H25
100/100
T. dionisii
T. c. marinkellei
T. cruzi
T. cruzi
T. erneyi
T. cruzi clade
70/100
100/100
Trypanosoma
100/100
100/100
T. conorhini
T. vespertilionis
T. rangeli
T. minasense
100/100
T. sp. F4
82/100
71/100
T. pestanai
100/100
T. sp. KG1
74/85
T. gilletti
Australian trypanosomes
100/100
T. copemani
100/100
T. sp. AAP
T. copemani
T. sp. D30
T. theileri
100/100
T. cyclops
T. theileri clade
80/100
T. sp. TL.AQ.22
T. sp. ABF
T. terrestris CBT46 [KF586846/KF586843]
T. terrestris CBT60 [KF586847/KF586844]
T. terrestris clade
100/100
T. terrestris CBT61 [KF586848/KF586845]
T. sp. 610
T. grayi
T. grayi clade
100/100
T. sp. 624
T. sp. 1092
Herpetomonas samuelpessoai
Herpetomonas muscarum
100/100
Herpetomonas megaseliae
10
Perissodactyla host



B. gGAPDH
Euglenids
Euglena gracilis
Eutreptiella sp.
Bodonids
Parabodo caudatus
Bodo saltans
Angomonas desouzai
Angomonas deanei
Phytomonas sp.
Herpetomonas samuelpessoai
Herpetomonas megaseliae
Herpetomonas muscarum
Leishmania major
Leishmania tarentolae
Leptomonas seymouri
Wallaceina brevicula
Crithidia fasciculata
Non-trypanosome trypanosomatids
A. PRAC
Trypanosoma sp. toad (TCC339)
Trypanosoma sp. lyzard (TCC878)
Trypanosoma grayi
Trypanosoma serpentis
Trypanosoma sp. bird (TCC1825)
Trypanosoma lewisi
Trypanosoma conorhini
Trypanosoma rangeli 701
Trypanosoma rangeli AM80
Trypanosoma erneyi
Trypanosoma dionisii
Trypanosoma cruzi marinkellei
Trypanosoma cruzi JJ
Trypanosoma cruzi TcPRACA
Trypanosoma cruzi TcPRACB
Trypanosoma vivax Y486
Trypanosoma vivax TvPRAC
Pseudogenes
T. cruzi Clade
0.08
Trypanosoma rotatorium
Trypanosoma mega
Trypanosoma terena
Trypanosoma ralphi
Trypanosoma microti
Trypanosoma rangeli
Trypanosoma vespertilionis
Trypanosoma cruzi
Trypanosoma sp. D30
Trypanosoma theileri
Trypanosoma cyclops
Trypanosoma sp. wallaby ABF
Trypanosoma sp. gecko
Trypanosoma varani
Trypanosoma cascavelli
Trypanosoma vivax
Trypanosoma brucei
Trypanosoma congolense
Trypanosoma avium chaffinch
Trypanosoma avium rook
Trypanosoma corvi OA6
Trypanosoma sp. AAT
T. brucei Clade
HGT
PRAC
Trypanosoma
0.1


Bodonids
Key:
Heteroptera
Diptera
Siphonaptera
Other
Europe
America
Asia
Africa
Australia
Clade 1
Trypanosoma
Clade 2
Phytomonas
Clade 3
Slow-evolving (Leishmaniinae)
Clade 4
Blastocrithidia
Clade 5
Lept. jaculum
Clade 6
Endosymbiont-bearing
Angomonas
Strigomonas
Clade 7
Herpetomonas
Clade 8
Sergeia
Clade 9
Lept. collosoma
Clade 10
Clade 11
Clade 12

Leishmania

Ross, 1903

- sempre heteroxênicos
- parasitas predominantemente de mamíferos (*Sauroleishmania*: lagartos)
- transmitidos por dípteros flebotomíneos (mosquito palha, tatuquira, birigui, cangalinha, asa branca, asa dura e palhinha)
- vivem, no vertebrado, dentro de tecidos

Subgênero *Leishmania*

- desenvolvimento nas regiões anterior e media do intestino do inseto

L. major

L. donovani

L. infantum

L. mexicana

L. amazonensis

L. tropica

L. aethiopica

etc. etc. etc.

Subgênero *Viannia*

- desenvolvimento também na porção posterior do intestino do inseto

L. braziliensis

L. peruviana

L. guyanensis

L. panamensis

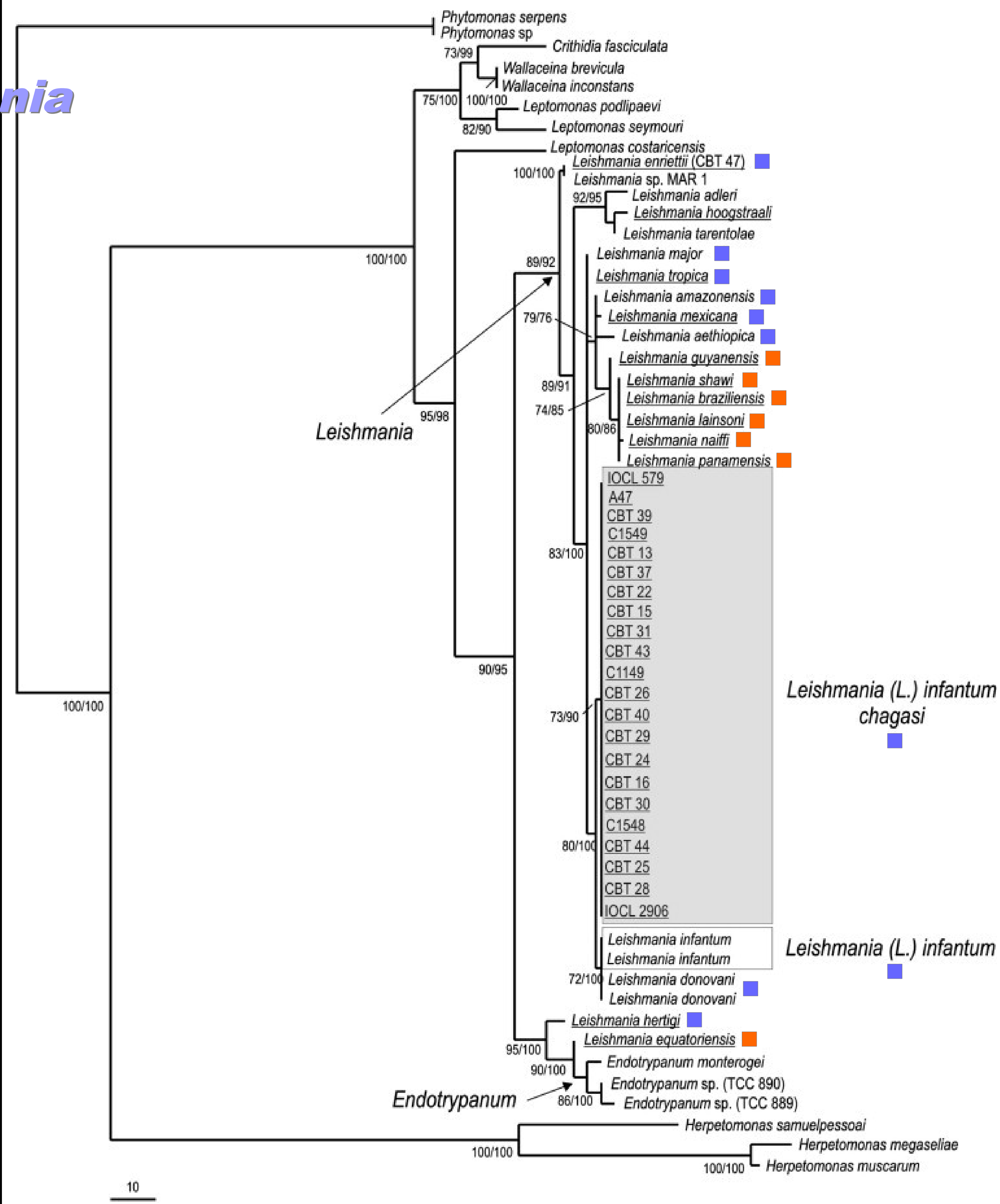
L. shawi

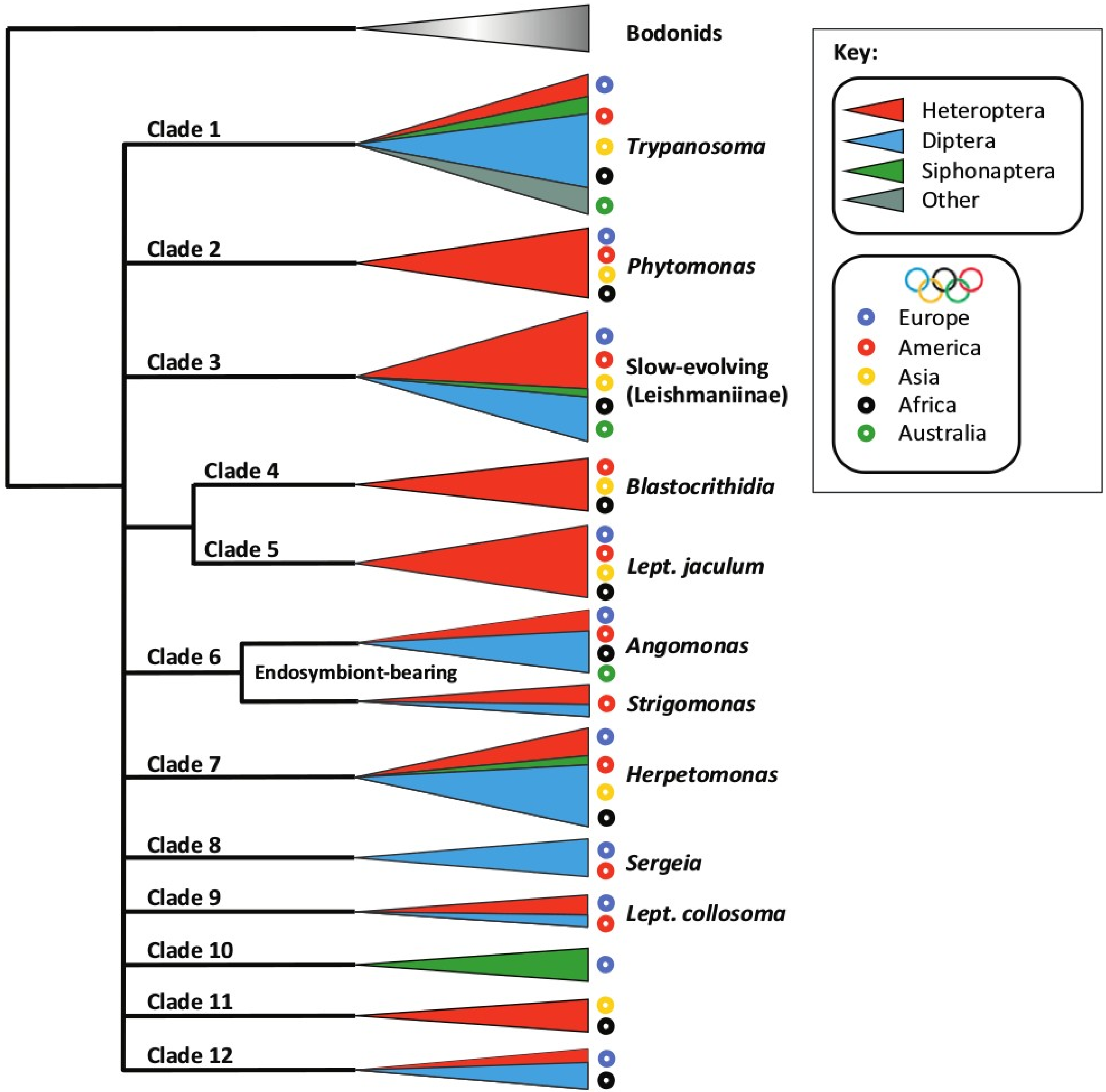
L. naiffi

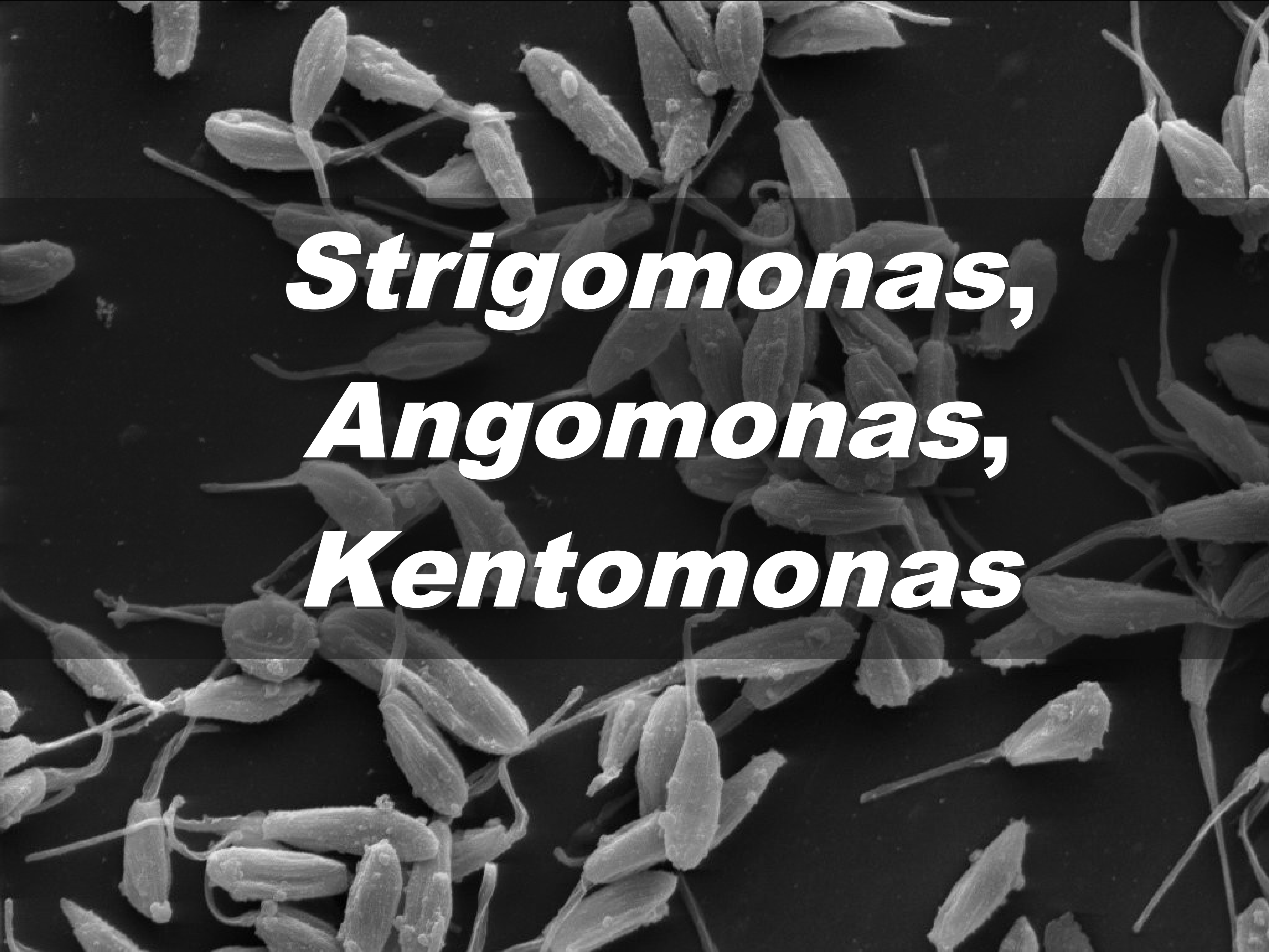
L. colombiensis

etc. etc. etc.

Leishmania
Viannia




Bodonids
Clade 1
Trypanosoma
Clade 2
Phytomonas
Clade 3
Slow-evolving
(Leishmaniinae)
Clade 4
Blastocrithidia
Clade 5
Lept. jaculum
Clade 6
Endosymbiont-bearing
Angomonas
Strigomonas
Clade 7
Herpetomonas
Clade 8
Sergeia
Clade 9
Lept. collosoma
Clade 10
Clade 11
Clade 12
Key:
Heteroptera
Diptera
Siphonaptera
Other
Europe
America
Asia
Africa
Australia



Strigomonas, Angomonas, Kentomonas

vida

ENDOSIMBIOSE

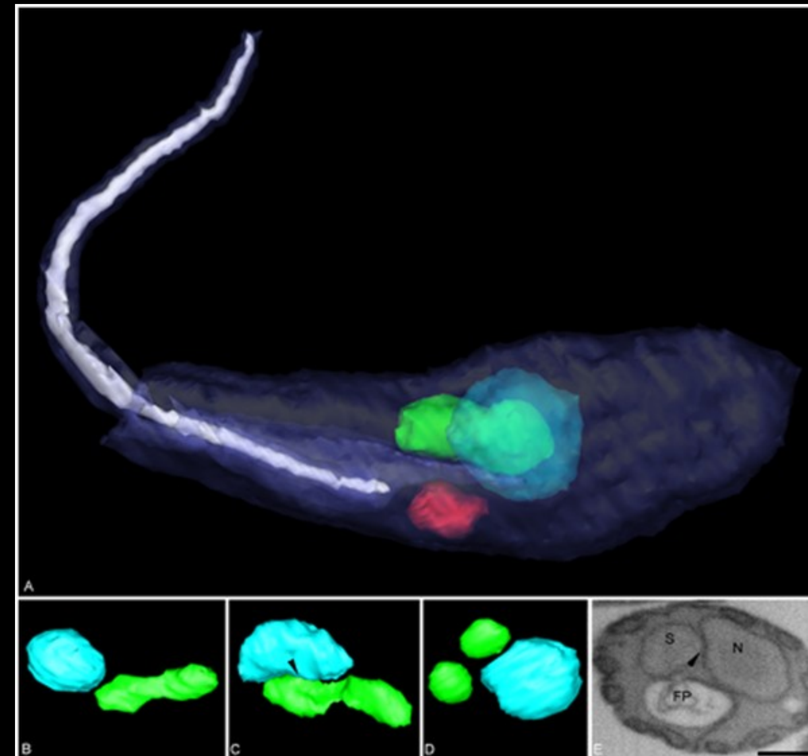
dentro

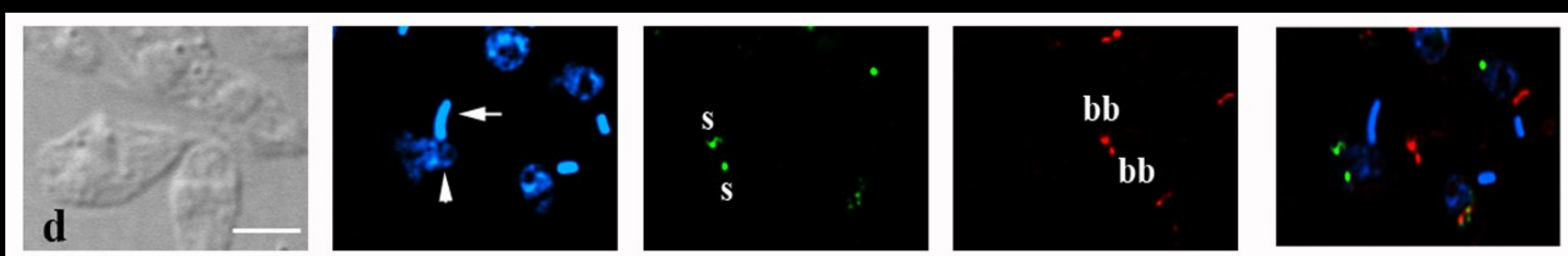
junto

Ca. **Kinetoplastibacterium crithidii**

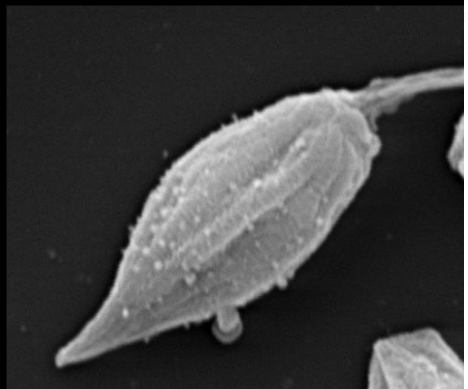
&

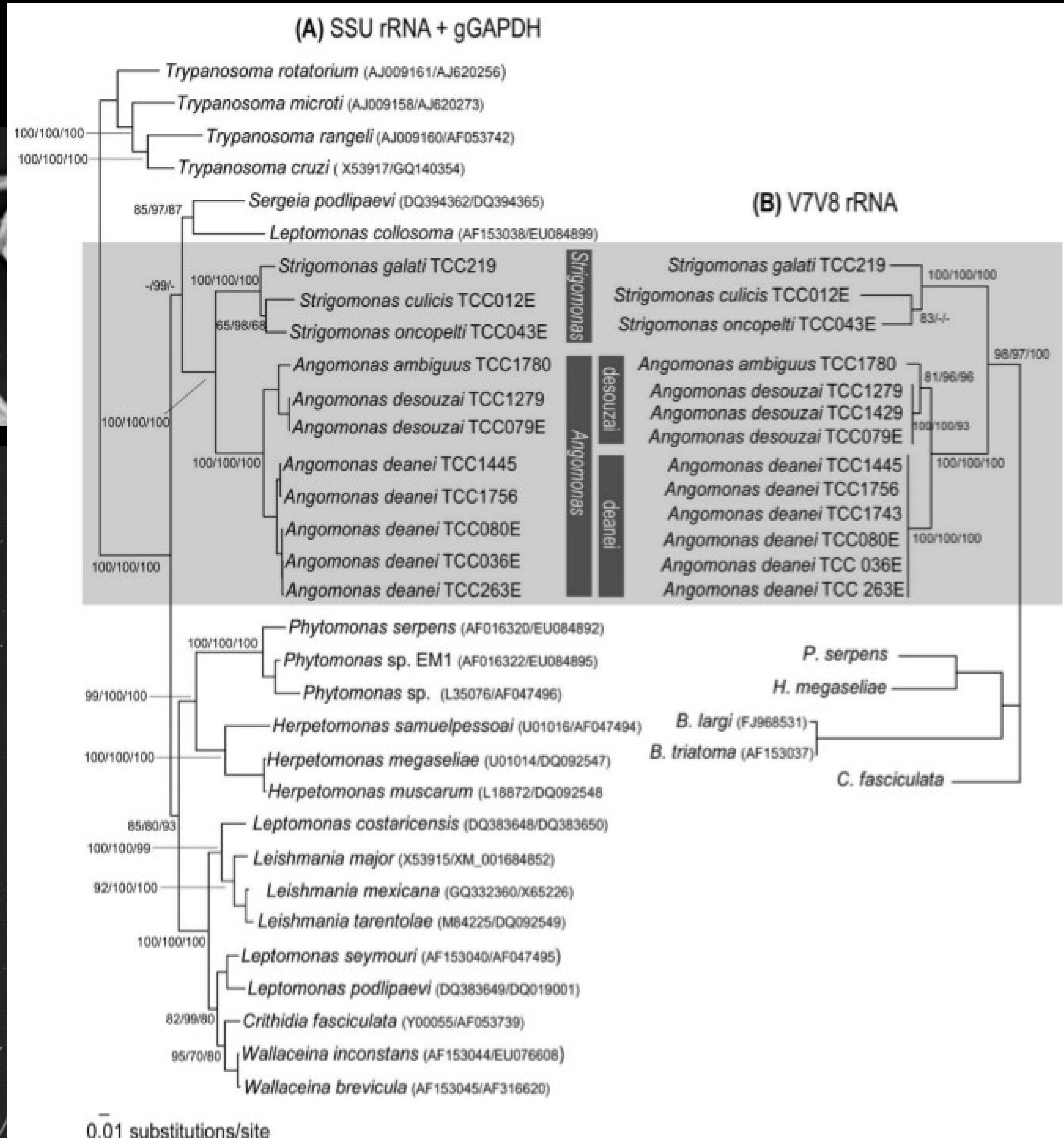
Angomonas deanei





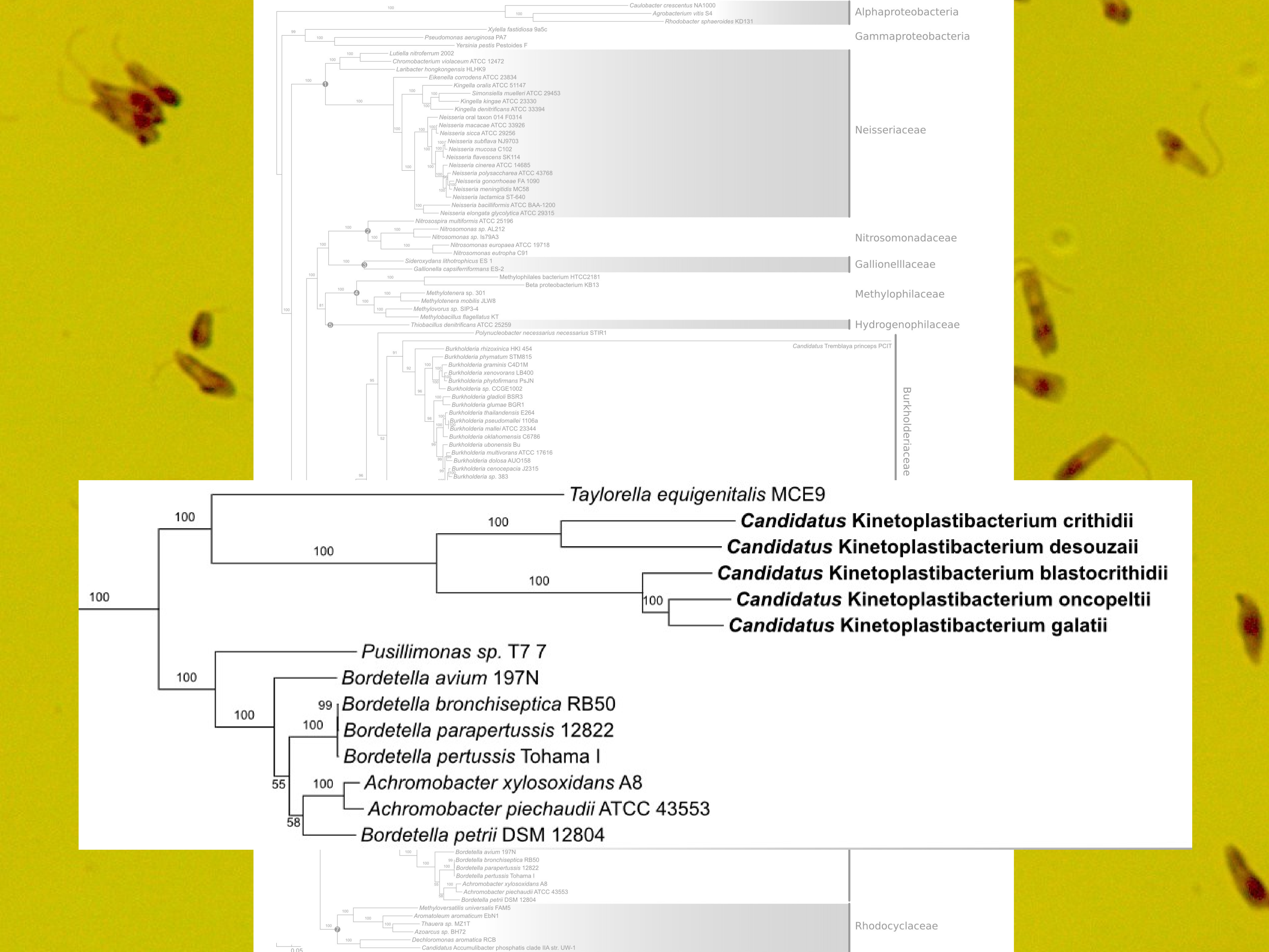
M.C.M. Motta et al., *PLoS ONE* (2010)





(A) SSU rRNA + gGAPDH
Trypanosoma rotatorium (AJ009161/AJ620256)
Trypanosoma microti (AJ009158/AJ620273)
Trypanosoma rangeli (AJ009160/AF053742)
Trypanosoma cruzi (X53917/GQ140354)
100/100/100
100/100/100
Sergeia podlipaevi (DQ394362/DQ394365)
Leptomonas collosoma (AF153038/EU084899)
85/97/87
-/99/-
Strigomonas galati TCC219
Strigomonas culicis TCC012E
Strigomonas oncopelti TCC043E
100/100/100
65/96/68
Strigomonas
Angomonas ambiguus TCC1780
Angomonas desouzai TCC1279
Angomonas desouzai TCC079E
Angomonas deanei TCC1445
Angomonas deanei TCC1756
Angomonas deanei TCC080E
Angomonas deanei TCC036E
Angomonas deanei TCC263E
100/100/100
100/100/100
100/100/100
Angomonas
desouzai
deanei
(B) V7V8 rRNA
Strigomonas galati TCC219
Strigomonas culicis TCC012E
Strigomonas oncopelti TCC043E
100/100/100
83/-/-
98/97/100
Angomonas ambiguus TCC1780
Angomonas desouzai TCC1279
Angomonas desouzai TCC1429
Angomonas desouzai TCC079E
81/96/96
100/100/93
Angomonas deanei TCC1445
Angomonas deanei TCC1756
Angomonas deanei TCC1743
Angomonas deanei TCC080E
Angomonas deanei TCC 036E
Angomonas deanei TCC 263E
100/100/100
100/100/100
Phytomonas serpens (AF016320/EU084892)
Phytomonas sp. EM1 (AF016322/EU084895)
Phytomonas sp. (L35076/AF047496)
100/100/100
99/100/100
Herpetomonas samuelpessoai (U01016/AF047494)
Herpetomonas megaseliae (U01014/DQ092547)
Herpetomonas muscarum (L18872/DQ092548)
100/100/100
P. serpens
H. megaseliae
B. largi (FJ968531)
B. triatoma (AF153037)
C. fasciculata
85/80/93
Leptomonas costaricensis (DQ383648/DQ383650)
Leishmania major (X53915/XM_001684852)
Leishmania mexicana (GQ332360/X65226)
Leishmania tarentolae (M84225/DQ092549)
100/100/99
92/100/100
100/100/100
Leptomonas seymouri (AF153040/AF047495)
Leptomonas podlipaevi (DQ383649/DQ019001)
Crithidia fasciculata (Y00055/AF053739)
Wallaceina inconstans (AF153044/EU076608)
Wallaceina brevicula (AF153045/AF316620)
82/99/80
95/70/80
0.01 substitutions/site


Caulobacter crescentus NA1000
Agrobacterium vitis S4
Rhodobacter sphaeroides KD131
Alphaproteobacteria
Xylella fastidiosa 9a5c
Pseudomonas aeruginosa PA7
Yersinia pestis Pestoides F
Gammaproteobacteria
Lutiella nitroferrum 2002
Chromobacterium violaceum ATCC 12472
Laribacter hongkongensis HLHK9
Eikenella corrodens ATCC 23834
Kingella oralis ATCC 51147
Simonsiella muelleri ATCC 29453
Kingella kingae ATCC 23330
Kingella denitrificans ATCC 33394
Neisseria oral taxon 014 F0314
Neisseria macacae ATCC 33926
Neisseria sicca ATCC 29256
Neisseria subflava NJ9703
Neisseria mucosa C102
Neisseria flavescens SK114
Neisseria cinerea ATCC 14685
Neisseria polysaccharea ATCC 43768
Neisseria gonorrhoeae FA 1090
Neisseria meningitidis MC58
Neisseria lactamica ST-640
Neisseria bacilliformis ATCC BAA-1200
Neisseria elongata glycolytica ATCC 29315
Neisseriaceae
Nitrosospira multiformis ATCC 25196
Nitrosomonas sp. AL212
Nitrosomonas sp. Is79A3
Nitrosomonas europaea ATCC 19718
Nitrosomonas eutropha C91
Nitrosomonadaceae
Sideroxydans lithotrophicus ES 1
Gallionella capsiferriformans ES-2
Gallionelllaceae
Methylophilales bacterium HTCC2181
Beta proteobacterium KB13
Methylotenera sp. 301
Methylotenera mobilis JLW8
Methylovorus sp. SIP3-4
Methylobacillus flagellatus KT
Methylophilaceae
Thiobacillus denitrificans ATCC 25259
Hydrogenophilaceae
Polynucleobacter necessarius necessarius STIR1
Candidatus Tremblaya princeps PCIT
Burkholderia rhizoxinica HKI 454
Burkholderia phymatum STM815
Burkholderia graminis C4D1M
Burkholderia xenovorans LB400
Burkholderia phytofirmans PsJN
Burkholderia sp. CCGE1002
Burkholderia gladioli BSR3
Burkholderia glumae BGR1
Burkholderia thailandensis E264
Burkholderia pseudomallei 1106a
Burkholderia mallei ATCC 23344
Burkholderia oklahomensis C6786
Burkholderia ubonensis Bu
Burkholderia multivorans ATCC 17616
Burkholderia dolosa AUO158
Burkholderia cenocepacia J2315
Burkholderia sp. 383
Burkholderia vietnamiensis G4
Burkholderia ambifaria AMMD
Ralstonia pickettii 12J
Ralstonia solanacearum GMI1000
Cupriavidus metallidurans CH34
Ralstonia eutropha JMP134
Cupriavidus taiwanensis
Cupriavidus necator N 1
Burkholderiaceae
Herbaspirillum seropedicae SmR1
Collimonas fungivorans Ter331
Oxalobacteraceae bacterium IMCC9480
Janthinobacterium sp. Marseille
Herminiimonas arsenicoxydans
Candidatus Zinderia insecticola CARI
Oxalobacter formigenes HOxBLS
Oxalobacteraceae
Methylibium petroleiphilum PM1
Leptothrix cholodnii SP-6
Rubrivivax benzoatilyticus JA2
Burkholderiales
incertae sedis
Hylemonella gracilis ATCC 19624
Ramlibacter tataouinensis TTB310
Rhodoferax ferrireducens T118
Polaromonas sp. JS666
Polaromonas naphthalenivorans CJ2
Verminephrobacter eiseniae EF01-2
Acidovorax delafieldii 2AN uid55645
Acidovorax avenae ATCC 19860
Alicycliphilus denitrificans BC
Acidovorax sp. JS42
Acidovorax ebreus TPSY
Comamonas testosteroni CNB-2
Delftia acidovorans SPH-1
Delftia sp. Cs1 4
Variovorax paradoxus EPS
Comamonadaceae
Thiomonas intermedia K12
Burkholderiales incertae sedis
Lautropia mirabilis ATCC 51599
Burkholderiaceae
Sutterella wadsworthensis 3 1 45B
Burkholderiales bacterium 1 1 47
Parasutterella excrementihominis YIT 11859
Sutterellaceae
Limnobacter sp. MED105
Burkholderiaceae
Taylorella equigenitalis MCE9
Candidatus Kinetoplastibacterium crithidii
Candidatus Kinetoplastibacterium desouzaii
Candidatus Kinetoplastibacterium blastocrithidii
Candidatus Kinetoplastibacterium oncopeltii
Candidatus Kinetoplastibacterium galatii
Pusillimonas sp. T7 7
Bordetella avium 197N
Bordetella bronchiseptica RB50
Bordetella parapertussis 12822
Bordetella pertussis Tohama I
Achromobacter xylosoxidans A8
Achromobacter piechaudii ATCC 43553
Bordetella petrii DSM 12804
Alcaligenaceae
Methyloversatilis universalis FAM5
Aromatoleum aromaticum EbN1
Thauera sp. MZ1T
Azoarcus sp. BH72
Dechloromonas aromatica RCB
Candidatus Accumulibacter phosphatis clade IIA str. UW-1
Rhodocyclaceae
0.05



Caulobacter crescentus NA1000
Agrobacterium vitis S4
Rhodobacter sphaeroides KD131
Alphaproteobacteria
Xylella fastidiosa 9a5c
Pseudomonas aeruginosa PA7
Yersinia pestis Pestoides F
Gammaproteobacteria
Lutiella nitroferrum 2002
Chromobacterium violaceum ATCC 12472
Laribacter hongkongensis HLHK9
Eikenella corrodens ATCC 23834
Kingella oralis ATCC 51147
Simonsiella muelleri ATCC 29453
Kingella kingae ATCC 23330
Kingella denitrificans ATCC 33394
Neisseria oral taxon 014 F0314
Neisseria macacae ATCC 33926
Neisseria sicca ATCC 29256
Neisseria subflava NJ9703
Neisseria mucosa C102
Neisseria flavescens SK114
Neisseria cinerea ATCC 14685
Neisseria polysaccharea ATCC 43768
Neisseria gonorrhoeae FA 1090
Neisseria meningitidis MC58
Neisseria lactamica ST-640
Neisseria bacilliformis ATCC BAA-1200
Neisseria elongata glycolytica ATCC 29315
Neisseriaceae
Nitrosospira multiformis ATCC 25196
Nitrosomonas sp. AL212
Nitrosomonas sp. Is79A3
Nitrosomonas europaea ATCC 19718
Nitrosomonas eutropha C91
Nitrosomonadaceae
Sideroxydans lithotrophicus ES 1
Gallionella capsiferriformans ES-2
Gallionelllaceae
Methylophilales bacterium HTCC2181
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