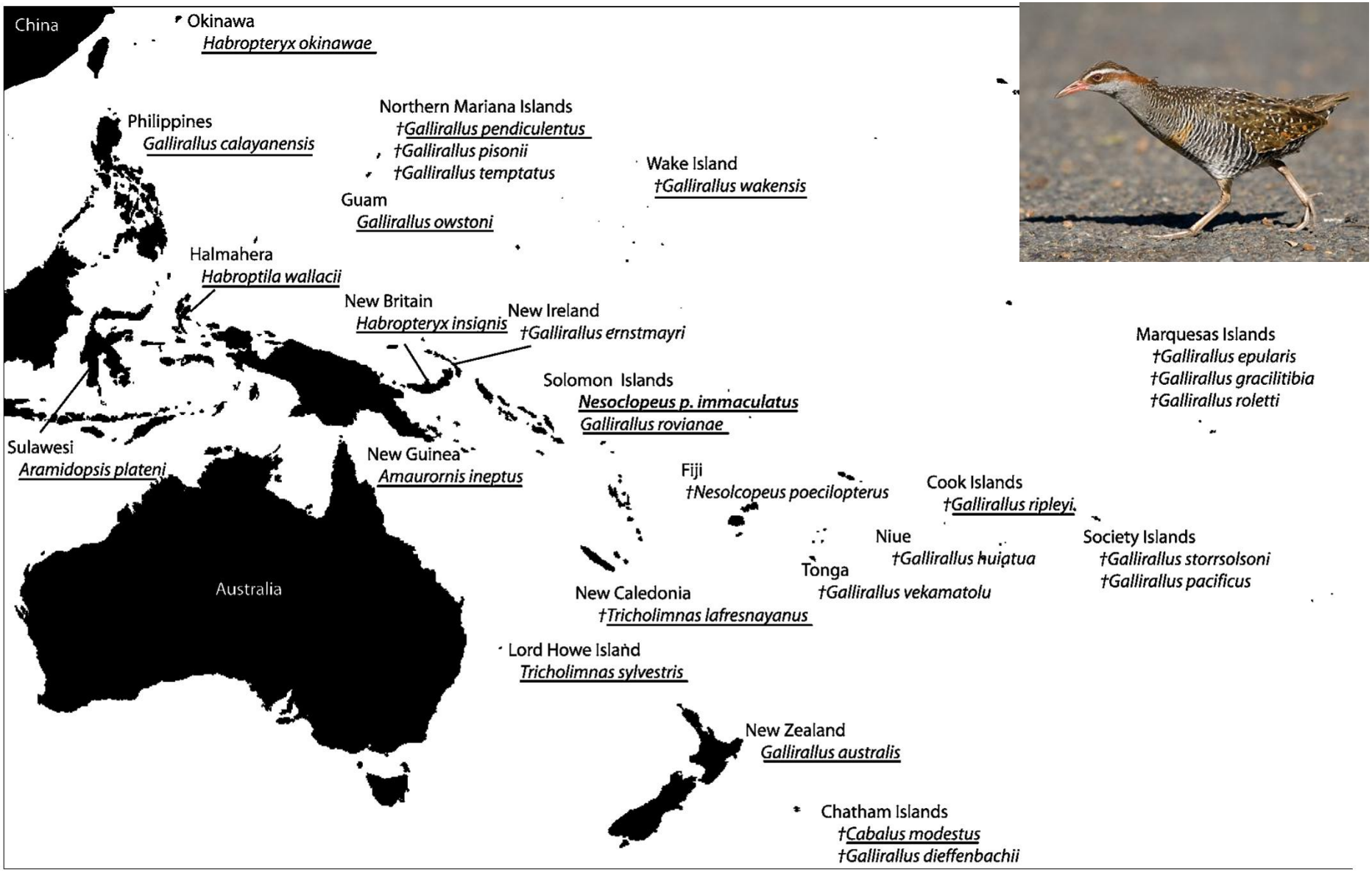
Why fly when you can walk?


© Jean-Michel Peers
www.oiseaux.net

Flightlessness occurs often



Takahe and Pukeko

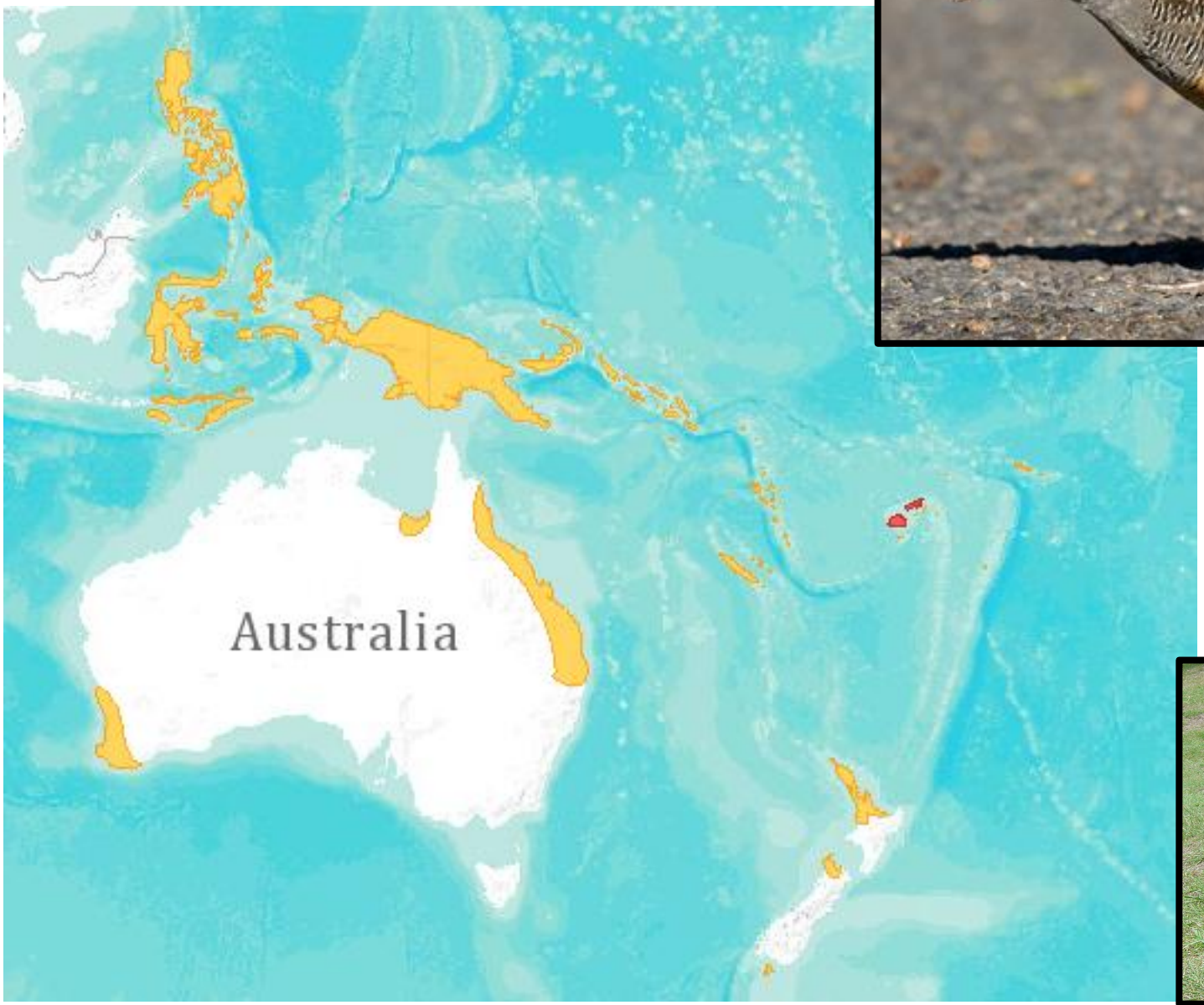
Porphyrio

Pukeko distribution

Weka and Banded Rail

Gallirallus

Banded Rail distribution



Flightless rails endemic to islands have lower energy expenditures and clutch sizes than flighted rails on islands and continents

Brian K. McNab [a,*], Hugh I. Ellis [b]

[a] *Department of Zoology, University of Florida, Gainesville, FL 32611, USA*
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Available online 28 February 2006

Evolutionary Ecology 1998, **12**, 569–580

The role of wing length in the evolution of avian flightlessness

ROBERT A. McCALL,* SEAN NEE and PAUL H. HARVEY

Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK

Vol. 144, No. 4 The American Naturalist October 1994

ENERGY CONSERVATION AND THE EVOLUTION OF FLIGHTLESSNESS IN BIRDS

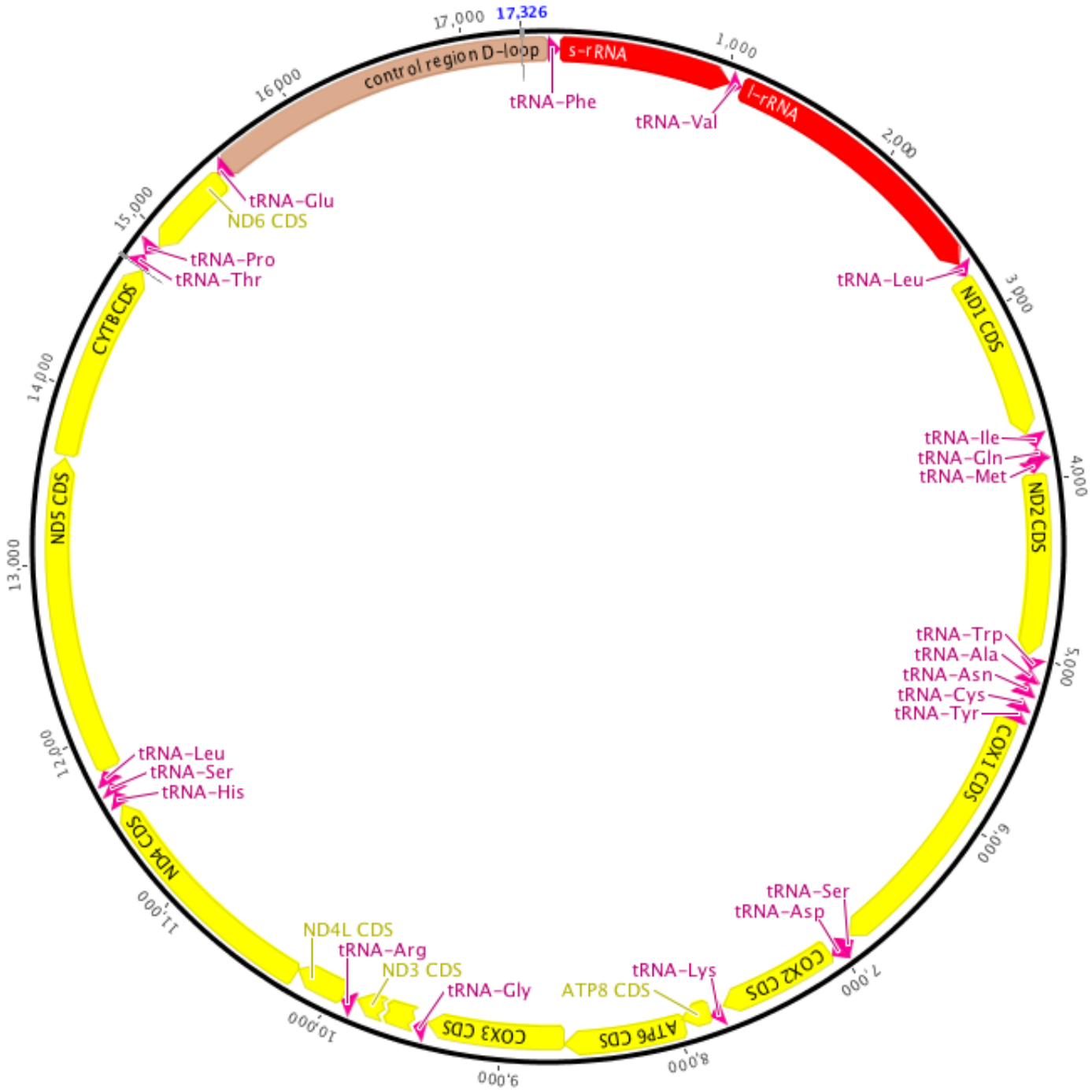
BRIAN K. MCNAB*

School of Biological Sciences, Victoria University of Wellington, Wellington, New Zealand

Submitted October 26, 1992; Revised October 26, 1993; Accepted November 9, 1993

Flightless rails:

- Have shorter wings
- Are generally bigger
- Produce less eggs
- Expend less energy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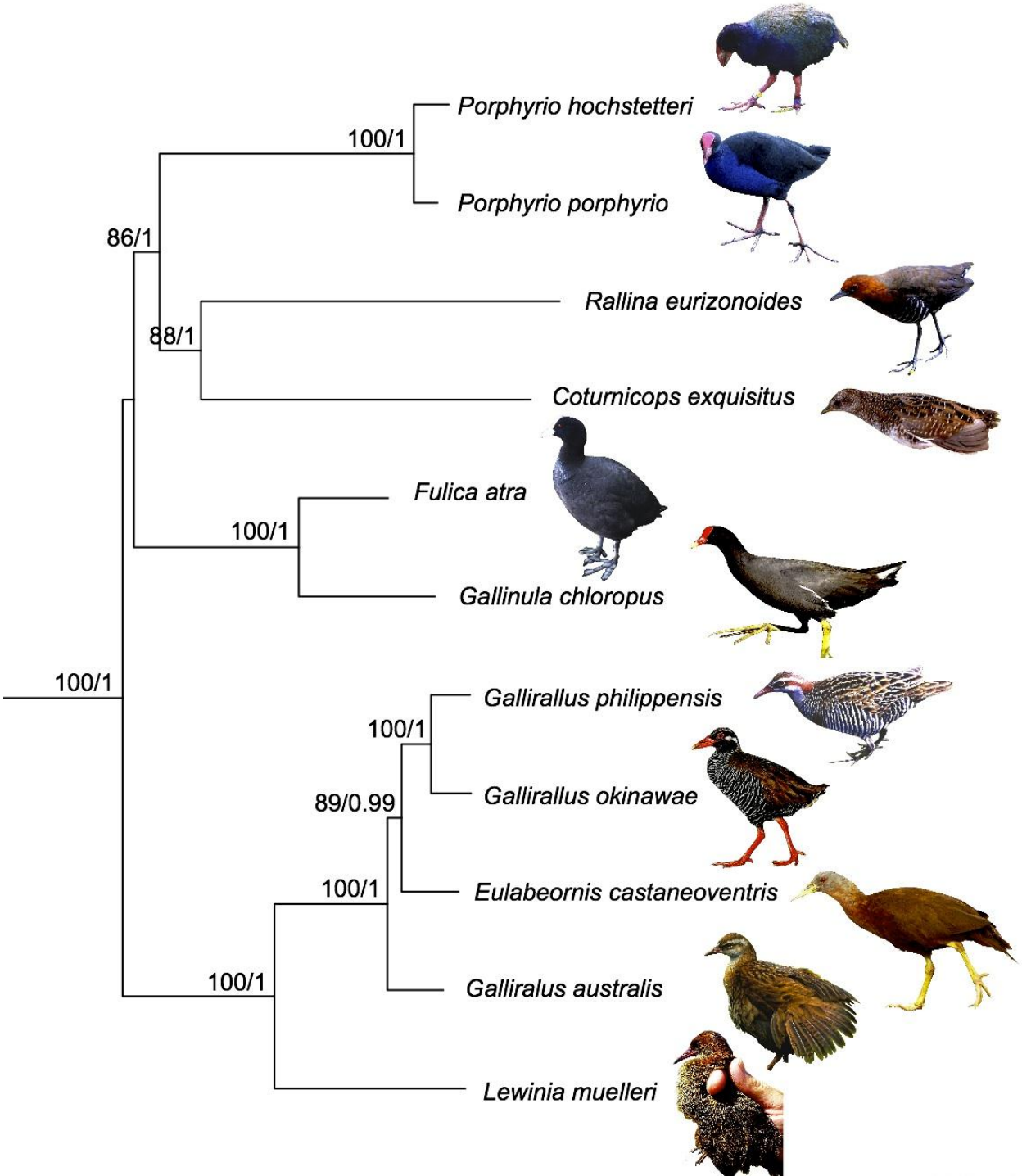
control region D-loop
s-rRNA
l-rRNA
tRNA-Phe
tRNA-Val
tRNA-Glu
ND6 CDS
tRNA-Pro
tRNA-Thr
CYTBCDS
tRNA-Leu
ND1 CDS
tRNA-Ile
tRNA-Gln
tRNA-Met
ND2 CDS
tRNA-Trp
tRNA-Ala
tRNA-Asn
tRNA-Cys
tRNA-Tyr
COX1 CDS
tRNA-Ser
tRNA-Asp
COX2 CDS
tRNA-Lys
ATP8 CDS
ATP6 CDS
COX3 CDS
tRNA-Gly
ND3 CDS
tRNA-Arg
ND4L CDS
ND4 CDS
tRNA-Leu
tRNA-Ser
tRNA-His
ND5 CDS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Porphyrio porphyrio
86/1
Rallina eurizonoides
88/1
Coturnicops exquisitus
Fulica atra
100/1
Gallinula chloropus
100/1
Gallirallus philippensis
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89/0.99
Eulabeornis castaneoventris
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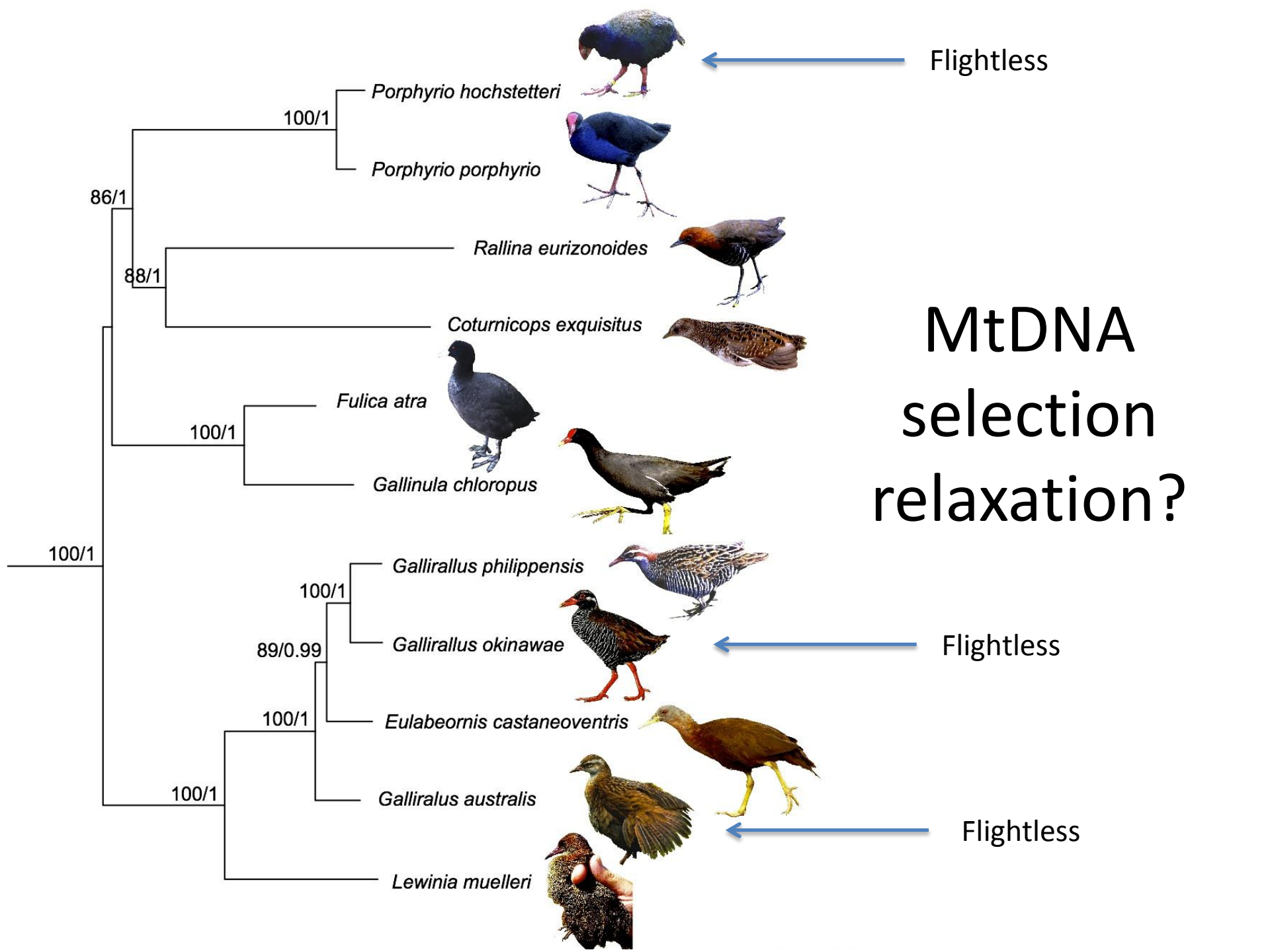
100/1
Lewinia muelleri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Porphyrio porphyrio
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Coturnicops exquisitus
Fulica atra
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Galliralus australis
Lewinia muelleri
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86/1
88/1
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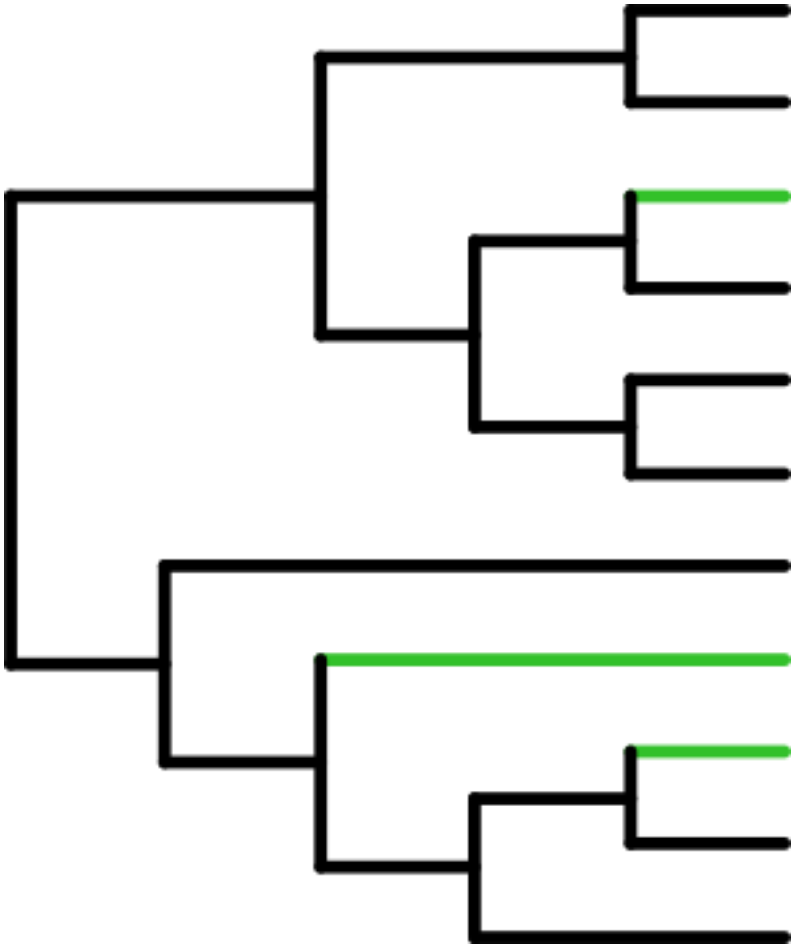
100/1
89/0.99
100/1
100/1
Flightless
Flightless
Flightless
MtDNA selection relaxation?

PAML: Codeml

- designate 1 or more d_N/d_S ratios (ω) over the tree
- calculate log likelihood for the different trees
- are they significantly different?



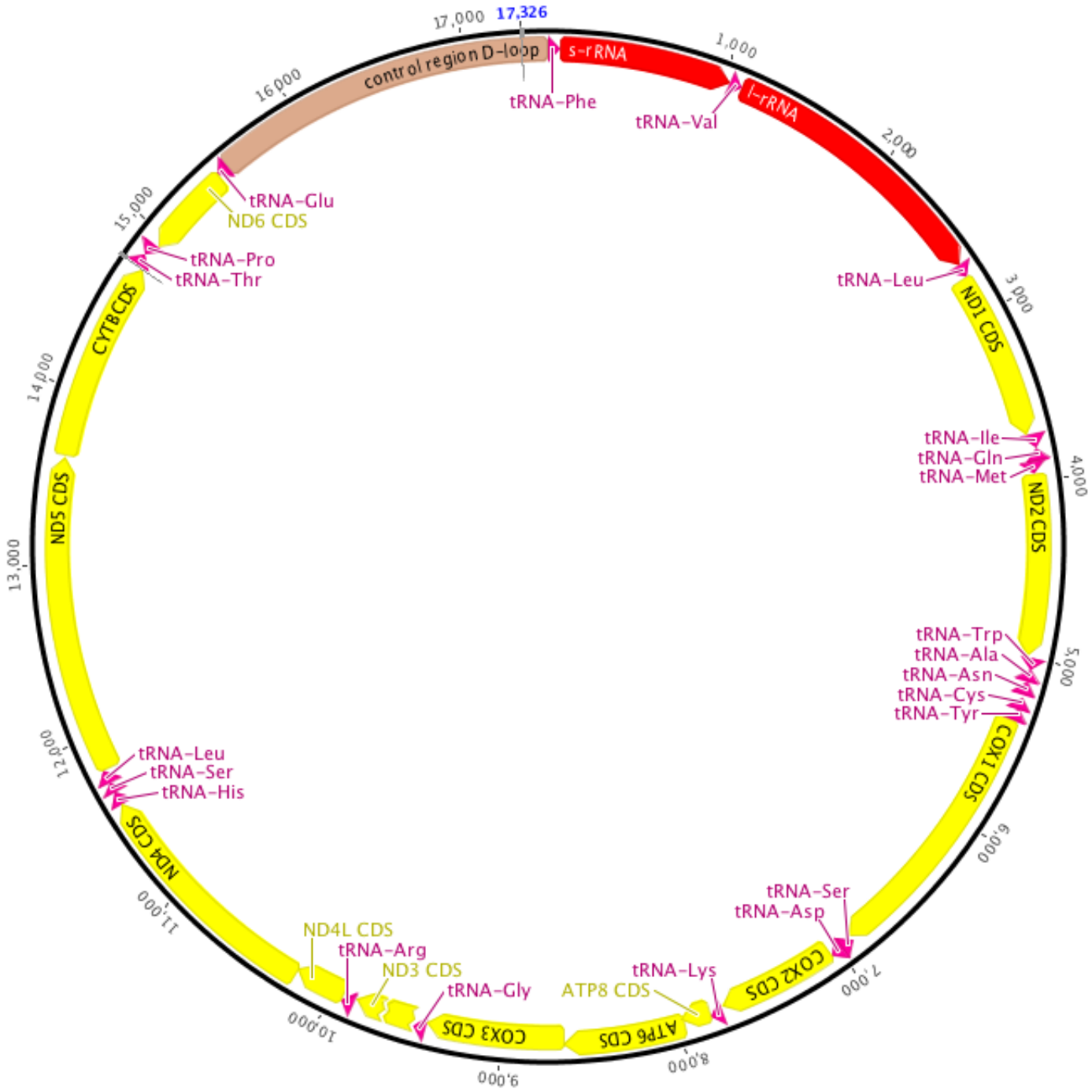
MtDNA selection relaxation

Significance level	**Gene**
*** (p<0.001)	CoI
** p(<0.01)	ND1 ND4 CoIII cyt*b*
* (p<0.05)	ND2 ND5 Atp8
not significant (p>0.05)	ND3 ND4L ND6 Co2 Atp6 Rag1

MtDNA selection relaxation

Significance level	**Gene**
*** (p<0.001)	CoI
** p(<0.01)	ND1 ND4 CoIII cyt*b*
* (p<0.05)	ND2 ND5 Atp8
not significant (p>0.05)	ND3 ND4L ND6 Co2 Atp6 Rag1

Significance level	**Gene**
*** (p<0.001)	cyt*b*
** p(<0.01)	ND4 CoI
* (p<0.05)	ND1 CoIII Atp8
not significant (p>0.05)	ND2 ND3 ND4L ND5 ND6 Co2 Atp6 Rag1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control region D-loop
s-rRNA
l-rRNA
tRNA-Phe
tRNA-Val
tRNA-Glu
ND6 CDS
tRNA-Pro
tRNA-Thr
CYTBCDS
tRNA-Leu
ND1 CDS
tRNA-Ile
tRNA-Gln
tRNA-Met
ND2 CDS
tRNA-Trp
tRNA-Ala
tRNA-Asn
tRNA-Cys
tRNA-Tyr
COX1 CDS
tRNA-Ser
tRNA-Asp
COX2 CDS
tRNA-Lys
ATP8 CDS
ATP6 CDS
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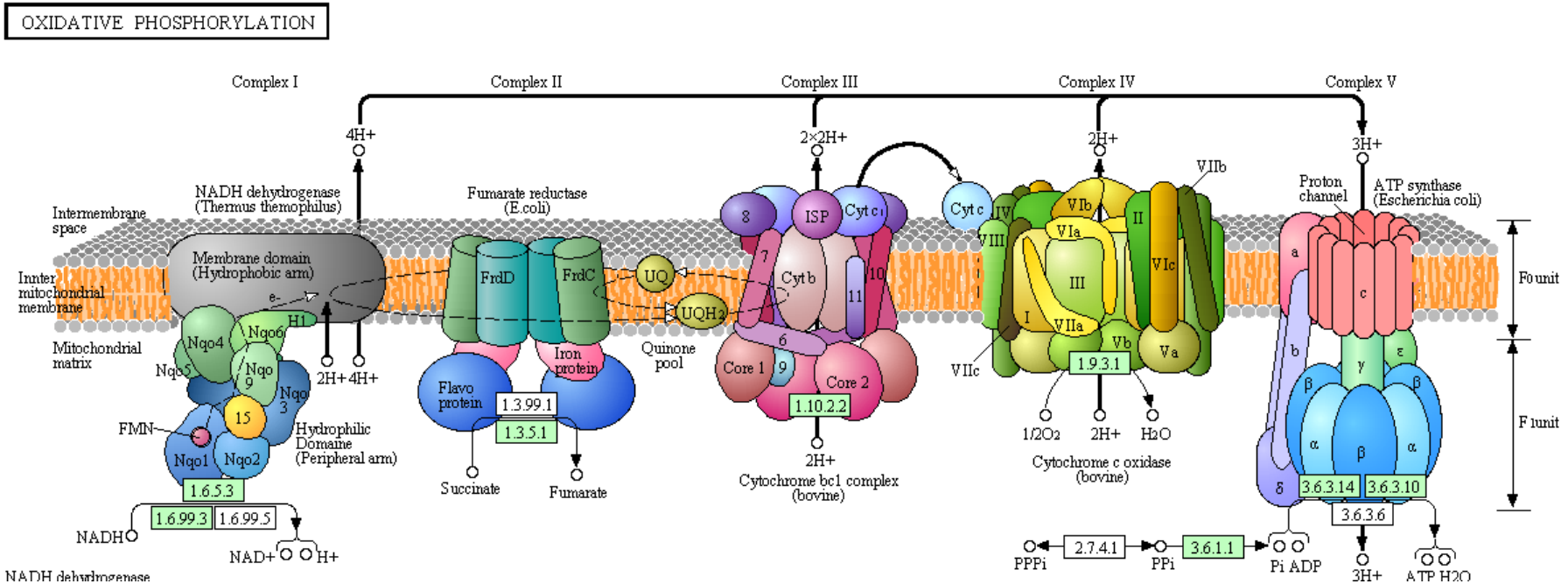
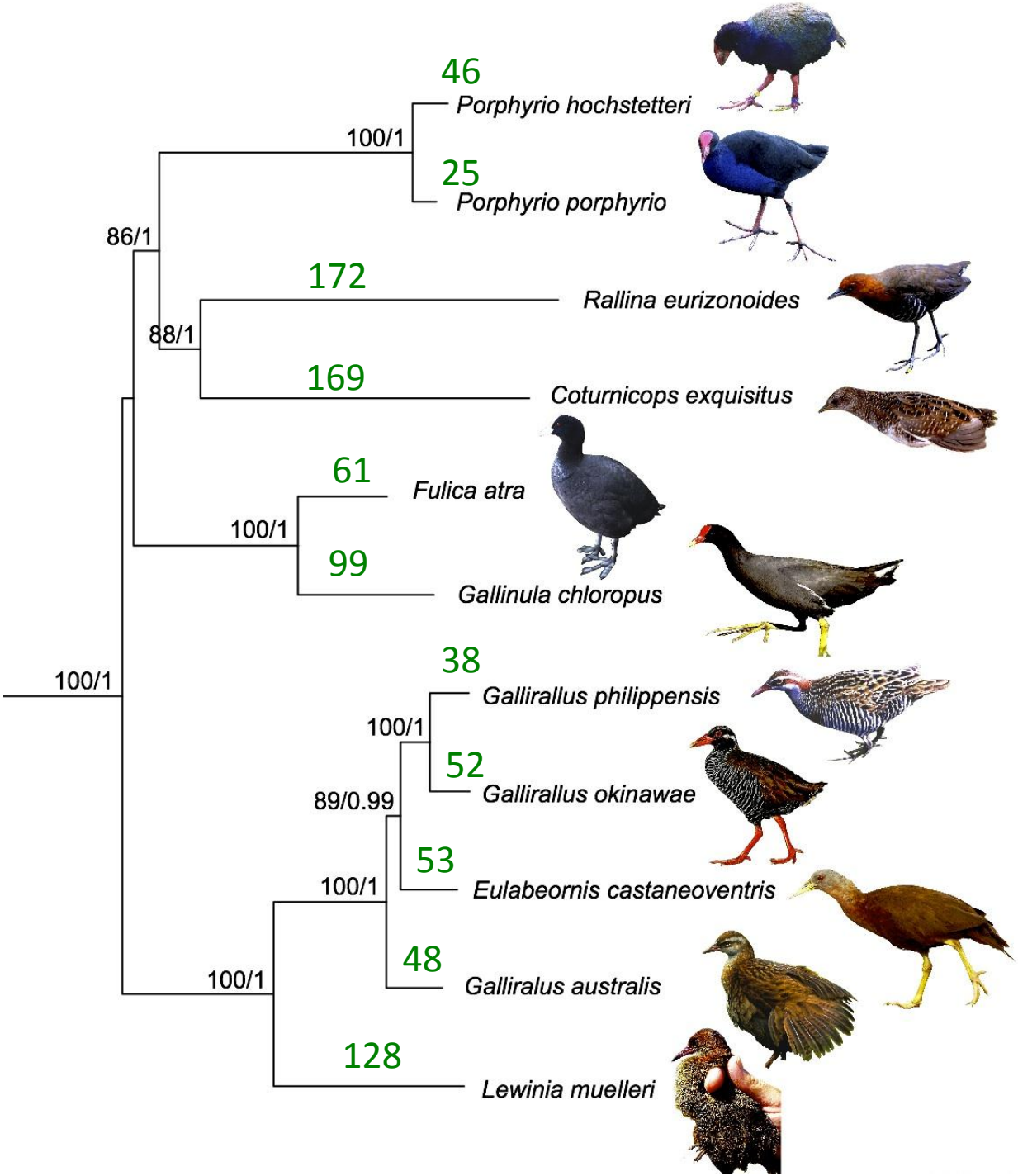
ND4L CDS
ND4 CDS
tRNA-Leu
tRNA-Ser
tRNA-His
ND5 CDS



NADH 1-6 Cyt *b* COI-III Atp 6&8

** p<0.01	NADH all
*** p<0.001	COX all
** p<0.01	Atp all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Porphyrio hochstetteri
100/1
25
Porphyrio porphyrio
86/1
172
Rallina eurizonoides
88/1
169
Coturnicops exquisitus
61
Fulica atra
100/1
99
Gallinula chloropus
100/1
38
Gallirallus philippensis
100/1
52
Gallirallus okinawae
89/0.99
53
Eulabeornis castaneoventris
100/1
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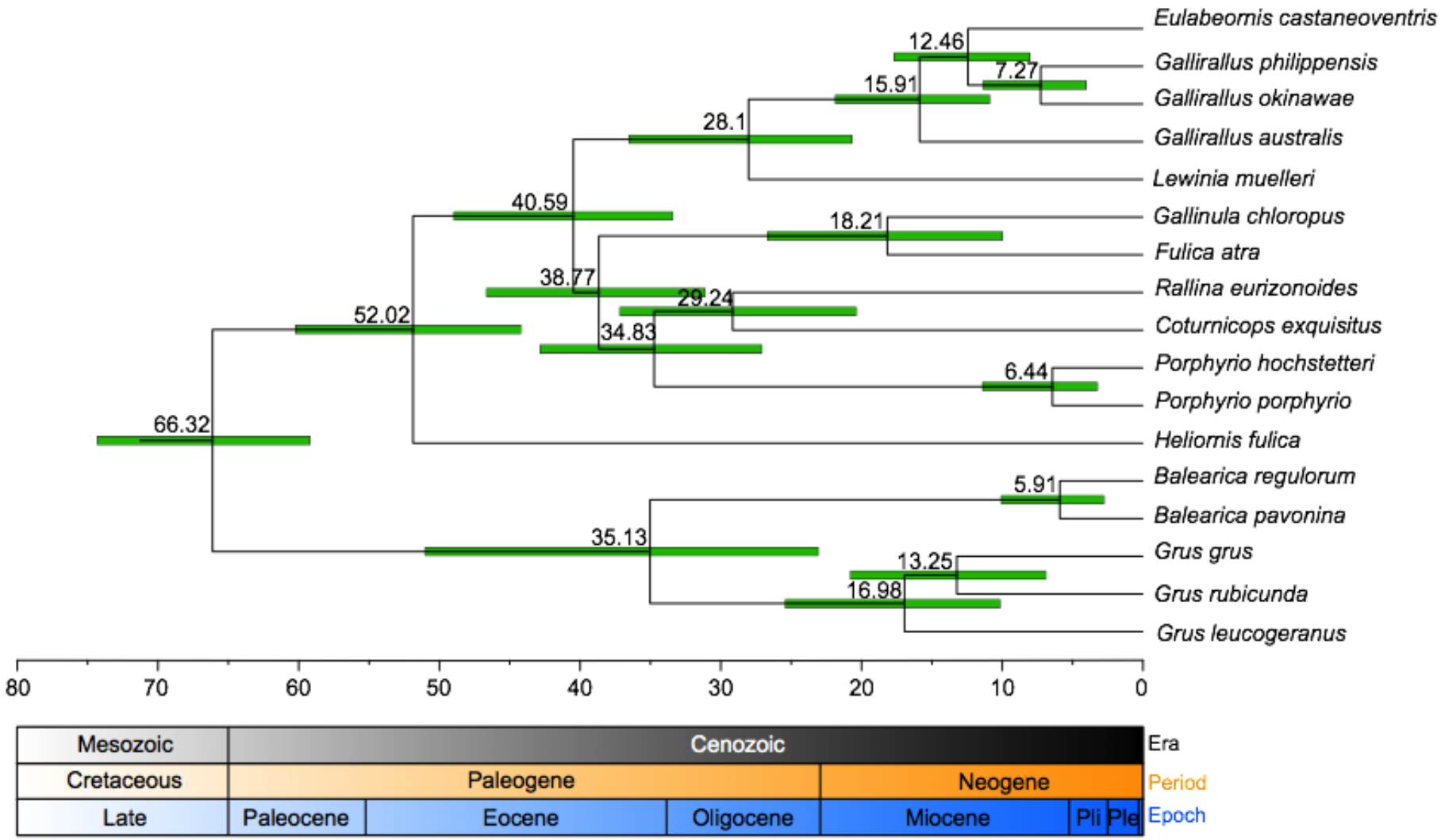
Galliralus australis
100/1
128
Lewinia muelleri


Eulabeornis castaneoventris
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Gallinula chloropus
Fulica atra
Rallina eurizonoides
Coturnicops exquisitus
Porphyrio hochstetteri
Porphyrio porphyrio
Heliornis fulica
Balearica regulorum
Balearica pavonina
Grus grus
Grus rubicunda
Grus leucogeranus
12.46
7.27
15.91
28.1
40.59
18.21
38.77
29.24
52.02
34.83
6.44
66.32
5.91
35.13
13.25
16.98
80
70
60
50
40
30
20
10
0
Mesozoic
Cenozoic
Era
Cretaceous
Paleogene
Neogene
Period
Late
Paleocene
Eocene
Oligocene
Miocene
Pli
Ple
Epoch

Ancient DNA

- *Gallirallus modestus*
- *Gallirallus dieffenbachi*
- *Porphyrio mantelli*

Future directions

- Is d_N/d_S a useful measure – how informative is it?
- What is happening with the nuclear-coded genes?
- More flightless species:

  Ancient DNA

Thanks for listening!

Phoenix Evolutionary Ecology & Genetics
www.evolves.massey.ac.nz

Thanks to:

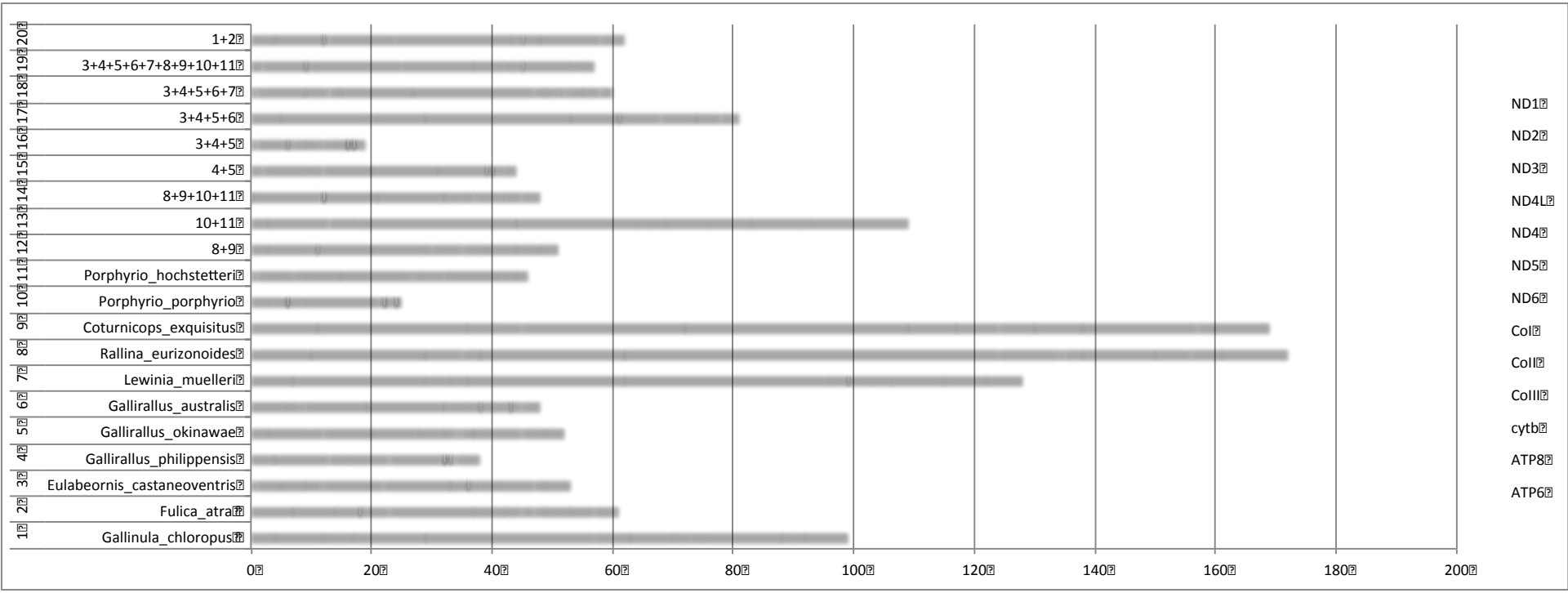
Steve Trewick
Juan-Carlos Garcia-Ramirez
Dave Wheeler

Massey University
Rutherford Foundation

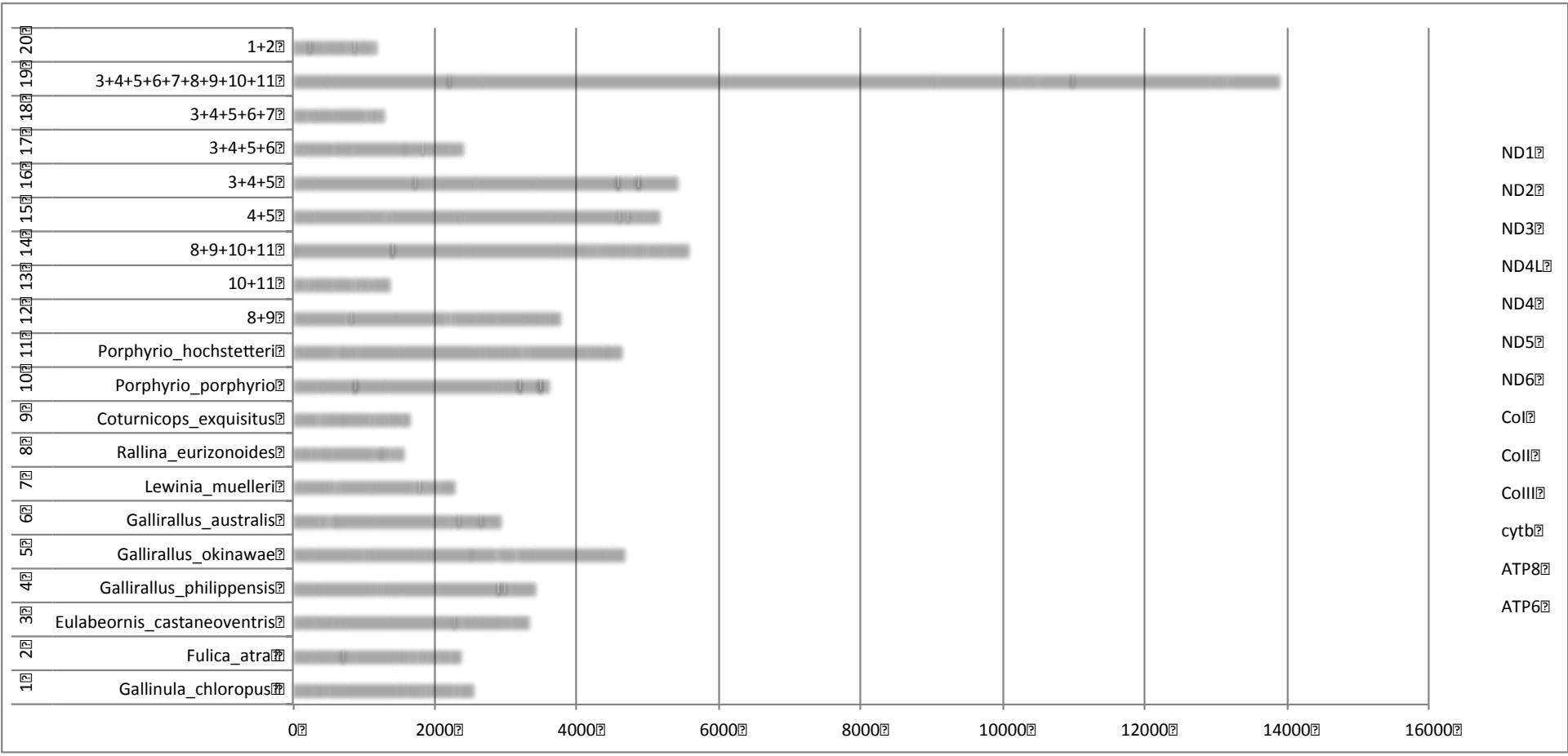
The Royal Society of New Zealand
RUTHERFORD FOUNDATION

Massey University

AA changes on branches



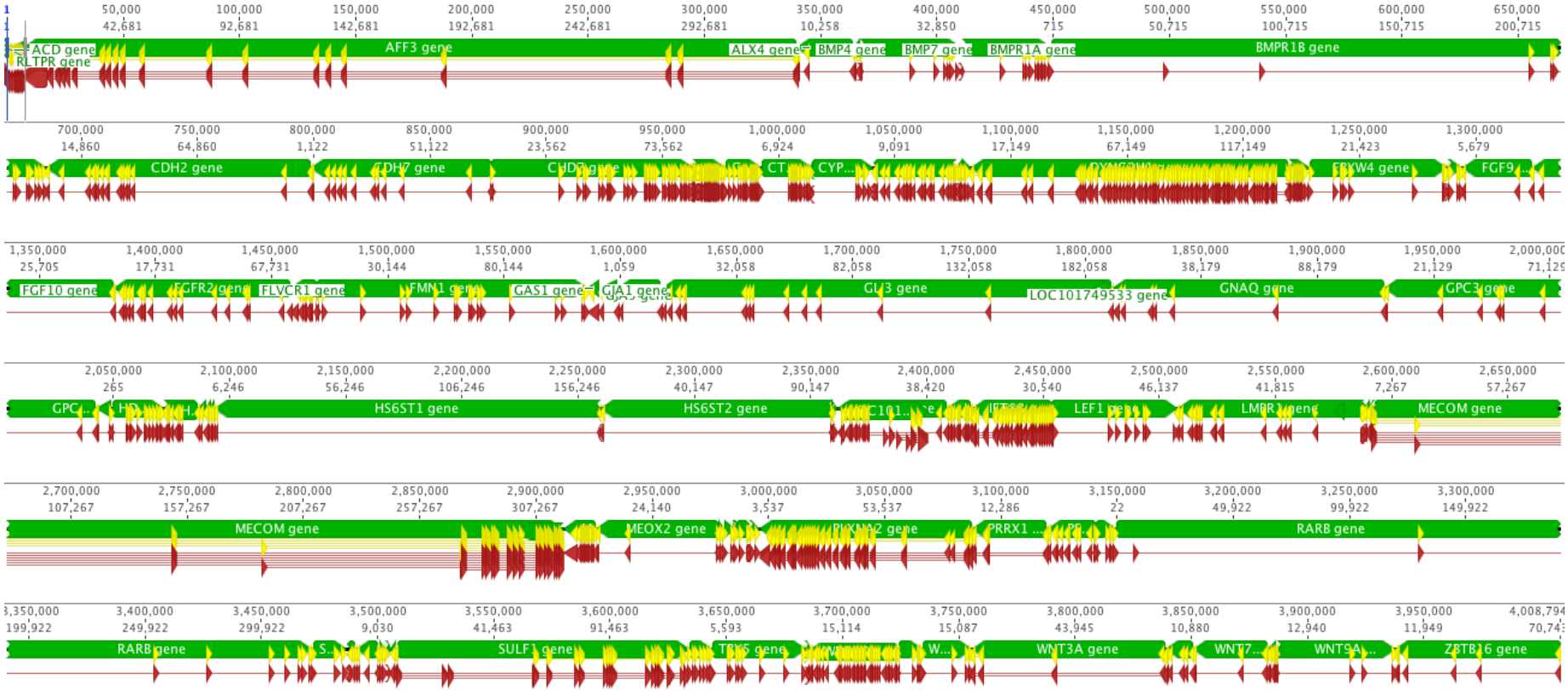
AA changes on branches, adjusted for branch length

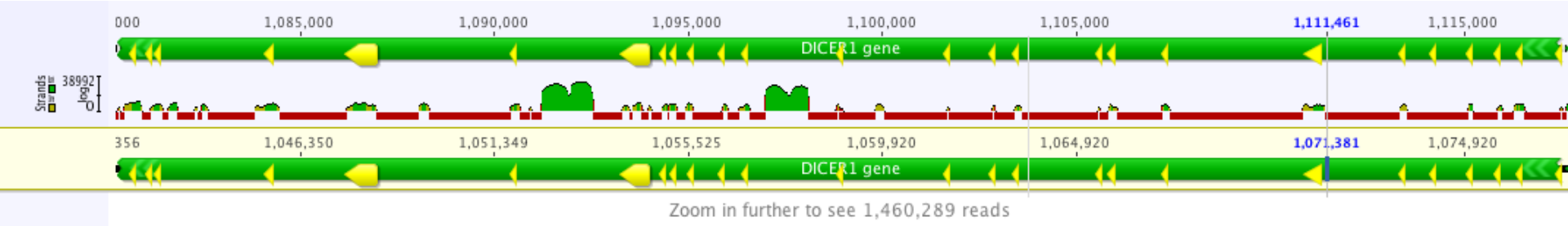


Amino acid changes, adjusted for branch and gene length

Nuclear genes

- AmiGO gene ontology database
- 79 genes associated with limb development in chicken




000
1,085,000
1,090,000
1,095,000
1,100,000
1,105,000
1,111,461
1,115,000
DICER1 gene
Strands
38992
log
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356
1,046,350
1,051,349
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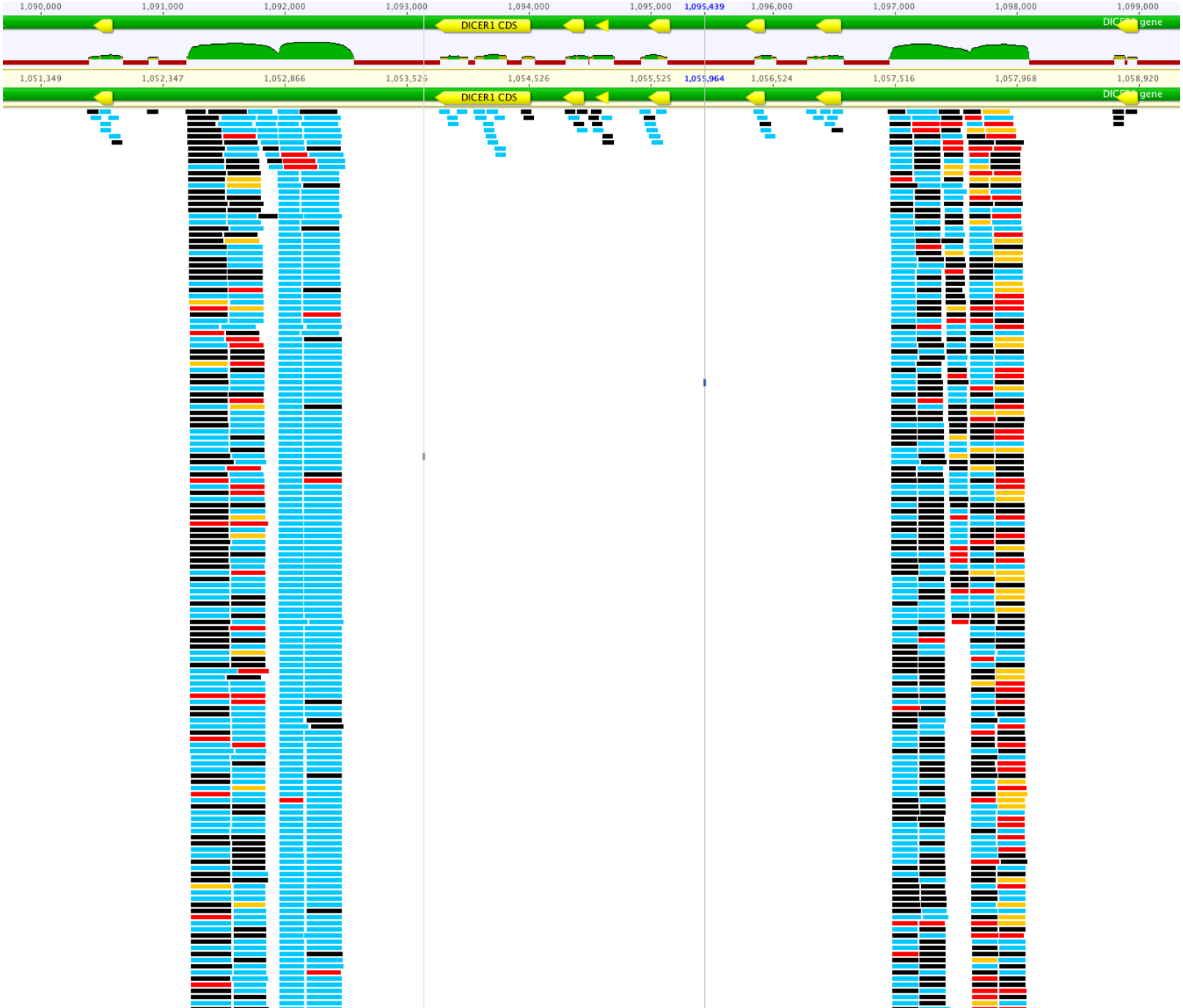
1,059,920
1,064,920
1,071,381
1,074,920
DICER1 gene
Zoom in further to see 1,460,289 reads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DICER1 CDS
DICER1 gene
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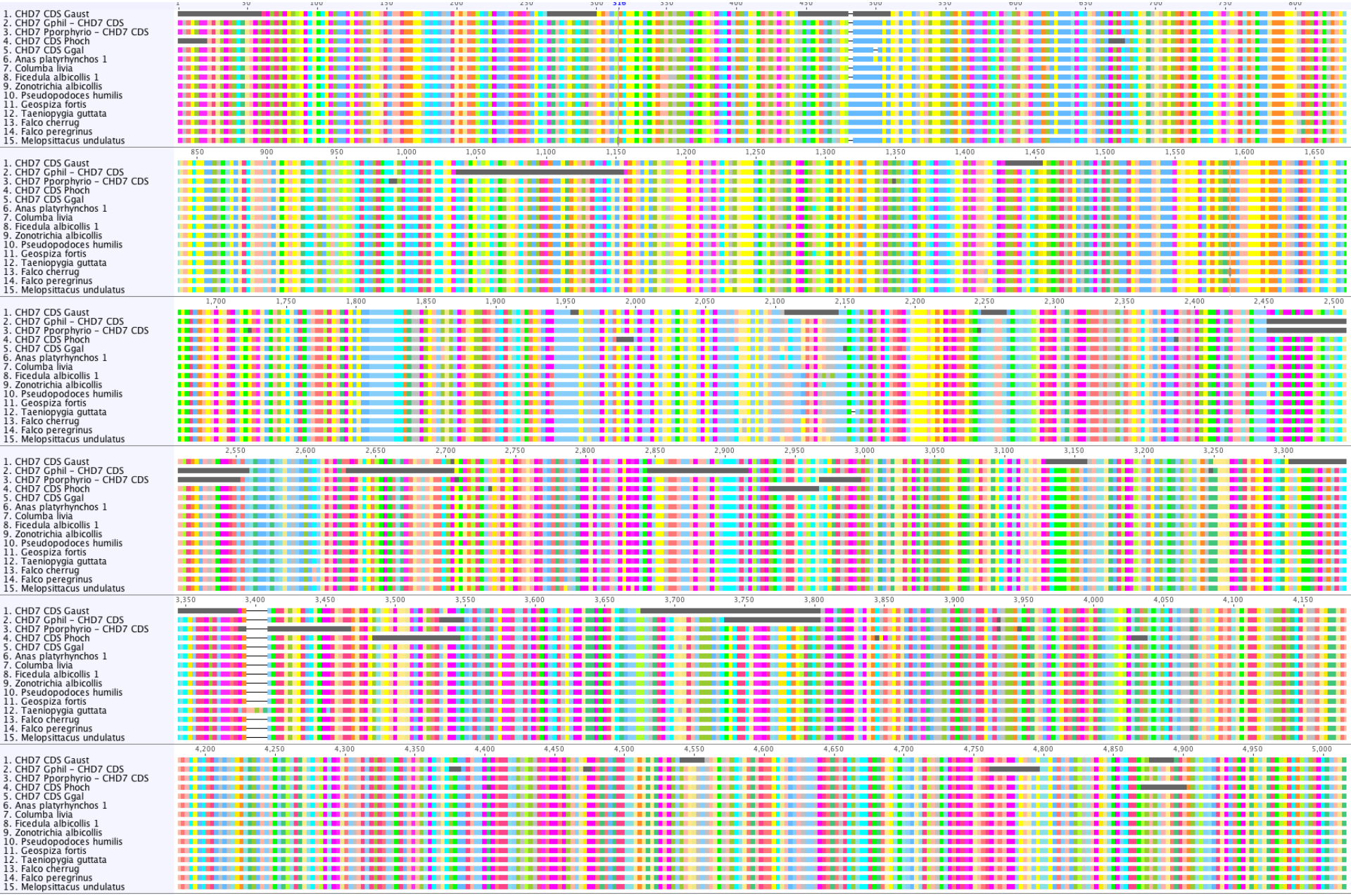
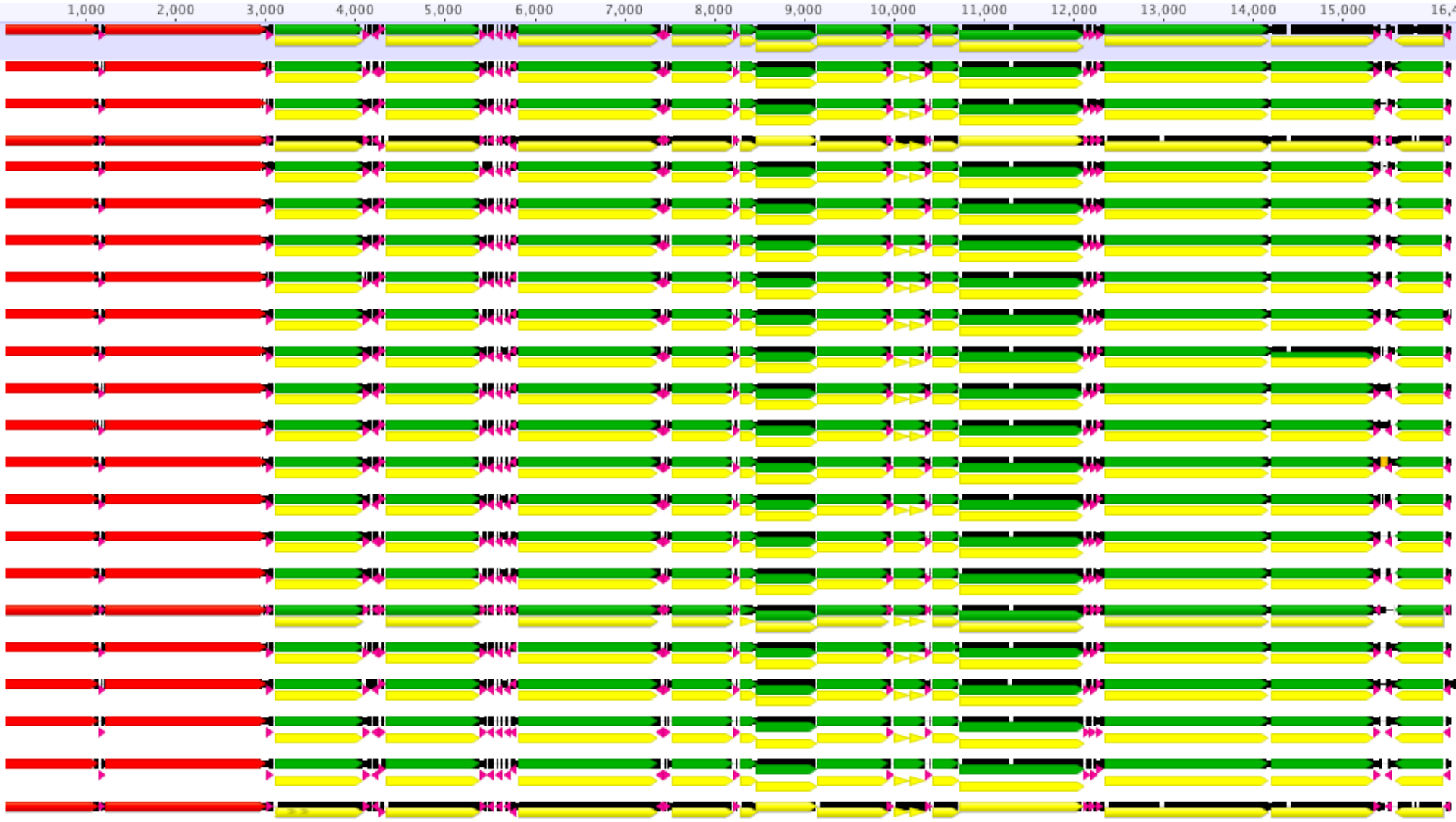
DICER1 CDS
DICER1 gene


1. CHD7 CDS Gaust
2. CHD7 Gphil - CHD7 CDS
3. CHD7 Pporphyrio - CHD7 CDS
4. CHD7 CDS Phoch
5. CHD7 CDS Ggal
6. Anas platyrhynchos 1
7. Columba livia
8. Ficedula albicollis 1
9. Zonotrichia albicollis
10. Pseudopodoces humilis
11. Geospiza fortis
12. Taeniopygia guttata
13. Falco cherrug
14. Falco peregrinus
15. Melopsittacus undulatus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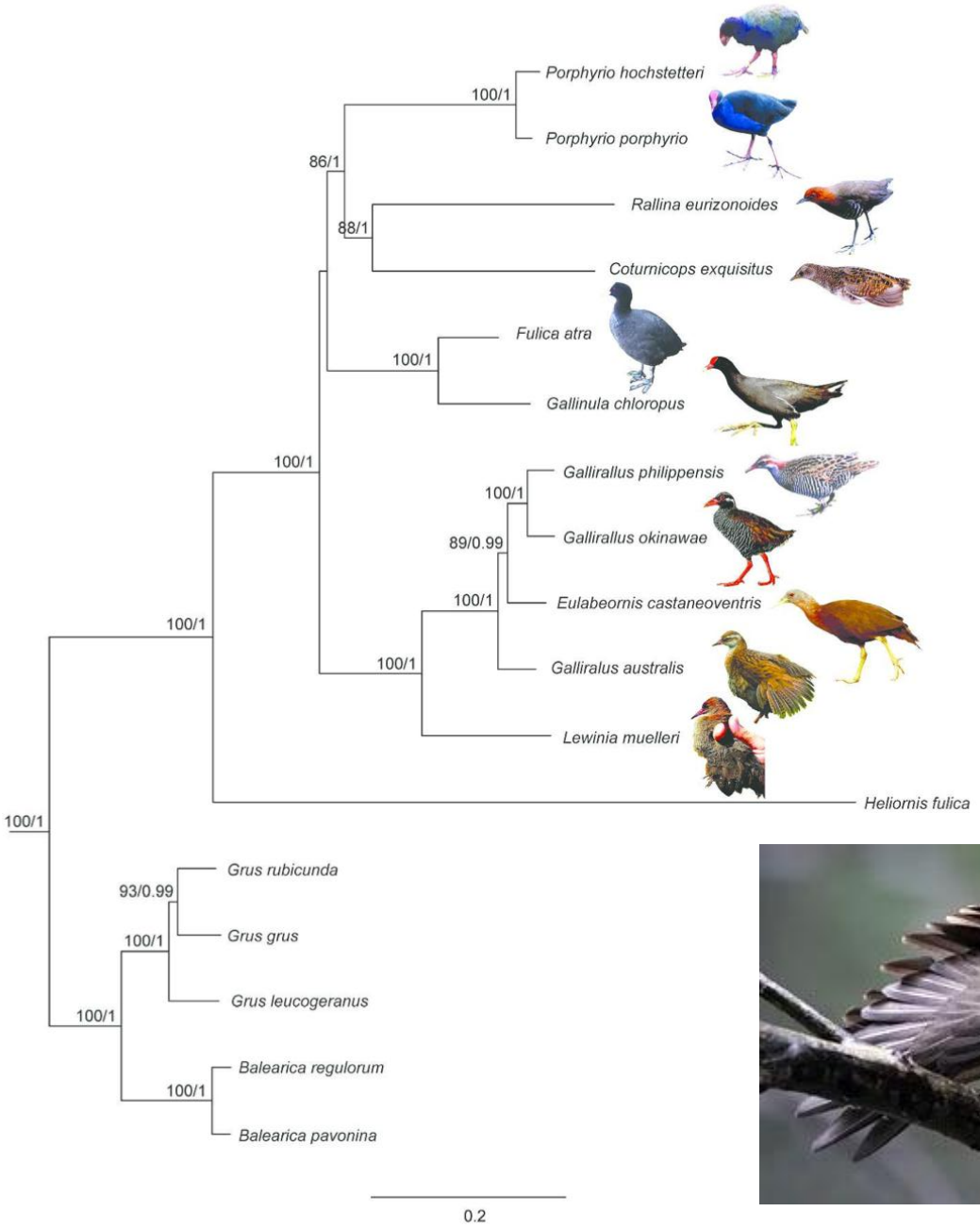
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Porphyrio porphyrio
Rallina eurizonoides
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Fulica atra
Gallinula chloropus
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Gallirallus okinawae
Eulabeornis castaneoventris
Galliralus australis
Lewinia muelleri
Heliornis fulica
Grus rubicunda
Grus grus
Grus leucogeranus
Balearica regulorum
Balearica pavonina
100/1
86/1
88/1
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93/0.99
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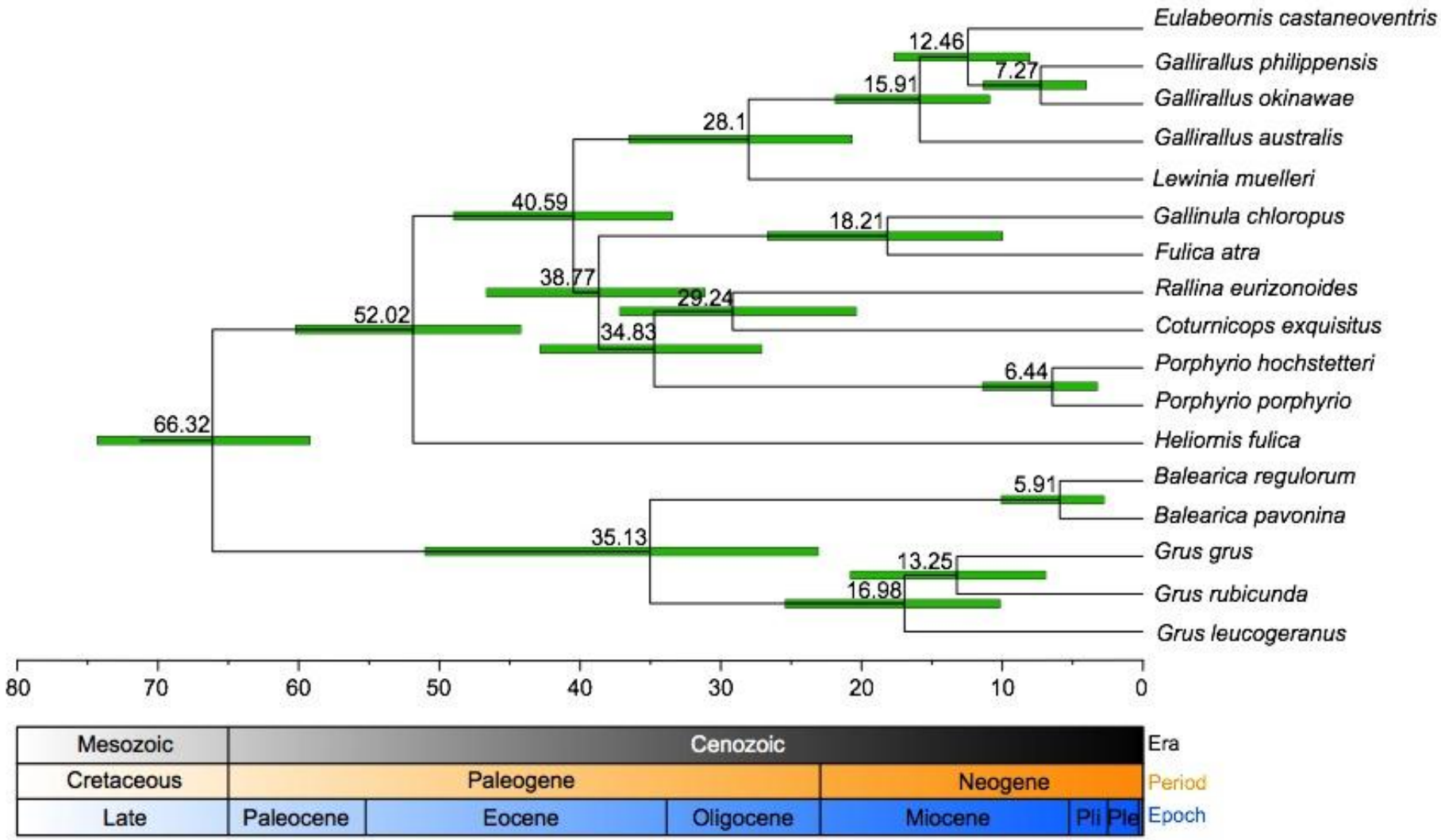
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Rallina eurizonoides
Coturnicops exquisitus
Porphyrio hochstetteri
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12.46
7.27
15.91
28.1
40.59
18.21
38.77
29.24
52.02
34.83
6.44
66.32
5.91
35.13
13.25
16.98
80
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0
Mesozoic
Cenozoic
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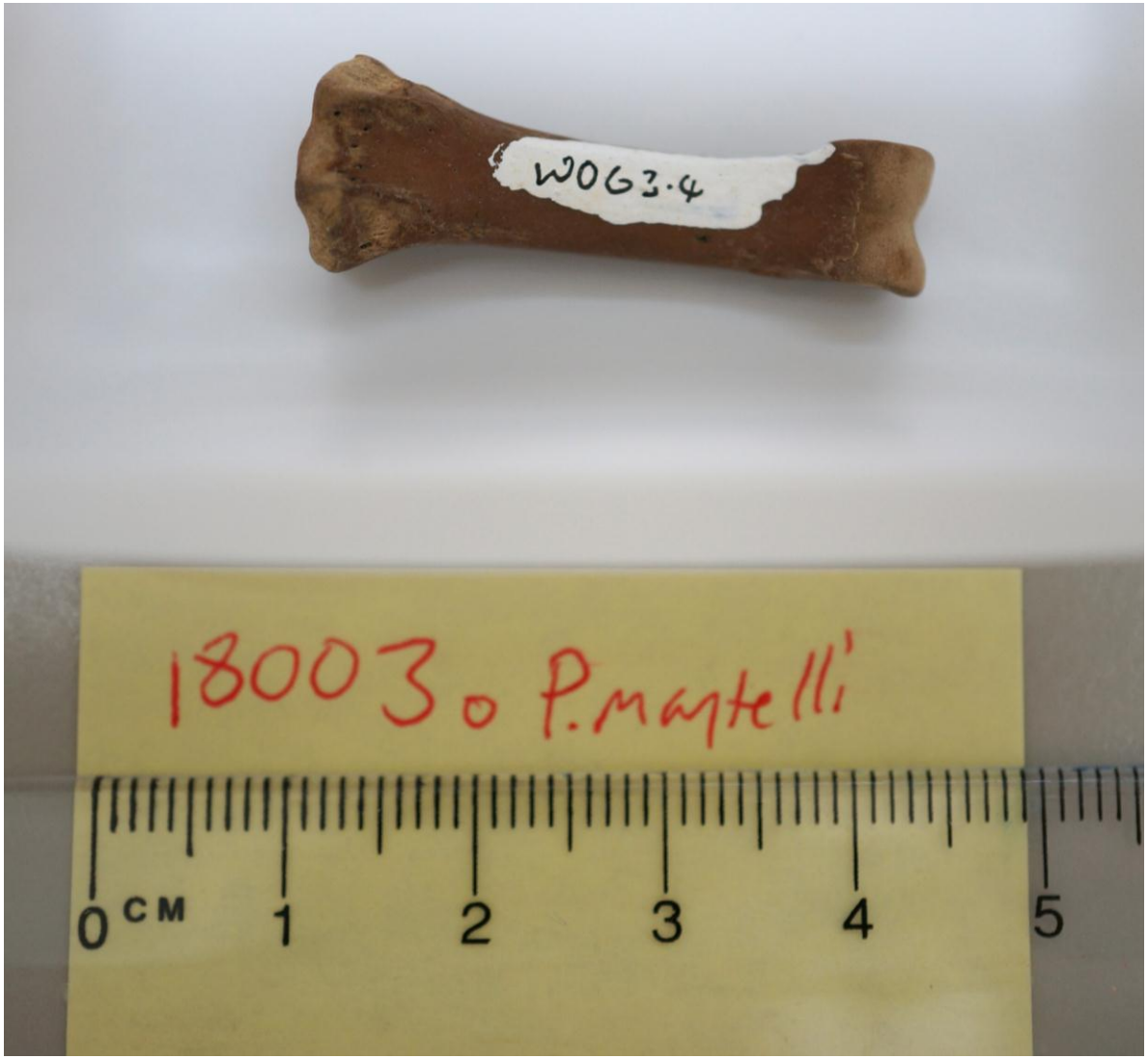
Cretaceous
Paleogene
Neogene
Period
Late
Paleocene
Eocene
Oligocene
Miocene
Pli
Ple
Epoch

Ancient DNA

- *Gallirallus modestus*
- *Gallirallus dieffenbachi*
- *Capellirallus karamu*
- *Porphyrio mantelli*
- *Fulica prisca*


W063.4
18003 o P. maytelli
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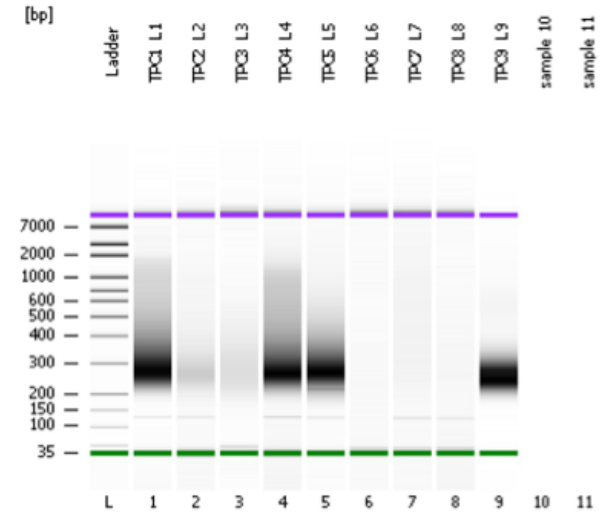
W063.4


G modestus
0 CM 1 2 3 4 5



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Version:	1.0
Assay Comments:	Copyright © 2003-2009 Agilent Technologies

Chip Information:

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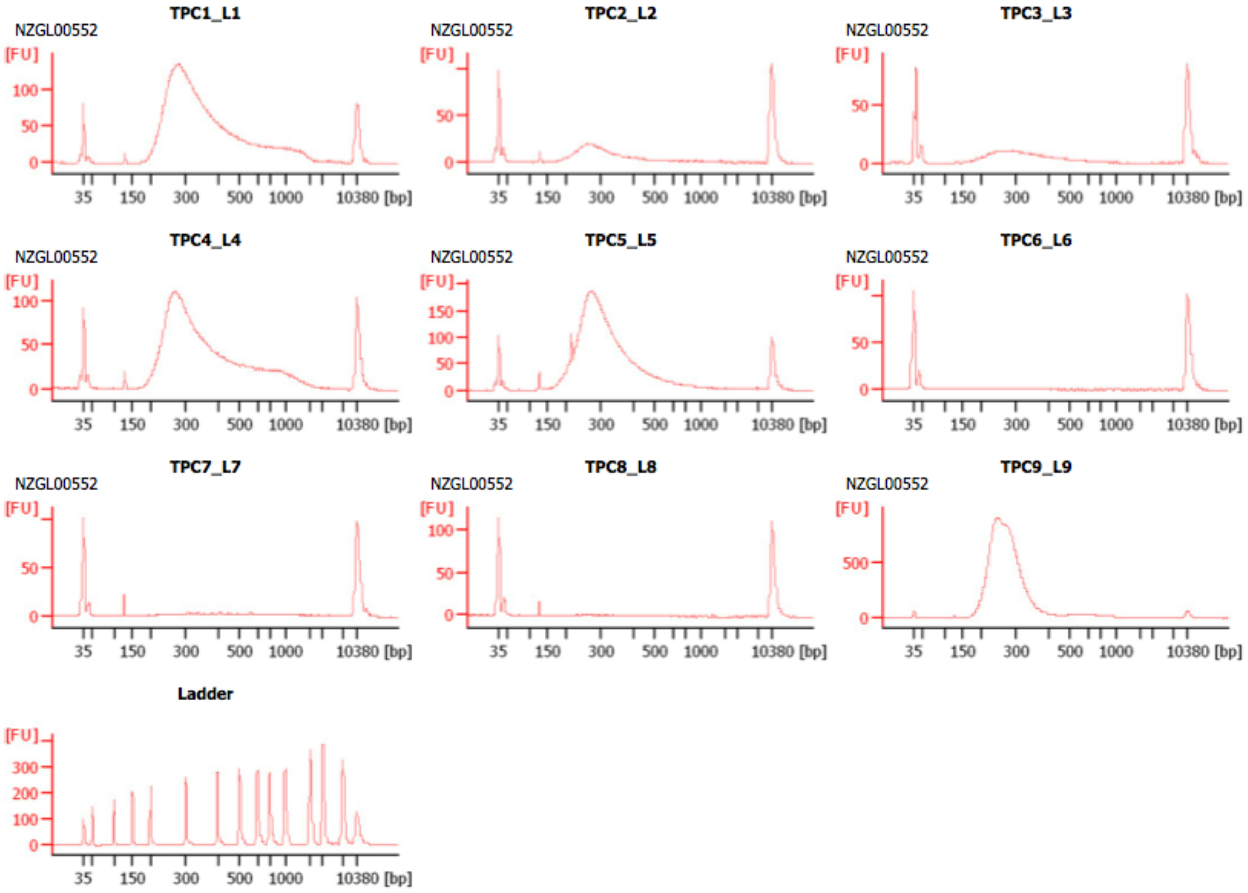
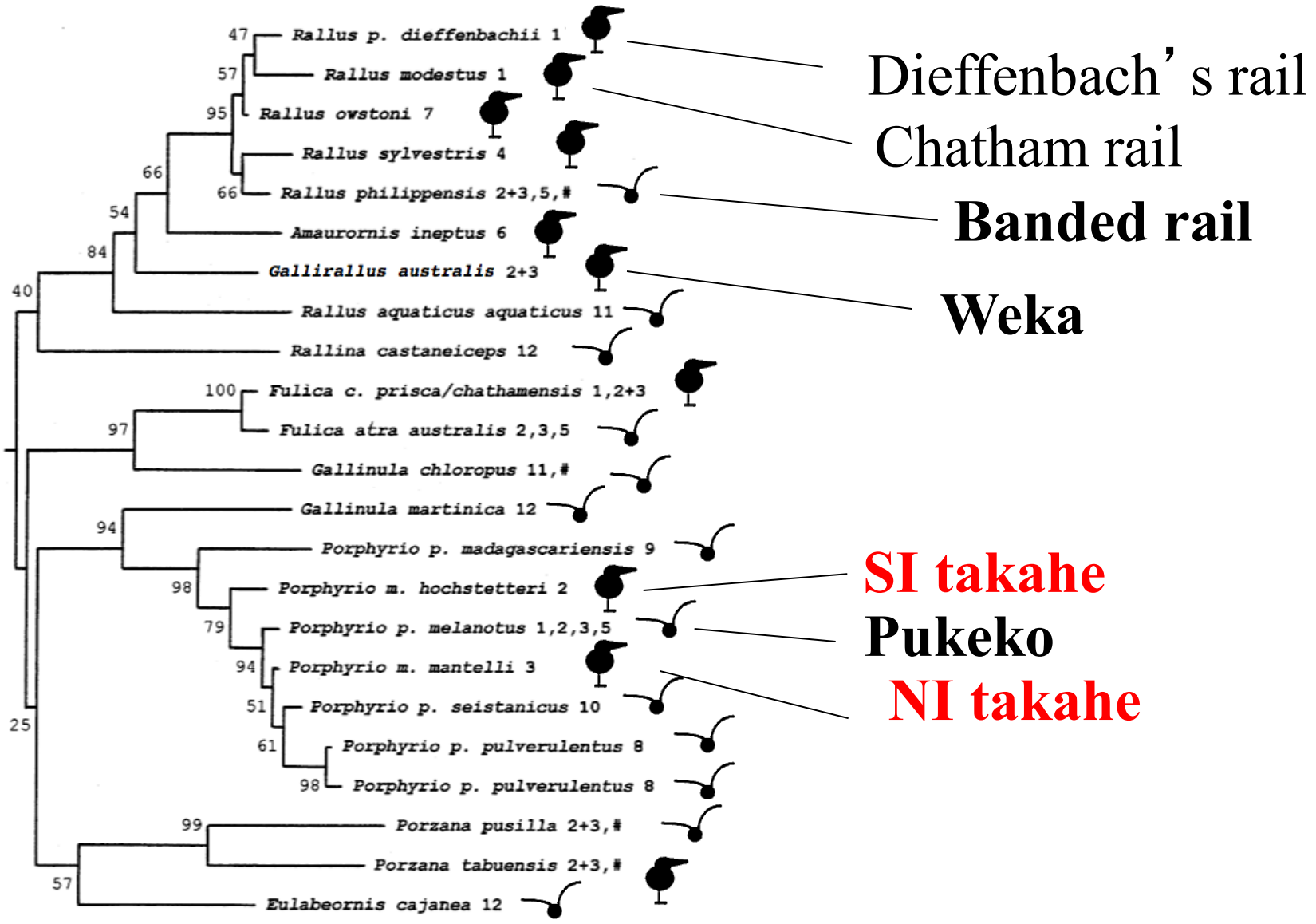


Predicted number of reads…

- *Gallirallus modestus* 4.2 million
- *Gallirallus dieffenbachi* 16 million
- *Capellirallus karamu* 5.5 million
- *Porphyrio mantelli* 18 million
- *Fulica prisca* 5.7 million



350bp 12S, Trewick 1997