Fossil calibrations and comprehensive taxon sampling clarify the timescale of shorebird evolution

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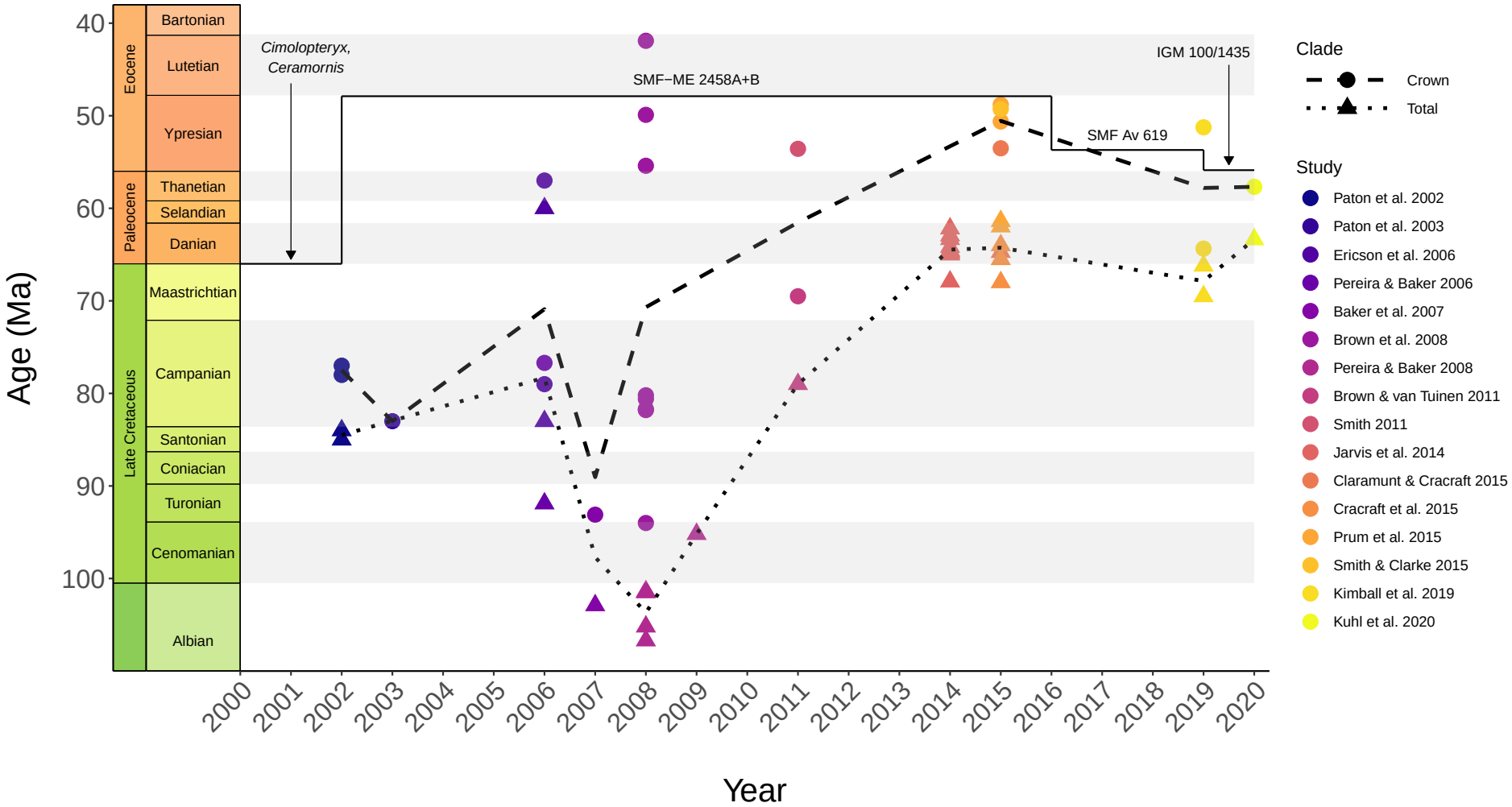
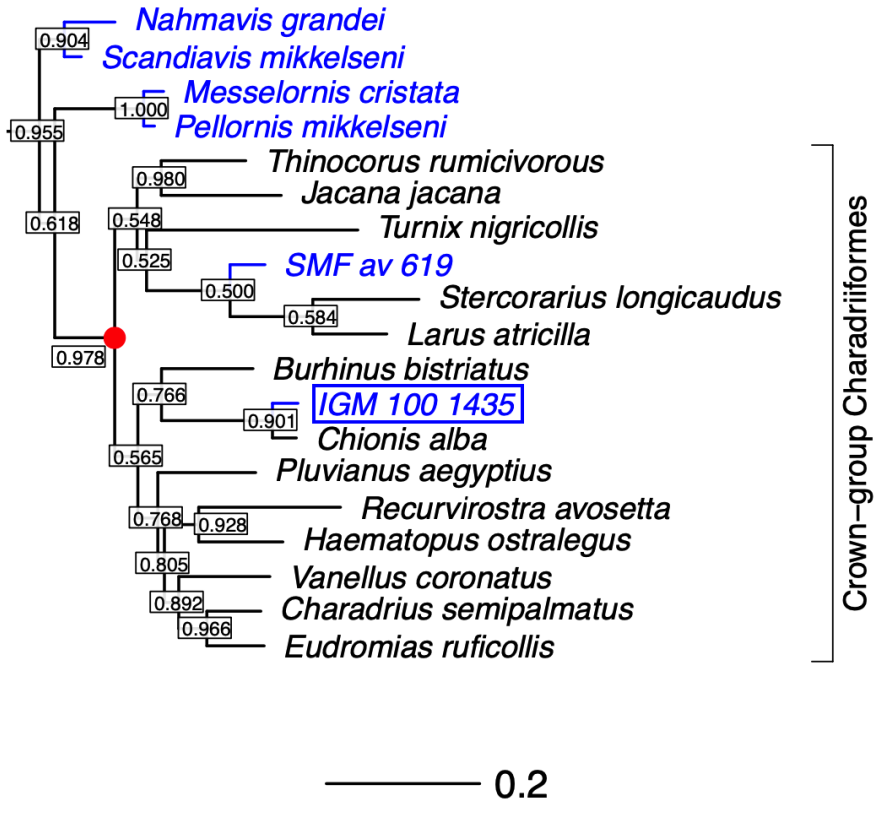
Previous divergence time estimates

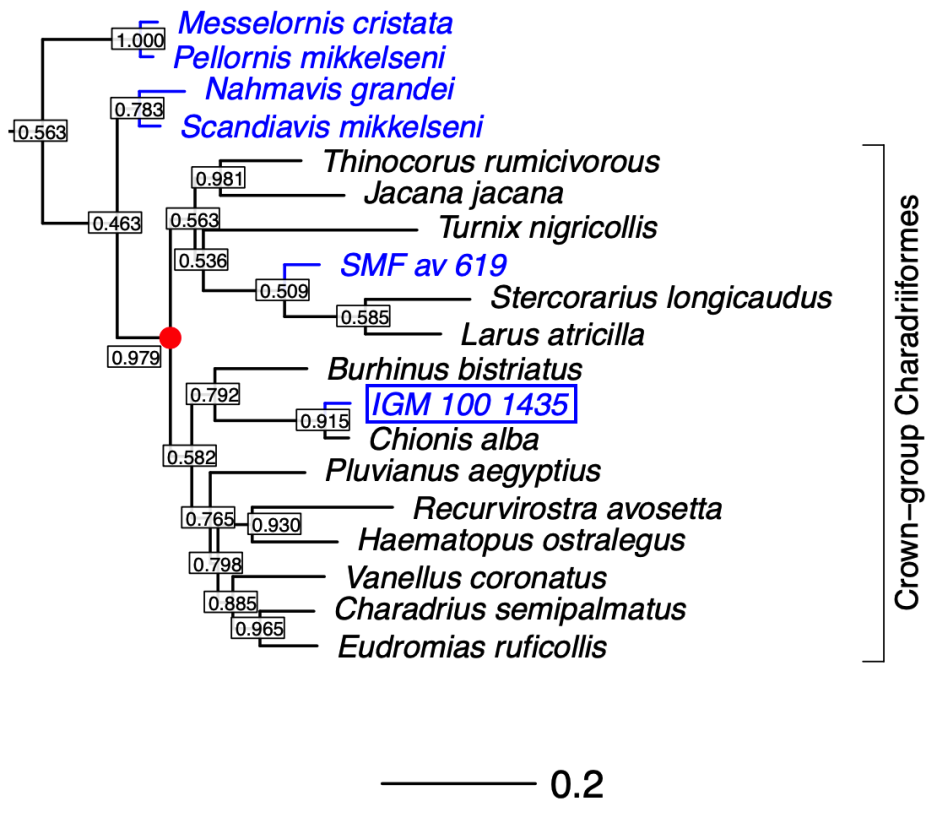


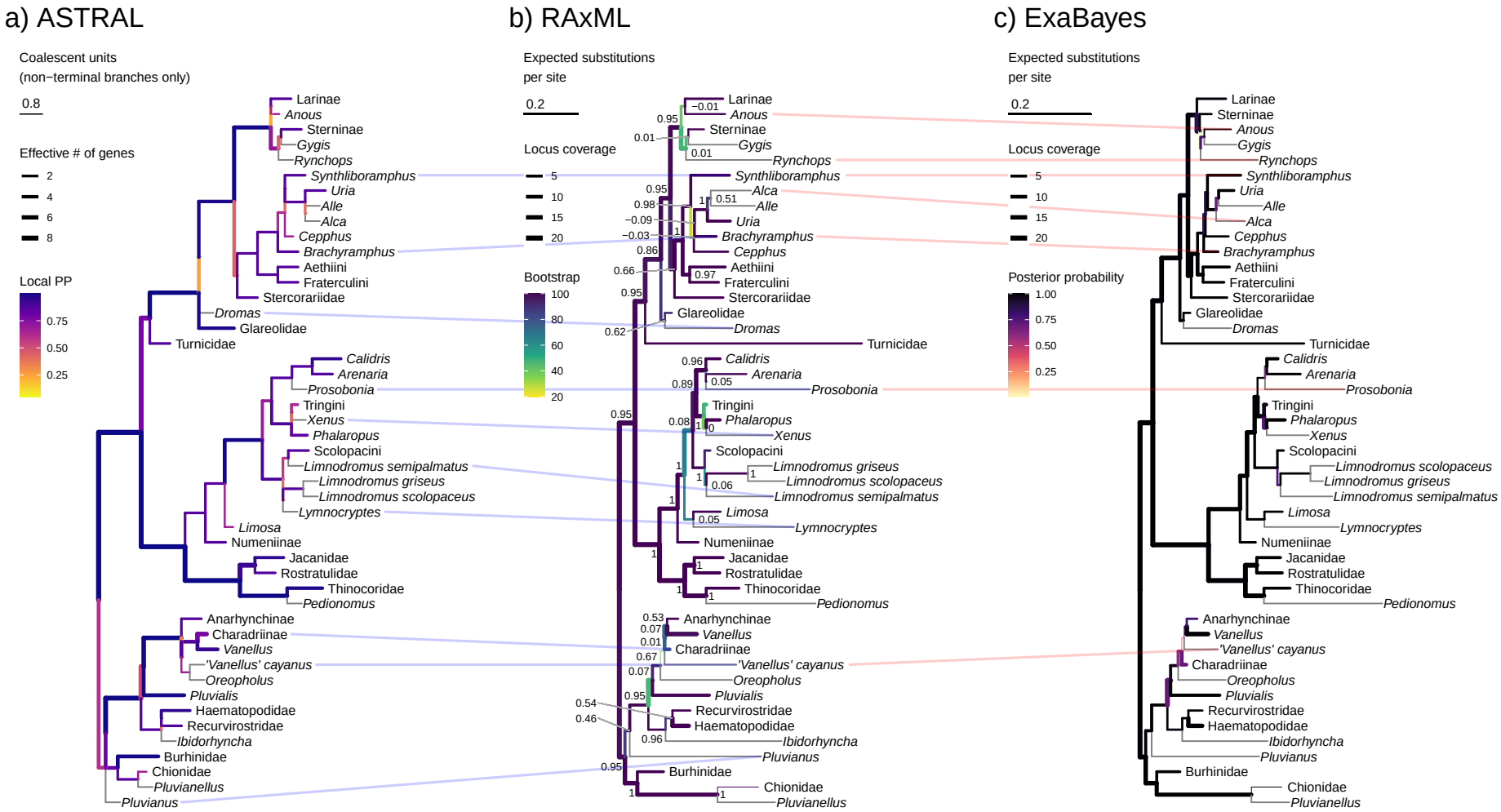
12S
16S
ADNH5
ADNH9
ATP6
ATP8
BDNF
CMOS
Cox1
Cox2
Cox3
Cytb
RAG1
GAPDH
Myo2
ND1
ND2
ND3
ND4
ND4L
ND5
ND6
NTF3
RAG1

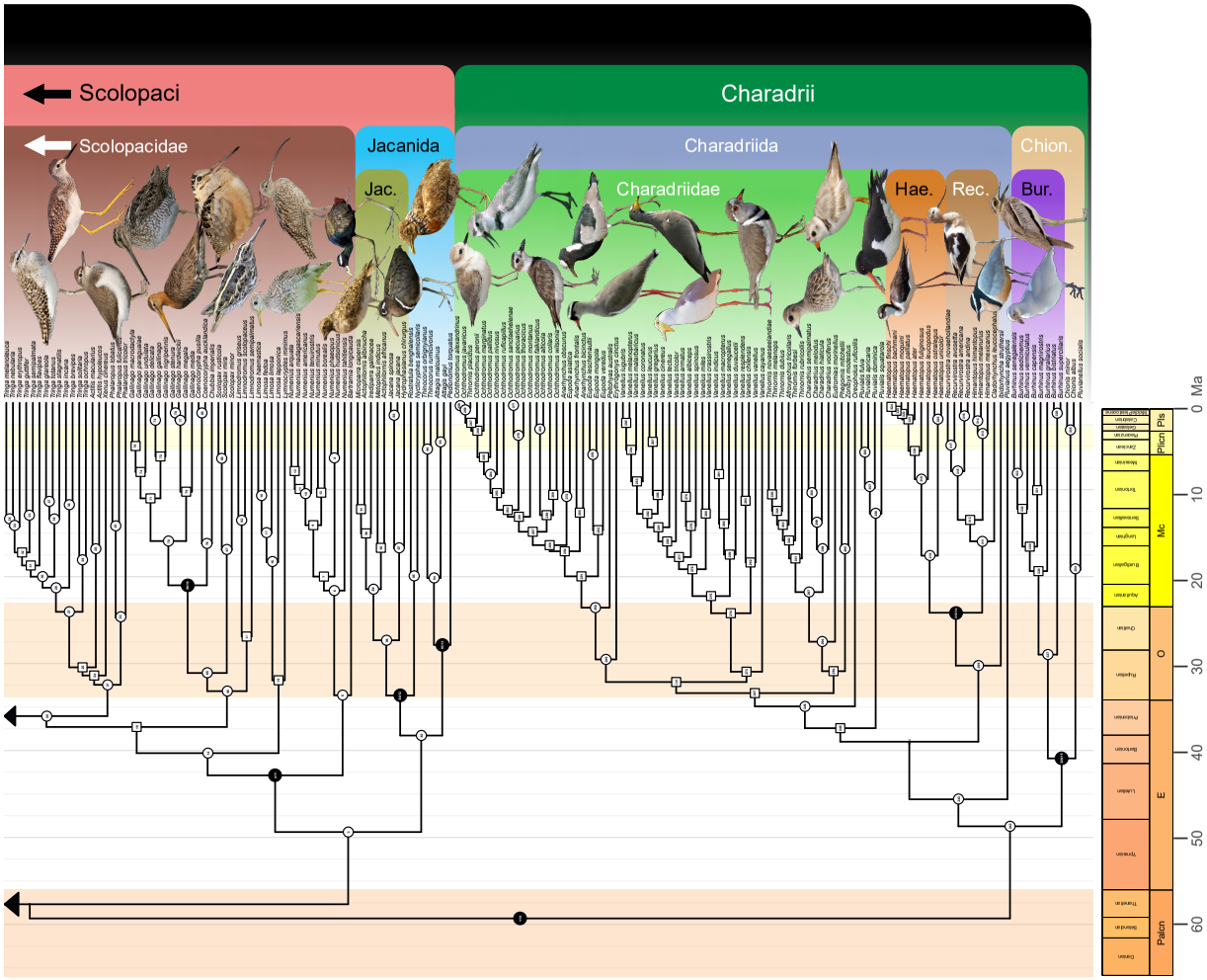
Kimball et al. (2019) backbone

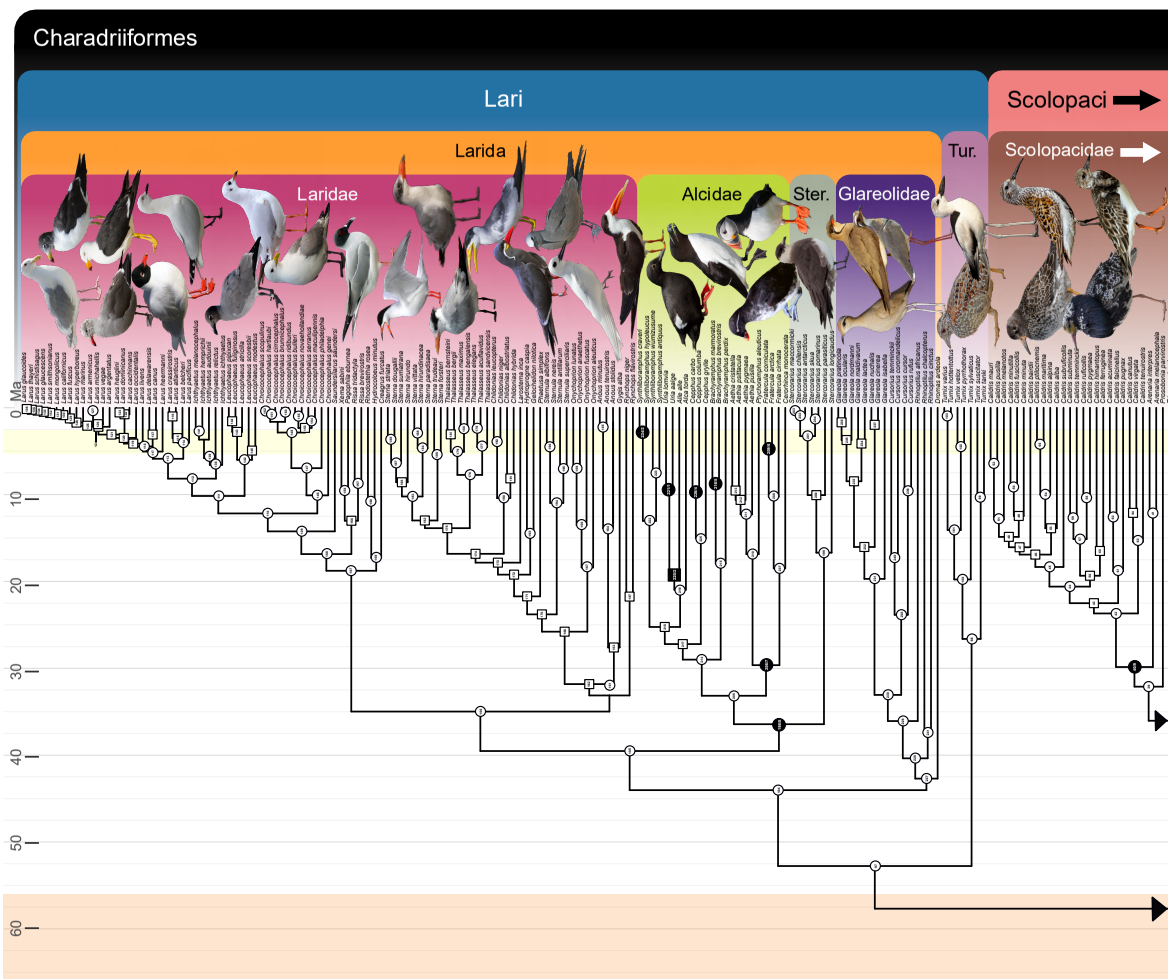


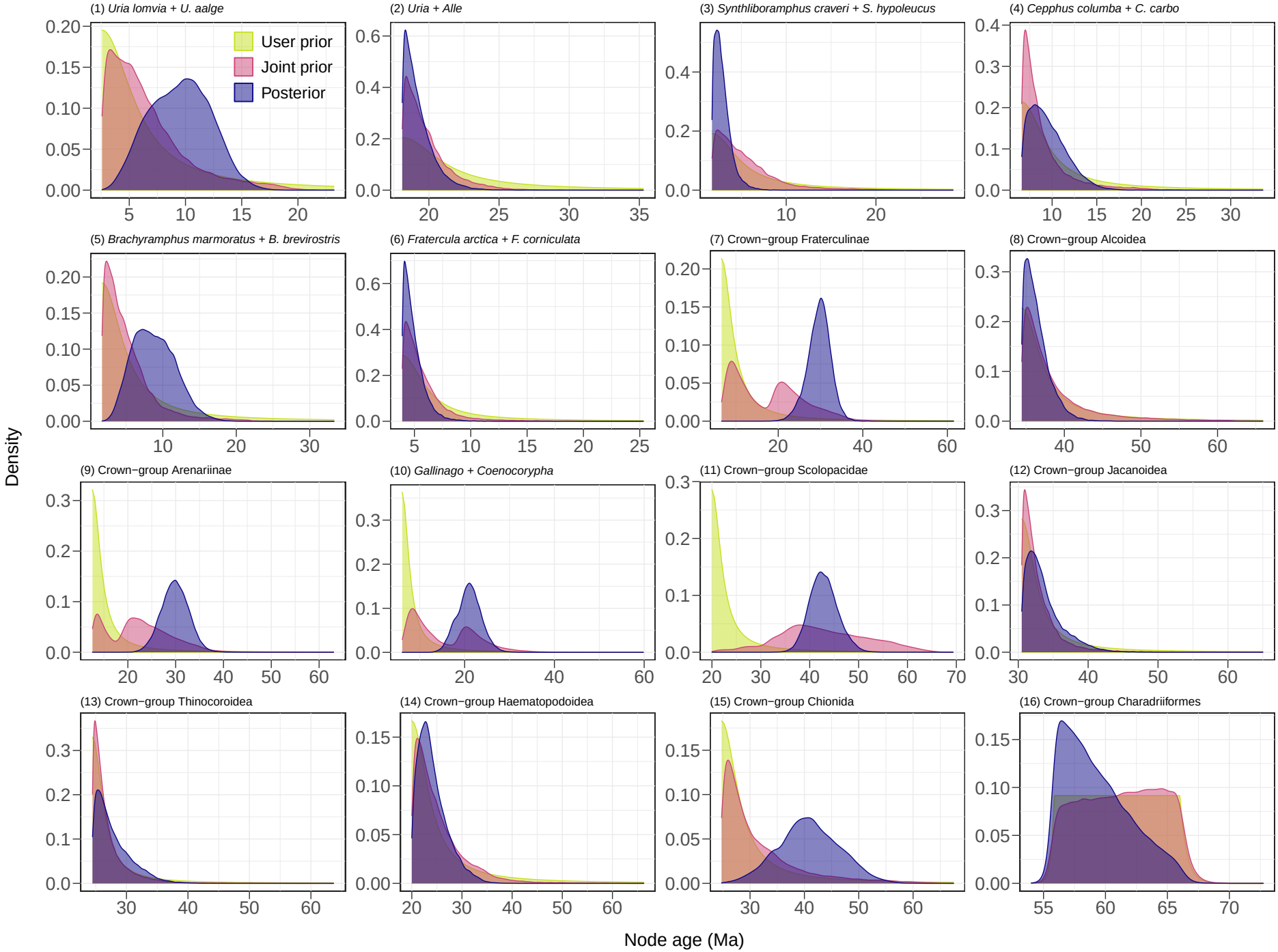
Reddy et al. (2017) backbone




a) ASTRAL
Coalescent units
(non−terminal branches only)
0.8
Effective # of genes
2
4
6
8
Local PP
0.75
0.50
0.25
b) RAxML
Expected substitutions
per site
0.2
Locus coverage
5
10
15
20
Bootstrap
100
80
60
40
20
c) ExaBayes
Expected substitutions
per site
0.2
Locus coverage
5
10
15
20
Posterior probability
1.00
0.75
0.50
0.25
Larinae
Anous
Sterninae
Gygis
Rynchops
Synthliboramphus
Uria
Alle
Alca
Cepphus
Brachyramphus
Aethiini
Fraterculini
Stercorariidae
Dromas
Glareolidae
Turnicidae
Calidris
Arenaria
Prosobonia
Tringini
Xenus
Phalaropus
Scolopacini
Limnodromus semipalmatus
Limnodromus griseus
Limnodromus scolopaceus
Lymnocryptes
Limosa
Numeniinae
Jacanidae
Rostratulidae
Thinocoridae
Pedionomus
Anarhynchinae
Charadriinae
Vanellus
'Vanellus' cayanus
Oreopholus
Pluvialis
Haematopodidae
Recurvirostridae
Ibidorhyncha
Burhinidae
Chionidae
Pluvianellus
Pluvianus

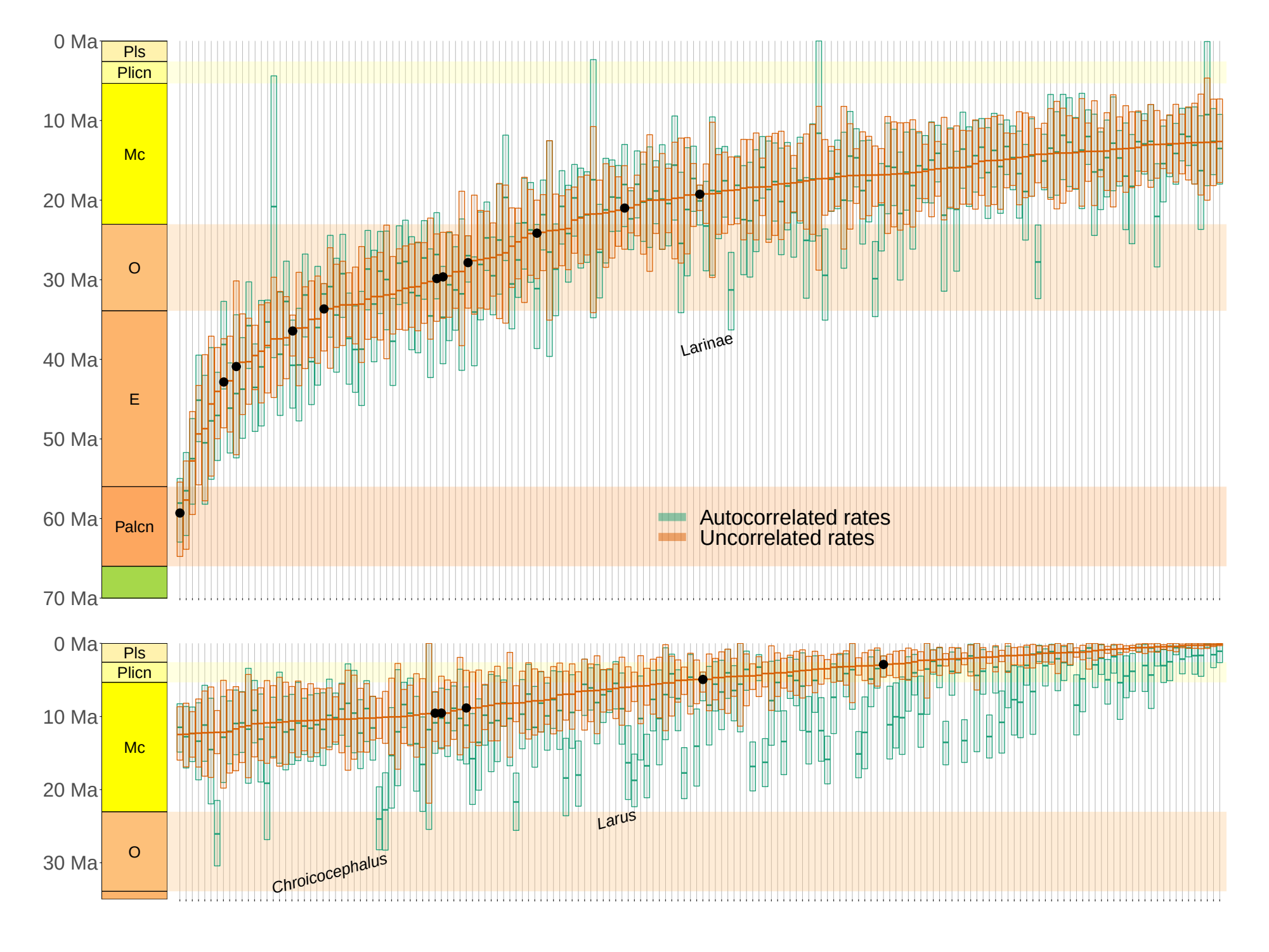

Scolopaci
Charadrii
Scolopacidae
Jacanida
Charadriida
Chion.
Jac.
Charadriidae
Hae.
Rec.
Bur.
0 Ma
10
20
30
40
50
60
Plio
Pleis
Mc
O
E
Palcn

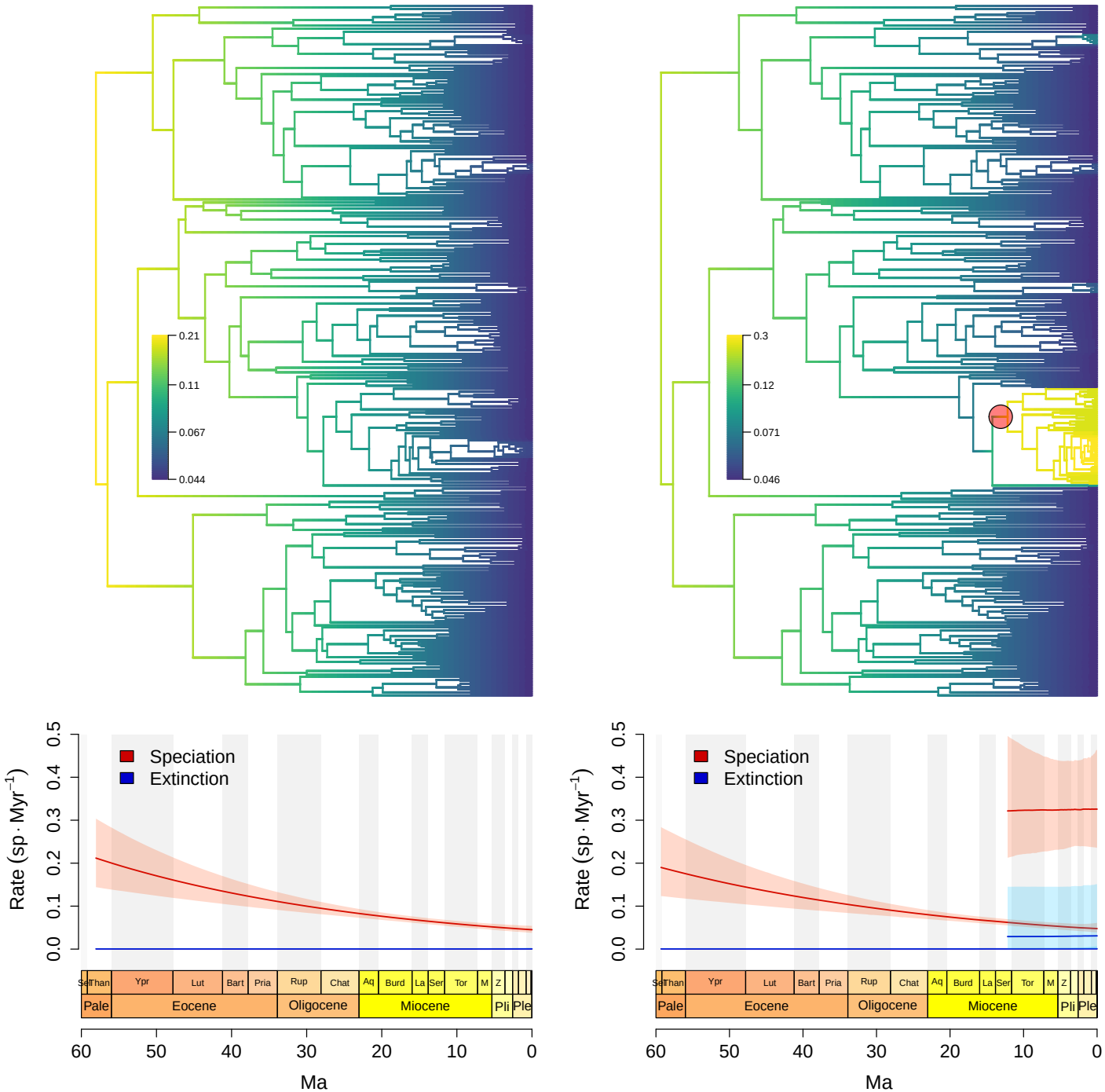

Charadriiformes
Lari
Scolopaci
Larida
Tur.
Scolopacidae
Laridae
Alcidae
Ster.
Glareolidae
0 Ma
10
20
30
40
50
60


(1) Uria lomvia + U. aalge
(2) Uria + Alle
(3) Synthliboramphus craveri + S. hypoleucus
(4) Cepphus columba + C. carbo
(5) Brachyramphus marmoratus + B. brevirostris
(6) Fratercula arctica + F. corniculata
(7) Crown−group Fraterculinae
(8) Crown−group Alcoidea
(9) Crown−group Arenariinae
(10) Gallinago + Coenocorypha
(11) Crown−group Scolopacidae
(12) Crown−group Jacanoidea
(13) Crown−group Thinocoroidea
(14) Crown−group Haematopodoidea
(15) Crown−group Chionida
(16) Crown−group Charadriiformes
User prior
Joint prior
Posterior
Density
Node age (Ma)

Relaxed-clock model comparisons

Dataset	Model	Bayes factor	Posterior probability
19 species	**Autocorrelated rates**	**72.64**	**0.986**
	Uncorrelated rates	1	0.014
40 species	Autocorrelated rates	1	0.130
	Uncorrelated rates	**6.67**	**0.870**


0 Ma
10 Ma
20 Ma
30 Ma
40 Ma
50 Ma
60 Ma
70 Ma
Pls
Plicn
Mc
O
E
Palcn
Larinae
Autocorrelated rates
Uncorrelated rates
0 Ma
10 Ma
20 Ma
30 Ma
Pls
Plicn
Mc
O
Chroicocephalus
Larus


0.21
0.11
0.067
0.044
0.3
0.12
0.071
0.046
Speciation
Extinction
Rate (sp · Myr^{-1})
0.0
0.1
0.2
0.3
0.4
0.5
Sel
Than
Ypr
Lut
Bart
Pria
Rup
Chat
Aq
Burd
La
Ser
Tor
M
Z
Pale
Eocene
Oligocene
Miocene
Pli
Ple
60
50
40
30
20
10
0
Ma