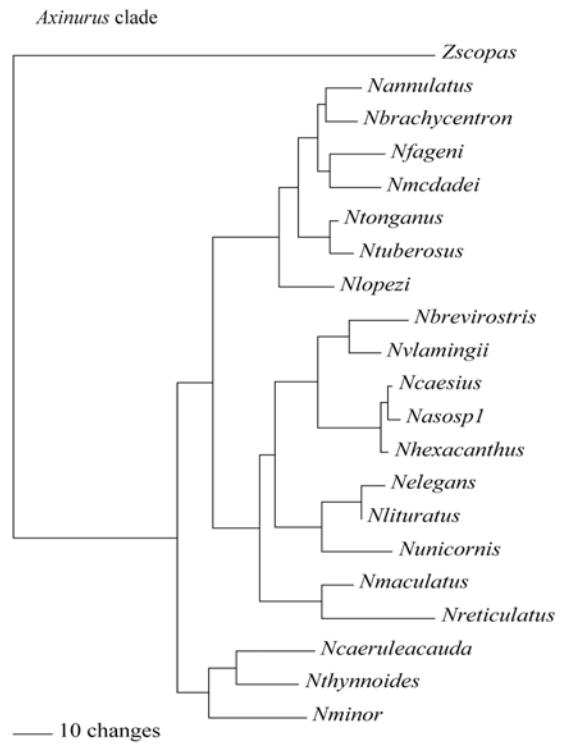
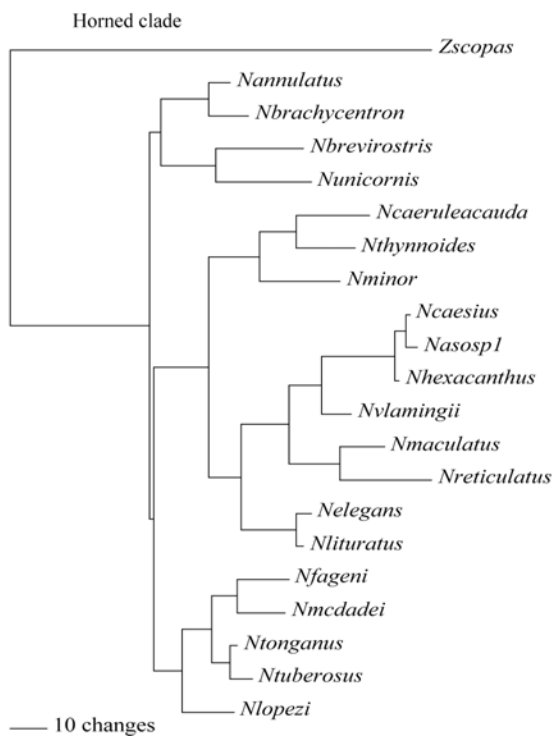
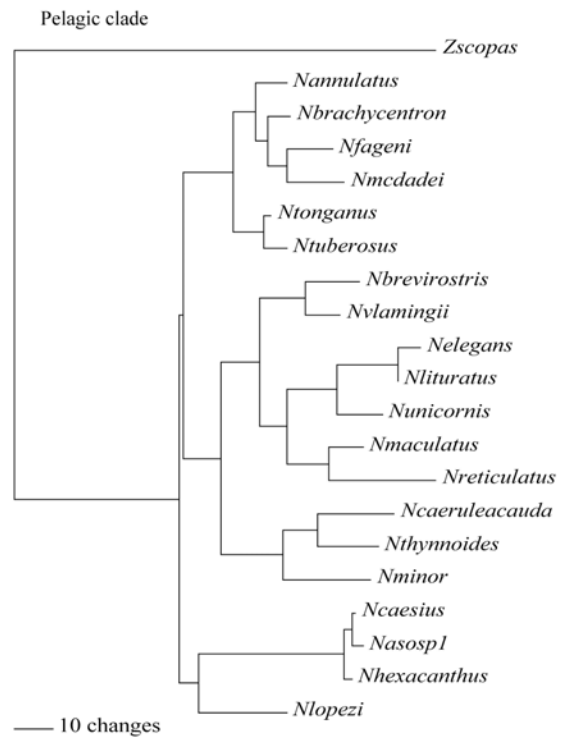
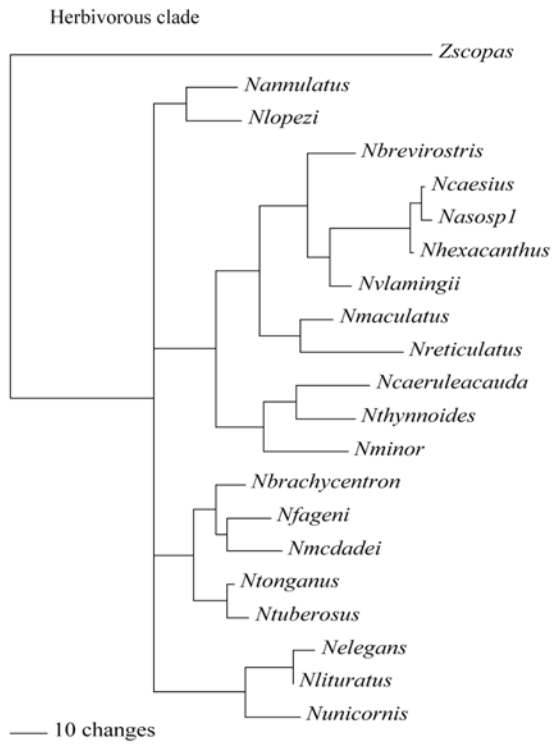


Appendix 1:

Trees for four different constraints (Hypotheses 2 - 4, Chapter 3)



Appendix 2:

Table 1.1: List for some fish studies that used related fossil records and/or geological event to calibrate a molecular clock.

Fish groups (Family, Genus)	Gene- region	Divergence rate %per MY	Based on	Source
Gymnotiform, Mormyriiform (electric fish)	12S, 16S rRNA	0.23%	Fossil record (America's, Africa)	(Alvez-Gomes 1999)
Sparidae, Scombridae, Carangidae, Percidae, Cichlidae	cyt- <i>b</i>	0.045% (1 st) 0.015% (2 nd) 0.75% (3 rd); Avg. 0.27%	Martin et al., 1992; Stationary Markov Clock (SMC)	(Cantantore et al. 1994) (Note: mammals 0.9%)
<i>Gasterosteus aculeatus</i> (threespine sticklebacks)	cyt- <i>b</i>	7.4-8.5% (3 rd codon)	Fossil record (Pacific Ocean)	(Orti et al. 1994)
<i>Aulostomus</i> (Trumpetfish)	cyt- <i>b</i>	1.8 - 2.2% (Avg. 2%)	Geological event (Isthmus of Panama)	(Bowen et al. 2001)
Sharks	cyt- <i>b</i>	0.22% (1 st & 2 nd codon)	Fossil record (America)	(Martin and Palumbi 1993a) (Note: mammals 1.4%)
Cyprinidae	cyt- <i>b</i>	0.37% (1 st & 2 nd codon)	Fossil record (Europe), geological events	(Briolay et al. 1998)
Cyprinidae	cyt- <i>b</i>	0.76%	Fossil record (Europe)	(Zardoya and Doadrio 1999)
Osteoglossidae	cyt- <i>b</i> ND2	0.05%	Fossil record, geological events	(Kumazawa and Nishida 2000)
<i>Galaxias vulgaris</i> complex (Galaxiidae)	cyt- <i>b</i> , d-loop	3% 3.6%	Geological events (New Zealand)	(Waters and Wallis 2001)
Sharks	cyt- <i>b</i> , COI	0.09% (3 rd codon, tv only)	Fossil record (America)	(Martin et al. 1992) (Note: primates 0.5%)
<i>Barbus, Luciobarbus</i> (Cyprinidae)	cyt- <i>b</i> , ATPase 6/8	1.32%	Geological & paleontological events	(Machordom and Doadrio 2001)

Table 1.1 cont\....

Fish groups (Family, Genus)	Gene- region	Divergence rate %per MY	Based on	Source
tropical marine & freshwater fish (19spp)	COI ND2 & ATPase6	1.2% 1.3%	Geological events (Isthmus of Panama)	(Bermingham et al. 1997)
<i>Pungitius</i> (ninespine sticklebacks)	d-loop	3 lineages: 1.37% 2.71% 0.98%	Fossil records (molecular clock rejected, lineages analysed separately)	(Takahashi and Goto 2001)
<i>Centropomus</i> group (snook)	d-loop, ND5/6	3.6% (3 rd codon, tv only)	Geological event (Isthmus of Panama)	(Donaldson and Wilson 1999)
Salmon Sharks Whales	RFLP	0.9 - 0.5% 0.31% 1.0-0.4%	Fossil records	(Martin and Palumbi 1993b)
Coral-reef fish (8 spp)	RFLP	1.0 - 2.0%	Geological event (Isthmus of Panama)	(Shulman and Bermingham 1995)