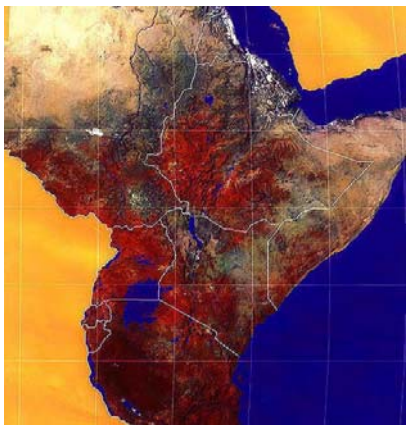
Ecological Convergence and its Effect on Fitness of Pelagic Planktivores in African Great Lakes: Who Grows Better, Cyprinids or Clupeids?

African Rift Lakes

- Ecological similarities in pelagic fauna in African Great Lakes



Ecological Similarities

- Phylogeny = Common Evolutionary History
- Parallelism and Convergence = Common Selective Pressures

Lake Victoria

- Area = 68,635 km2
- Maximum Depth = 93 meters

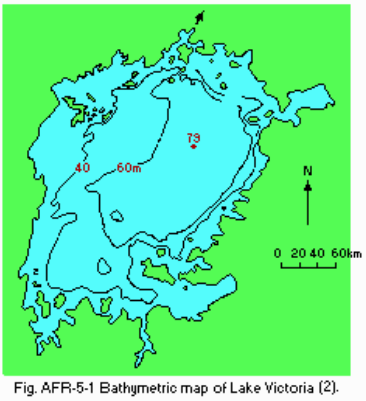


Fig. AFR-5-1 Bathymetric map of Lake Victoria (2).

Lakes Malawi and Tanganyika

- Lake Malawi
  - Area = 29,604 km2
  - Max Depth = 704 m
- Lake Tanganyika
  - Area = 34,000 km2
  - Max Depth = 1470 m

Fauna Comparisons

- Clupeiformes = Most are open water, pelagic, schooling, 80% marine spp. 4 families, 83 genera, 363 species
- Clupeidae
  - 66 genera, 222 species = herrings, shads, alewives, sprats, sardines, pilchards, menhadens, etc.

Comparisons

- Cypriniformes – 2660 species
- Cyprinidae
  - 6 families, 284 genera, 2050 species; Almost all freshwater = minnows, shiners, carps, barbs, barbels, gudgeons, chubs, dace, squawfish, rudd, goldfish, koi, sharks, danios, etc.

Phylogenetic Comparison

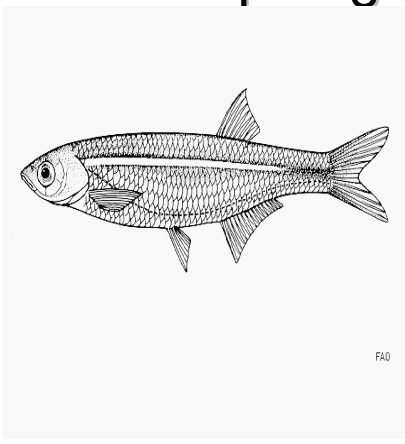
Clupeocephala = Subdivision Clupeomorpha + Subdivision Euteleostei

- Clupeomorpha = Engraulidae + Clupeidae + Denticipitidae + Chirocentridae
- Ostariophysi = Gonorhynchiformes + Cypriniformes + Characiformes + Siluriformes + Gymnotiformes
- Cypriniformes = Cyprinidae + Gyrinochellidae + Catostomidae + Cobitidae + Balitoridae

Lake Tanganyika pelagic fauna

- Clupeidae
- *Limnothrissa miodon (top)*
- *Stolothrissa tanganicae (bottom)*
- Cyprinid – *Chelaethiops (Engraulicypris) minutus*

Lakes Victoria and Malawi pelagic fauna

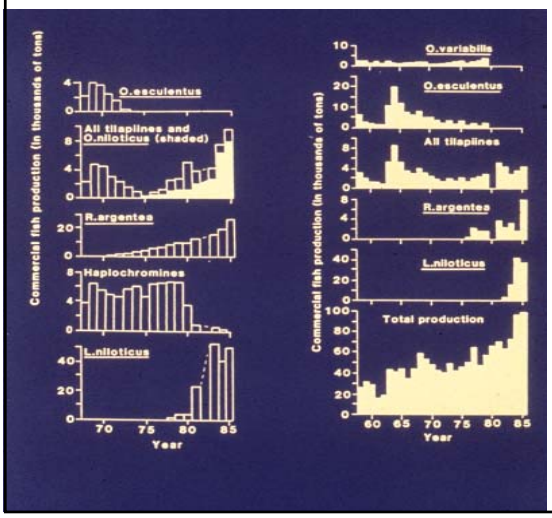


- Cyprinidae
- Lake Victoria - Dagga
  - *Rastrineobola argentea*
- Lake Malawi - Usipa
  - *Engraulicypris sardella*

Changes in Lake Victoria Fauna

- Multi-species cichlid fishery
- Nile Perch dominated – three species
  - *Lates niloticus*
  - *Oreochromis niloticus*
  - *Rastrineobola argentea*

Changes in Lake Victoria Fauna

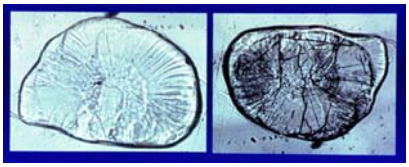


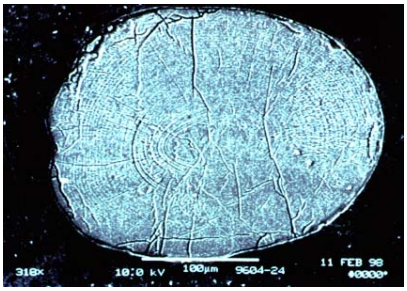
- *Rastrineobola argentea* shows concurrent increase

Rastrineobola argentea

- Zooplanktivore
- 1.5 – 2 yr life span ??
- 2nd most important fishery
- Important resource for Nile perch
- Little known

Age Study





- Otoliths
- Light and SEM counts
- Individuals between 7.4 mm and 67.1 mm Standard length
- 26 to 291 days old – They live less than one year

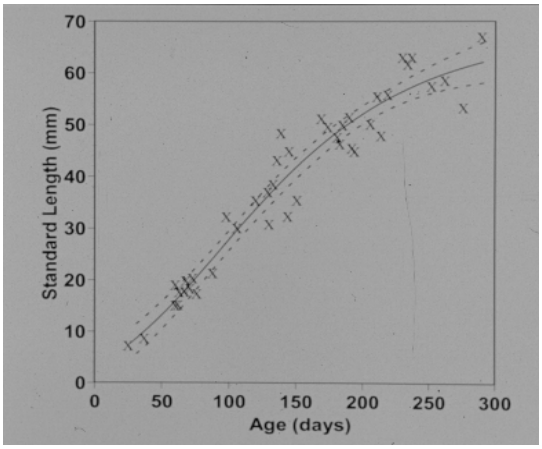
Model Descriptions

Linear model	$SL = m * age + b$
von Bertalanffy	$SL = L_\infty (1-e^{-k (age - t_0)})$
Gompertz	$SL = L_\infty e^{-e^{-g (age - t_{infl})}}$

Table of Gompertz and von Bertalanffy Parameters

	r^2	Estimate	Standard error	95 % confidence interval lower	upper
von Bertalanffy	.939				
L_∞		87.98	12.96	61.76	114.20
k		0.005	0.001	0.002	0.007
t_0		16.90	6.97	2.80	31.00
Gompertz	.941				
L_∞		67.68	4.17	59.24	76.13
g		0.012	0.002	0.009	0.015
t_{infl}		90.36	6.404	77.40	103.31

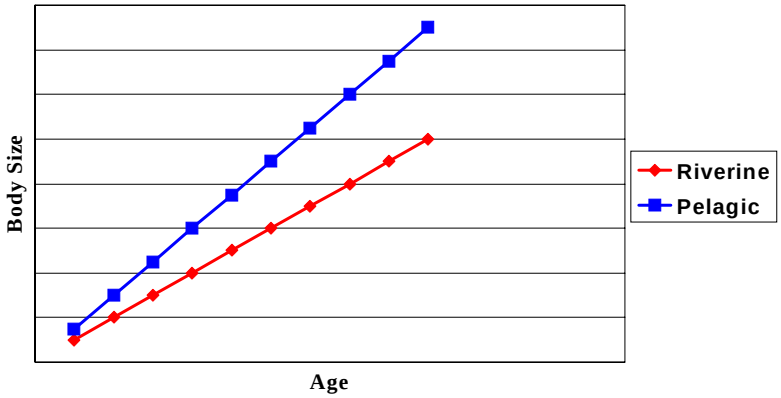
Gompertz Model Best Fit



Growth Performance

- $\Phi = \log k + 2 \log L_{\infty}$
- Where k is Brody growth coefficient and L_{∞} is von Bertalanffy asymptotic length
- Attempt to measure the "growth performance" of a species by incorporating measures of maximum size and growth into one parameter

Allometric Graphs and Habitat Shifts



Comparisons of Growth Performance

	L_∞	(mm)	k	Φ'	
Rastrineobola argentea					
Lake Victoria	87	SL	1.74	4.13	This study
	50	SL	1.8	3.65	Njiru (1995) Nyanza Gulf
	65	SL	1.5	3.80	Njiru (1995) open waters
	65	SL	1.04	3.64	Wandera and Wanink (1995)
Engraulicypris sardella					
Lake Malawi	154		2.14	4.70	FAO (1982)
	116		2.55	4.53	Tweddle and Lewis (1990)
Stolothrissa tanganicae					
Lake Tanganyika	94	FL	2.52	4.34	Chapman and van Nell (1978)

Species Introductions

- Pitcher *et al*. 1996 - lower Φ (earlier studies) suggest clupeid introduction into Lake Victoria
- Φ' calculated here for *R. argentea* is closer to other ecologically equivalent species. Introducing ecologically similar species to Lake Victoria to boost fishery production not supported.

Productivity in Pelagic Zones

- Performance convergence of phylogenetic and ecologically diverse lineages
- Incorporate growth rather than just per capita output into fitness