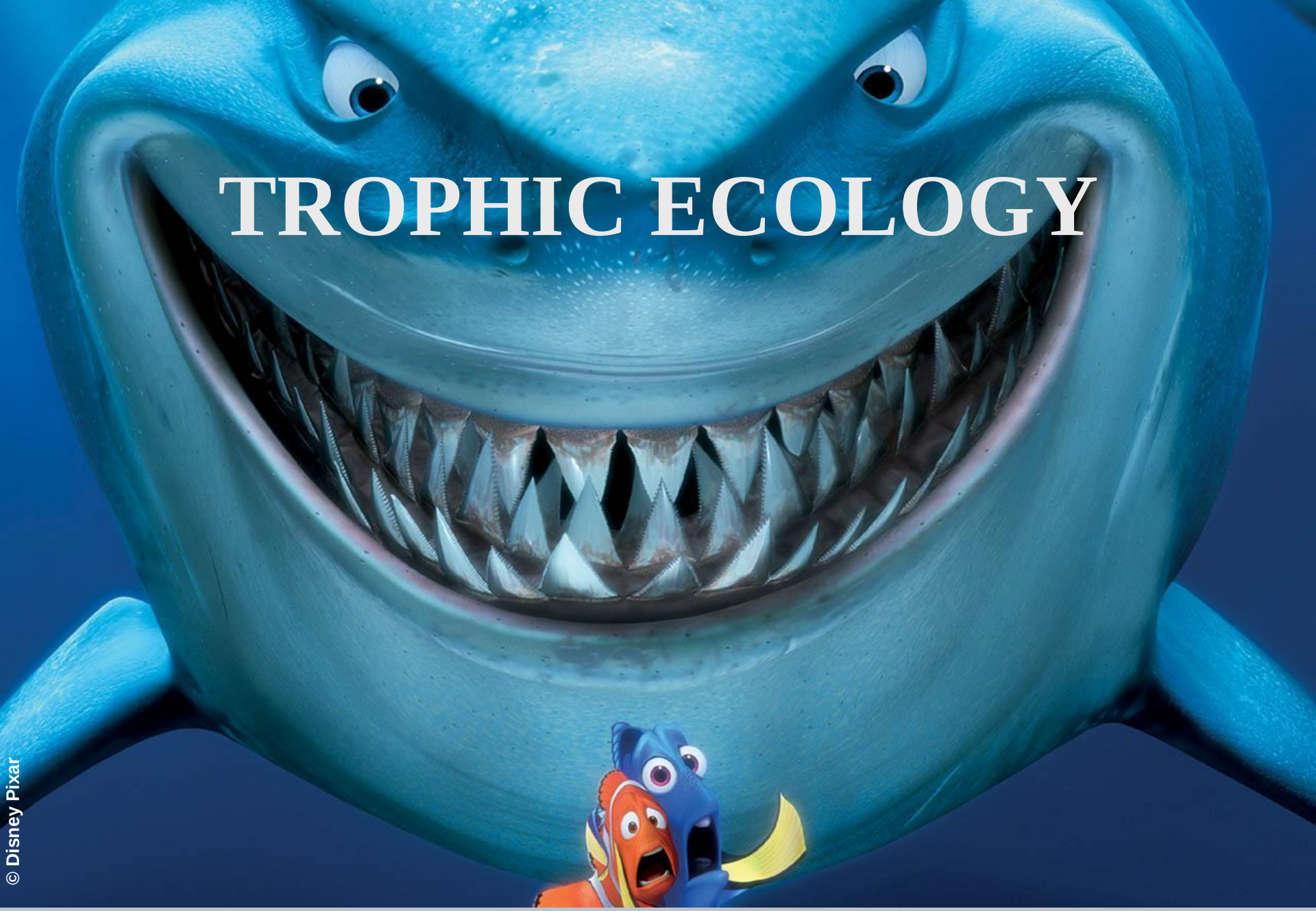
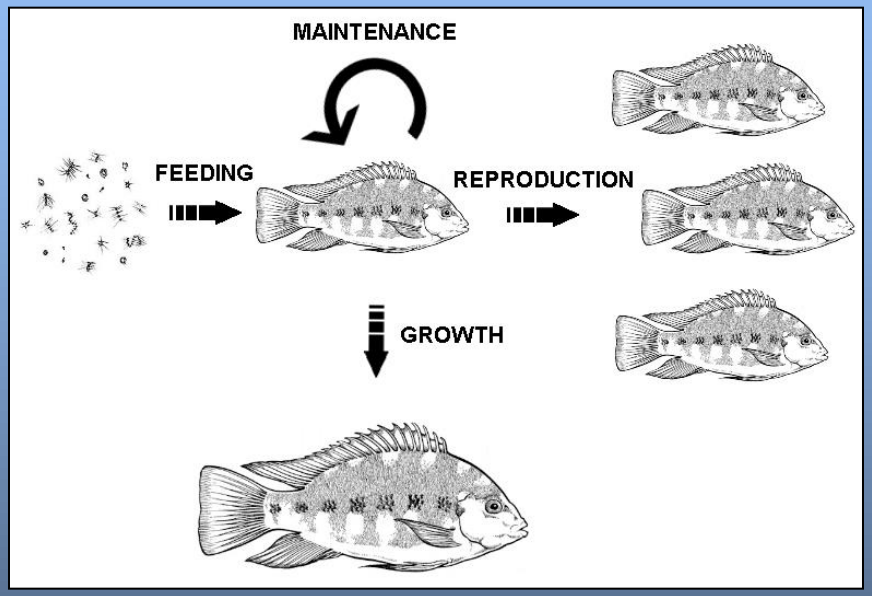
TROPHIC ECOLOGY



1. Introduction

Feeding is the only way for an animal to acquire energy for maintenance, growth and reproduction.



Basically, the best prey is that which gives maximum energy for a minimum cost of capture

2. Some morphological adaptations to feeding

- Position, shape and size of mouth: mainly jaw modifications, sometimes also lips

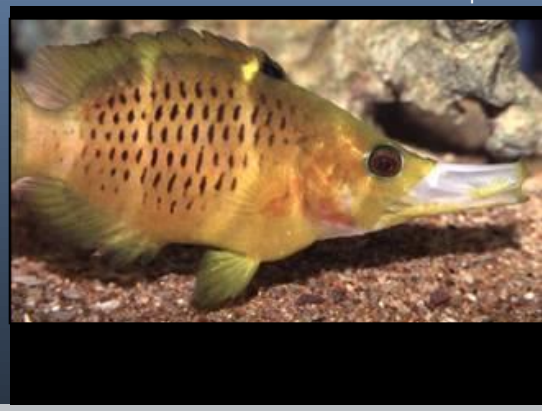
  - (dorso-)terminal mouth in fish feeding at the surface or in the middle of the water column; ventroterminal or ventral mouth in fish feeding from the substrate

  - piscivores have a wide gape and strong jaws

  - protrusible jaw: occurs in more evolutionary advanced fishes; advantages include a momentarily but crucial increase of the rate of approach to the prey, larger distance from which prey can be captured, decrease of lower jaw rotation needed to close the mouth, and obtaining prey from otherwise inaccessible places

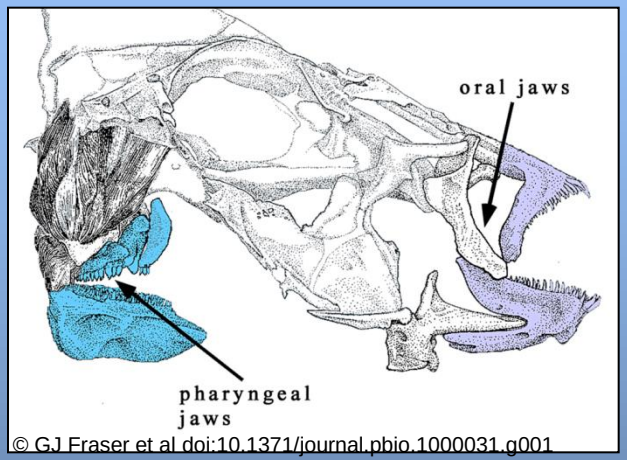
Gnathochromis permaxilaris
© www.malawijan.dk

Hydrocynus sp.
© JumpNews

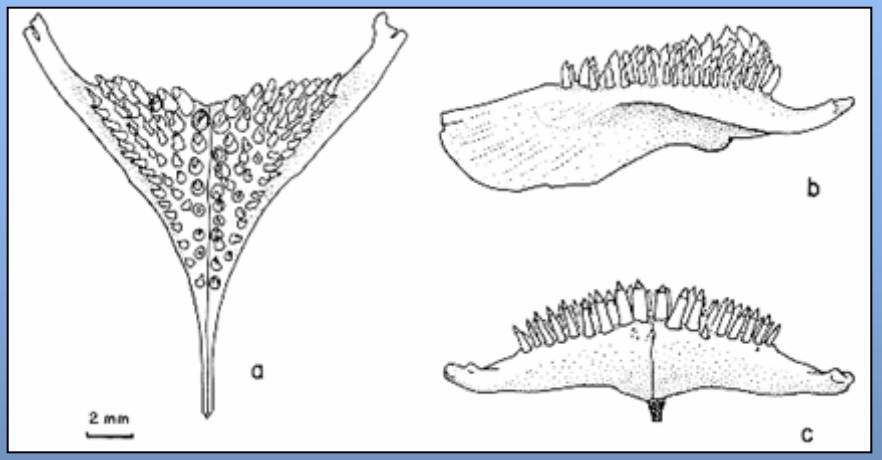


2. Some morphological adaptations to feeding

- Marginal and pharyngeal teeth: teeth may be present on tongue, marginal bones, palatal bones and pharyngeal bones



Lower pharyngeal bone (fused fifth ceratobranchials) of *Exochochromis anagenys* (from Oliver 1984)

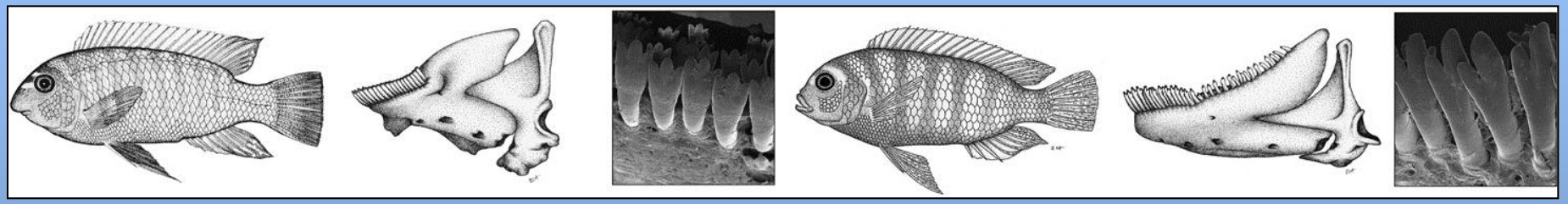


Premaxillary, vomerine and palatine teeth of *Chrysichthys* sp.

Piranha

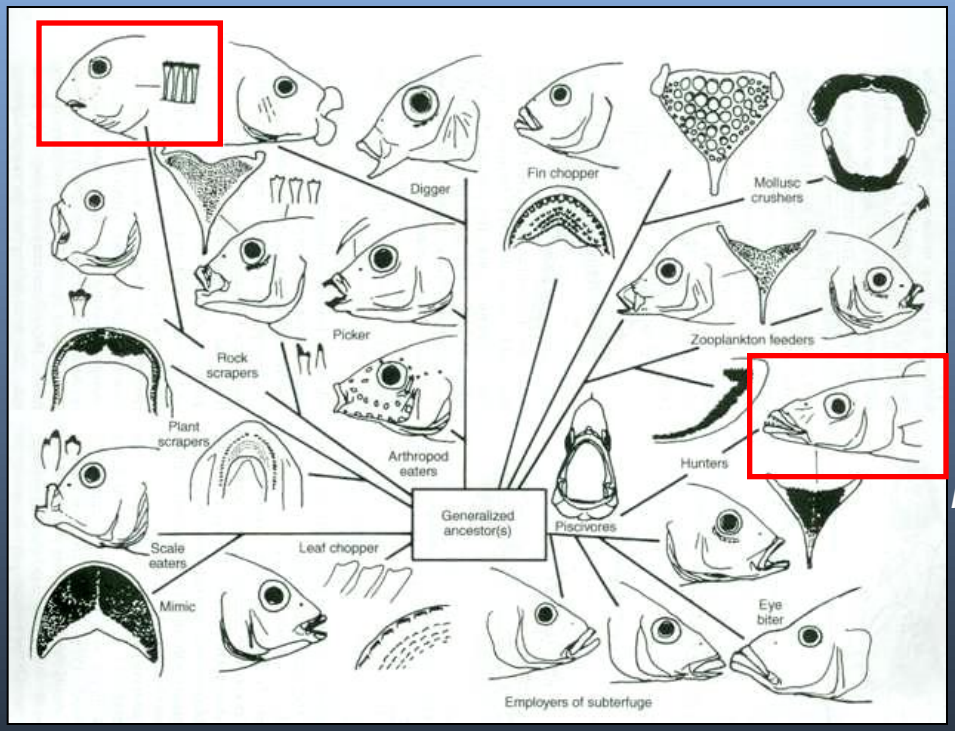
2. Some morphological adaptations to feeding

African Great Lakes cichlids show a large variety of marginal and pharyngeal teeth, related to their diet



Labeotropheus fuelleborni (left) and *Maylandia zebra*

Labeotropheus



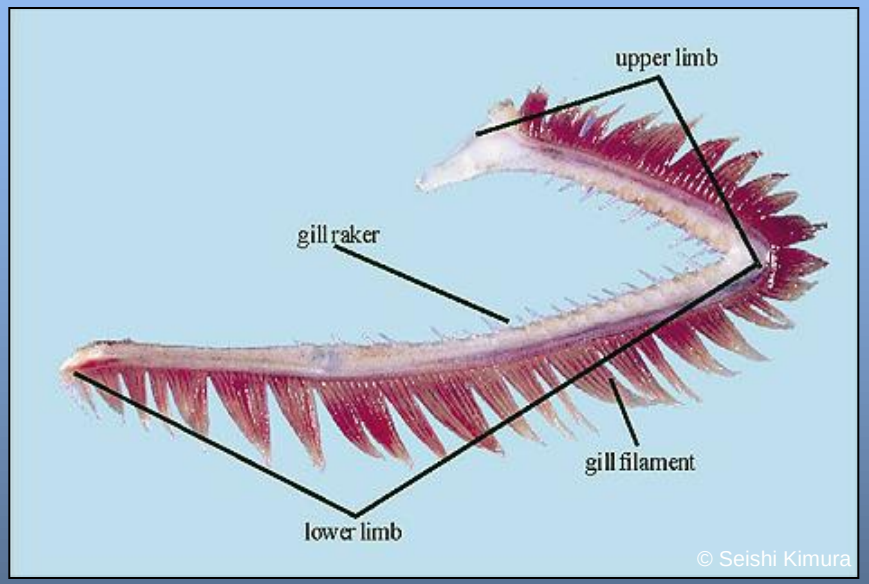
Rhamphochromis

2. Some morphological adaptations to feeding

- Gill-rakers: forward-directed projections from the inner margins of the gill arches, of which shape and abundance are related to diet:

  - numerous long, fine gill-rakers usually found in fish feeding on small food particles

  - fewer shorter, blunter gill-rakers found in fish that feed on larger particles



Gill-rakers and filaments in filter feeders entrap food particles bound in mucus, and transport this material back, after which it is sorted and raked by the pharyngeal teeth; sometimes the rakers play no direct role, but the food is trapped in mucus clumps which pass over the pharyngeal teeth to the oesophagus

2. Some morphological adaptations to feeding

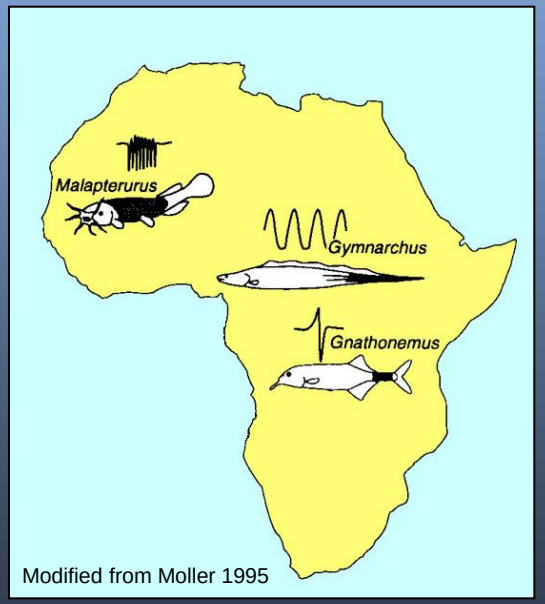
- Intestine length:
  - large stomach, short intestine: ichthyophages (carnivores)
  - no stomach, very long intestine: limivores, phytophages (herbivores)
  - no real relation between intestine length and trophic specialisation exists in omnivores, zooplanktonivores or invertivores

  Relative gut length may increase as the fish grows

- Electric organs: used to paralyze prey; e.g. *Malapterurus electricus*, *Electrophorus electricus*

Malapterurus sp.
© www.planetcatfish.com

Electrophorus electricus
© William Fink

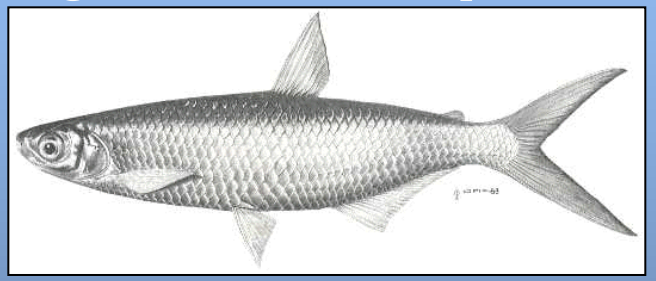


Modified from Moller 1995

2. Some morphological adaptations to feeding

- Body form and locomotion:

  - preying on dispersed food items (macrophages, filter feeders): body fusiform, caudal peduncle small, caudal fin forked or V-shaped; good swimmers capable of migrating over long distances; e.g. *Alestes baremoze*



Alestes baremoze (Lévêque *et al.* 1990)

  - hunting moveable prey: body flexible, dorsal fin positioned far back on the body; good swimmers with fast acceleration; e.g. *Hepsetus odoe*

Hepsetus sp. © Frank Teigler

2. Some morphological adaptations to feeding

- preying on hidden or bottom-distributed prey: in need of manoeuvrable body, made possible by use of the paired and unpaired fins; e.g. many cichlids, Mormyridae, Notopteridae

Gnathonemus petersii

Xenomystus nigri

- generalists have less developed locomotory abilities, but they have developed other catch-adaptations: improved suction, protractile mouth,…

- fish often have a broader feeding spectrum than morphology indicates

3. Trophic categories

- Primary consumers: feed on algae, higher plants (macrophytes) and vegetal debris

  - phytoplankton feeders, e.g. *Sarotherodon galilaeus*

Sarotherodon galilaeus

  - macrophyte feeders, e.g. *Brycinus macrolepidotus*

Brycinus macrolepidotus

  - sediment and periphyton browsers, e.g. *Labeo senegalensis*, *Citharinus citharus*, *Distichodus rostratus*

Distichodus rostratus

  - detritivores, e.g. certain tilapias

3. Trophic categories

- Secondary consumers: feed on benthic invertebrates, zooplankton and zooperiphyton

  - zooplankton feeders, e.g. *Alestes baremoze*, *Synodontis batensoda*, *Hemisynodontis membranaceus*

Alestes baremoze

© J.H. Larsen

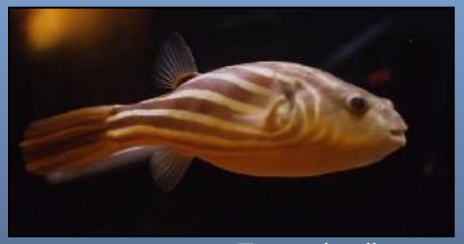
Synodontis batensoda

© Aqualog Verlag

  - benthivores, e.g. *Synodontis schall*, *Heterotis niloticus*, *Tetraodon lineatus*

Synodontis schall

© Aqualog Verlag



Tetraodon lineatus

© Annie Komarisky

  - surface feeders, e.g. *Brycinus macrolepidotus*, *Pantodon buchholzi*

Pantodon buchholzi

© Terra Nova

3. Trophic categories

- Tertiary/final consumers: mainly piscivores feeding on primary and secondary consumers

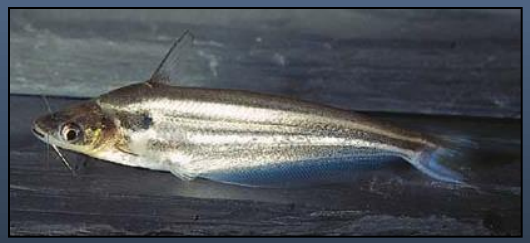
  - strict piscivores, e.g. *Lates niloticus*, *Hydrocynus brevis*

Lates niloticus
© Demeke Admassu

Hydrocynus brevis
© Kai Arendt

  - partial piscivores, e.g. *Schilbe mystus*, *Bagrus bajad*, *Hydrocynus forskahlii*

B. bajad © NTUGuppy



S. mystus
© Exomarc

H. forskahlii
© www.fishingmurchinson.com

3. Trophic categories

Other classifications are possible:

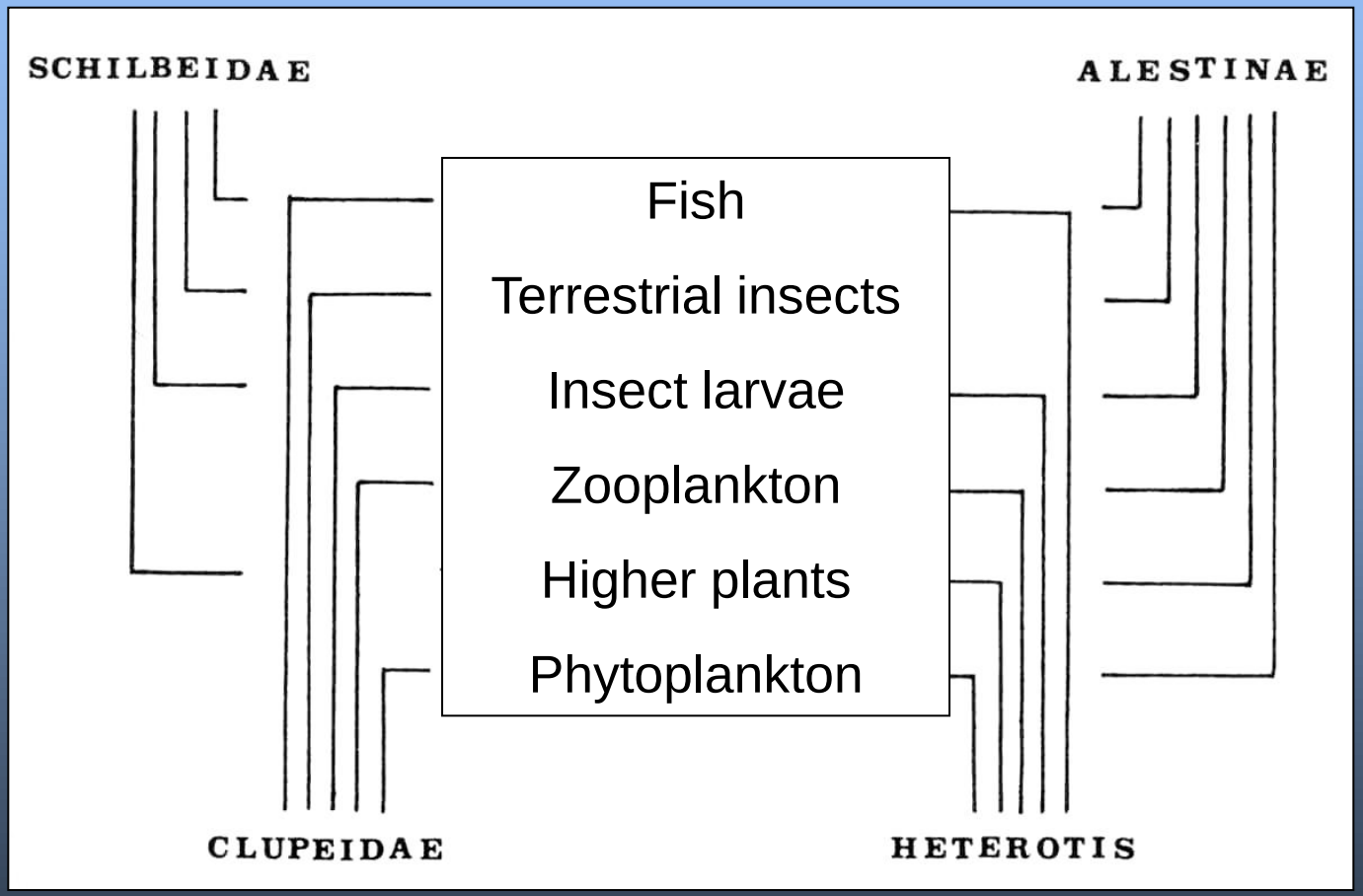
Table 3.1 Major trophic categories in teleost fishes*

1. Detritivores, e.g. *Tilapia* spp. (Cichlidae), *Puntius* spp. (Cyprinidae)
2. Scavengers, e.g. *Anguilla* (Anguillidae) (opportunistically)
3. Herbivores
   - 3.1 Grazers, e.g. *Hypostomus* (Loricariidae)
   - 3.2 Browsers, e.g. *Ctenopharyngodon* (Cyprinidae)
   - 3.3 Phytoplanktivores, e.g. *Tilapia* spp. (Cichlidae)
4. Omnivores, e.g. *Rutilus* (Cyprinidae)
5. Carnivores
   - 5.1 Benthivores
     - a. Picking at relatively small prey, e.g. *Gasterosteus* (Gasterosteidae)
     - b. Disturbing, then picking at prey, e.g. *Sufflamen* (Balistidae)
     - c. Picking up substrate and sorting prey, e.g. *Lethrinops* (Cichlidae)
     - d. Grasping relatively large prey, e.g. *Balistes* (Balistidae)
   - 5.2 Zooplanktivores
     - a. Filter feeders, e.g. *Engraulis* (Engraulidae) feeding on nauplii
     - b. Particulate feeders, e.g. *Engraulis* feeding on adult zooplankters
   - 5.3 Aerial feeders, e.g. *Toxotes* (Toxotidae)
   - 5.4 Piscivores
     - a. Ambush hunters, e.g. *Cottus* (Cottidae)
     - b. Lurers, e.g. *Lophius* (Lophiidae)
     - c. Stalkers, e.g. *Esox* (Esocidae)
     - d. Chasers, e.g. *Salmo* (Salmonidae)
     - e. Ectoparasites, including scale eaters, e.g. *Exodon* (Characidae) and fin eaters, e.g. *Belonophago* (Citharinidae)

*Modified after Keenleyside (1979).

3. Trophic categories

Classifications can be too precise, so that species, often omnivores with complex trophic relations, do not belong to one category



4. Flexibility in feeding ecology

- Ontogenetic changes

  Hydrocynus forskahlii: 30mm: zooplanktivores
  >50mm: piscivores

  Docimodus evelynae: <50mm: fungi from other fish
  50-80mm: plankton, insects, algae
  >80mm: scales, fins, skin

Docimodus evelynae
© George Turner

- Feeding rhythm
- Seasonal changes

  e.g. *Synodontis batensoda* feeds on zooplankton or sediment, depending on the intensity of the drought/water level; Tilapias in Lake Malawi share phytoplankton when abundant, but diverge into their feeding places when phytoplankton becomes scarce

→ consequences for classifications (trophic categories)!

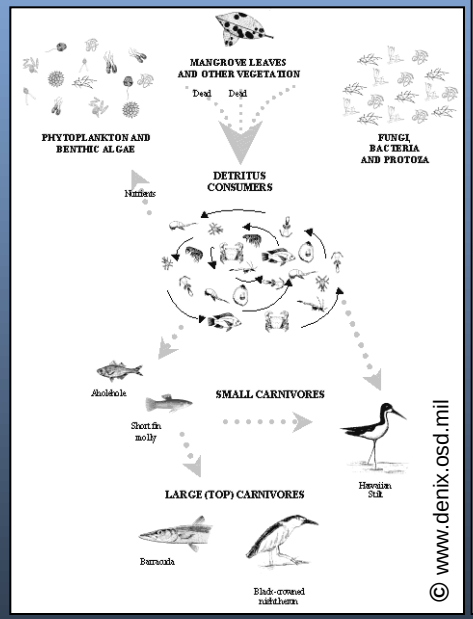
Morphological differences between individuals of a species, related to dietary differences, can reflect phenotypic plasticity, genetic differences or a combination of both; morphological differences between populations, related to trophic ecology, can reflect evolutionary processes (e.g. African Great Lake cichlids)

5. Trophic chains and webs

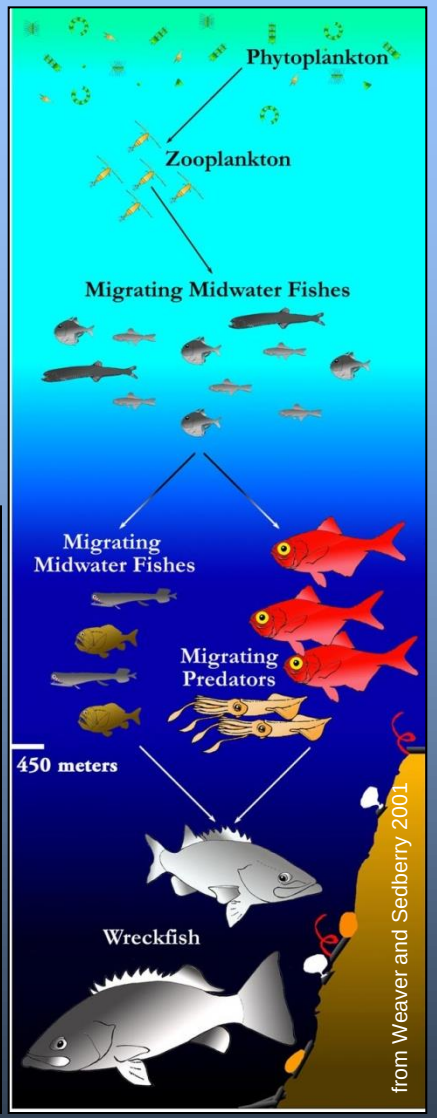
- a trophic chain describes the transfer of energy between different trophic levels

- this energy transfer is subject to thermodynamic laws: heat production and loss of energy; this implicates that trophic levels are generally short, not surpassing 4 or 5 levels (80-90% energy loss)

- 2 types of trophic chains can be distinguished:
  - vegetal chains based on phyto-plankton: pelagic ecosystems and lakes
  - detritus chains based in sediment detritus: benthic ecosystems



Detritus based chain



Vegetal chain

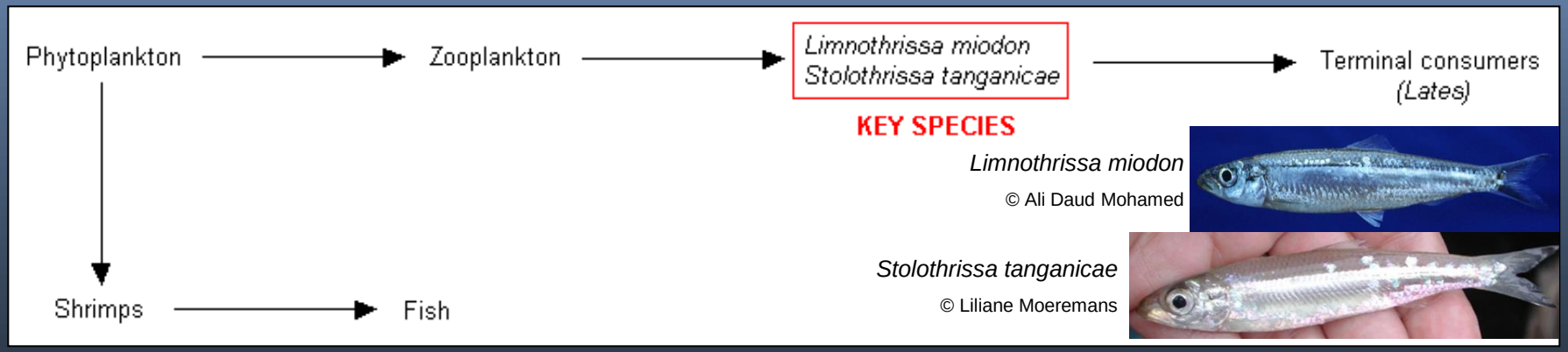
5. Trophic chains and webs

- phytoplanktonivore-dominated communities:

  -shortest chains: fish feeding directly on phytoplankton; only ± 7% of all fish are primary consumers (*Labeo*, *Citharinus*, *Distichodus*, *Tilapia*, *Oreochromis*, *Sarotherodon*)

- pelagic community of a great lake: relatively simple web

  -few species adapted to open water environment in continental habitat
  -comparable to marine pelagic food web
  -e.g. Lake Tanganyika



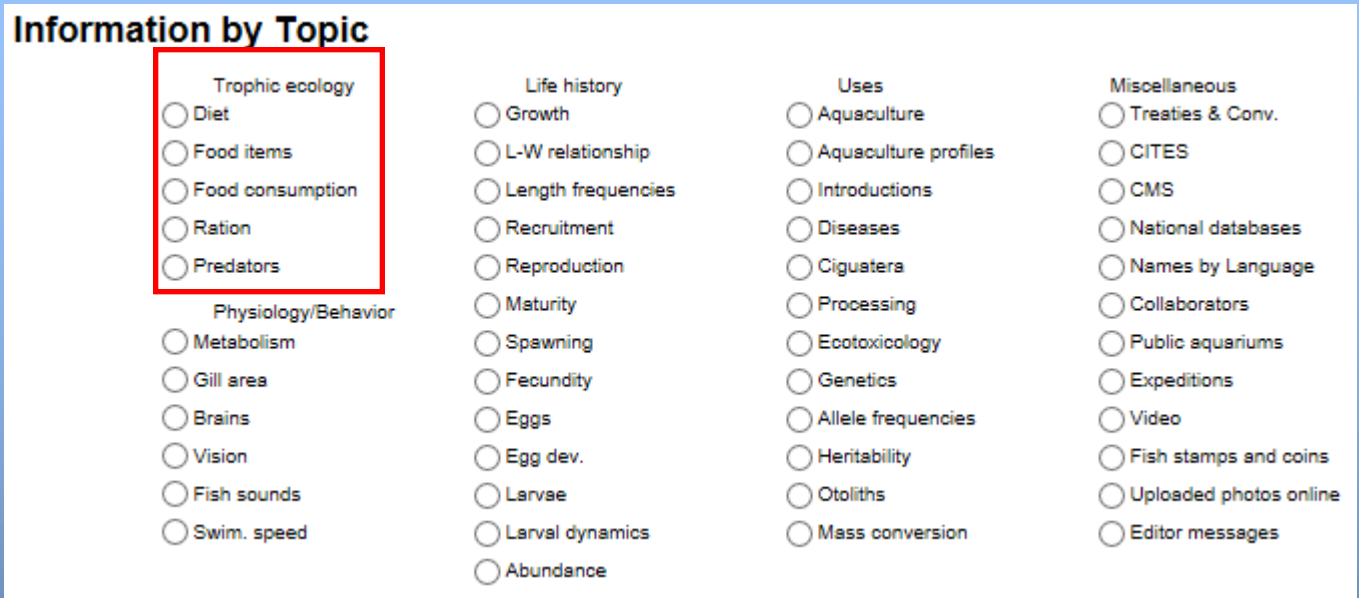
5. Trophic chains and webs

- complex food web of undeep lakes:

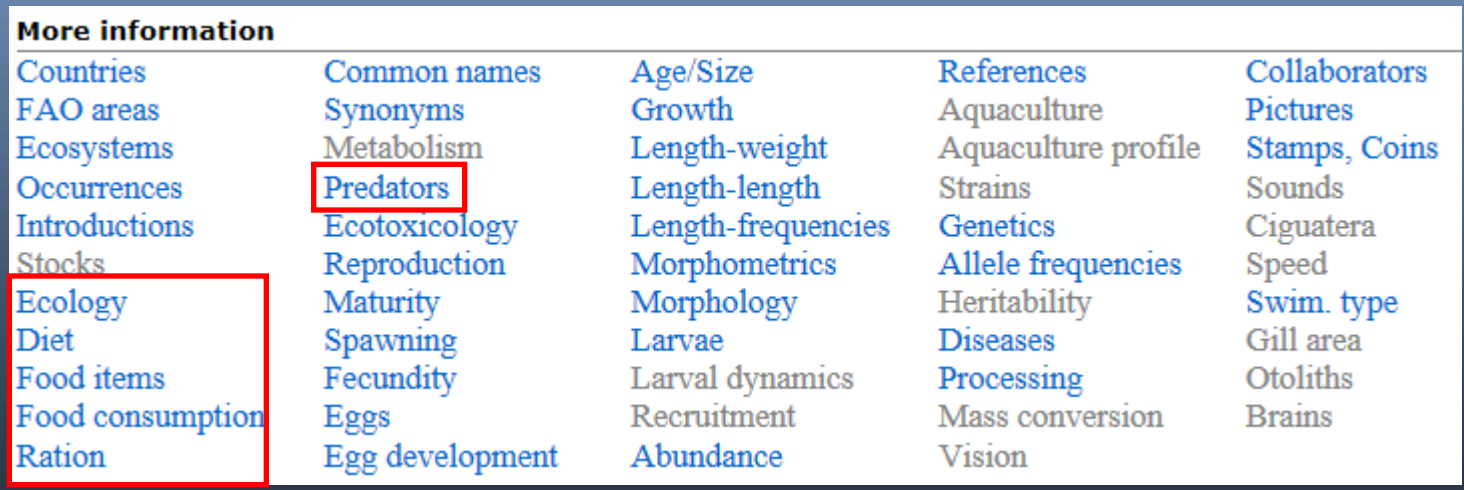
  e.g. Lake Chad:
  - 2 closely interspersed food webs, one vegetal and one detrital based
  - zooplanktonivores are food of large predators
  - also important contribution of terrestrial insects (for species like *Bagrus bajad* and *Schilbe mystus*, the latter linking external food sources to terminal predators)

6. FishBase: trophic categories and levels

Search Page



Species Summary Page



6. FishBase: trophic categories and levels

Ecology of *Oreochromis aureus*

Main Ref.	Trewavas, E., 1983

Distribution

Marine - Neritic	Marine - Oceanic	Brackishwater	Freshwater
supra-littoral zone littoral zone sublittoral zone	epipelagic mesopelagic epipelagic abyssopelagic hadopelagic	**estuaries/lagoons/brackish seas** mangroves marshes/swamps	**rivers/streams** **lakes/ponds** caves exclusively in caves

Highighted items on the list are where *Oreochromis aureus* may be found.

Remarks

Cold tolerant (Ref. 61), occuring at temperatures ranging from 8°-30°C, with small size fish less tolerant to low temperatures than larger specimens (Ref. 2). Tolerates fairly brackish conditions (Ref. 3, 61, 2001, 6465, 54362), with small specimens less tolerant than larger ones (Ref. 96, 54403, 54459) and ontogenetic changes in salinity tolerance related to body size rather than to chronological age (Ref. 54403, 54459). Forms schools; is sometimes territorial; inhabits warm ponds and impoundments as well as lakes and streams (Ref. 5723, 11028), in open water as well as among stones and vegetation (Ref. 11028). Omnivorous (Ref. 61, 52307), but with a tendency towards a vegetarian diet (Ref. 52307). Feeds on phytoplankton and small quantities of zooplankton (Ref. 3, 61, 6465, 52307). Young fish have a more varied diet which includes large quantities of copepods and cladocerans (Ref. 2, 61, 6465), but they also take pieces of small invertebrates (Ref. 52307). Particulate feeder during larval and juvenile stages, filter feeder when adult (Ref. 46977). Ovophilic, agamous (Ref. 52307), maternal mouthbrooder (Ref. 364, 52307). Reproduces in both fresh and brackish water (Ref. 61, 5723

Info on habitat, general distribution, food and feeding (including ontogenetic shifts), salinity and temperature tolerance,…

Substrate

Substrate	
Substrate Ref.	
Special habitats	
Special habitats Ref.	

Associations

Ref.	
Associations	
Associated with	
Association remarks	
Parasitism	

Feeding

Feeding type	mainly plants/detritus (troph. 2-2.19)
Feeding type ref	Trewavas, E., 1983
Feeding habit	filtering plankton
Feeding habit ref	Lazzaro, X., 1987

Trophic level(s)

	Original sample		Unfished population		Remark
Estimation method	Troph	s.e.	Troph	s.e.	
From diet composition	2.07	0.14			Troph of juv./adults.
Ref.	Jiménez-Badillo, M.L. and M.R. Nepita-Villanueva, 2000				
From individual food items	2.51	0.24			Trophic level estimated from a number of food items using a randomized resampling routine.

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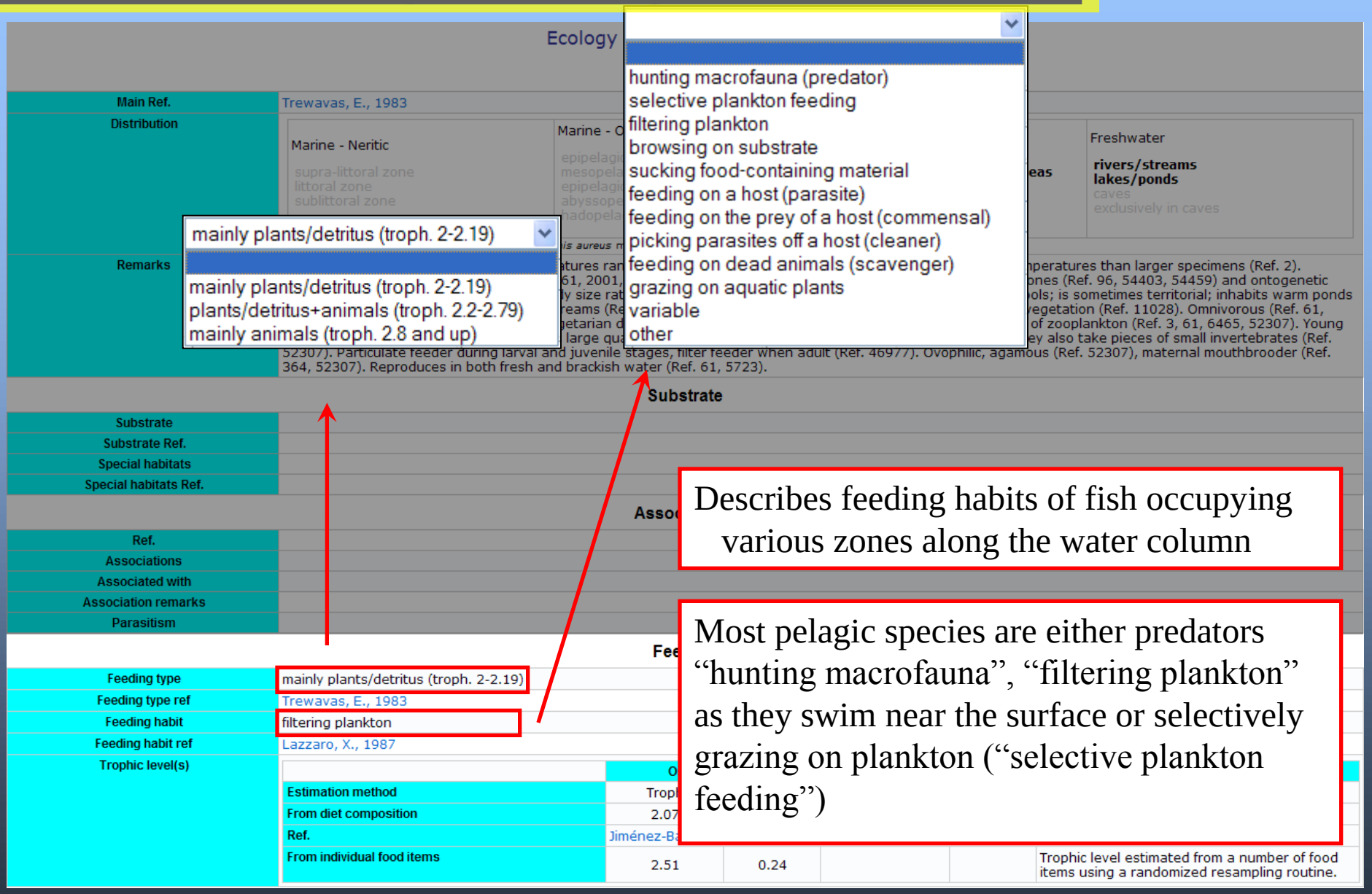
6. FishBase: trophic categories and levels

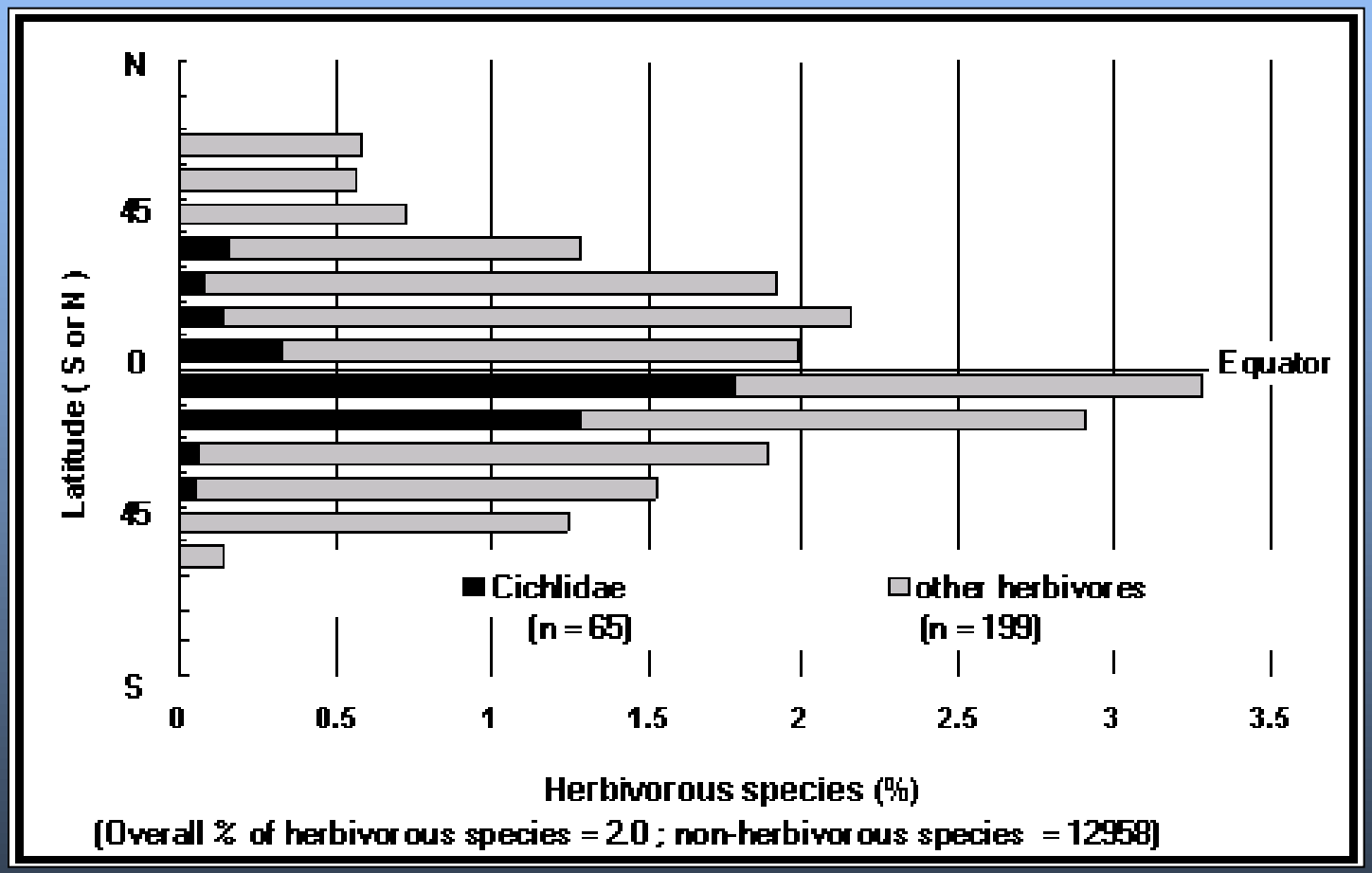


Describes feeding habits of fish occupying various zones along the water column

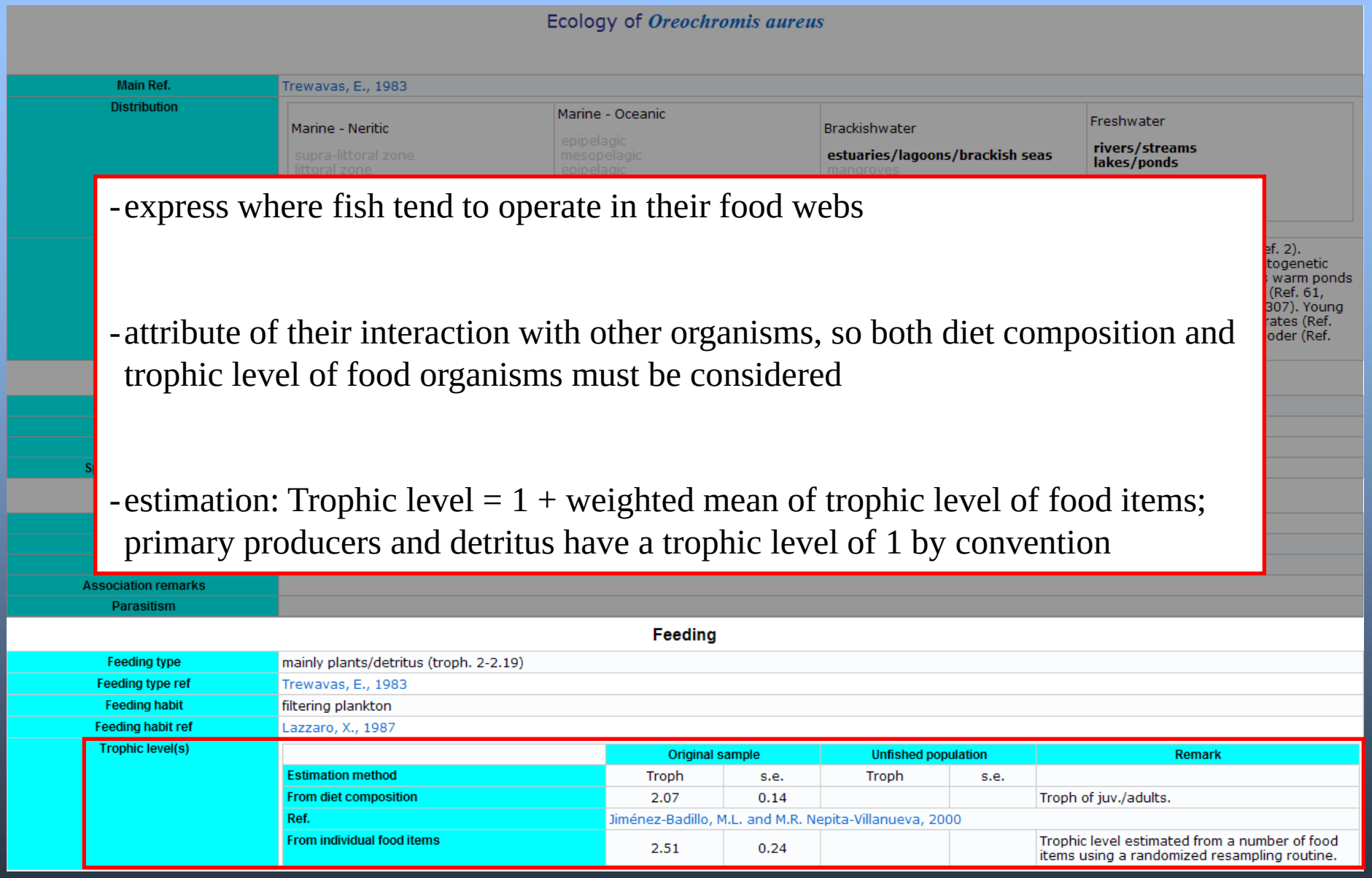
Most pelagic species are either predators "hunting macrofauna", "filtering plankton" as they swim near the surface or selectively grazing on plankton ("selective plankton feeding")

6. FishBase: trophic categories and levels

Application based on feeding type: percentage of herbivores versus latitude



6. FishBase: trophic categories and levels



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Association remarks	
Parasitism	

- express where fish tend to operate in their food webs

- attribute of their interaction with other organisms, so both diet composition and trophic level of food organisms must be considered

- estimation: Trophic level = 1 + weighted mean of trophic level of food items; primary producers and detritus have a trophic level of 1 by convention

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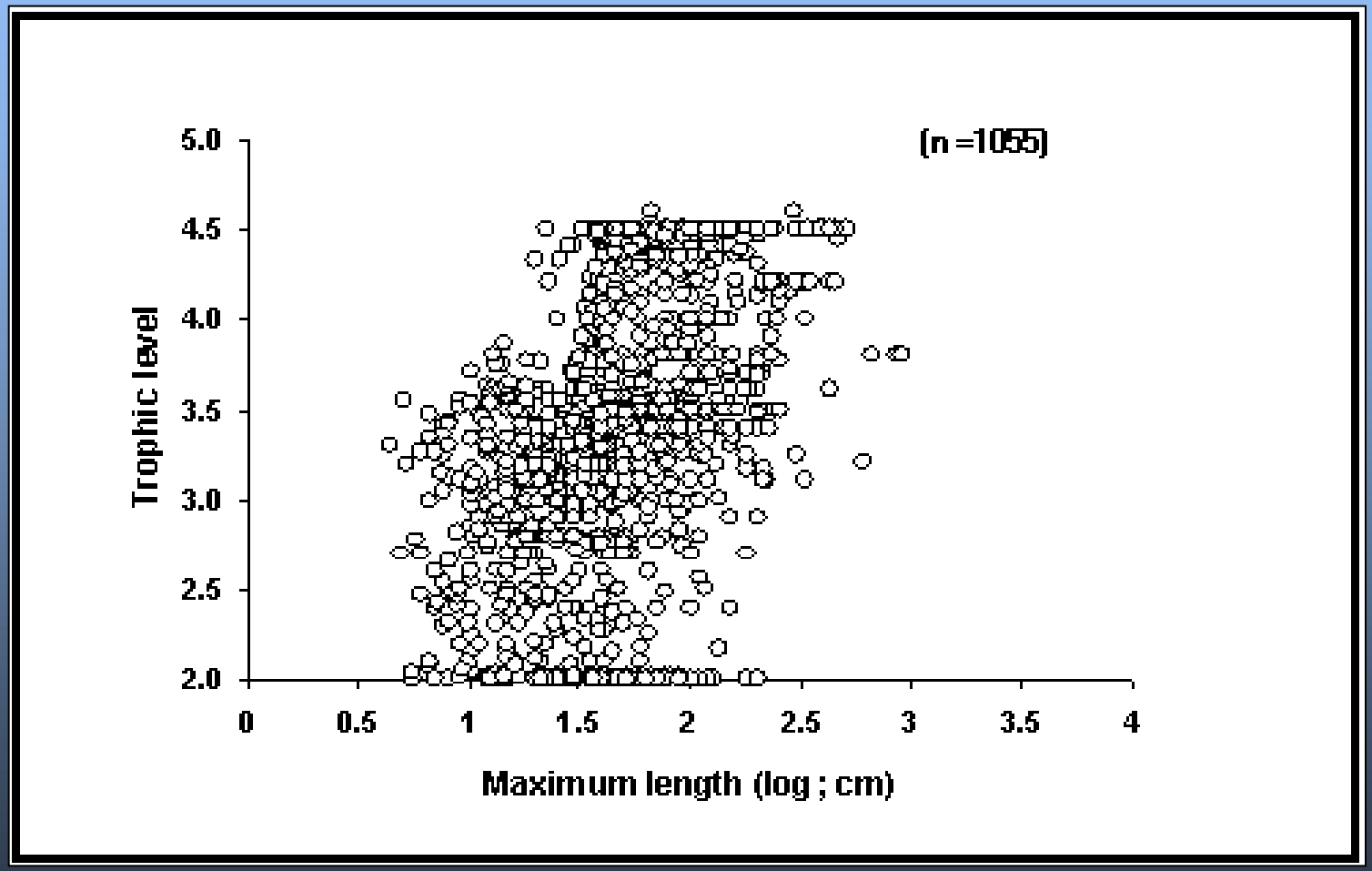
6. FishBase: trophic categories and levels

Application based on trophic levels: relation between trophic levels and maximum length of fish species



7. Diet Composition

Assessing the relative importance of food items eaten by fish; several methods used to provide quantitative description of samples:

- frequency of occurrence: number of stomachs in which a given food item category occurs is expressed as a percentage of the total number of stomachs sampled; this method does not gives relative numbers or bulk of categories
- numerical method: importance of a category is estimated by expressing the number of items in that category as a percentage of the total number of items counted in all the stomachs; method emphasizes the importance of small and numerous items (e.g. zooplankton), but can only be used with discrete and individual prey items
- volumetric and gravimetric techniques: volume or weight of each category in each stomach is estimated; relative importance of a food category is expressed as a percentage of the total volume or weight of all the categories in the samples

7. Diet Composition

- points method: points are allocated to each food category in proportion to its contribution to the total volume of the stomach contents; subjective but quick

example:

Stomach number	**1**	**2**	**3**	**4**	**5**	
Chaoborus larvae	4	8	20	1	17	0.5g/piece
Fish	3	2	0	4	2	100g/piece

Results:

1) frequency of occurrence: *Chaoborus* larvae 100%
Fish 80%

2) numerical method: *Chaoborus* larvae 82%
Fish 18%

3) gravimetric method: *Chaoborus* larvae 2%
Fish 98%

7. Diet Composition

problems for (statistical) analysis:

- many food categories may be present, which often represent only a small amount
- fish sampled at the same time and at the same place may have stomach contents that are very different
- some food categories are quickly digested and so difficult to detect
- caught but living fish may, due to stress situations, ingest food items which normally are not a part of the diet

8. FOOD ITEMS table

Food items reported for *Hydrocynus vittatus*

n = 24

Food I	Food II	Food III	Food name	Country	Predator Stage
nekton	finfish	bony fish	Barbus paludinosus	South Africa	juv./adults
nekton	finfish	bony fish	Brycinus imberi	Zimbabwe	juv./adults
nekton	finfish	bony fish	Brycinus lateralis	Zimbabwe	juv./adults
zoobenthos	benth. crust.	shrimps/prawns	Caridina nitotica	Zimbabwe	juv./adults
zoobenthos	insects	insects	Chaoborus sp.	South Africa	juv./adults
nekton	finfish	bony fish	Clarias gariepinus	Zimbabwe	juv./adults
nekton	finfish	bony fish	Limnothrissa miodon	Zimbabwe	juv./adults
nekton	finfish	bony fish	Oreochromis macrochir	Zambia	juv./adults
nekton	finfish	bony fish	Oreochromis mortimeri	Zimbabwe	juv./adults
nekton	finfish	bony fish	Pharyngochromis acuticeps	Zimbabwe	juv./adults
nekton	finfish	bony fish	Pharyngochromis darlingi	South Africa	juv./adults
zoobenthos	insects	insects	Povilla adusta nymphs	South Africa	juv./adults
nekton	finfish	bony fish	Pseudocrenilabrus philander	Zimbabwe	juv./adults
nekton	finfish	bony fish	Sargochromis codringtonii	Zimbabwe	juv./adults
nekton	finfish	bony fish	Schilbe intermedius	Zimbabwe	juv./adults
nekton	finfish	bony fish	Tilapia spp.	South Africa	juv./adults
zoobenthos	insects	insects	unidentified adults	South Africa	juv./adults
zoobenthos	insects	insects	unidentified aquatic insects	South Africa	juv./adults
zoobenthos	insects	insects	unidentified grasshoppers	Zimbabwe	juv./adults
zoobenthos	insects	insects	unidentified nymphs	South Africa	juv./adults
zoobenthos	insects	insects	unidentified nymphs	South Africa	juv./adults
zoobenthos	insects	insects	unidentified nymphs	South Africa	juv./adults
zoo					
zoo					

Food item summary for *Hydrocynus vittatus*

Main Ref.	Mhlanga, W., 2003		
Predator stage	juv./adults		
Food I	nekton		
Food II	finfish		
Food III	bony fish		
Food group	Cichlidae	**Prey Stage/Part**	juv./adults
Food name	Pseudocrenilabrus philander		
Commonness			
Country	Zimbabwe		
Remark	Locality: Eastern basin of Lake Kariba, March 1994-January 1997.		

8. FOOD ITEMS table

Multilevel structure with increasing detail level for food items (hierarchy of food items):

food I (6 categories)

food II (22 categories)

food III (55 categories)

Food I	Food II	Food III
Detritus	detritus	*debris; carcasses*
plants	phytoplankton	*blue-green algae; dinoflagellates; diatoms; green algae; n.a./other phytoplankton*
	other plants	*benthic algae/weeds; periphyton; terrestrial plants*
zoobenthos	sponges/tunicates	*sponges; ascidians*
	cnidarians	*hard corals; n.a./other polyps*
	worms	*polychaetes; n.a./other annelids; non-annelids*
	mollusks	*chitons; bivalves; gastropods; octopi; n.a./other mollusks*
	benthic crustaceans	*ostracods; benthic copepods; isopods; amphipods; stomatopods; shrimps/prawns; lobsters; crabs; n.a./other benthic crustaceans*
	insects	*insects*
	echinoderms	*sea stars/brittle stars; sea urchins; sea cucumbers; n.a./other echinoderms*
	other benthic invertebrates	*n.a./other benthic invertebrates*
zooplankton	jelly fish/hydroids	*jellyfish/hydroids*
	planktonic crustaceans	*planktonic copepods; cladocerans; mysids; euphausiids; n.a./other planktonic crustaceans*
	other planktonic invertebrates	*n.a./other planktonic invertebrates*
	fish (early stages)	*fish eggs/larvae*
nekton	cephalopods	*squids/cuttlefish*
	finfish	*bony fish*
		n.a./other finfish
others	herps	*salamanders/newts; toads/frogs; turtle; n.a./other reptiles*
	birds	*sea birds; shore birds; n.a./other birds*
	mammals	*dolphins; pinnipeds; n.a./other mammals*
	others	*n.a./others*

8. FOOD ITEMS table

Stages for both plants and animals

roots, stem
leaves/blades,
fruits/seeds,
n.a./others

eggs,
larvae/pupae,
recruits/juv.,
juv./adults, adults,
n.a./others

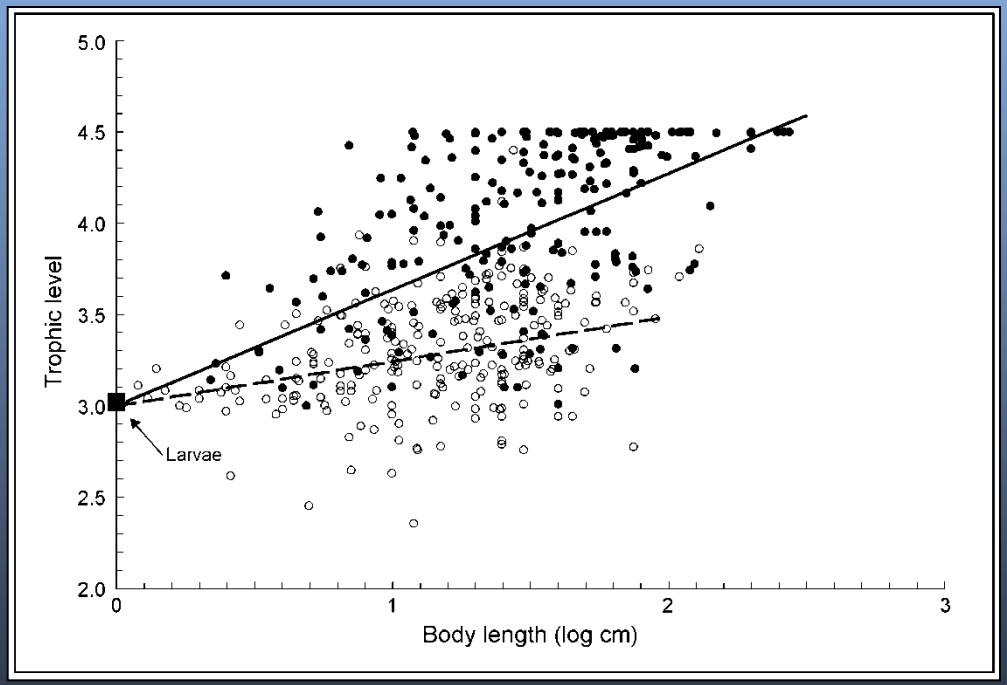
8. FOOD ITEMS table

- can be used to:

  - identify food item preferences

  - define predator-prey relationships

  - make preliminary estimates of the trophic level (but less accurate than from diet composition), especially when no diet composition information is available



9. DIET table

- Diet information of a fish species at a specific locality is important:

  - to assess its ecological function and impact
  - for the construction of ecosystem models
  - to help define nutritional requirements of potential aquaculture species

- Diet composition data in FishBase also used to estimate trophic levels

- Entries are based on

  - wild populations, not experimental studies
  - weight or volume (or energy) percentage, not frequency of occurrence

9. DIET table

Food and Feeding Habits: Diet Composition *Bagrus bajad*

n = 10

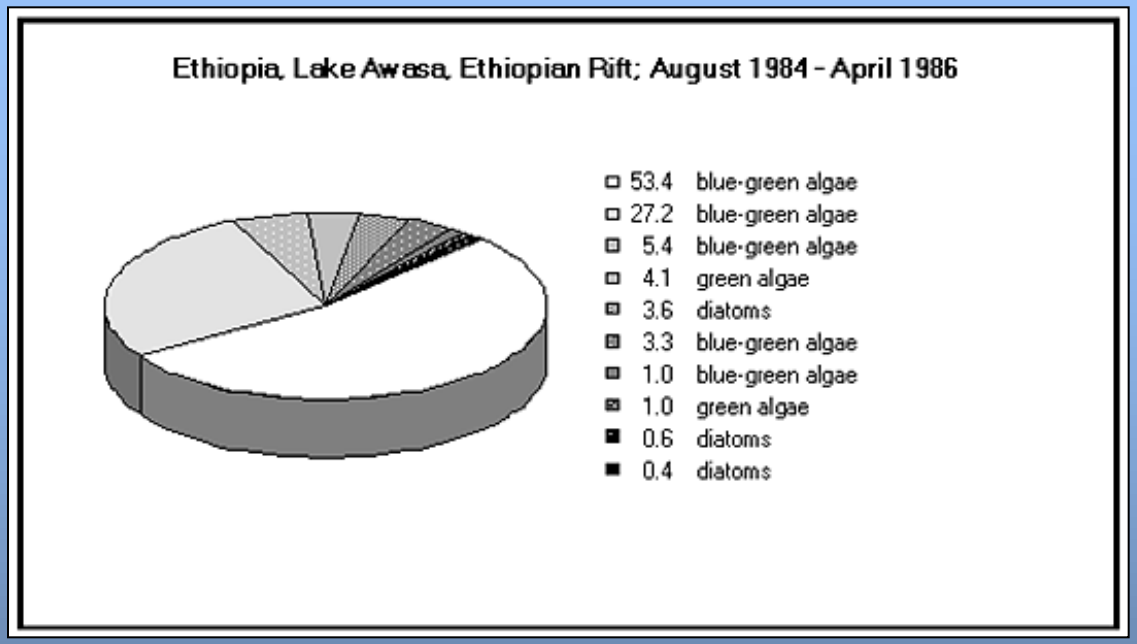
Main Food	Percent	Trophic Level (y)	Predator Life Stage	Country	Locality	Ref.
zoobenthos	98	3.6	juv./adults		Lake Chad	50593
zoobenthos	85	3.7	juv./adults		Lake Chad	50593
zoobenthos	73	3.8	juv./adults		Lake Chad	50593
zoobenthos	48	3.9	juv./adults		Lake Chad	50593
nekton	69	4.0	juv./adults		Lake Chad	50593
nekton	67	4.0	juv./adults		Lake Albert	49805
nekton	67	4.1	juv./adults		Lake Albert	49805
nekt						
nekt						
nekt						

Food and Feeding Habits Summary *Bagrus bajad*

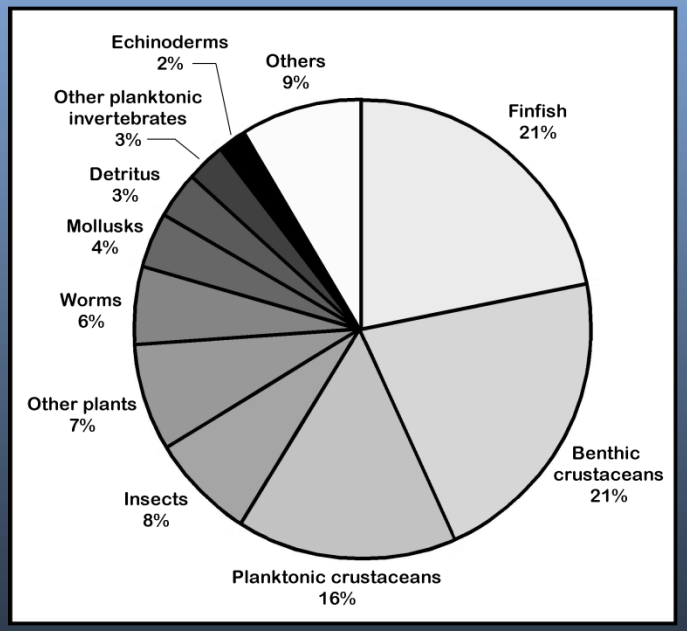
Main Ref.	Worthington, E.B., 1929		
Fish stage	juv./adults	Mean length	
Sample size	35	Percent empty	31.43
Country		Locality	Lake Albert
Period	January February March April May June July August September October November December Highighted items on the list are known Feeding Periods of Bagrus bajad		

Diet percent	Food I	Food II	Food III	Prey stage	Comments
4.16 %	zoobenthos	mollusks	gastropods	juv./adults	Opercula.
4.16 %	zoobenthos	insects	insects	adults	
12.50 %	zoobenthos	insects	insects	nymphs	Dragonfly nymphs.
8.33 %	zoobenthos	benth. crust.	shrimps/prawns	juv./adults	
66.67 %	nekton	finfish	bony fish	n.a./others	
4.16 %	detritus	detritus	debris	n.a./others	

9. DIET table



O. niloticus niloticus



10. Rate of food consumption

Species-specific consumption can be expressed in 2 ways:

- at the individual level, i.e. as the daily consumption of a particular food type by a fish of a certain size, in the form of a daily ration: $\mathbf{R_d}$

- at the population level, i.e. as the consumption Q by an age-structured population of weight B, in the form of a population weighted food consumption per unit biomass: **Q/B**

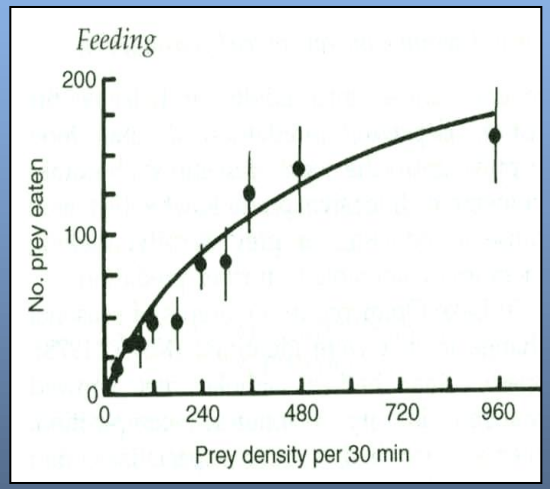
10. Rate of food consumption

- Effects of prey, conspecifics and predators

functional response curve:

benefial and adverse

reduce the food consumption rate



- Hunger and appetite: depend on systemic demand and rate at which the digestive system can process food, gastric evacuation rate, physiological state, light level, photoperiod, pH,…

10. Rate of food consumption

Individual level
RATION table

Food Consumption List for *Rutilus rutilus*

n = 1

Weight (g)	Ration (% BWD)	K1	Evac'n. rate (/h)	Temperature (°C)	Salinity	Food I
67.0	5.27		0.16000	12	freshwater	plants

Ration and Related Information *Rutilus rutilus*

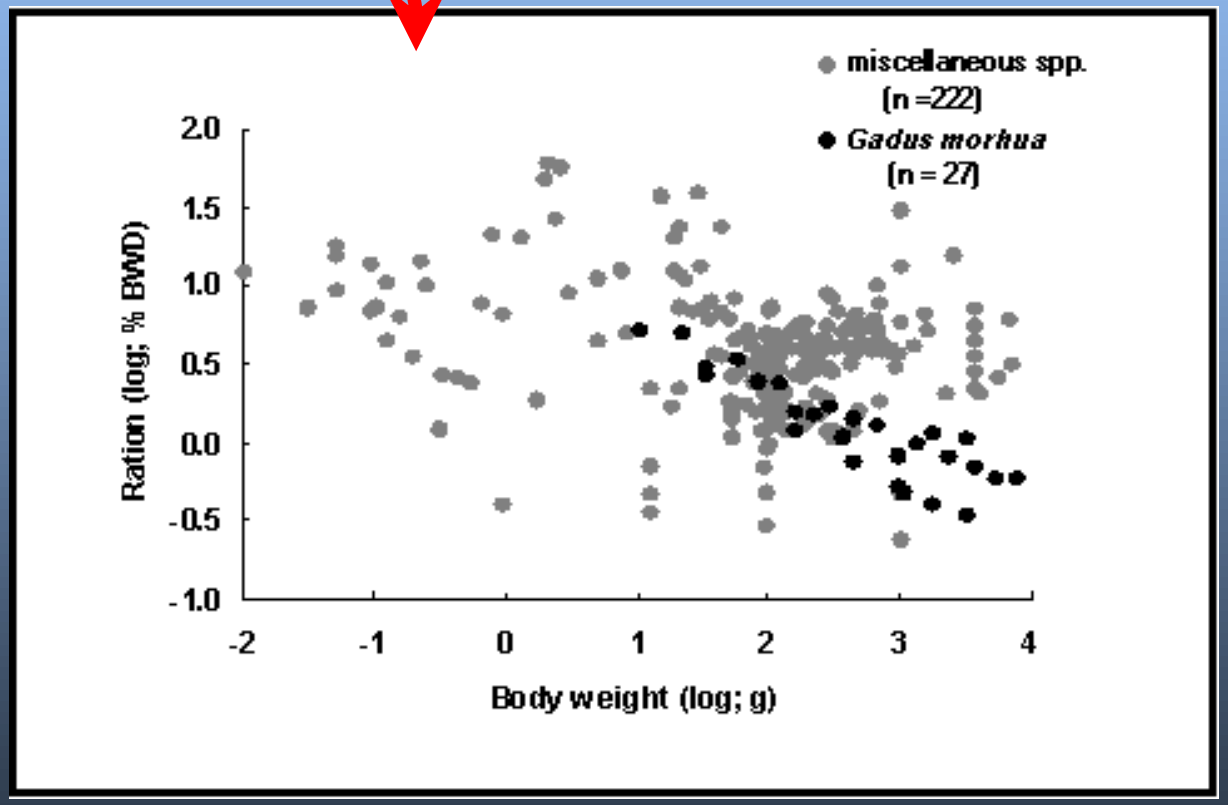
Main Ref.	2939
Ration and Related Information	Ref. 2939
Ration	5.3 (% bwd)
Weight of Fish	67.0 (g)
Evacuation Rate	0.16000 (/h)
K1	
Locality	Garonne River
Country	France - 250
Food i	plants
food ii	other plants
Food Name	plants, insects, plankton
Water Temp.	12 (°c)
Salinity	freshwater
Comments	
Methods Used	Ref.
Evac. Rate	MAXIMS with stom. field data
Daily Ration	stomach contents and MAXIMS
Daily Feeding Cycle	two feeding peaks
Feed Begin	09:00:00
Feed Stop	11:00:00
additional Remarks	

10. Rate of food consumption

Individual level
RATION table

Ration, evacuation rate and food conversion efficiency K_1 vary with:

- weight of the fish studied
- type of food ingested
- mean water temperature



10. Rate of food consumption

Population level

- important for:

  - assessing demands that fish make on their food resources
  - assessing the extent to which survival, growth and reproduction are limited by food availability
  - estimating the energy and nutrients available for allocation between maintenance, growth and reproduction

- indirect methods must be used:

  - estimation of the rate of passage of food through the gut
  - integration of consumption over a relatively long period and estimating it by calculating the rate that would give the observed growth during that period
  - using the flux in a radioactive isotope with a relatively long half-life
  - quantitative collection of faeces produced over known time period
  - using material opaque to X-rays in the food (e.g. small glass balls)

10. Rate of food consumption

Population level
FOOD CONSUMPTION table

Food Consumption List for *Rutilus rutilus*

n = 3

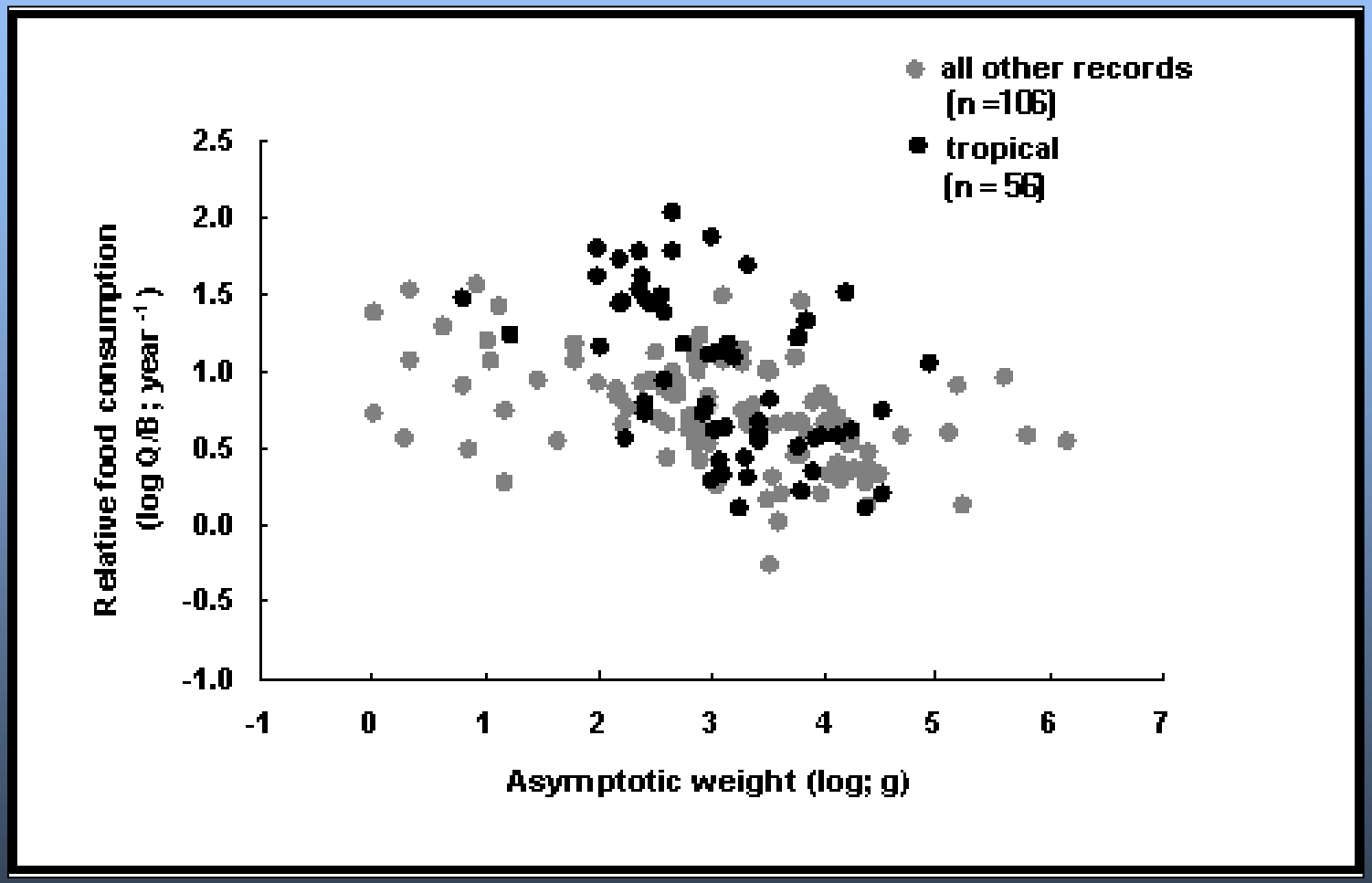
Country	Q/B (1/y)	Winf (g)	K (/y)	Mortality (/y)	Temperature (°C)	Food type	Ref.
France	13.60	316	0.46	0.63	9	plants	002939
France	14.50	1,769	0.18	0.35	12	plants	002939
Sweden	2.68	766	0.09	0.27	14	others	002939

Population Food Consumption (Q/B) for *Rutilus rutilus*

Population Q/B (/y)	14.50	**Main Ref.**	Palomares, M.L.D., 1991
Maintenance Q/B (/y)	11	**Food type**	plants
Winf (g):		**Salinity**	freshwater
K (/y):	0.18	**Temperature**	12.4
t0 (y):	0.00		
Mortality (y)	0		
Exponent	3.30 (of length-weight relationship)		
Locality	Garonne River		
Country	France		
Remarks			

10. Rate of food consumption

Population level
FOOD CONSUMPTION table



11. PREDATORS table

Lists the reported predators for a particular fish species

Information used:

- by fishery and conservation workers, as predator-prey relationships may help to explain the status of fish stocks
- for the construction of trophic pyramids
- to test hypotheses about relative sizes of prey and predator

Nycticorax nycticorax

11. PREDATORS table

Organisms Preying on *Oreochromis mossambicus*

n = 32

Country	Functional Groups		Family	Name
	finfish	bony fish	Centrarchidae	Micropterus salmoides
Guyana	finfish	bony fish	Centropomidae	Centropomus
South Africa	finfish	bony fish	Clariidae	Clarias gariepinus
	finfish	bony fish	Elopidae	Elops hawaiensis
South Africa	finfish	bony fish	Elopidae	Elops machnata
	finfish	bony fish	Megalopidae	Megalops cyprinoides
Guyana	finfish	bony fish	Megalopidae	Tarpon
South Africa	finfish	bony fish	Sciaenidae	Argyrosomus hololepidotus
Guyana	finfish	bony fish	Sciaenidae	Cynoscion
Guyana	finfish	bony fish	Serranidae	Promicrops
India	finfish	bony fish	Bagridae	Mystus montanus
South Africa	other	n.a./other	Crocodylidae	Crocodylus niloticus
South Africa	birds	shore birds	Ardeidae	Ardea cinerea
South Africa	birds	shore birds	Ardeidae	Ardea goliath
South Africa	birds	shore birds	Ardeidae	Egretta garzetta
South Africa	birds	shore birds	Accipitridae	Haliaeetus vocifer
South Africa	birds	shore birds	Accipitridae	Pandion haliaetus
South Africa	birds	shore birds	Cerylinae	Megaceryle maxima
South Africa	birds	shore birds	Accipitridae	Milvus migrans aegyptius
South Africa	birds	shore birds	Ardeidae	Ardea purpurea
South Africa	birds	shore birds	Ardeidae	Egretta alba

Predator Summary for *Oreochromis mossambicus*

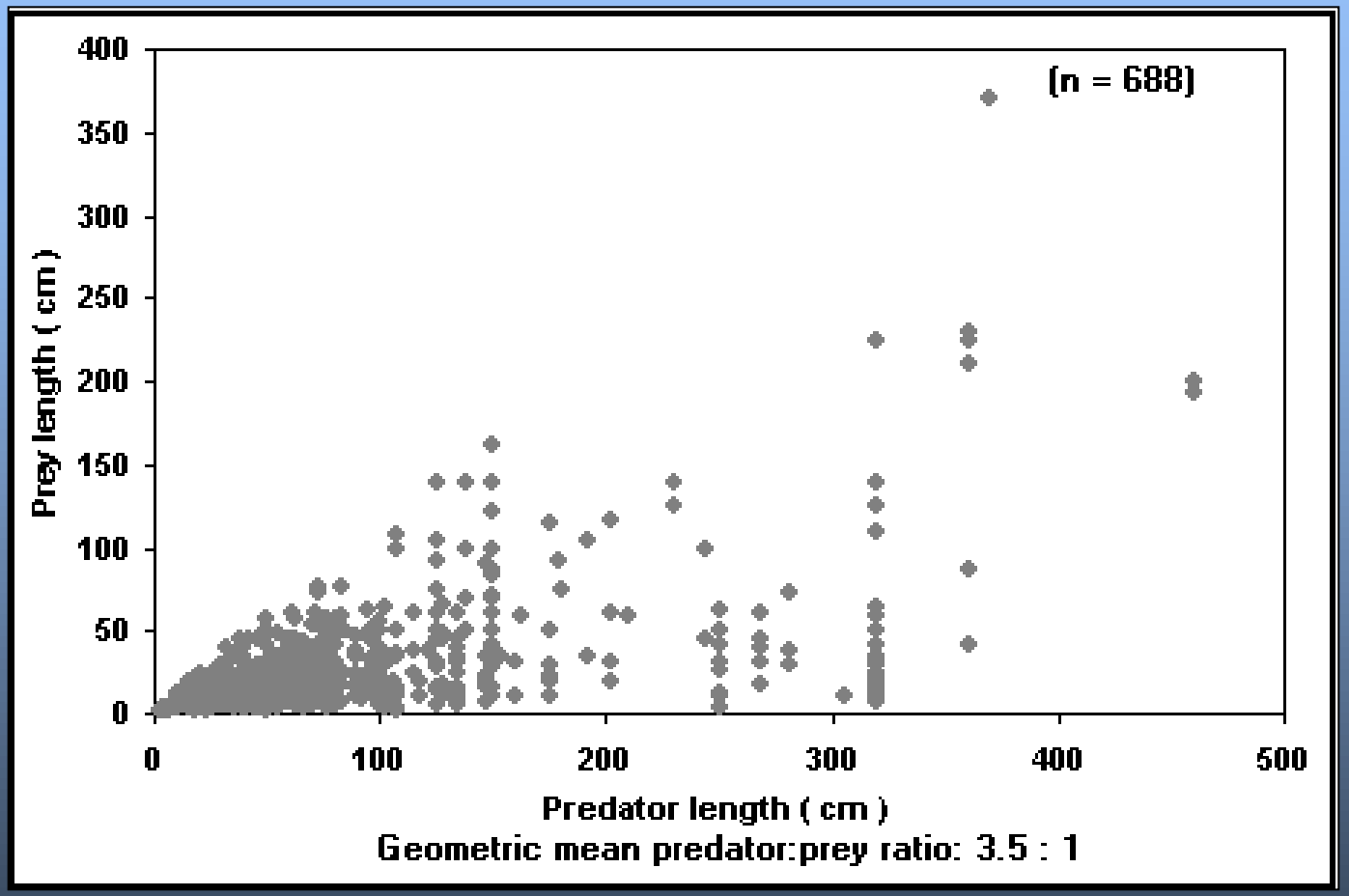
Predator name	Clarias gariepinus	**Main Ref.**	Trewavas, E., 1983
Predator group	Clariidae	**Predator stage**	juv./adults
Predator I	finfish	**Predator II**	bony fish
Prey stage	juv./adults		
% of stomach contents	0		
Locality	Lake Sibaya		
Country	South Africa - (710)		

11. PREDATORS table

Hierarchy of predators:

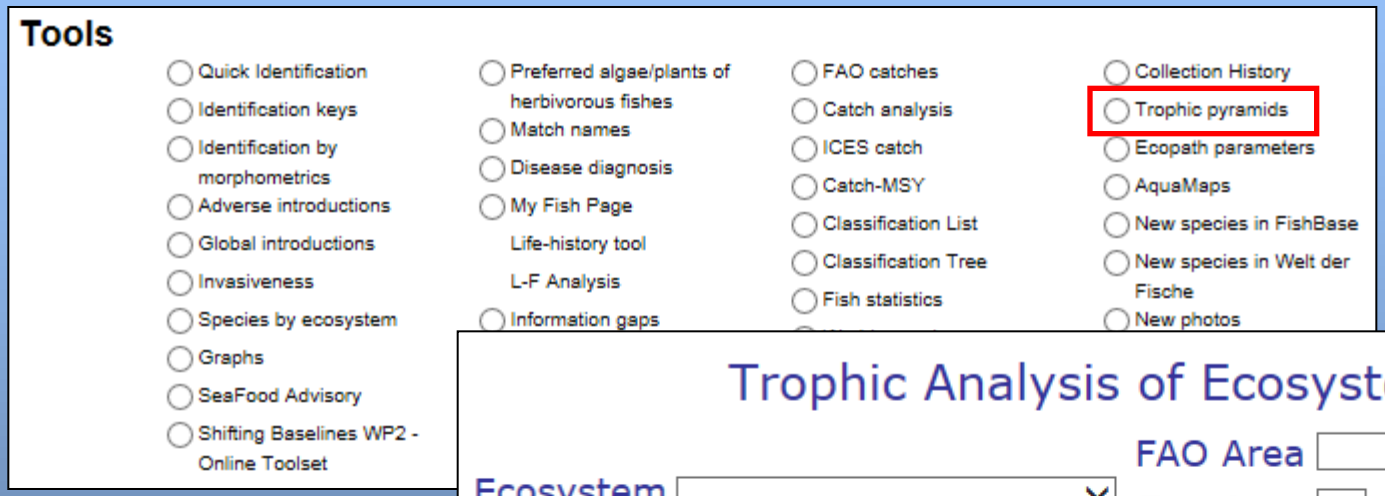
Predator I	Predator II
cnidarians	jellyfish/ hydroids; sea anemones; corals
mollusks	gastropods; squids/cuttlefish; octopus
crustaceans	copepods; mysids; isopods; amphipods; stomatopods; euphausiids; shrimps/prawns; lobsters; crabs; other crustaceans
insects	insects
echinoderms	sea stars
finfish	sharks/rays; bony fish; n.a./other finfish
herps	salamanders/newts; toads/frogs; crocodiles; turtles; snakes
birds	sea birds; shore birds
mammals	whales/dolphins; seals/sea lions
others	others

11. PREDATORS table



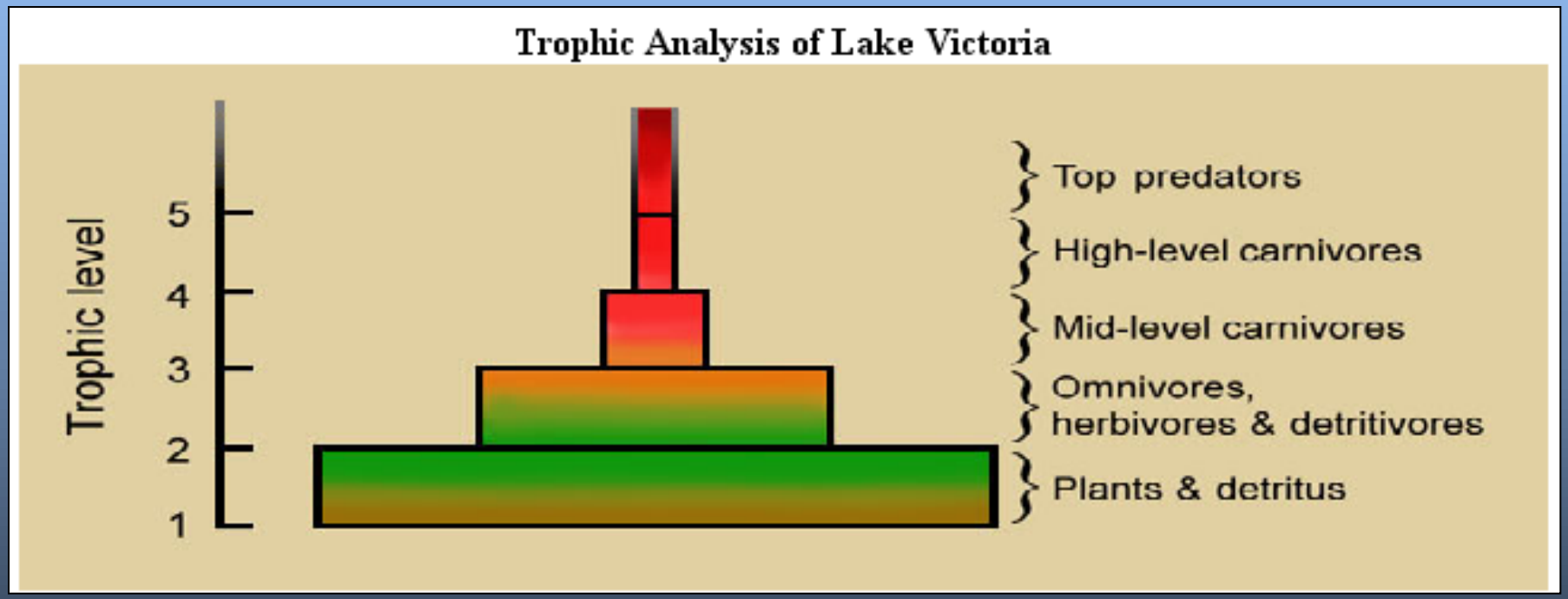
12. Trophic pyramids

Available from the Search Page



12. Trophic pyramids

FishBase routine outputs a pyramid whose steps represent different trophic levels and the species (and/or functional groups) therein:



12. Trophic pyramids

Trophic Level 2.50 - 2.99	
Number of fish species:	8
Length range:	12 - 61 cm TL
Geom. mean length (95% CI):	27.4 (18.0-41.8)
Mean Trophic Level (95% CI):	2.79 (2.70-2.88)
	Invertebrate groups

Reported as food item or predator in ecosystem

Fish Species in Trophic Level 2.50 - 2.99

Mean Trophic Level (95% CI): 2.79
n=32

Species	Family	Habitat	Length (cm)	Trophic level
Barbus trispilopleura	Cyprinidae	benthopelagic	4.5 TL	3.0
Barbus kerstenii	Cyprinidae	benthopelagic	11.0 TL	3.0
Barbus viktorianus	Cyprinidae	benthopelagic	7.1 TL	3.0
Barbus nyanzae	Cyprinidae	benthopelagic	8.5 TL	3.0
Barbus loveridgii	Cyprinidae	benthopelagic	8.1 TL	3.0
Barbus magdalenae	Cyprinidae	benthopelagic	8.1 TL	3.0
Barbus sexradiatus	Cyprinidae	benthopelagic	6.8 TL	3.0
Barbus jacksoni	Cyprinidae	benthopelagic	14.1 TL	3.0
Barbus paludinosus	Cyprinidae	benthopelagic	18.3 TL	2.9
Barbus acuticeps	Cyprinidae	benthopelagic	40.3 TL	2.9
Haplochromis empodisma	Cichlidae	benthopelagic	14.3 TL	2.9