

Digestivo y alimentación en peces



Pieter Bruegel el Viejo

Contenido de la presentación

Anatomía y Morfología del Sistema Digestivo

Boca-cavidad bucal-faringe-esófago-estomago-intestino-anexos

Digestión y absorción

Actividad enzimática

Absorción

Irrigación e inervación del digestivo

Hábitos tróficos

Piscívoros, omnívoros, herbívoros

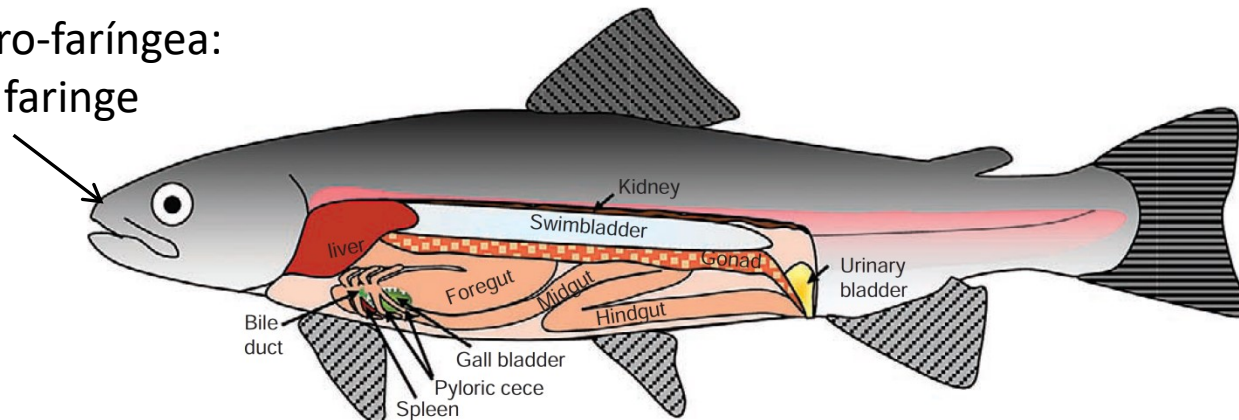
Plasticidad del digestivo

Predicciones de la teoría digestiva

Anatomía y Morfología del Sistema Digestivo

«La **digestión** es la descomposición mecánica y química (hidrólisis enzimática) de los alimentos en componentes más pequeños para que puedan ser absorbidos por el epitelio intestinal»

Cavidad oro-faríngea:
boca, faringe



Anterior: esófago
y estómago

Posterior:
intestino

control hormonal

excreción y funciones inmunes

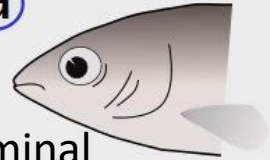
Boca



Gape limitation

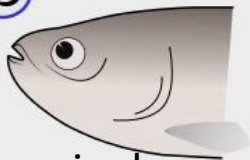


(a)



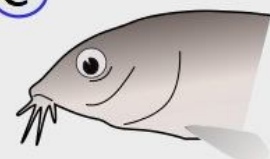
terminal

(b)



Subterminal superior

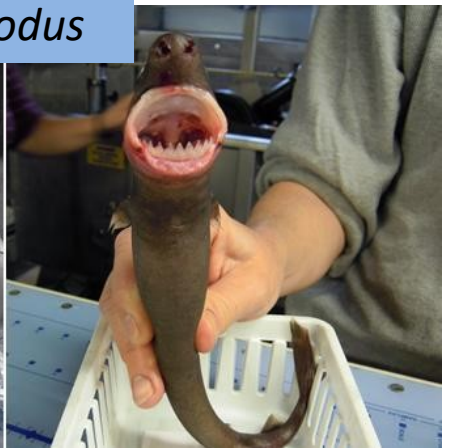
(c)



Subterminal inferior



Isistius brasiliensis and *I. plutodus*



Agnatos: mixinas y lampreas

Cavidad Bucal: Dientes, lengua, paladar.

Dentición

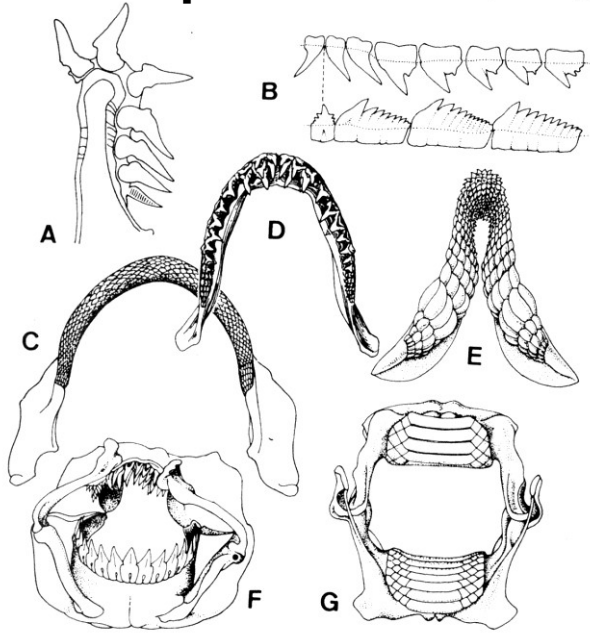
Los agnatos vivientes poseen en su lengua dientes raspantes y cónicos de queratina.

Las lampreas también tienen dientes alrededor de la boca.

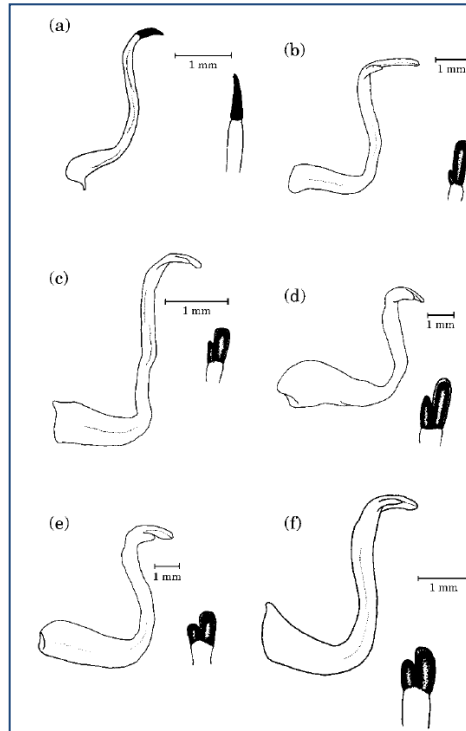
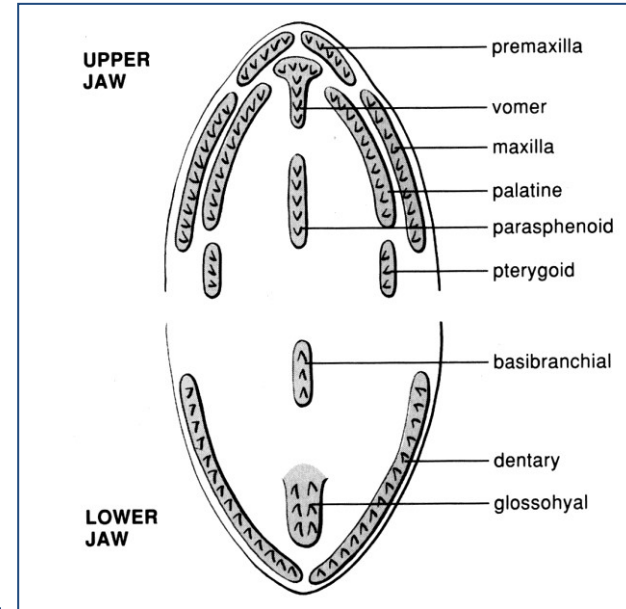


Dentición

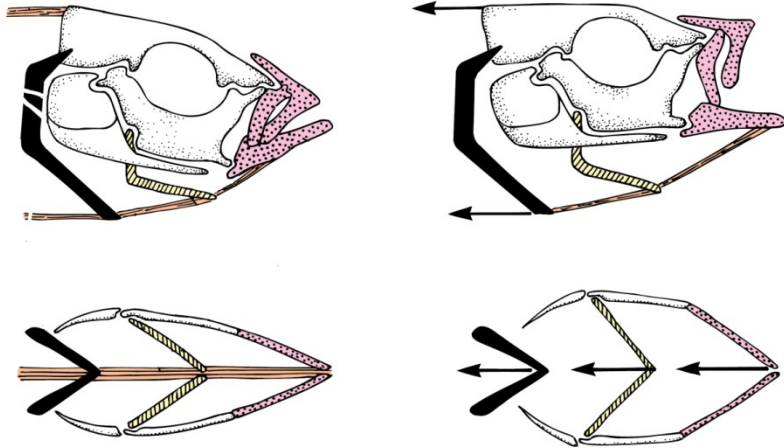
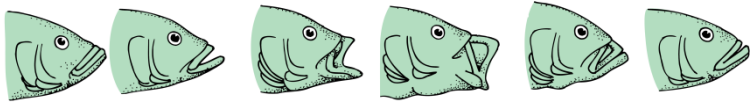
Elasmobranquios



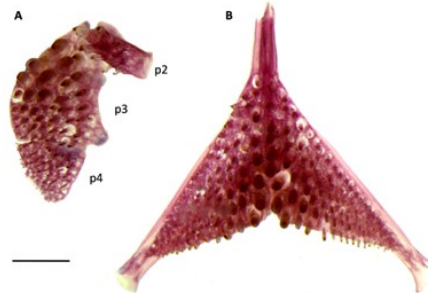
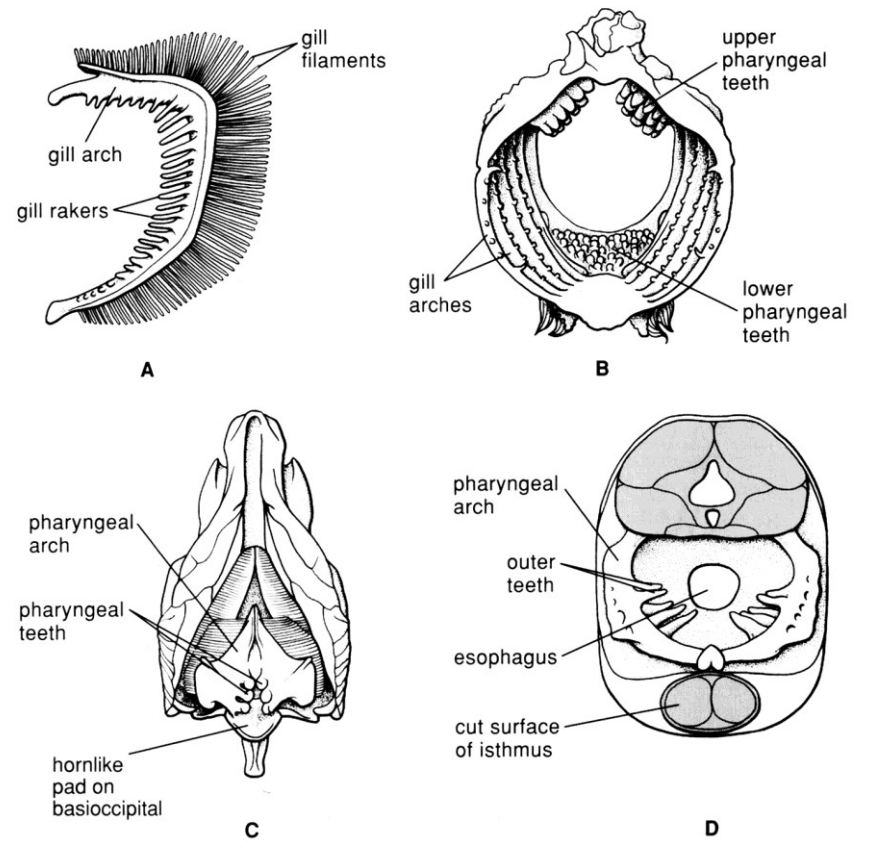
Teleósteos



Cavidad bucal (paladar mejillas y lengua)



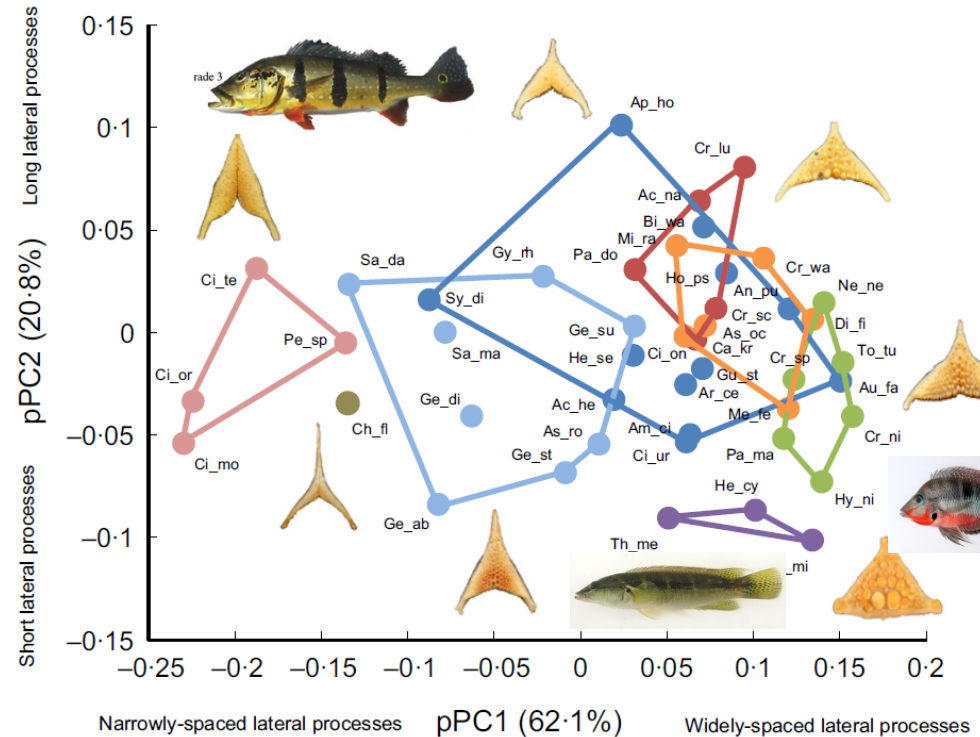
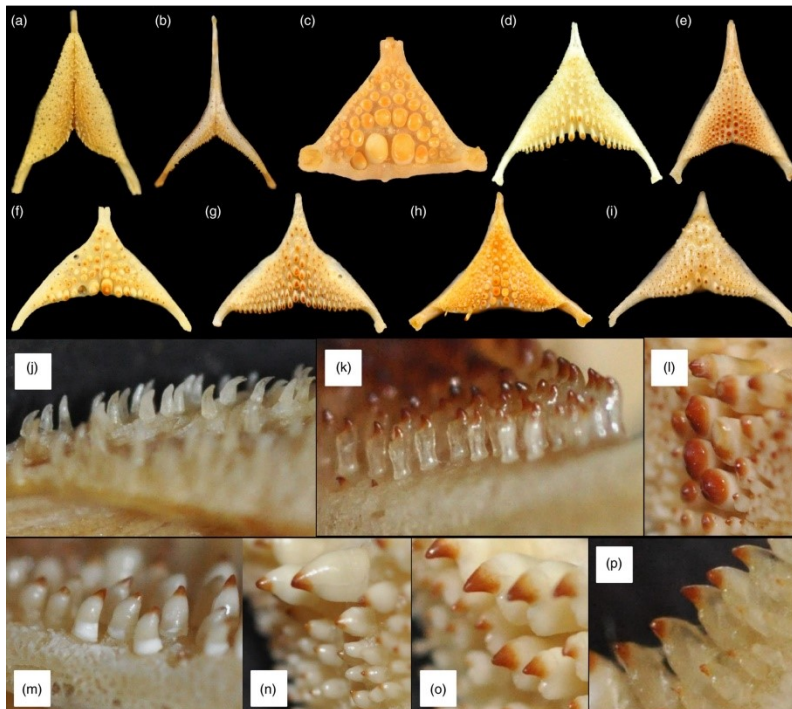
Faringe (arcos branquiales branquiespinas y dientes faríngeos)



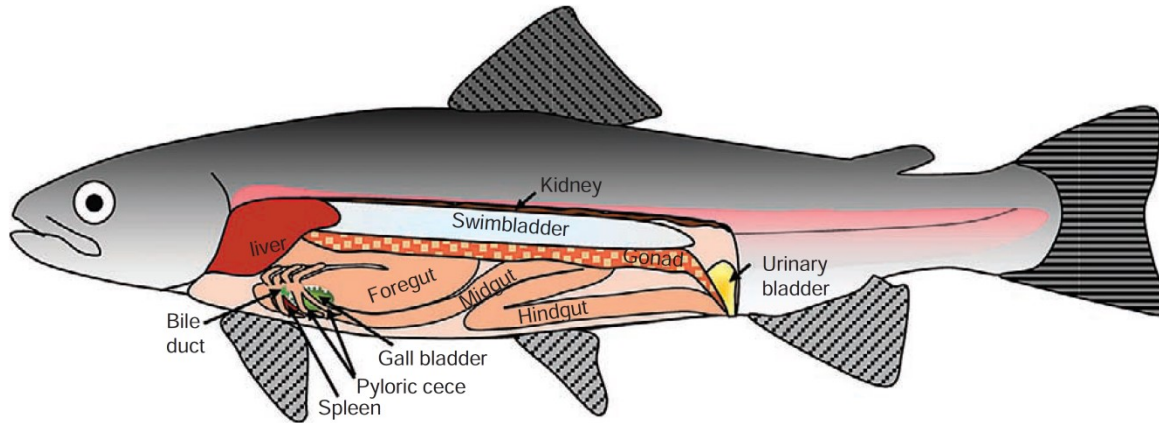
Ecological diversification associated with the pharyngeal jaw diversity of Neotropical cichlid fishes

Edward D. Burress*

Department of Biological Sciences and Auburn University Museum of Natural History, Auburn University, Auburn, AL 36849, USA

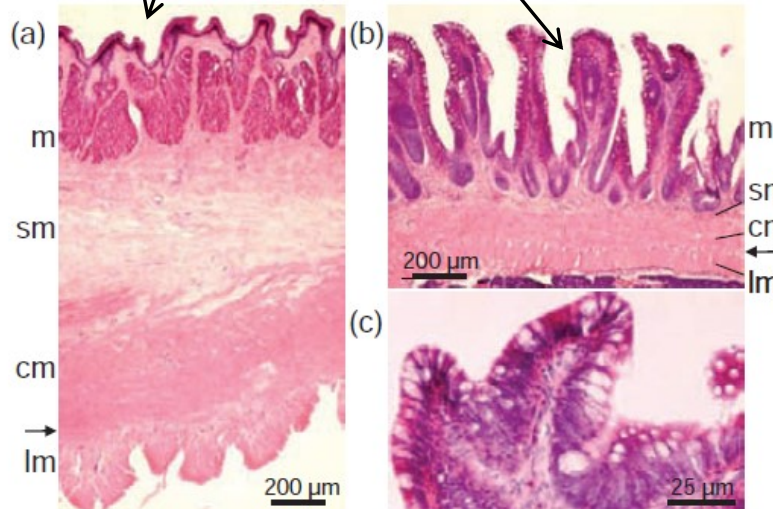
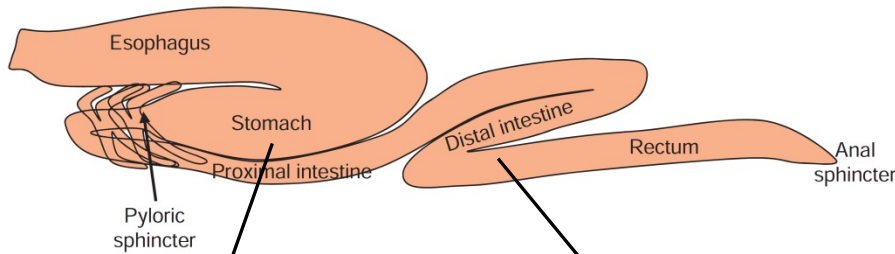


Anatomía y Fisiología del Sistema Digestivo



Anterior: esófago y estómago

Posterior: intestino



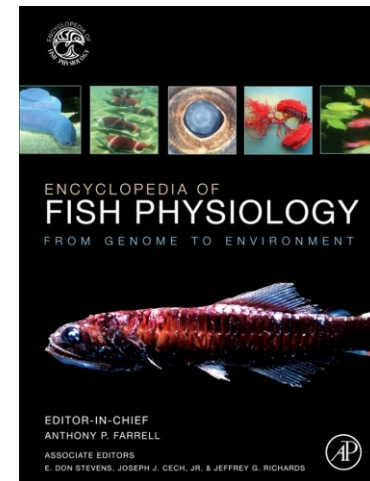
Mucosa

Submucosa

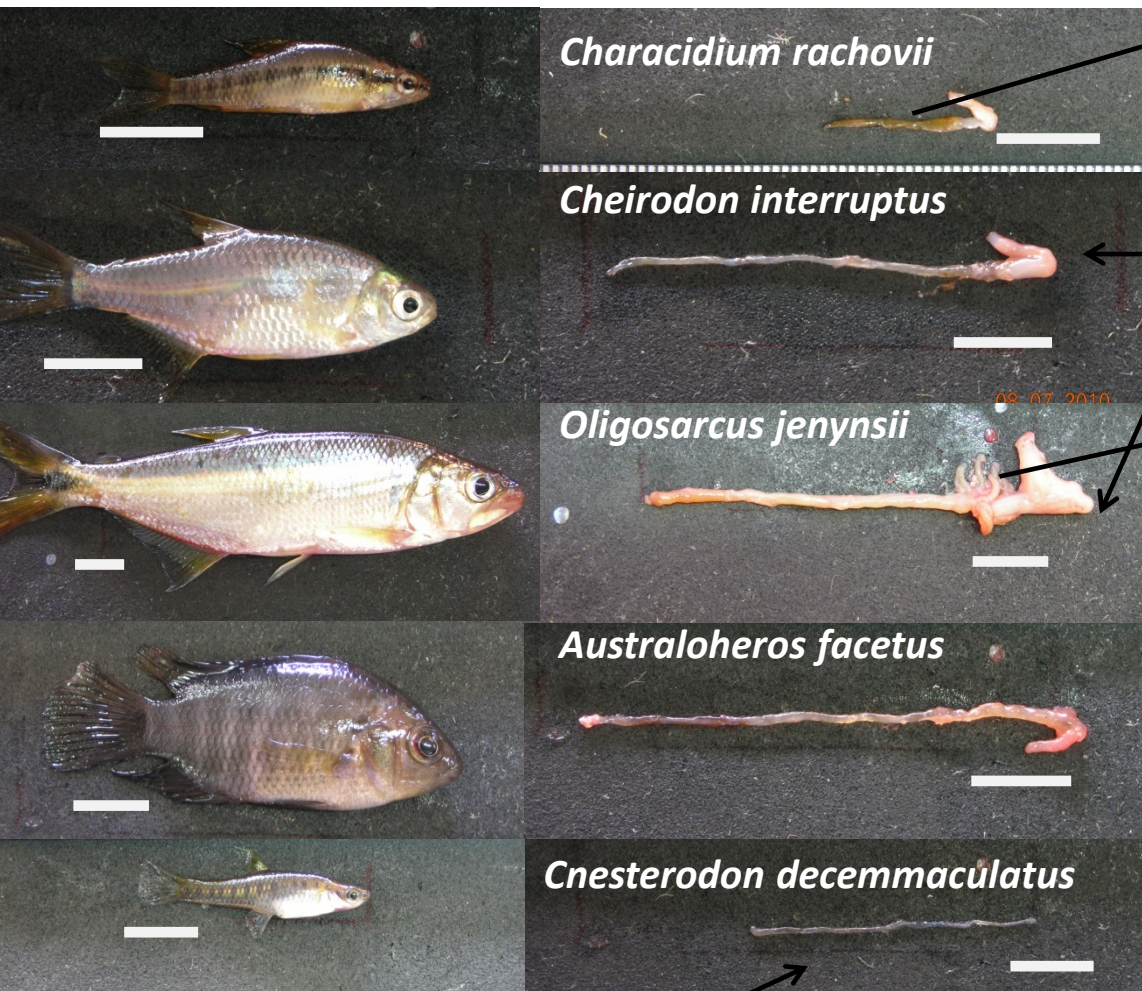
Músculo circular

Músculo longitudinal

Serosa



Variación morfológica

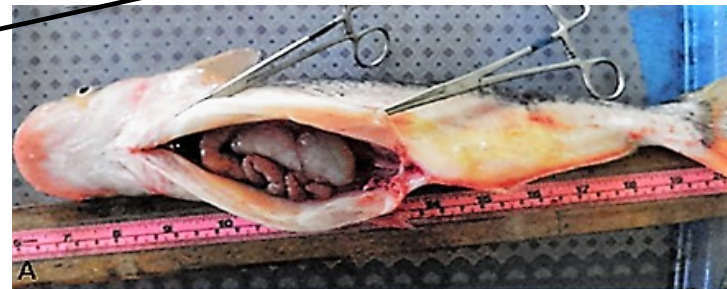


Intestino

En forma de U

En forma de V

Ciegos



Sin estomago

En forma de tubo

Estructuras y secreción de órganos anexos

Estómago-> ácido clorhídrico y pepsinógeno (celulas oxinticopepticas)

Intestino, páncreas y bilis -> Bicarbonato

Ácidos biliares -> Emulsionantes de grasa

Jugo pancreático->

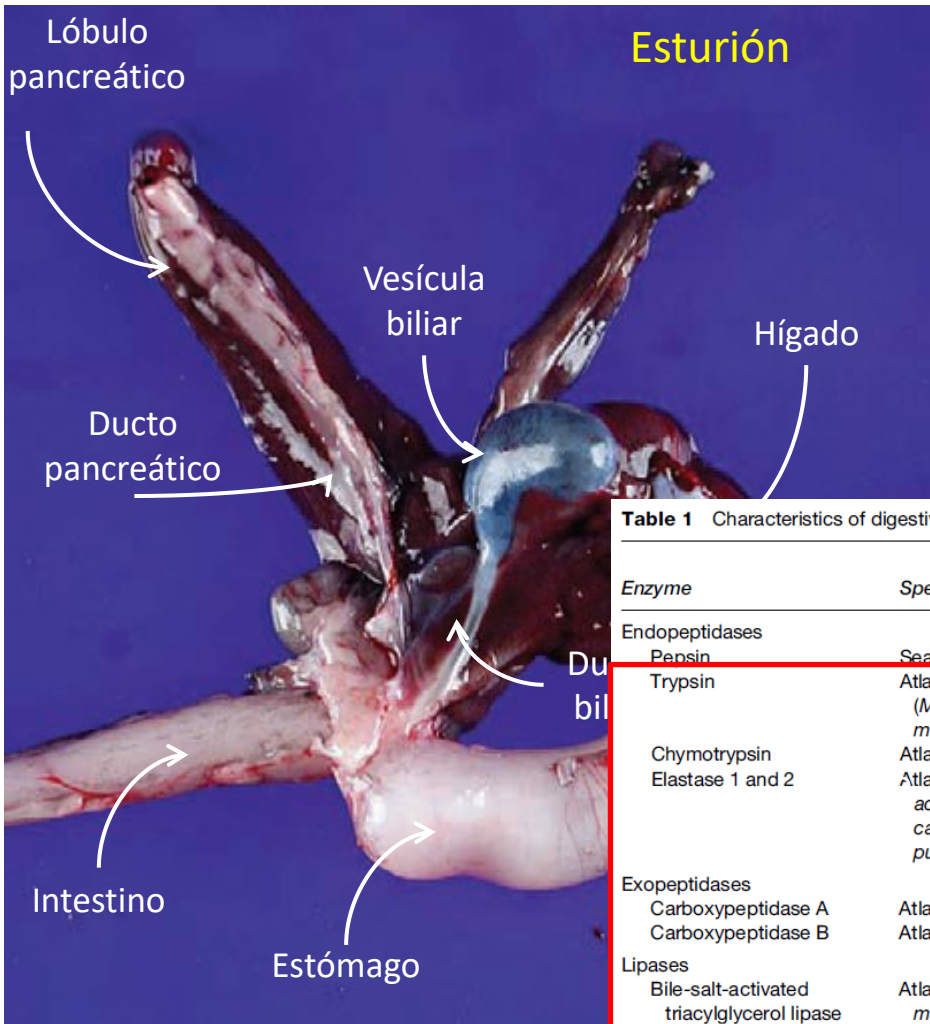


Table 1 Characteristics of digestive enzymes secreted by the gastrointestinal tract and its accessory organs

Enzyme	Species investigated	Tissue	pH optimum	Substrate specificity
Endopeptidases				
Pepsin	Sea bass (<i>Dicentrarchus labrax</i>)	Stomach	3	Tyr, Phe, Leu
Trypsin	Atlantic salmon (<i>Salmo salar</i>), capelin (<i>Mallotus villosus</i>), Atlantic cod (<i>Gadus morhua</i>)	Pancreas	7-10	Arg, Lys
Chymotrypsin	Atlantic salmon	Pancreas	7-9	Tyr, Trp, Phe, Met, Leu,
Elastase 1 and 2	Atlantic salmon, spiny dogfish (<i>Squalus acanthias</i>), common carp (<i>Cyprinus carpio</i>), channel catfish (<i>Ictalurus punctatus</i>)	Pancreas	7-9	Ala, Gly, Ser
Exopeptidases				
Carboxypeptidase A	Atlantic salmon, Atlantic cod	Pancreas	7-10	Val, Leu, Ile, Ala
Carboxypeptidase B	Atlantic salmon, Atlantic cod	Pancreas	7-10	Arg, Lys
Lipases				
Bile-salt-activated triacylglycerol lipase	Atlantic cod, European turbot (<i>Psetta maxima</i>)	Pancreas	7-10	Ester bond in triacylglycerides, esp. in the 1- and 3-positions
Co-lipase-activated triacylglycerol lipase				
Phospholipase A	Sea bream (<i>Sparus aurata</i>)	Pancreas	8-9	Phospholipids
Amylase	Atlantic salmon, rainbow trout (<i>Onchorynchus mykiss</i>), common carp	Pancreas	4-9	α -1,4-bonds in starch

Estructuras y secreción de órganos anexos

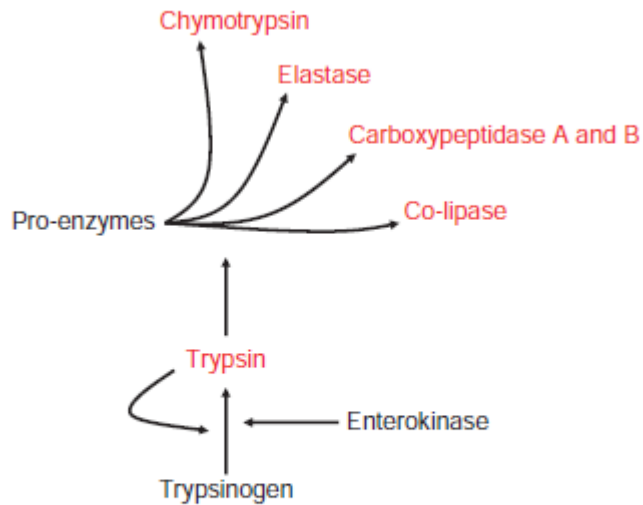
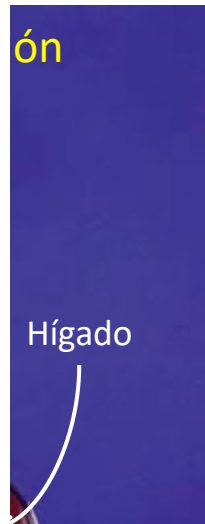


Figure 7 Illustration of activation of pro-enzymes secreted from the pancreas. Enterokinase activates trypsinogen to trypsin, which activates the other pro-enzymes. Trypsin also shows autoactivation.



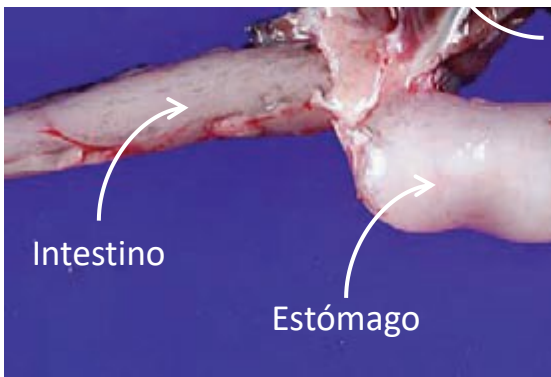
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Characteristics of digestive enzymes secreted by the gastrointestinal tract and its accessory organs



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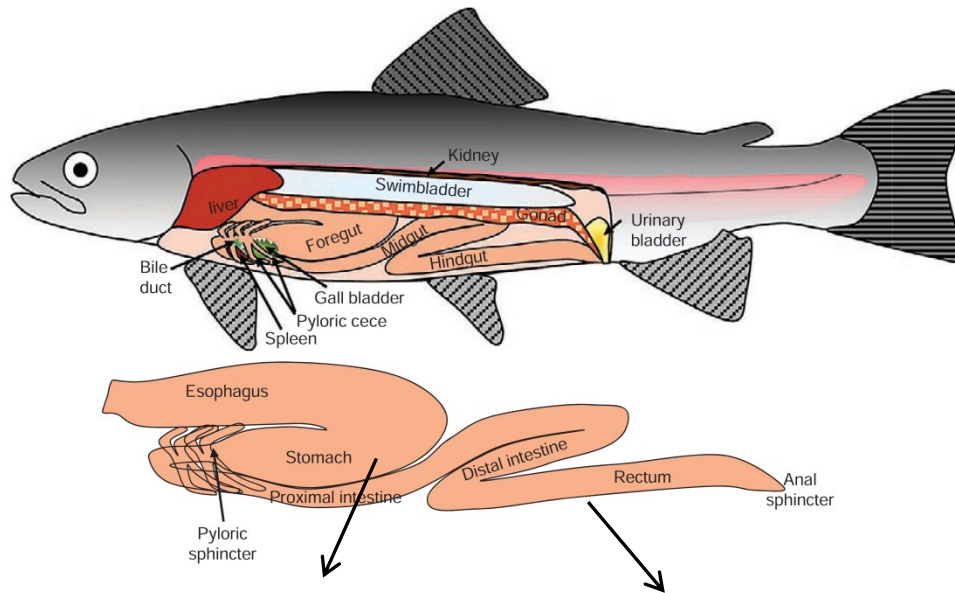
ENZIMAS

Table 1 Characteristics of digestive enzymes secreted by the gastrointestinal tract and its accessory organs

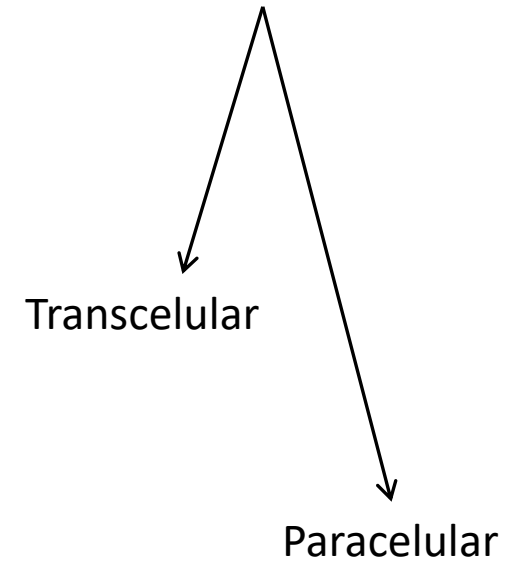
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Digestión

«La digestión es la descomposición mecánica y química (hidrólisis enzimática) de los alimentos en componentes más pequeños para que puedan ser absorbidos por el epitelio intestinal»



Absorción

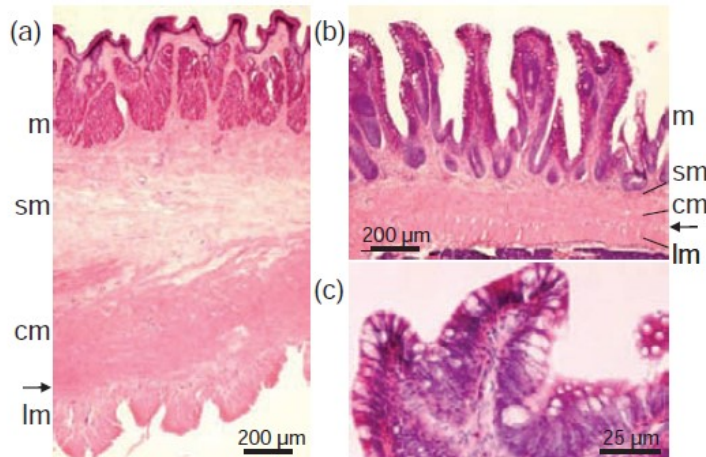


Mucosa

Submucosa

Músculo circular

Músculo longitudinal



Absorción

Paracelular: entre las uniones estrechas de las células epiteliales

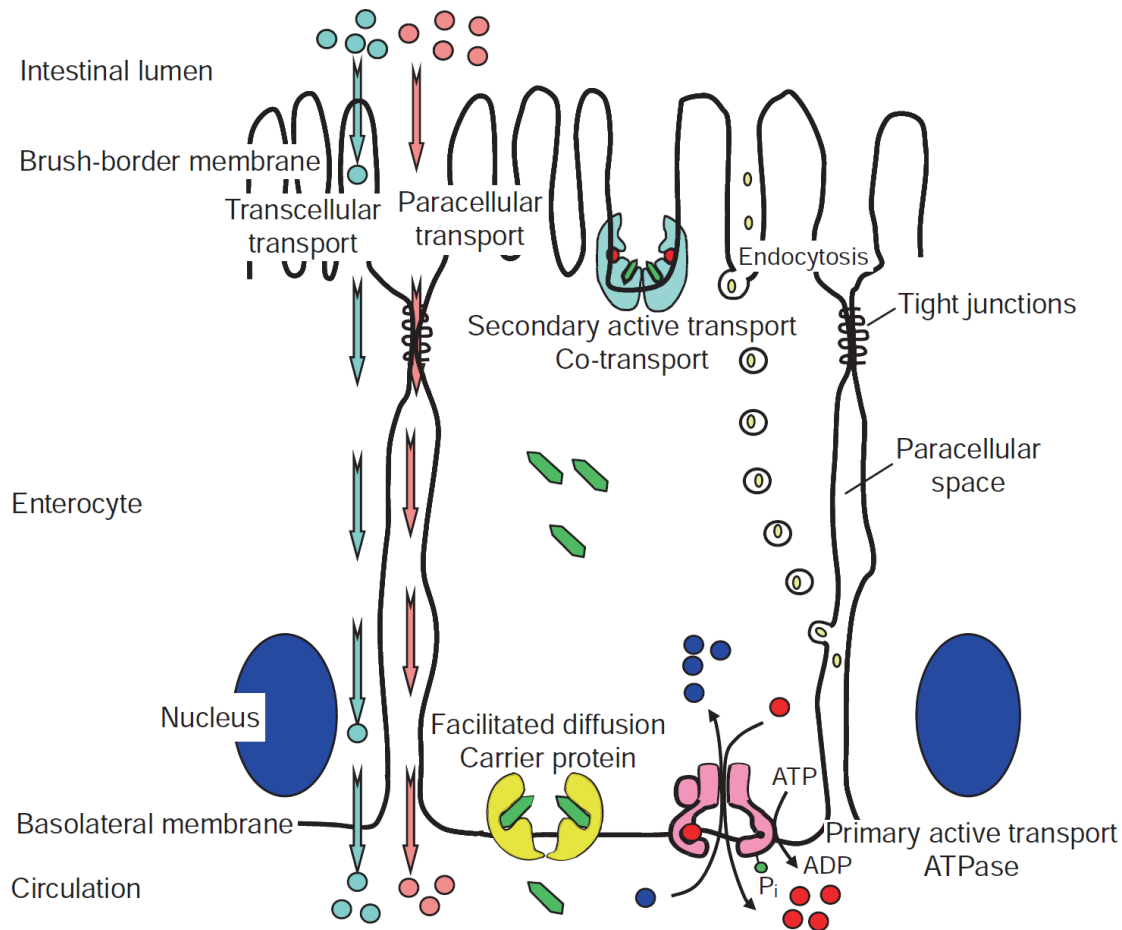
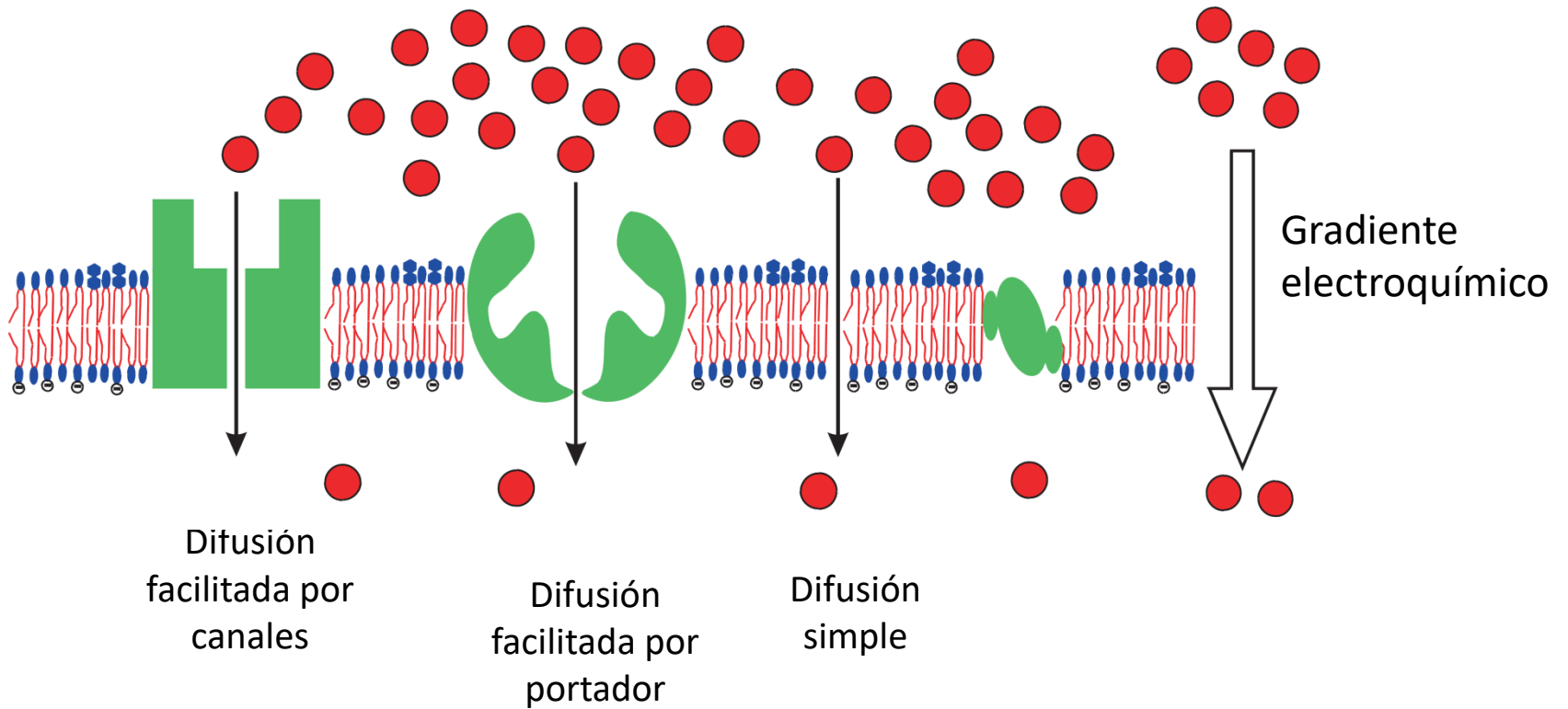


Figure 4 Pathways for absorption across the intestinal epithelium including examples of transporting enzymes inserted in the brush-

Absorción transcelular

Difusión



Irrigación del sistema digestivo

Metil metacrilato

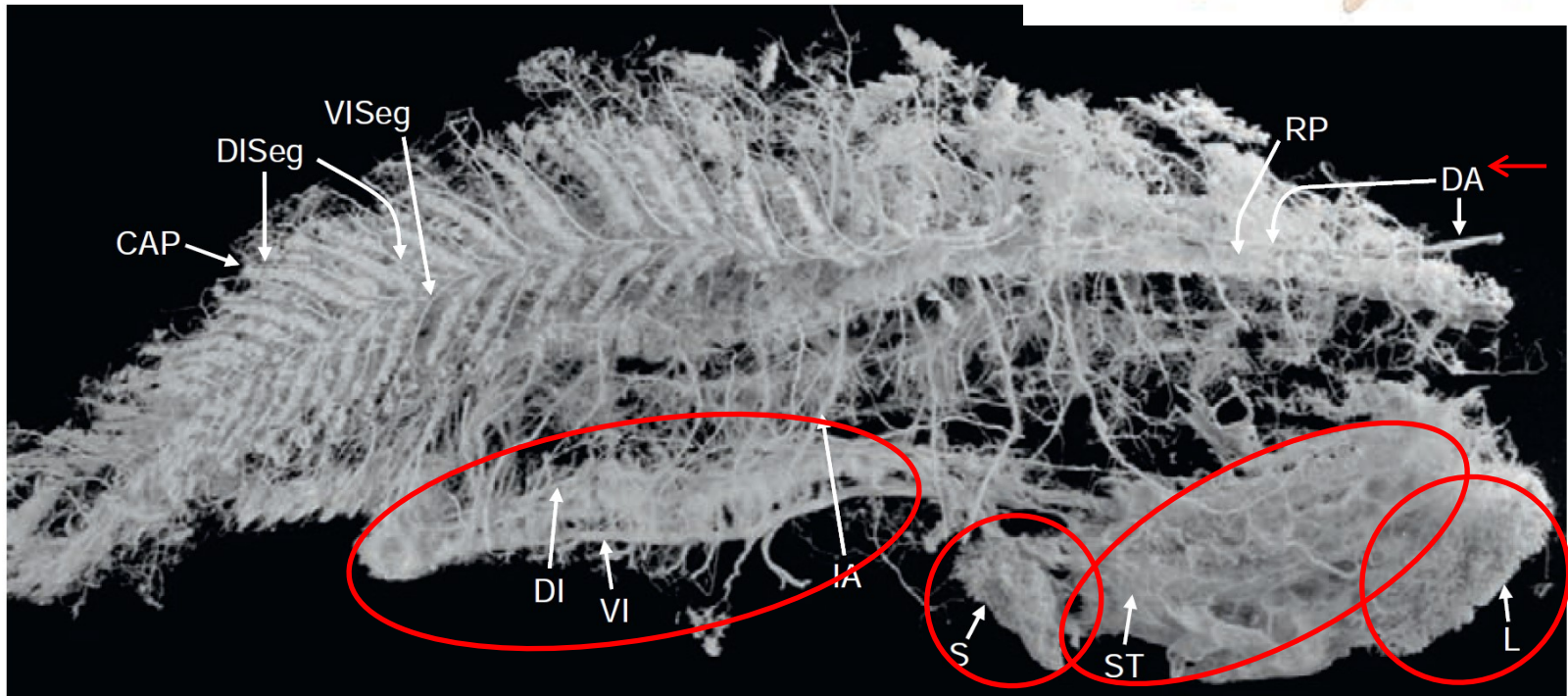
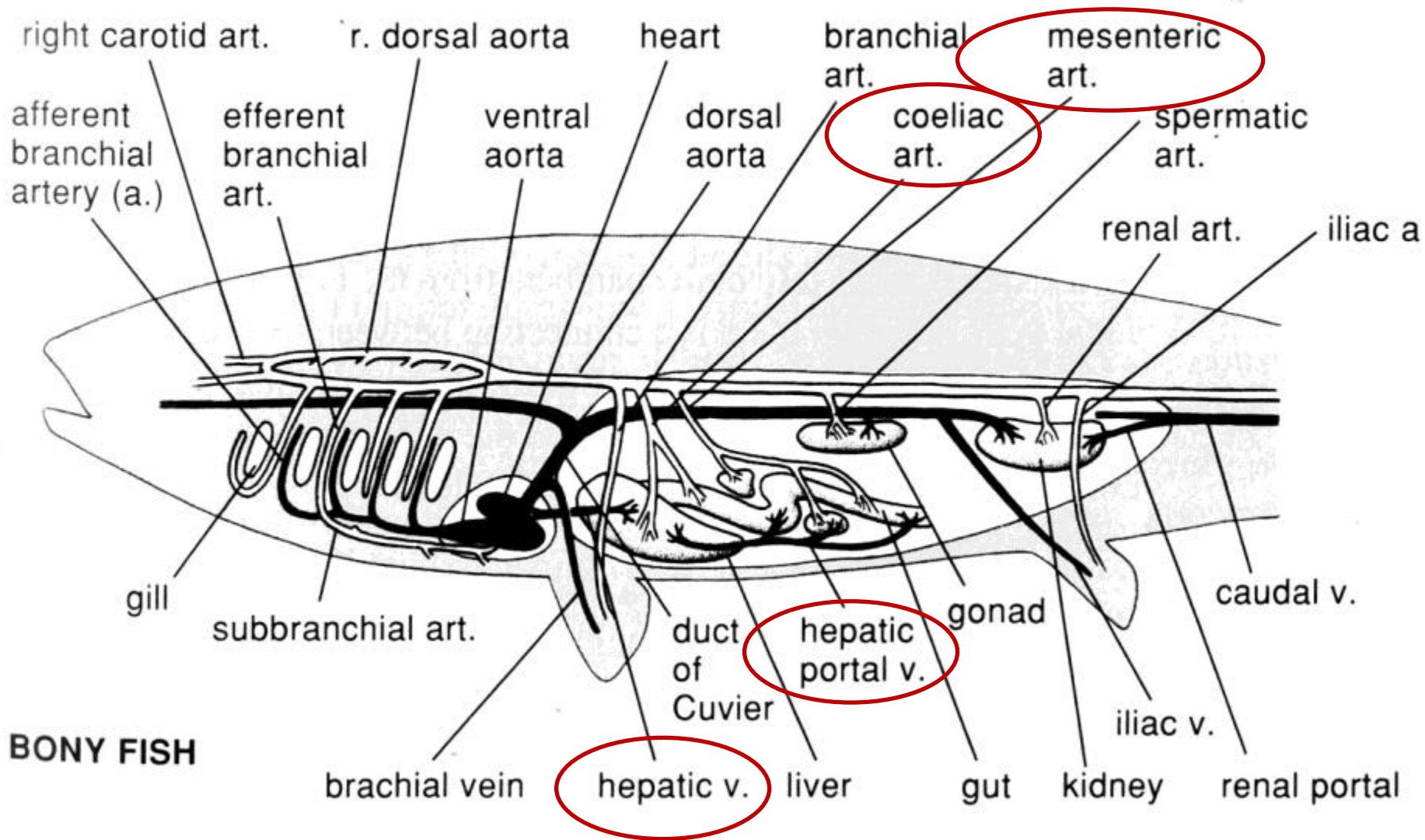


Figure 6 Vascular corrosion replica of the systemic circulation of rainbow trout. The dorsal aorta (DA) and celiacomesenteric artery (not visible) were perfused with liquid methyl methacrylate. After polymerization, the tissue was digested away leaving a vascular replica. This figure shows the dorsal and ventral intersegmental (DISeg and VISeg) and intercostal (IA) arteries and the extensive capillary networks (CAP) they supply. Also visible is the renal portal (RP), liver (L), stomach (S), spleen (SP), and dorsal and ventral intestinal (DI and VI) circulations. **See Figure 1** for abbreviations.

Esquema de irrigación del sistema digestivo



Sistema nervioso del digestivo (SNE y extrínseco)

Sistema Nervioso Entérico (SNE):

Neuronas sensoriales

Inter-neuronas

Neuronas motoras

Cientos de neurotransmisores

Función:

Reflejos autónomos, movimientos peristálticos, regulación de la secreción (biliar y pancreática), sensible a hormonas.

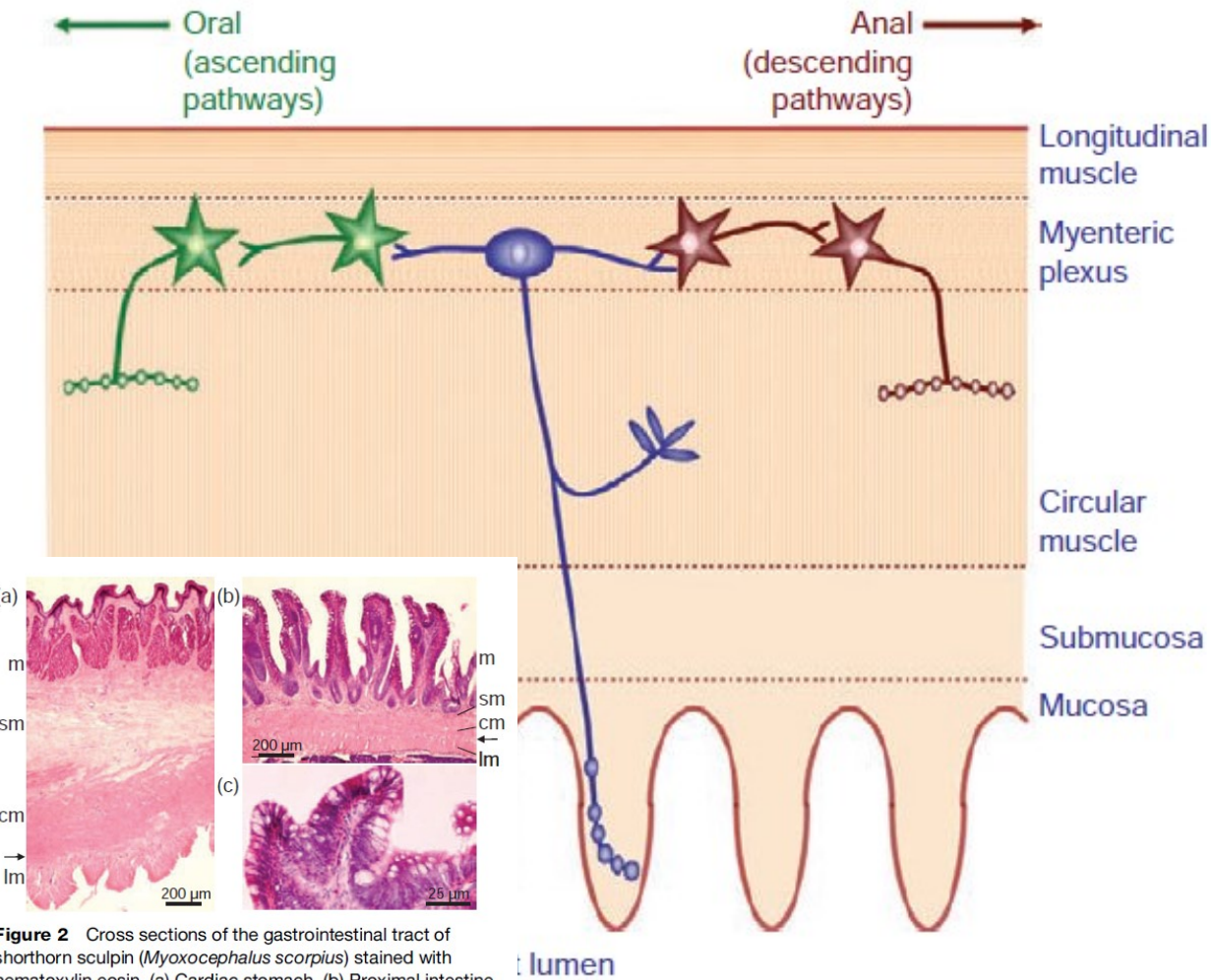
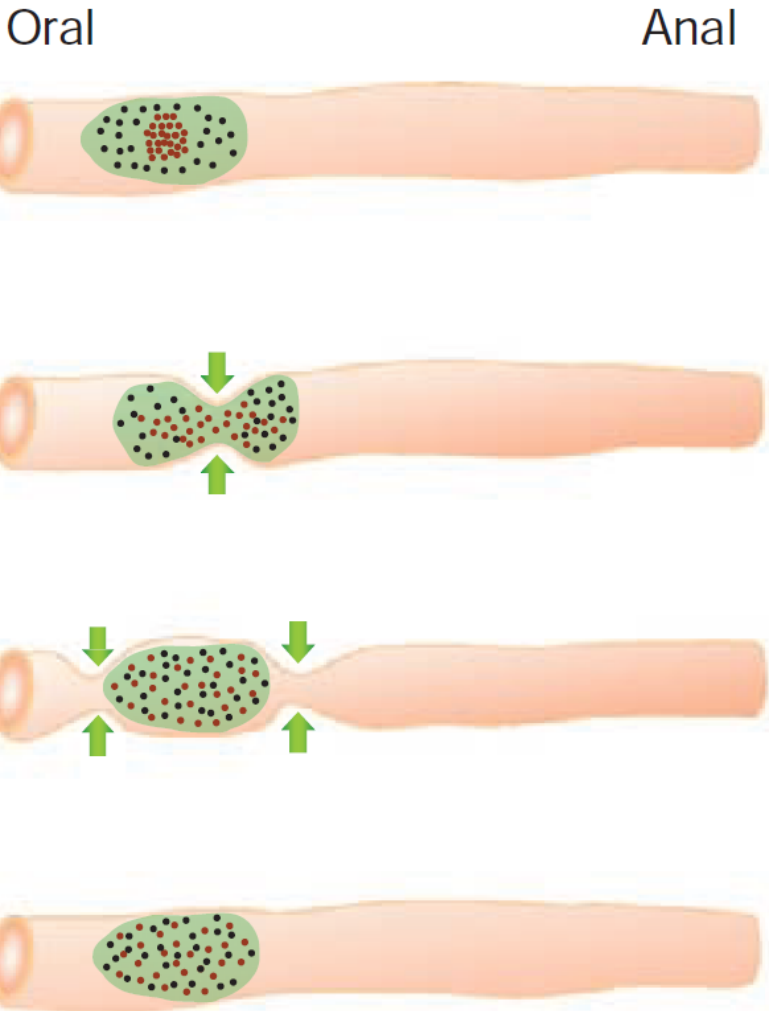


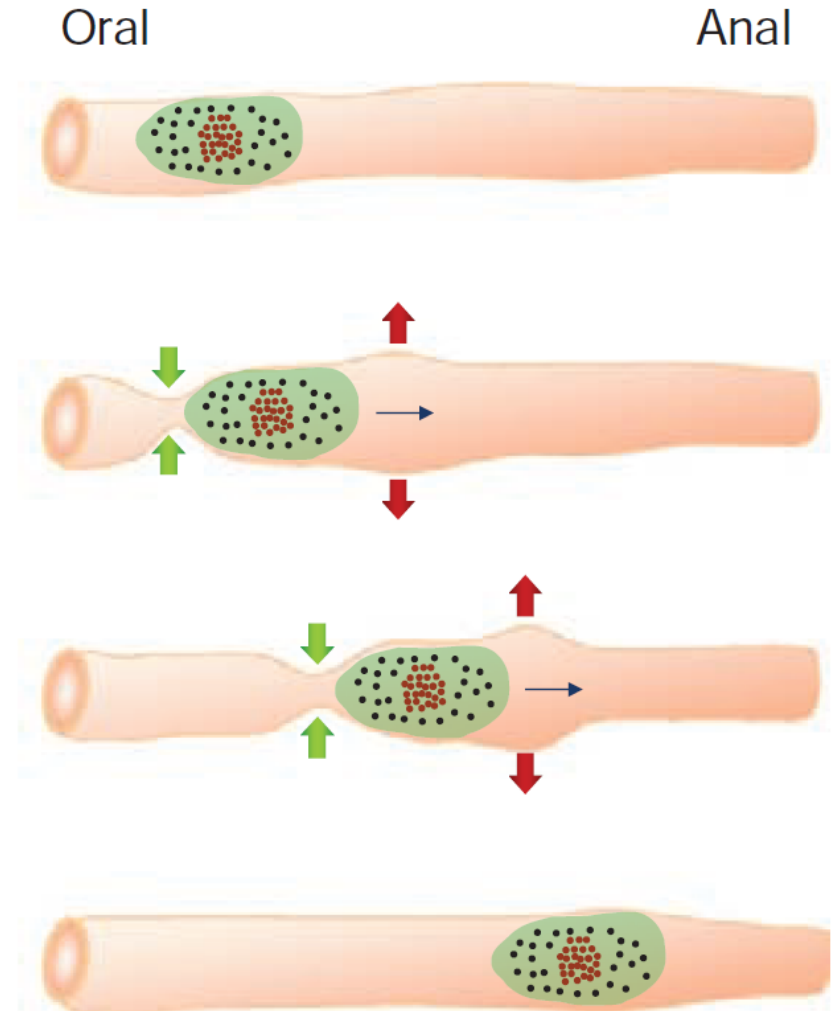
Figure 2 Cross sections of the gastrointestinal tract of the shorthorn sculpin (*Myoxocephalus scorpius*) stained with hematoxylin eosin. (a) Cardiac stomach. (b) Proximal intestine. (c) Higher magnification of the epithelium in the proximal

Movimientos peristálticos

Contracciones locales sin avance

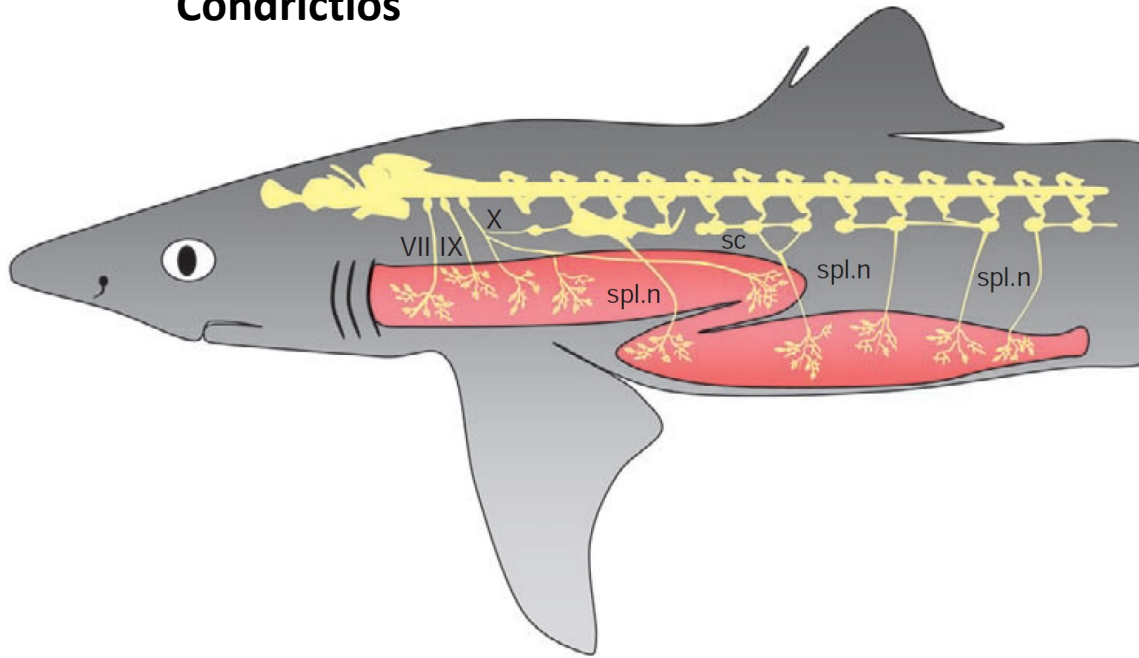


Contracciones de propagación



Sistema nervioso extrínseco

Condrictios



Nervios craneales (**parasimpático**)

VII nervio facial

IX glossofaríngeo

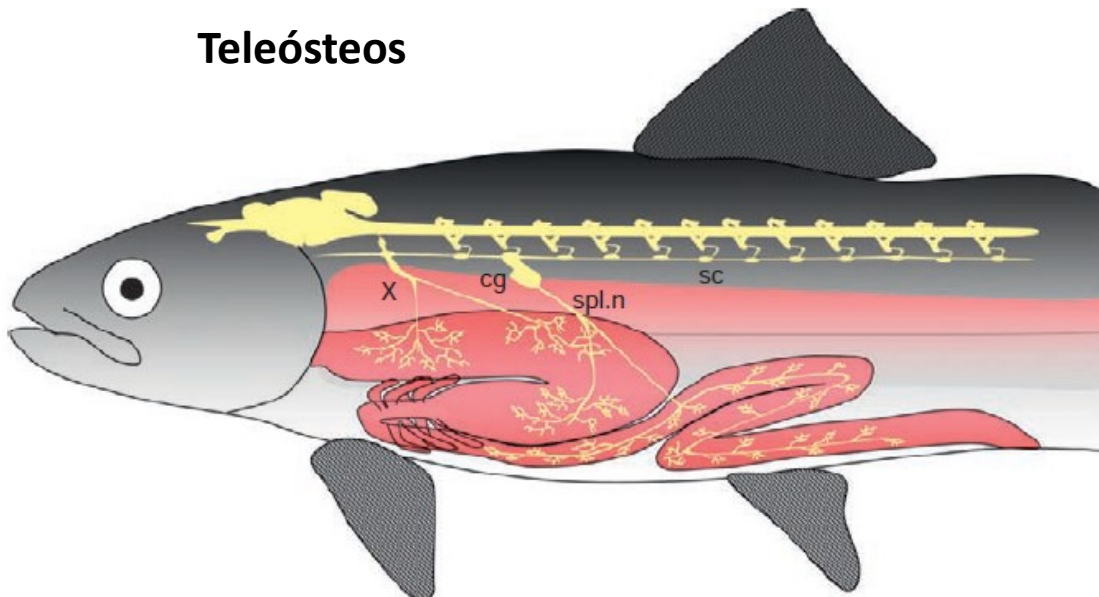
X vago

Simpático

sc cadena simpática

spl. n nervio espláncnico

Teleósteos



Nervio craneal (**parasimpático**)

X vago

Simpático

cg ganglio celíaco

spl. n nervio espláncnico

sc cadena simpática

Función: prepara al sistema digestivo ante un proceso digestivo y posteriormente participan en la coordinación del mismo.

Alimentación y Hábitos tróficos



Cleaner wrasse mimics inflict higher costs on their models when they are more aggressive towards signal receivers

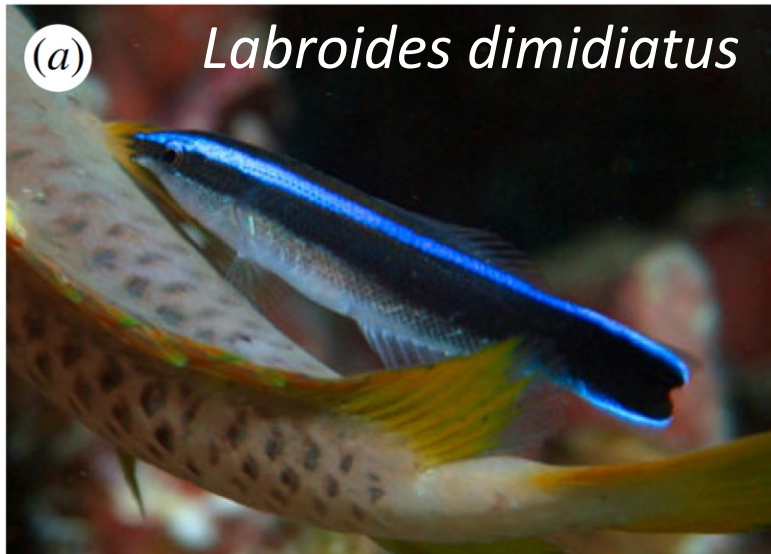
Karen L. Cheney*

*School of Biological Sciences, The University of Queensland,
Brisbane, Queensland 4072, Australia*

**k.cheney@uq.edu.au*



Simbiontes limpiadores y los que los imitan y garronean



Ectoparásitos

Algunos Serrasalminidae



Roebooides



Comedores de escamas

Homodiaetus

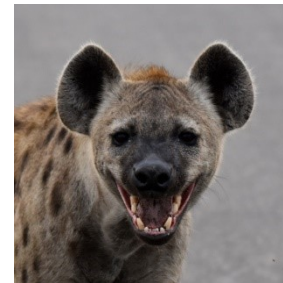


Comedores de moco

Isistius brasiliensis and *I. plutodus*



Ectoparasitos



Comedores de niños



Comedores de colas



Hervíboros



Filtradores



Sardinella



Hypophthalmichthys

Ramoneador de Perifiton



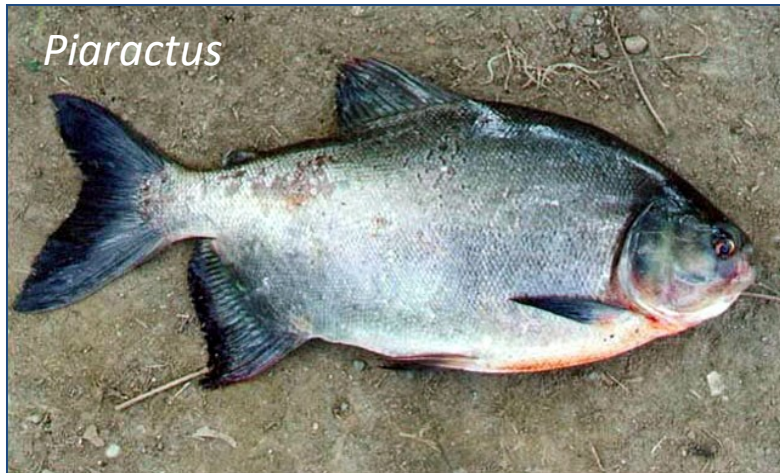
Apareiodon

Macrófitas



Ctenopharyngodon

Frugívoro



Piaractus



Box 5.1 BOX 5.1

Herbivory in fishes

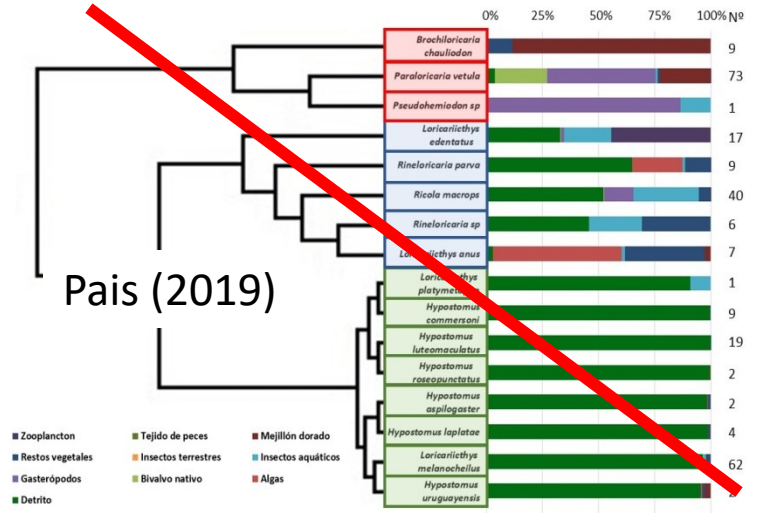
Although carnivory is more common than herbivory among fishes, herbivorous species can have a substantial effect on macrophyte or algal communities in both marine (Alcoverro & Marsini 2004) and freshwater (Nurminen et al. 2003) environments. Herbivorous fishes may depend in part on fermentation by symbiotic microorganisms in their guts to digest the plants they consume. Many of 27 primarily herbivorous tropical marine fishes from five families (Pomacanthidae, Scaridae, Kyphosidae, Acanthuridae, Siganidae) showed elevated levels of short-chained fatty acids (SCFAs) in the posterior gut segments (Clements & Choat 1996). SCFAs are characteristic products of plant matter

suggesting a direct contribution of metabolic fuel by microbial fermentation.

Fermentation digestion may not only benefit herbivorous fishes, however, as some planktivorous fishes studied by Clements and Choat (1996) also showed elevated SCFA levels. The relative contribution of gut microorganisms to digestion and nutrition in fishes deserves further study.

Some herbivorous fishes seem to rely on physical grinding or low stomach pH to break through plant cell walls (Lobel 1981). Of the 27 herbivores studied by Clements and Choat (1996), the majority showed the lowest SCFA levels.

Detritívoros

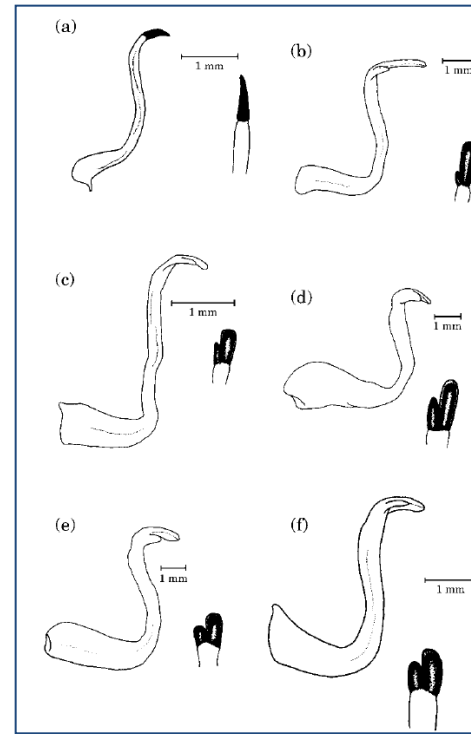
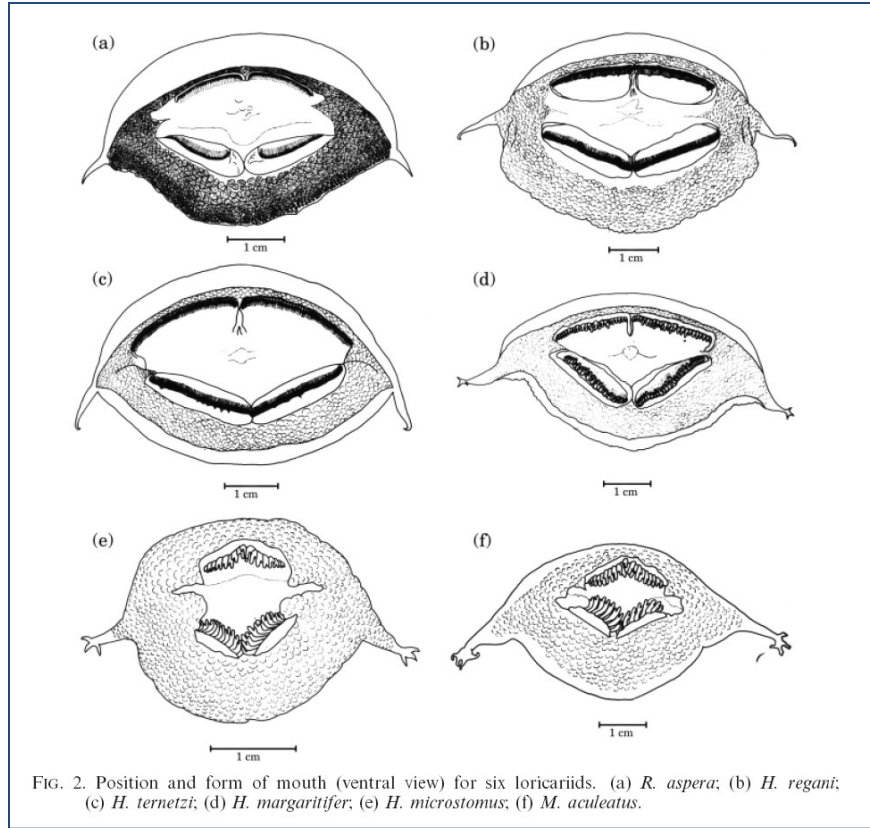


Loricariidae: *Hypostomus* y *Loricarichthys*



Lamprea del Caspio: La larva Ammocoete se alimenta de diatomeas y detritus. Los adultos en algas, plantas vasculares y carroña.

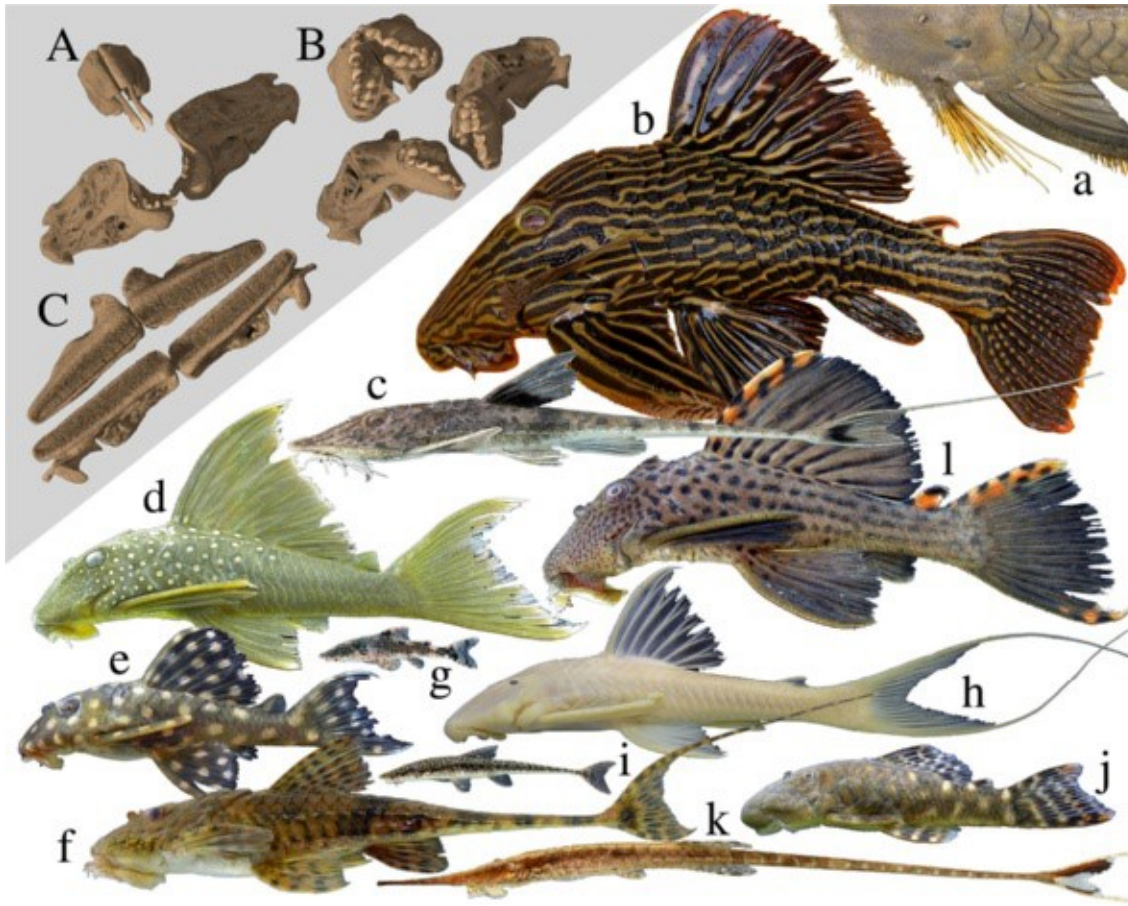
Ramoneadores omnívoros



Loricariidae: *Ricola*, *Paraloricaria*

Trophic diversity in the evolution and community assembly of loricariid catfishes

Nathan K Lujan^{1,2,3*}, Kirk O Winemiller¹ and Jonathan W Armbruster²



Partición de nicho

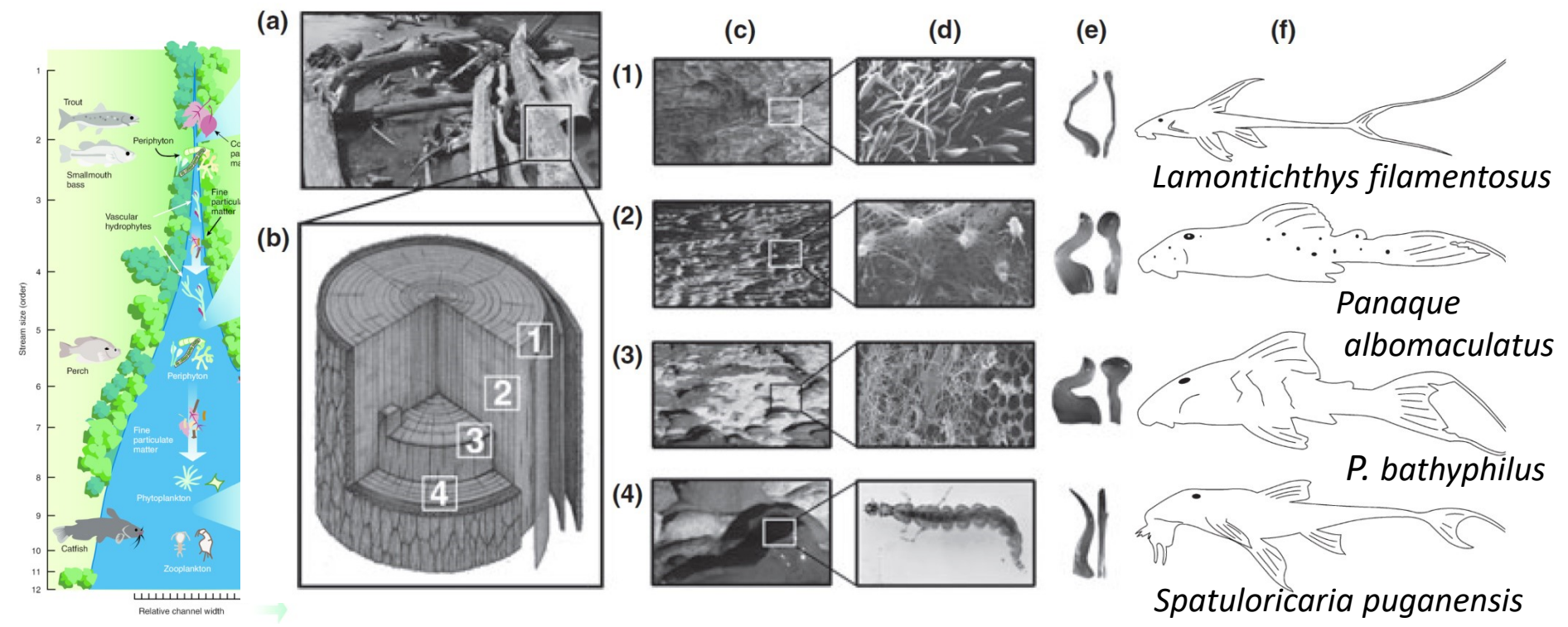
Insectívoros

Comedores de madera

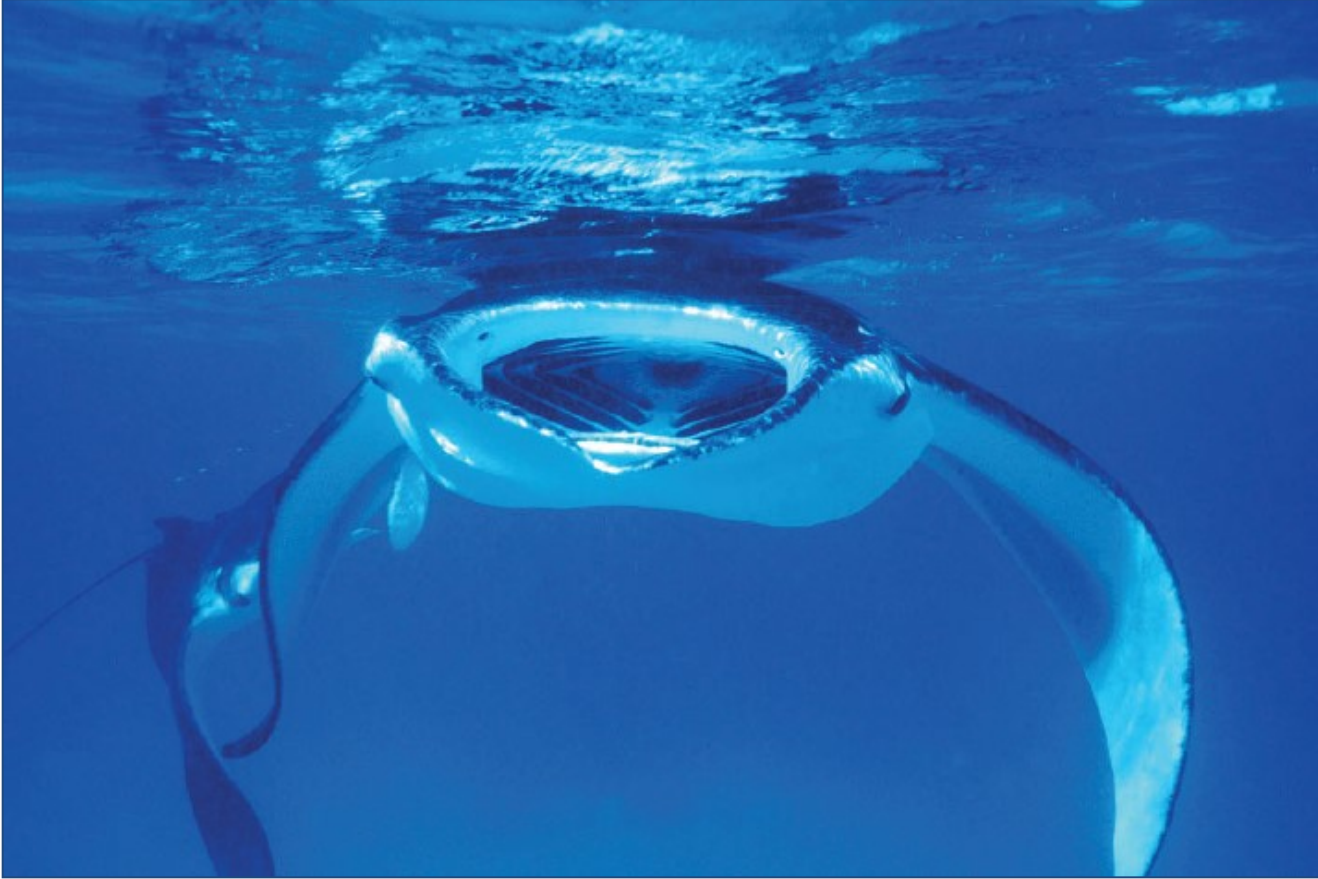
Alguívoros

Do wood-grazing fishes partition their niche?: morphological and isotopic evidence for trophic segregation in Neotropical Loricariidae

Nathan K. Lujan^{*1,2}, Donovan P. German³ and Kirk O. Winemiller²



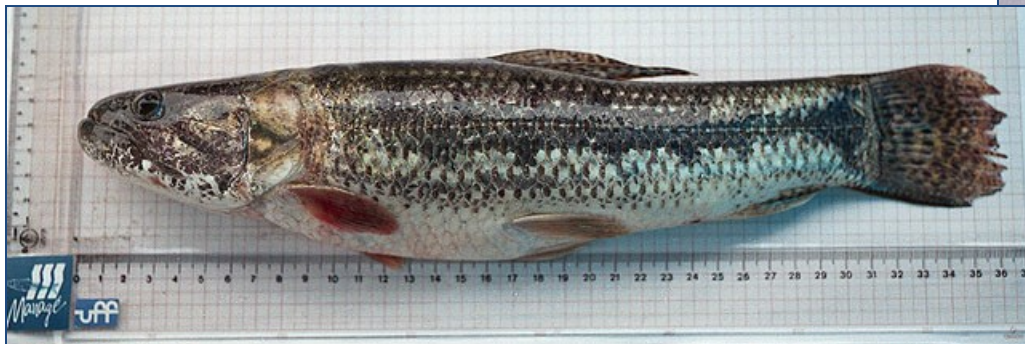
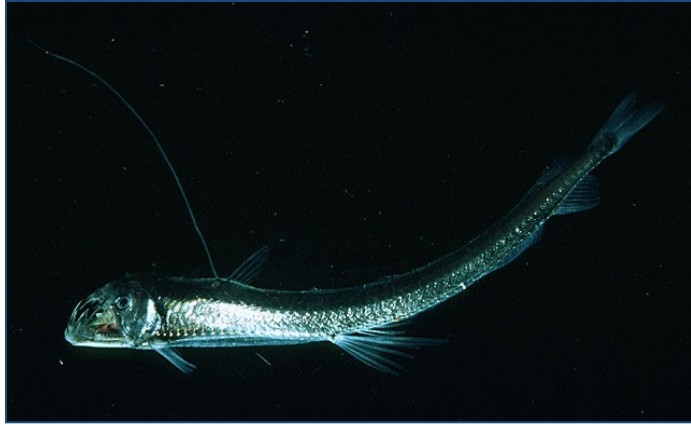
Filtradores omnívoros



Carnívoros



Carnívoros



Cambios ontogenéticos en la dieta: Gap limitation

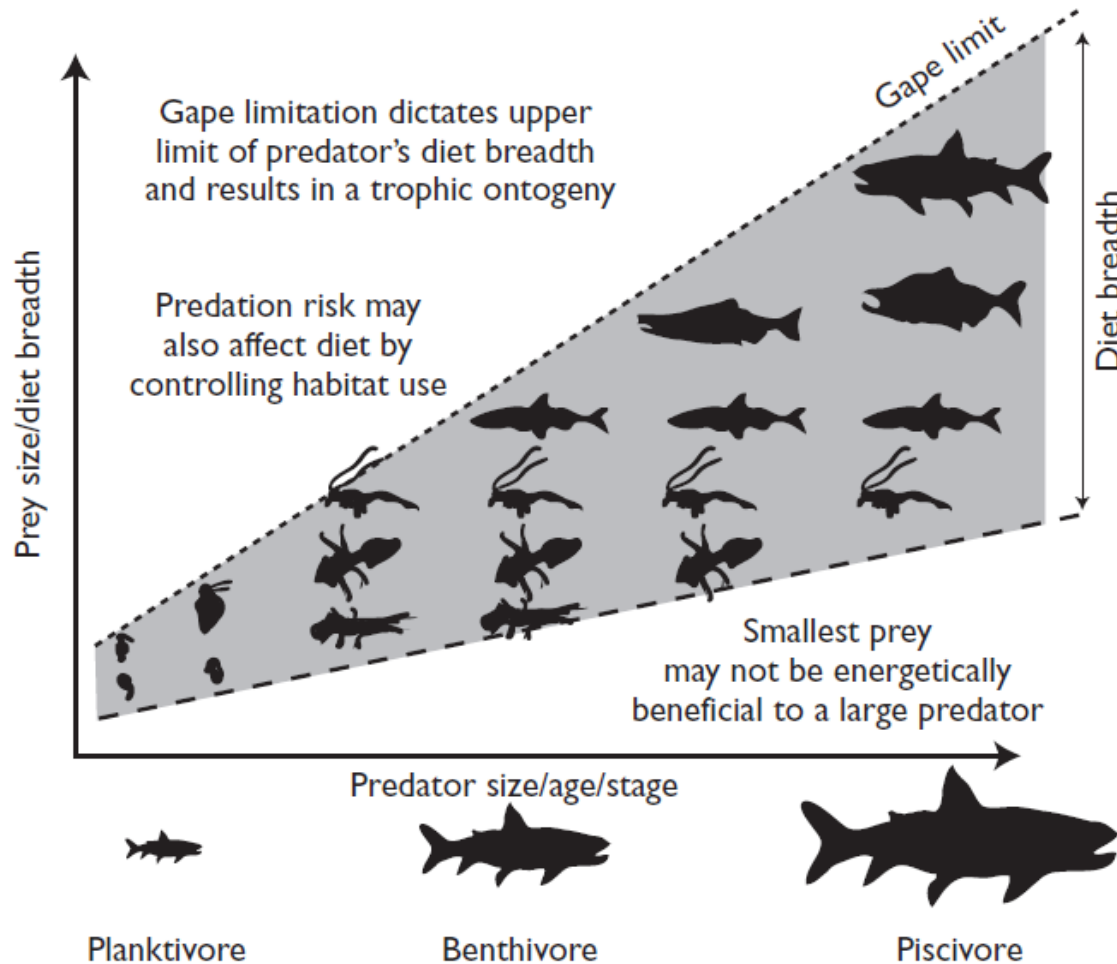


Figure 7.3 Feeding ontogeny of lake trout. Size of food as well as dietary breadth increases with growth. Adapted with permission from Brett Johnson. http://www.warnercnr.colostate.edu/class_info/fw300/flashcrd/ontogeny.gif

Alimentación

Mecanismos

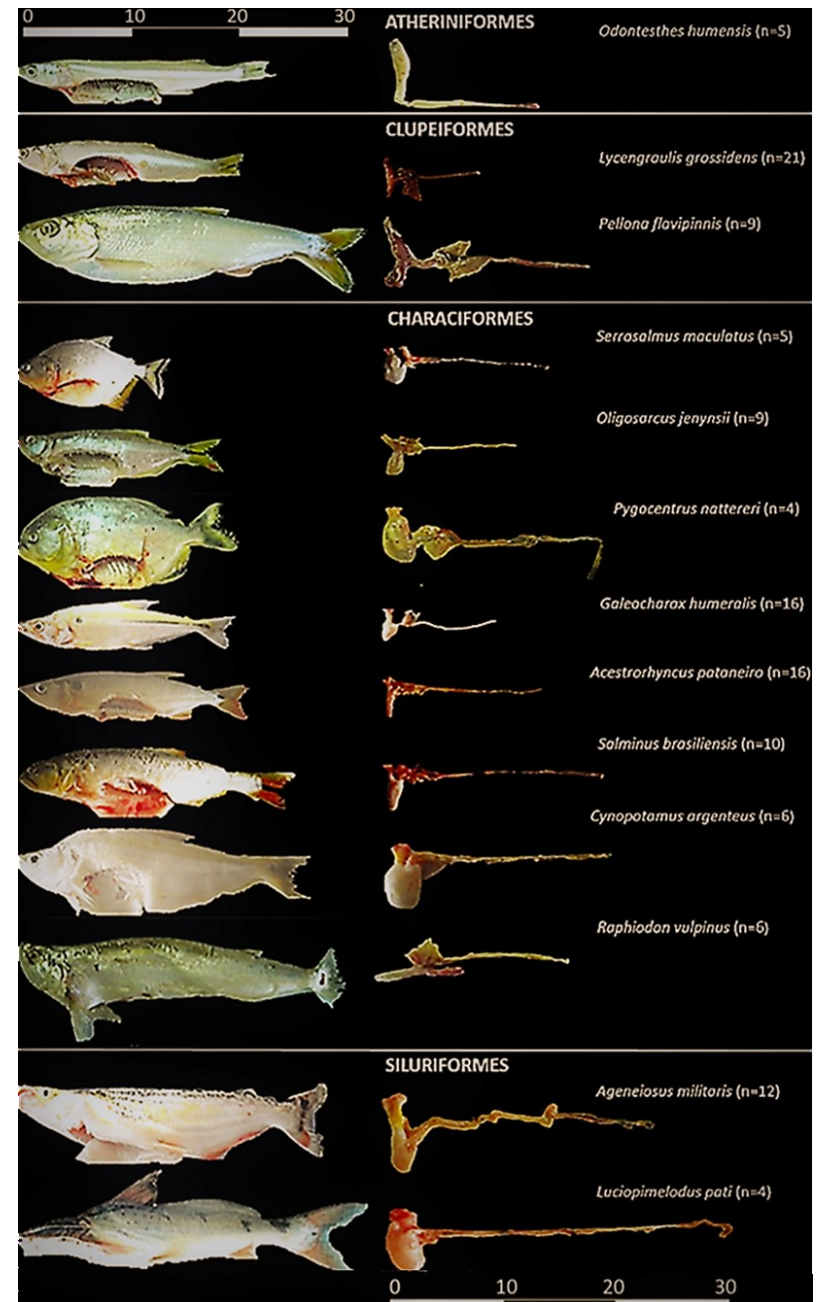
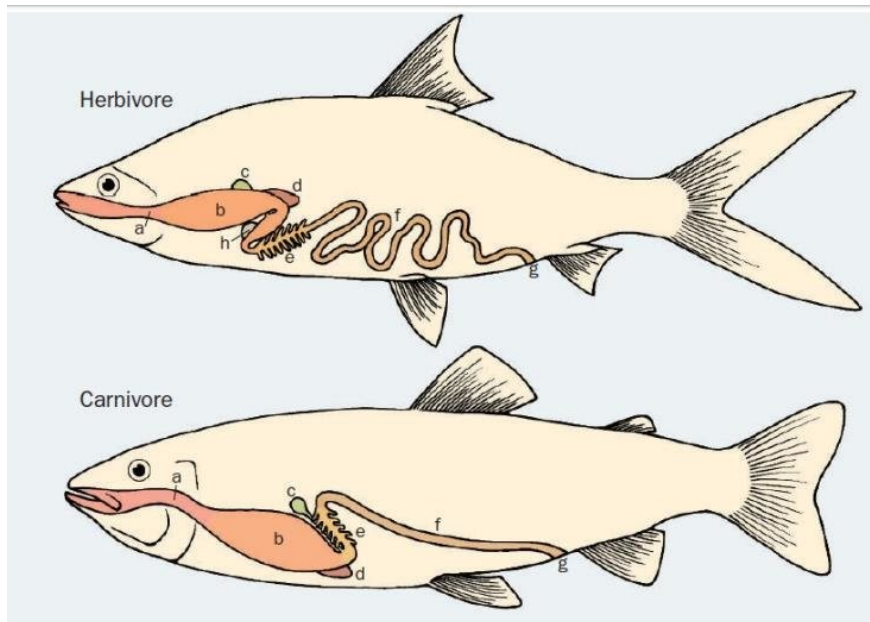
Ram: Boca abierta mientras ocurre el nado. Las branquiespinas importantes para retener el alimento, o directamente al esófago.

Succión: Expansión de la cavidad oral y generación de vacío que mueve la presa hacia adentro.

Mordida: Movimiento activo de las mandíbulas para extraer un pedazo de la presa.

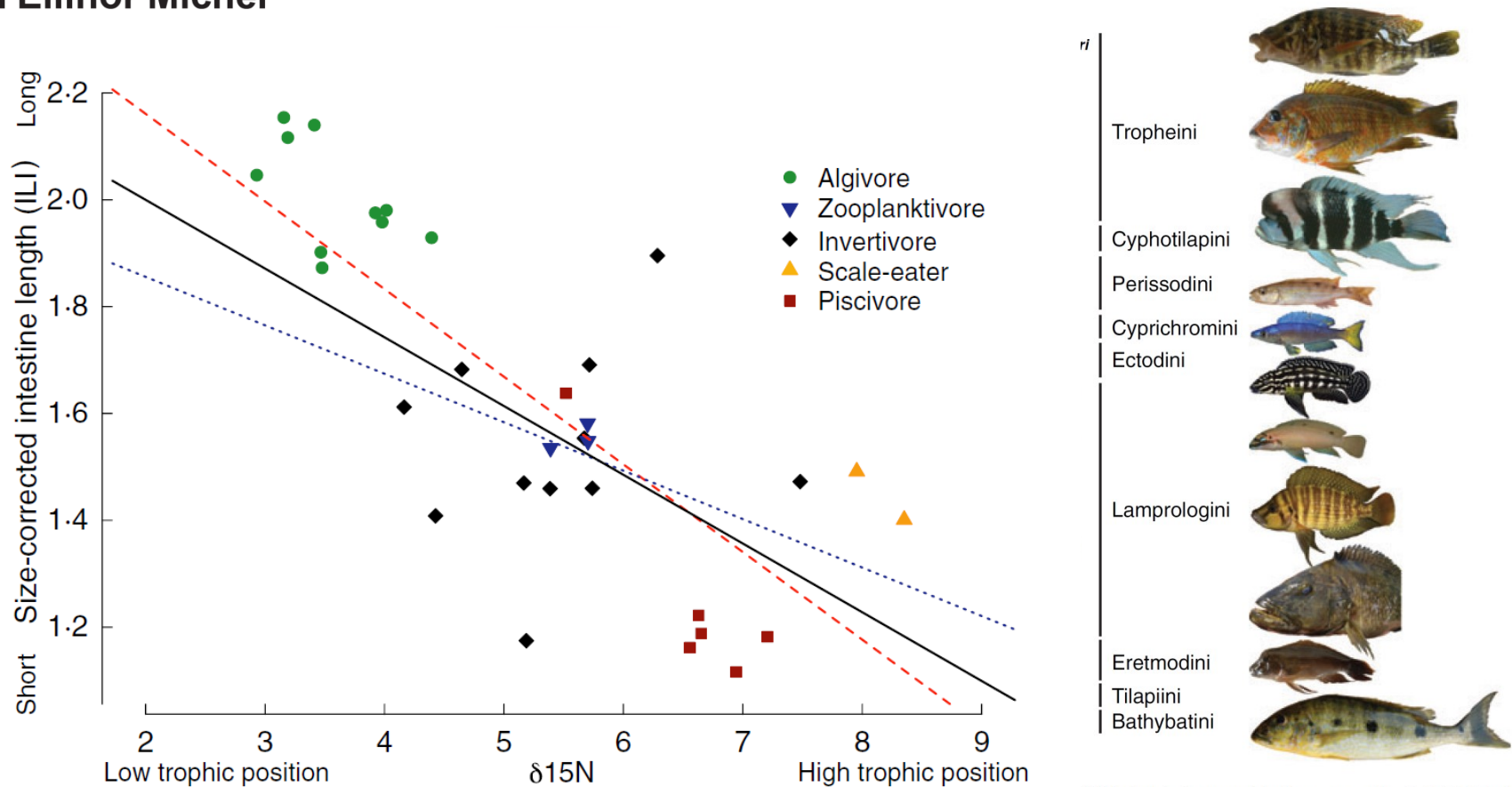
Plasticidad del digestivo

Una de las predicciones de la Teoría Digestiva indica que individuos que consumen mayor % de alimento difícil de digerir requieren mayor tiempo de digestión y por lo tanto tractos digestivos mayores



Diet predicts intestine length in Lake Tanganyika's cichlid fishes

Catherine E. Wagner^{*,†,1,2,3}, Peter B. McIntyre^{†,1,2,4}, Kalmia S. Buels^{1,5}, Danielle M. Gilbert² and Ellinor Michel^{2,6}





Morphological variation of the digestive tract: a feeding behaviour response in a freshwater fish species

Nicolás Vidal · Alejandro D'Anatro ·
Iván González-Bergonzoni ·
Franco Teixeira de Mello · Daniel E. Naya

Pachyrurus bonariensis



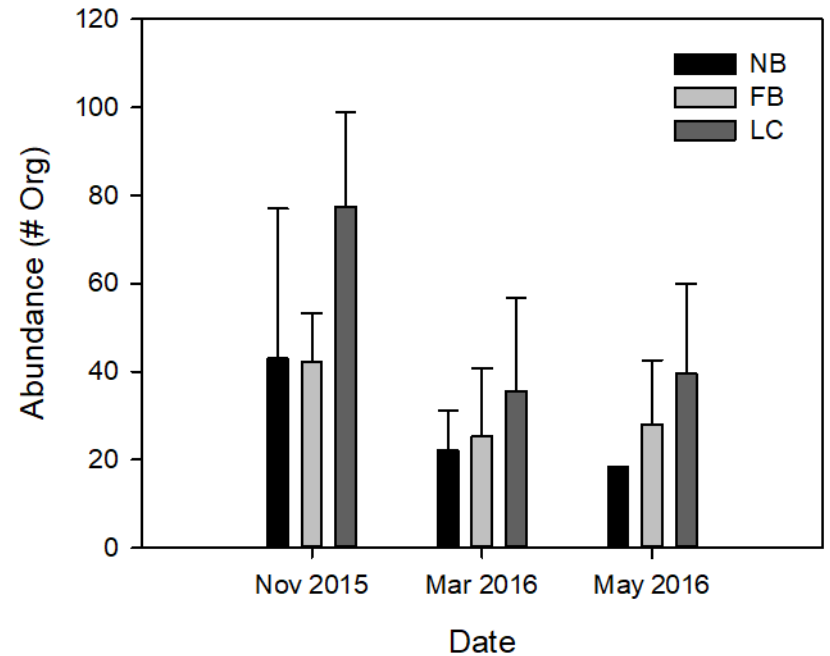
Oferta de alimento

Porcentaje de materia orgánica del sedimento

Table 1. Organic mater percentage in the sediment in each site , measured as grams of organic matter per 100 grams of dry sediment.

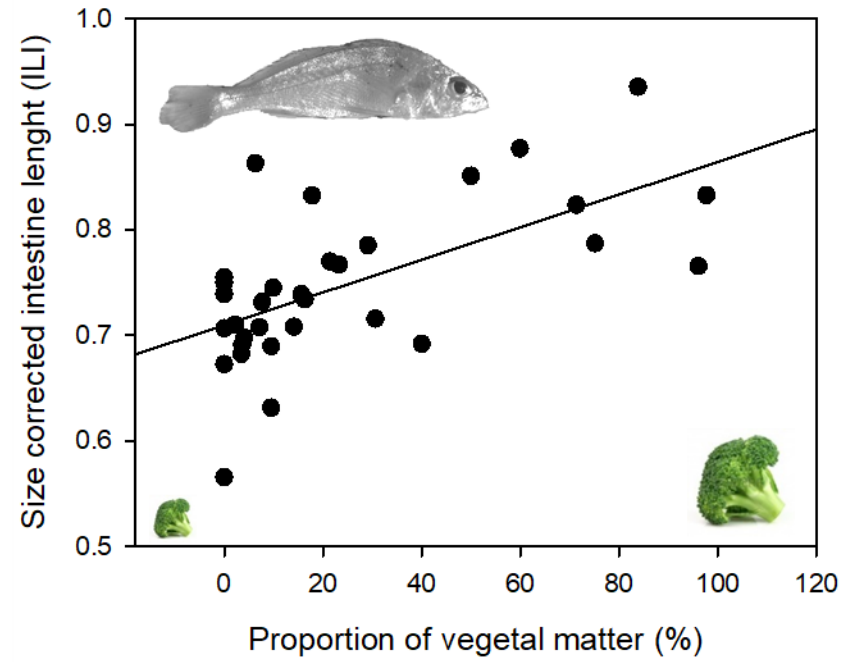
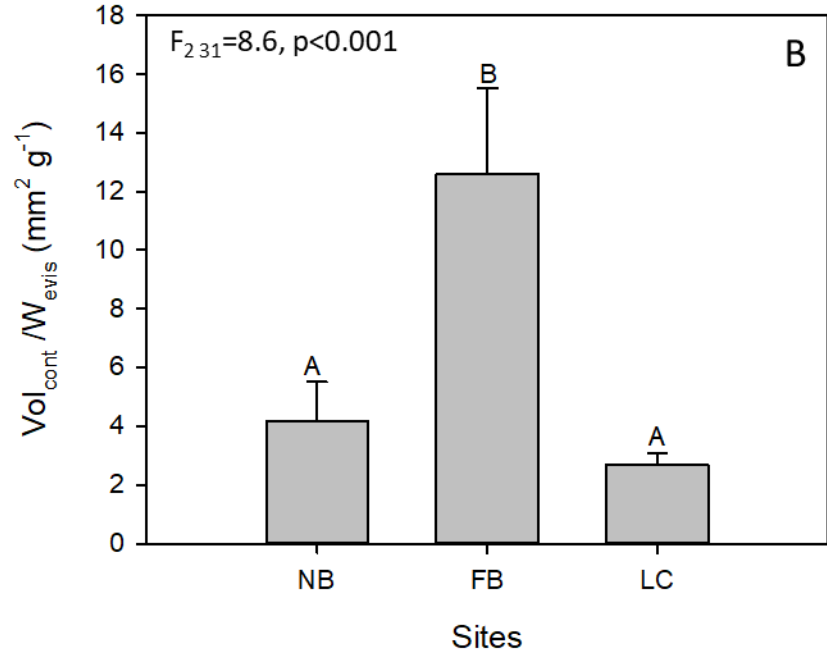
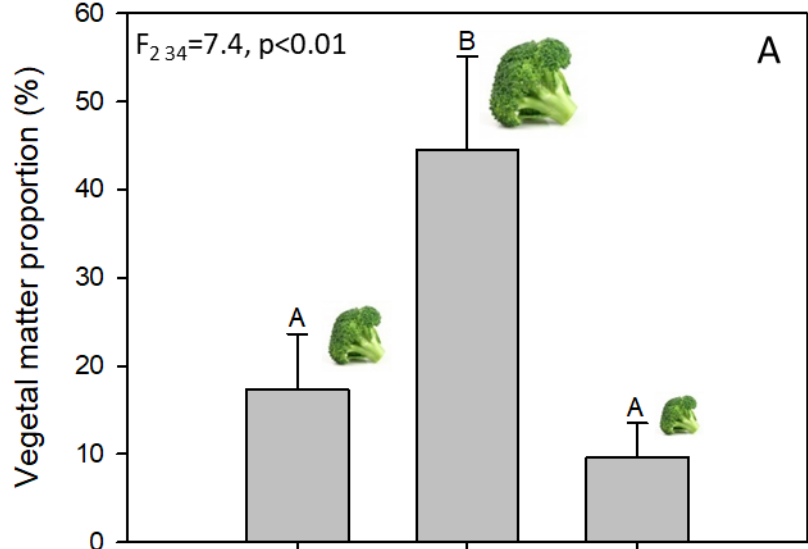
Dates	Sites					
	NB (N=27)		FB (N=27)		LC (N=21)	
Nov-15	0.9±	1.1	4.7±	1.8	0.9±	0.8
Mar-16	1.1±	1.6	2.5±	2.1	1.1±	0.9
May-16	1.6±	2.3	3.8±	3.0	1.0±	1.4

NB= Nuevo Berlin, FB= Fray Benatos, LC= Las Cañas, N= sample size.
Data presented are absolute means ± 1 SDM



Abundancia de macroinvertebrados

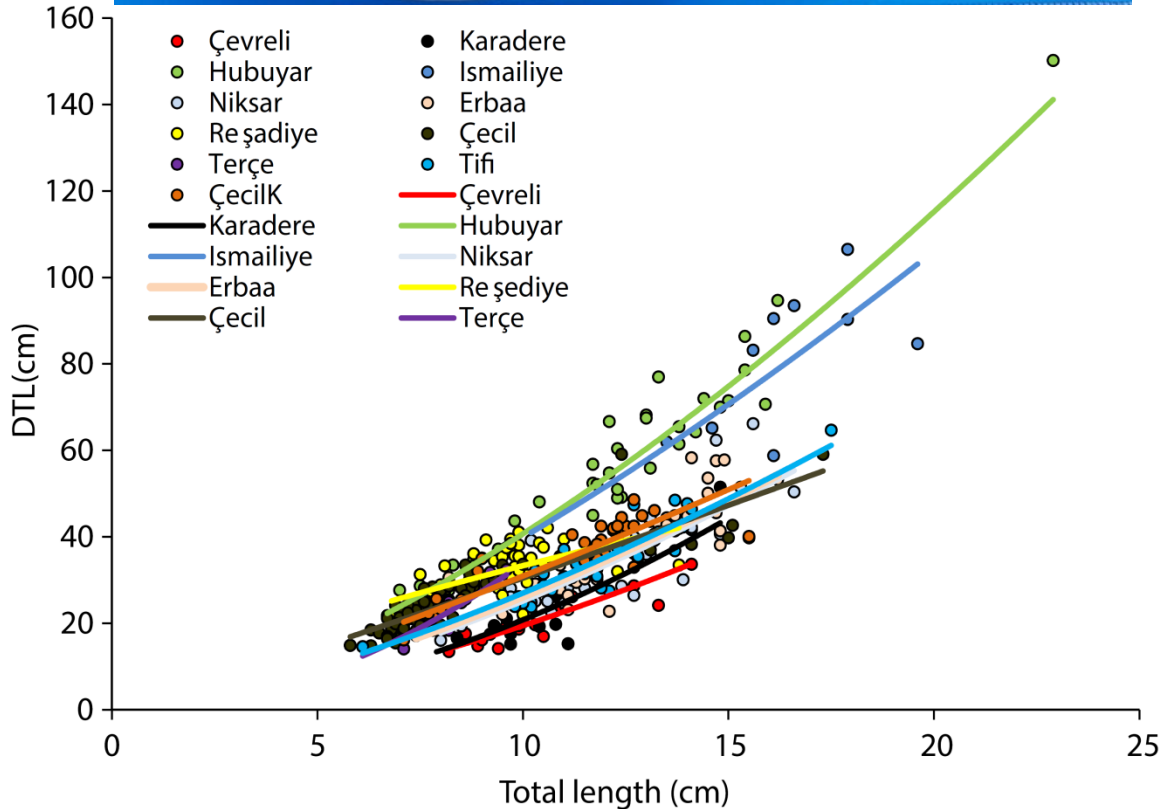






Does diet variation determine the digestive tract length of *Capoeta banarescui* Turan, Kottelat, Ekmekci and Imamoglu, 2006?

By S. Akin, H. Turan and N. Kaymak



● Hubuyar



Algae

● Çevreli



Chironomidae

RESEARCH ARTICLE

Contrasting Population and Diet Influences on Gut Length of an Omnivorous Tropical Fish, the Trinidadian Guppy (*Poecilia reticulata*)

Eugenia Zandonà^{1^{oa}*}, Sonya K. Auer^{2^{ob}}, Susan S. Kilham¹, David N. Reznick²

