And now something completely different

Vývojové souvislosti I: vznik a vývoj zubu jako produkt genetických regulačních kaskád
Vývojové souvislosti II: d. lamina, zubní epitel a mesenchym; teorie o evoluci zubu/dentice
***Vývojové souvislosti* III: zuby 1. a 2. typu, vznik a vývoj čelistí, integrace čelistí a dentice**

JOURNAL OF EXPERIMENTAL ZOOLOGY (MOL DEV EVOL) 312B:416–424 (2009)

Odontoblast: A Mechano-Sensory Cell

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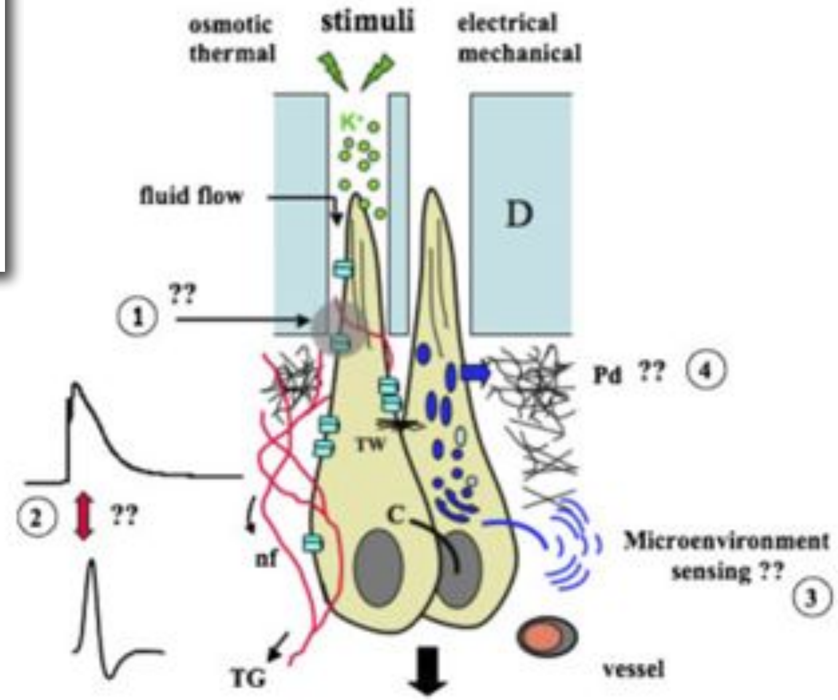
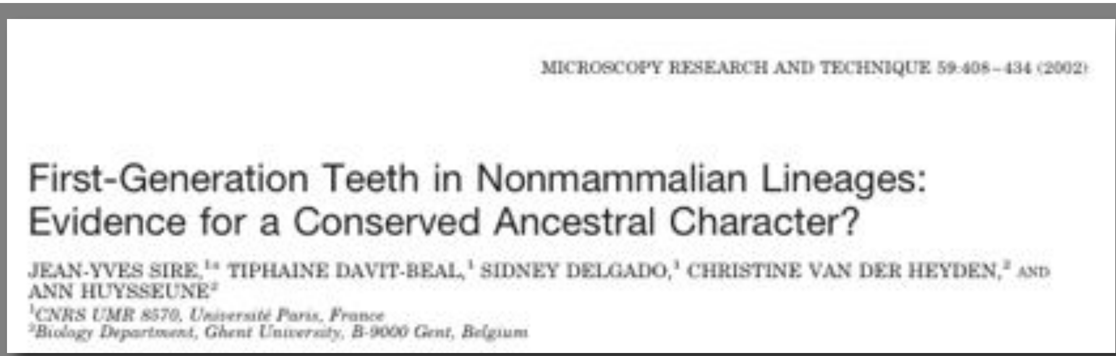


Fig. 7. Schematic representation of hypothetical mechanisms underlining the role of mechano-sensitive ion channels ( ) and cilium structure (C) to odontoblast response under stimuli. Odontoblasts may operate as excitable sensor cells whose excitation is transmitted to nerve fibers (nf) and conducted to the trigeminal ganglion (TG). The question marks (1, 2) refer to the remaining open question of the type of transmission of excitation from odontoblasts to nerve endings (intercellular communication? chemical synapses?). Identically, the question marks (3, 4) concern the putative role of primary cilia in the regulation of the architecture of primary or secondary dentine formation as odontoblasts move centripetally toward the pulp core (black arrow) throughout the life of the tooth. Pd, predentine; TW, terminal web.


MICROSCOPY RESEARCH AND TECHNIQUE 59:408–434 (2002)

First-Generation Teeth in Nonmammalian Lineages: Evidence for a Conserved Ancestral Character?

JEAN-YVES SIRE,[1*] TIPHAINE DAVIT-BEAL,[1] SIDNEY DELGADO,[1] CHRISTINE VAN DER HEYDEN,[2] AND ANN HUYSSEUNE[2]
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Zuby první generace u nesavčích skupin:

zub 1. a 2. typu

Generalizovaný typ 1 (Actinopterygii, Dipnoi, Urodela):

Malá velikost, jednoduchý konický tvar, atubulární dentin, malá zubní kavita bez kapilár a krevního zásobení - krátké období embryogeneze. (tedy plesiomorfní typ?), ekonomicky výhodné, častější polyfyodoncie

Generalizovaný typ 2 (Chodrichthyes, Squamata, Crocodilia):

Spíše větší velikost, komplexní tvar, tubulární dentin, velká zubní kavita s kapilárami - v zásadě miniaturní kopie zubu dospělého - prodloužené období embryogeneze.

I.H.: Operační předpoklad odontologické analýzy

- jednotlivé zuby (i jejich strukturní elementy jsou vzájemně *homologní*
- existuje zde homologie ***historická, *seriální *iterativní *stranová**

… aneb cvičná dekonstrukce některých zažitých odontologických pravd ;-)

I.H.: Operační předpoklad odontologické analýzy

- Monofyletický původ zubu

A co to je vlastně zub?
„Propracovaná“ odontoda?
Struktura vznikající na bázi DL?
Entita vznikající na rozhraní mesenchymu NL a epitelu?
Enamel vs. enameloid vs. keratinizované zuby (mihule)?

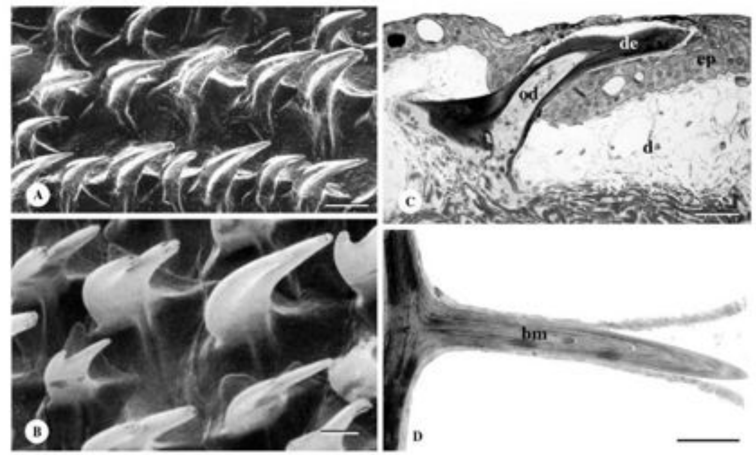


Fig. 1. Examples of homoplasy in the dermal skeleton: similarity in shape but difference in structure. (A, B) Scanning electron micrographs of (A) odontodes ornamenting the body surface of the catshark, *Scyliorhinus canicula*, and (B) postcranial dermal plates ornamenting the body surface of the gasterosteiform, *Notopogon xenosoma*. Note the similar shape and orientation. (C, D) 1-μm-thick sections of (C) an odontode of a 6-month-old embryo of *S. canicula*, and (D) a postcranial dermal plate in *N. xenosoma*. The odontode shows a dental structure whereas the scute is composed of bone matrix only. bm, bone matrix; d, dermis; de, dentine; ep, epidermis; od, odontoblast. Scale bars: A, B, D = 50 μm; C = 10 μm.

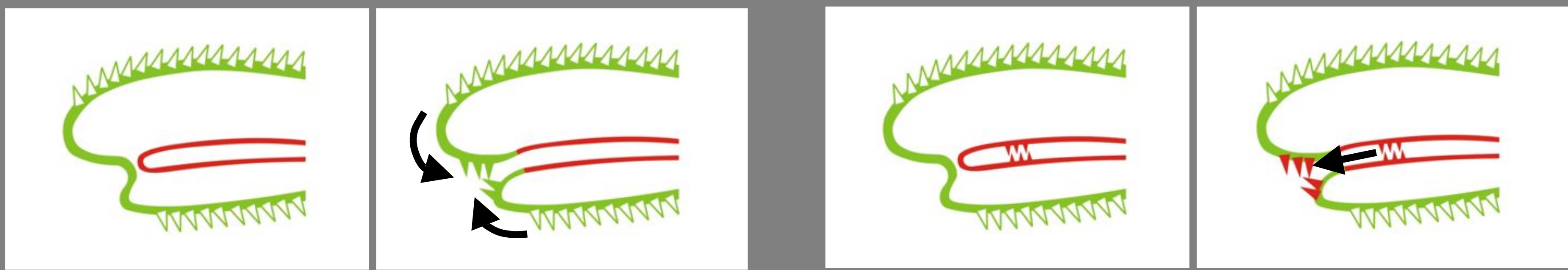
I.H.: Operační předpoklad odontologické analýzy

- EKT vs. ENT původu zubu a homologie

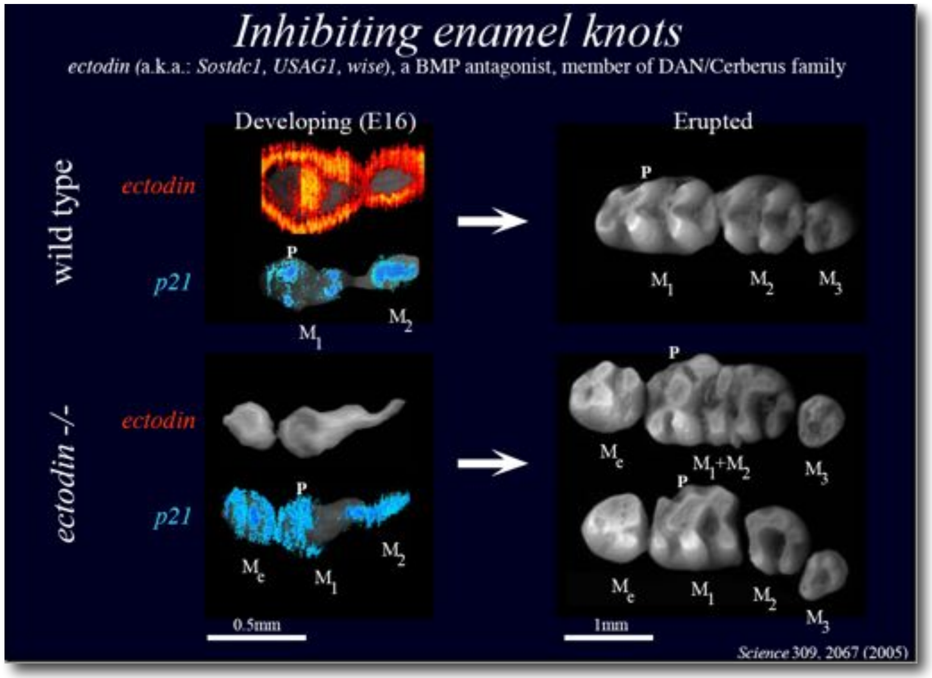
Vznikly EKT (orální) zuby z povrchové odontody a faryngeální zuby z ENT odontody (*M. M. Smith*)??

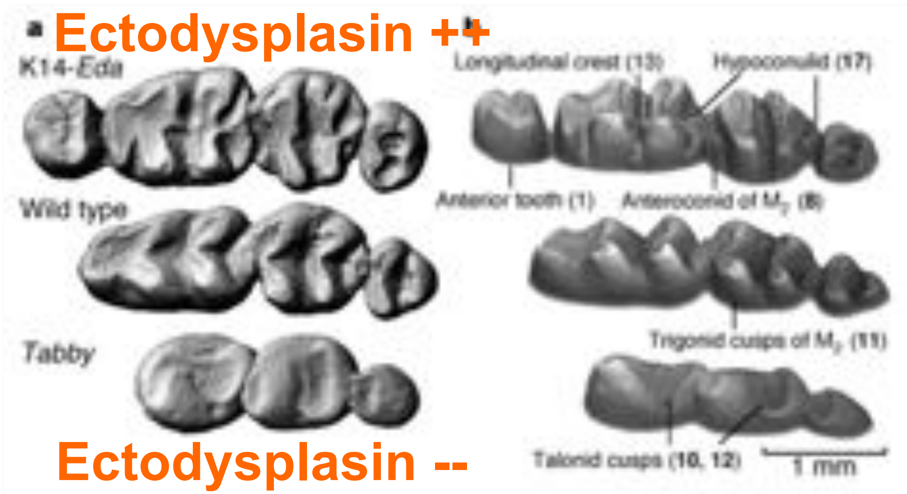
Jsou odlišnosti zubů (kupř. i jen v rámci orální kavity, viz. vnější vs. vnitřní zubní oblouk) vysvětlitelné práve iniciálním odvozením zubů z různých zárodečných vrstev?

(*A. Tucker & P. Sharpe*)



Kaspy jsou generovány enamelovýmy uzly;
nemají však specifický genetický kod - to, co je důležité,
co je selektováno, je celkovostní tvar



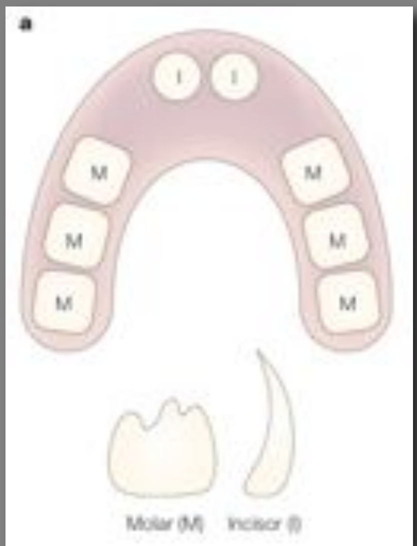


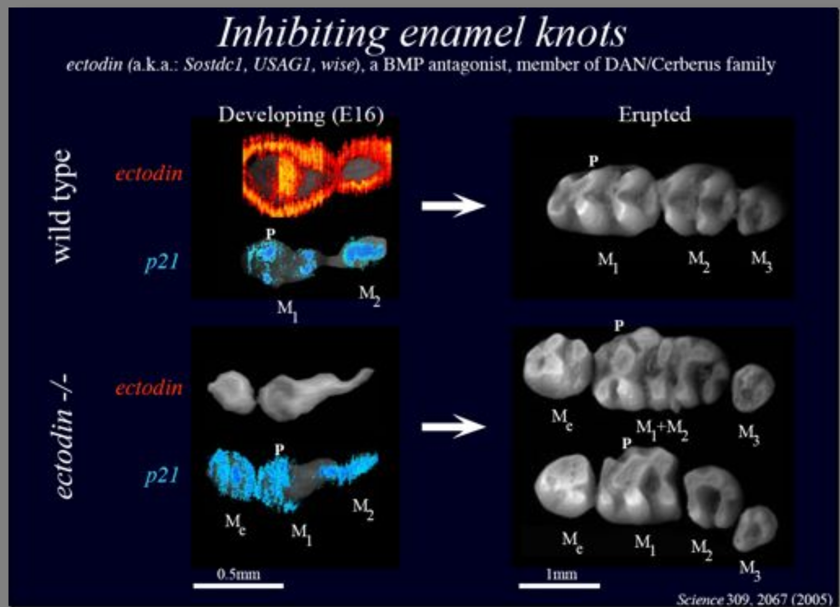
I.H.: Operační předpoklad odontologické analýzy

- jednotlivé zuby (i jejich strukturní elementy) jsou vzájemně *homologní*

Na jednotlivé hrbolky moláru můžeme nahlížet jako na splynulé jednohrbolkové zuby (viz „odontodová“ iniciace Shh);

z tohoto pohledu tedy nemůžeme homologizovat kupř. I1 a M1

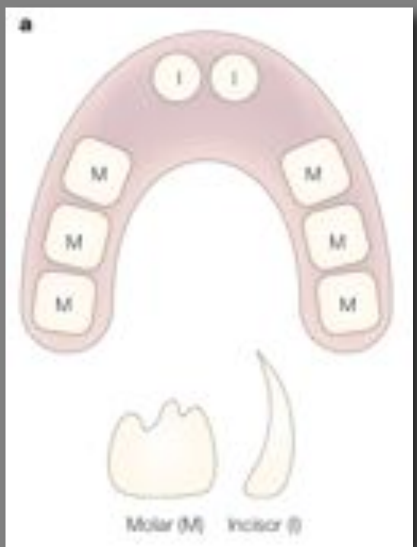




I.H.: Operační předpoklad odontologické analýzy

- jednotlivé zuby (i jejich strukturní elementy) jsou vzájemně *homologní*

To, co u myši nazýváme M1=
(minimálně!) R1 + M1



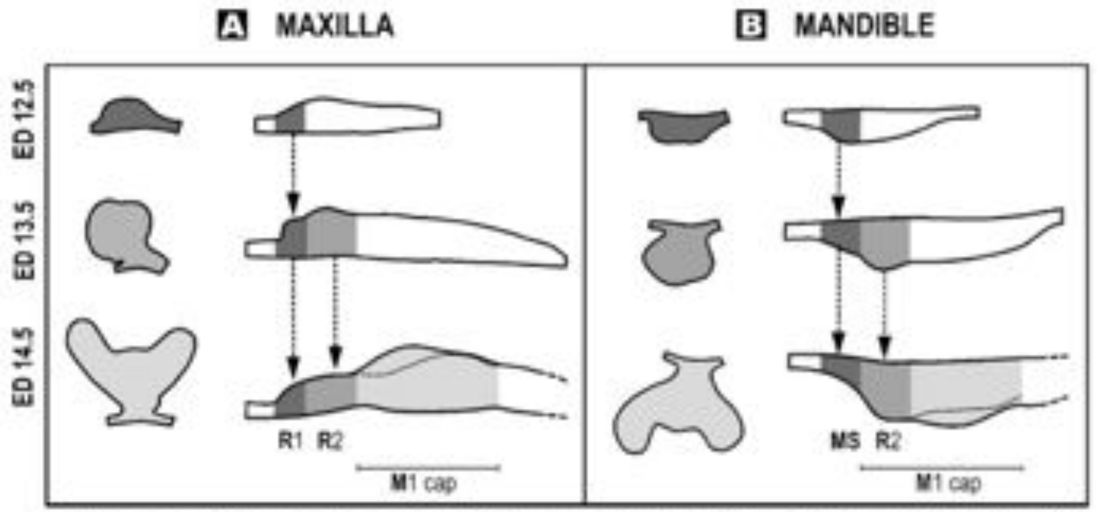


Fig. 2. A scheme of the consecutive origin of tooth primordia in the mouse cheek region. In each maxilla (**A**) and mandible (**B**), the individual tooth primordia are presented on frontal sections (left) and their location in the mound of dental epithelium is shown from sagittal aspect (right). Three distinct structures consecutively develop along the antero-posterior axes in each jaw: At embryonic day (ED) 12.5, the anterior large diastemal bud (R1 and MS—in black) emerges in the maxilla and mandible, respectively. At ED 13.5, the posterior large diastemal bud (R2—dark gray) is conspicuous in both jaws, while the anterior buds (R1 and MS) already regress. At ED 14.5, a cap of the first molar (M1—light gray) differentiates. The R2 degenerates in the maxilla (Peterkova et al., '96), while it is incorporated and participates in the formation of the anterior part of the M1 in the mandible (Viriot et al., 2000). The homology has been proposed between the large diastemal vestiges and the structures related in the literature to signaling centers at ED 12.5 and 13.5 (Peterkova et al., 2000, 2002a).

ZUB ve skeletálním kontextu:

vznik a vývoj čelistí,

ECT a ENT čelisti,

faryngobranchiale 5

integrace čelistí a dentice

Nezbytným předpokladme pro funkci zubu je jeho zasazení do čelisti …

Nezbytným předpokladme pro funkci zubu je jeho zasazení do čelisti …

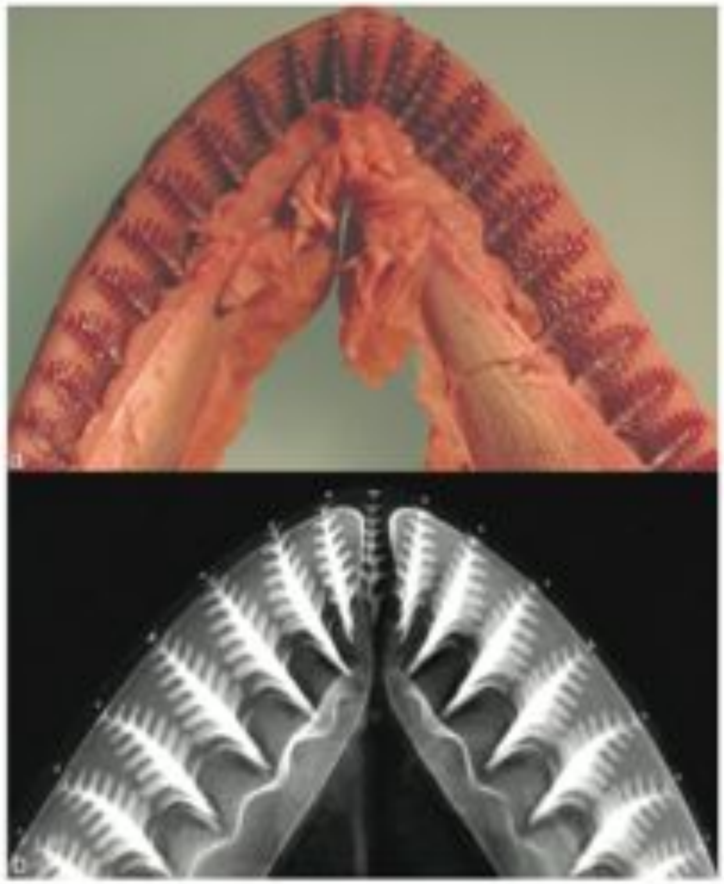


Fig. 9. Lower jaw with epithelium removed (a) and radiograph (b) of the same specimen of embryo gray reef shark (*C. amblyrhyncos*). Regular tooth files are shown each in line with single first rudimentary teeth (tooth shards, beyond the cartilage margin) and space between these used for increase in size of later tooth bases, but nonalternation of teeth.

Nezbytným předpokladme pro funkci zubu je jeho zasazení do čelisti …

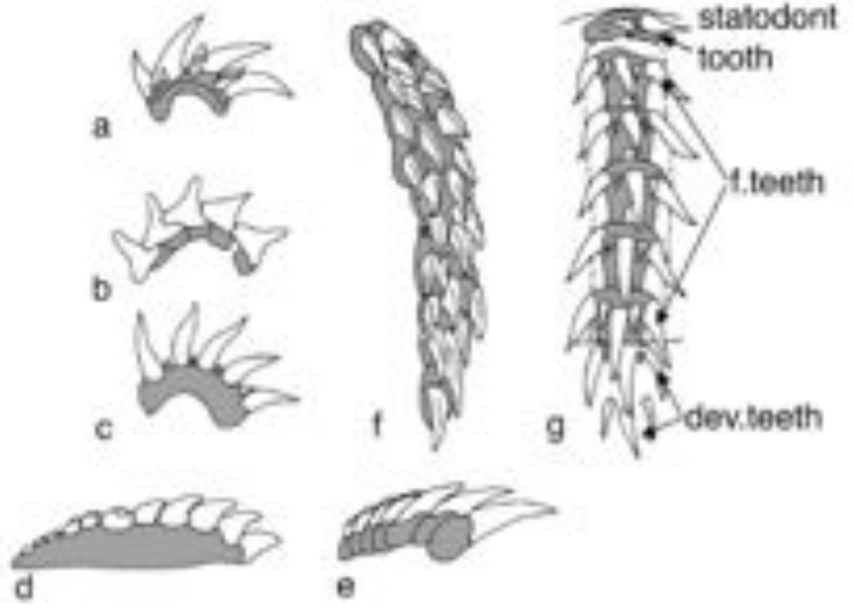


Fig. 2. Representation of tooth whorls in the jaws of fossil and extant fish, anterior to the left in a–d: (a) acanthodian; (b) chondrichthyan, one tooth set in a modern shark with separate tooth bases; (c) sarcopterygian; (d) one row of lungfish tooth-plate. (e) Pharyngeal joined denticle set from early stethacanthid *Akmonistion zangerli*, a primitive chondrichthyan. (f) Pharyngeal joined denticle set of an agnathan, the thelodont *Loganellia scotica*. (g) One tooth set from the frilled shark *Chlamydoselachus anguineus*, five functional teeth (f. teeth) are locked together with special attachment region, one is outside the edge of the jaw (statodont tooth), two developing teeth are below the lingual epithelium (see Fig. 7). Sources for drawings in a–e are Denison (1979), Reif (1976), Moy-Thomas and Miles (1971), Smith (1988), and Smith and Coates (2001).

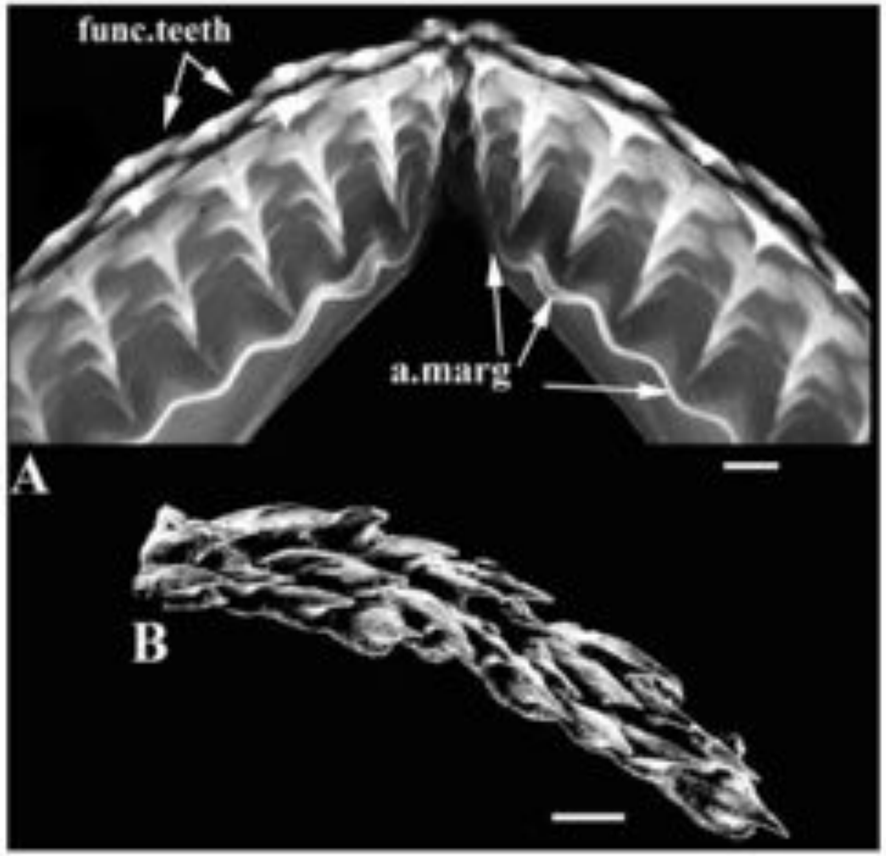
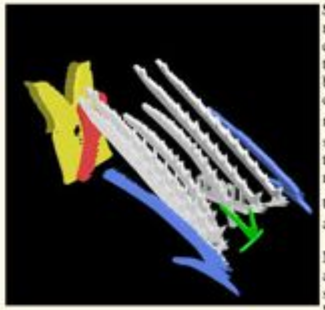


Fig. 2. **A:** Tooth sets along the lower jaw of the chondrichthyan *Carcharhinus melanopterus*. Note staggered or offset positions of tooth sets, particularly with regard to the alternation of the functional teeth at the jaw margin (func.teeth). Scale bar = 1.0 cm. **B:** Denticle whorl of the agnathan (jawless fish) *Loganellia* (Thelodonti). Scale bar = 1.0 mm. Adapted from Smith and Coates (2001: fig. 14.1H). a.marg, active margin of dental lamina, site of most recent tooth production; small dentine tooth cores.

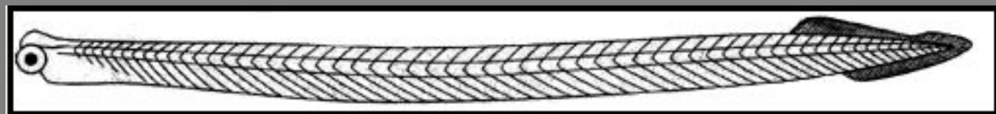
Zubní elementy: Konodonta

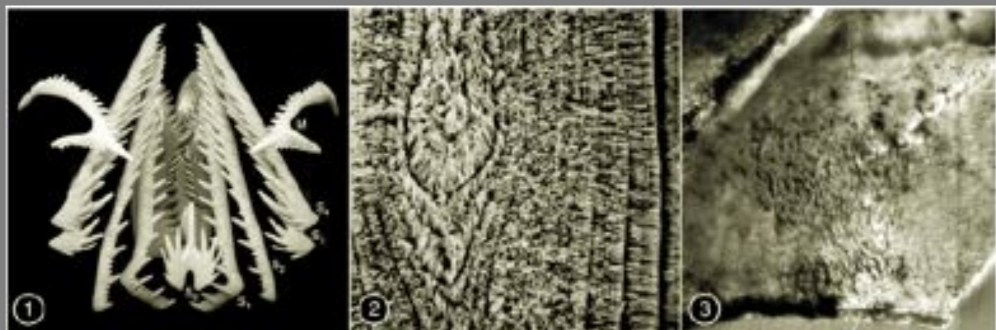


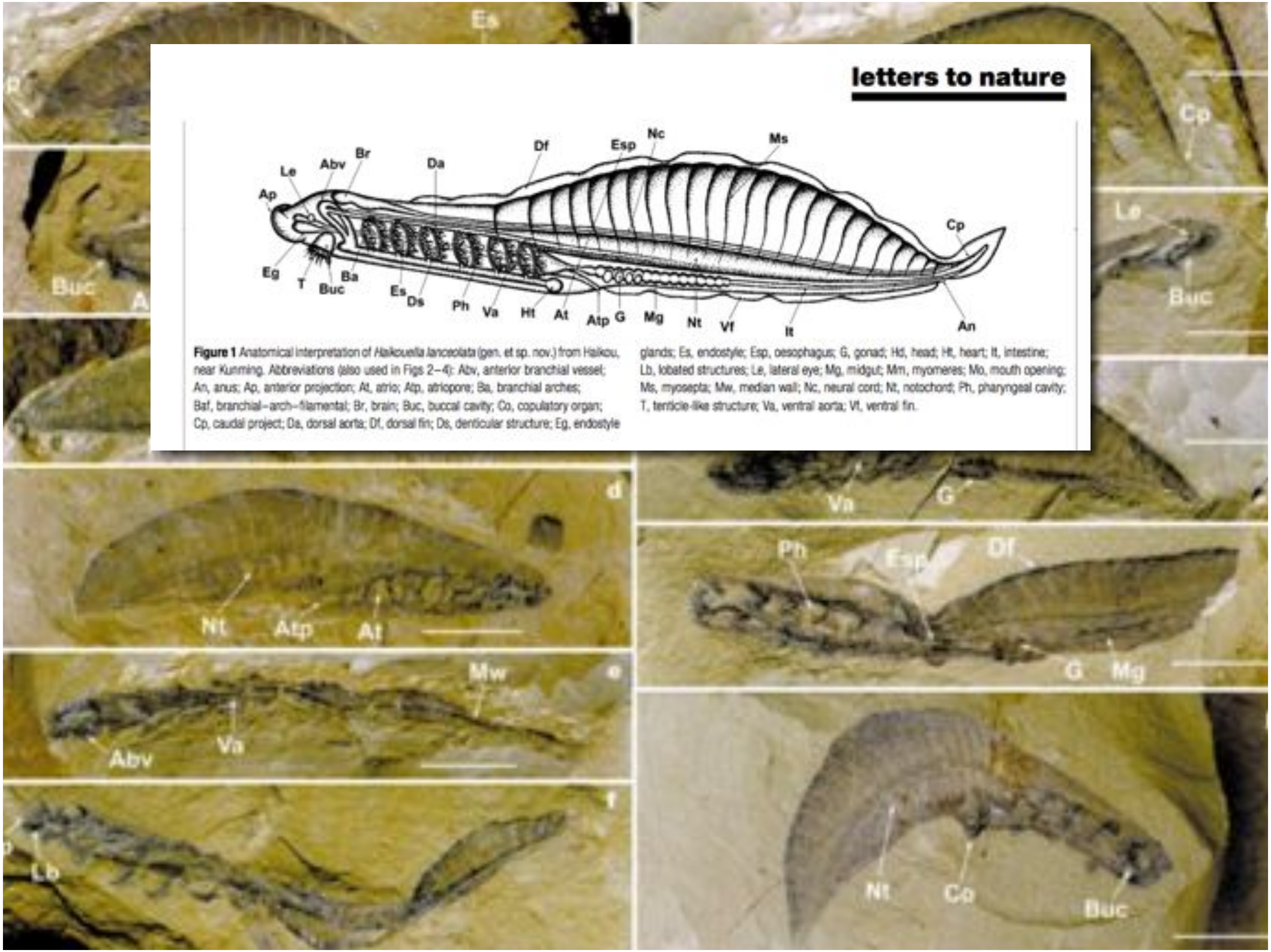
S-Elements: In the image of an *Idiognathodus* natural assemblage at right, the S-elements are the long, rod-like bones with straight, transverse pectinate teeth and a sort of pick-axe at the anterior or rostral end. More generally, S-elements are frequently curved, as in the *Manticolepis* model below. However, they are all relatively simple in shape, relatively gracile, and with strong longitudinal asymmetry, the base being located much closer to one end than the other. Each conodont has 4 or 5 mirror-image pairs of S-elements, numbered S_1 to S_4 or S_5. In addition, each conodont possesses a symmetrical, unpaired, median S_0 element, shown as green on the figure on the left. The S_0 is an unpaired, bilaterally symmetrical, medial element which is effectively at least triramous. Two of its branches create a stout, transverse, *rastrate* bar across the bottom of the mouth, denticles facing upward. The S-element numbering system is symmetrically arranged around this S_0 element, with the first element to the left of the S_0 designated S_1^s, the first to the right S_1^d, and so on (with the superscript designations for sinister and *dexter*).

M-Elements: Conodonts have a single pair of M-elements. These are only loosely connected to the S-assemblage and appear to have been attached in the mouth cavity on its dorsal or lateral surface. Their shapes are frequently complex, vaguely reminiscent of anything from a nunchuck to a dart. While the M-elements are structurally obscure, their functional role is clear. They are the fork which held the food item in place as it was sliced or scooped by the S-elements, which acted as a combination knife and spoon.

P-Elements: The P-elements are the stout bones at the right of the right image, the left of the left image, and the bottom of the bottom (*Manticolepis*) image. Contrary to everyone's expectations, they appear to have been oriented vertically, with the two sets of denticles facing and, in fact, interdigitating as shown in the *Idiognathodus* natural assemblage. Purnell has produced convincing SEM images showing regular wear facets. The clear implication is that, at least in *Idiognathodus*, the teeth occluded in a regular and precise way. High resolution images of these facets may be found at Wear on conodont elements.







letters to nature

Figure 1 Anatomical interpretation of *Haikouella lanceolata* (gen. et sp. nov.) from Haikou, near Kunming. Abbreviations (also used in Figs 2–4): Abv, anterior branchial vessel; An, anus; Ap, anterior projection; At, atrio; Atp, atriopore; Ba, branchial arches; Baf, branchial–arch–filamental; Br, brain; Buc, buccal cavity; Co, copulatory organ; Cp, caudal project; Da, dorsal aorta; Df, dorsal fin; Ds, denticular structure; Eg, endostyle glands; Es, endostyle; Esp, oesophagus; G, gonad; Hd, head; Ht, heart; It, intestine; Lb, lobated structures; Le, lateral eye; Mg, midgut; Mm, myomeres; Mo, mouth opening; Ms, myosepta; Mw, median wall; Nc, neural cord; Nt, notochord; Ph, pharyngeal cavity; T, tenticle-like structure; Va, ventral aorta; Vf, ventral fin.

Co vše „nejsou“ zuby?

The Keratinised Teeth of *Myxine glutinosa*. A Histological, Histochemical, Ultrastructural and Experimental Study[1]

Jennifer Dawson Department of Biology as Applied to Medicine, Middlesex Hospital Medical School, London[2]

(Received September 1967)

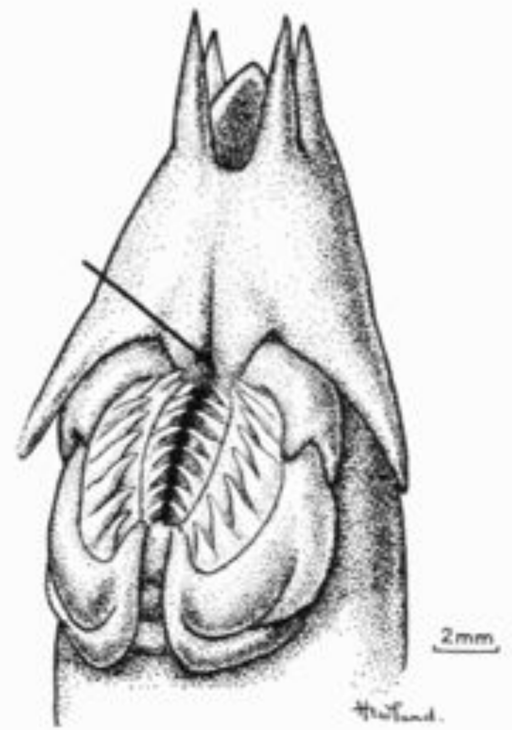
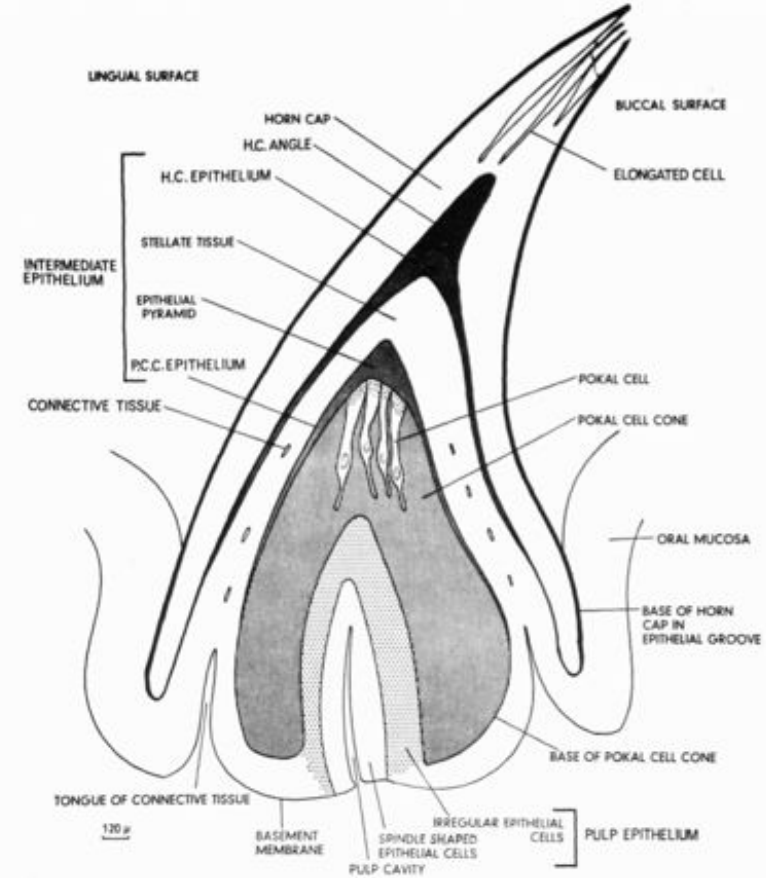
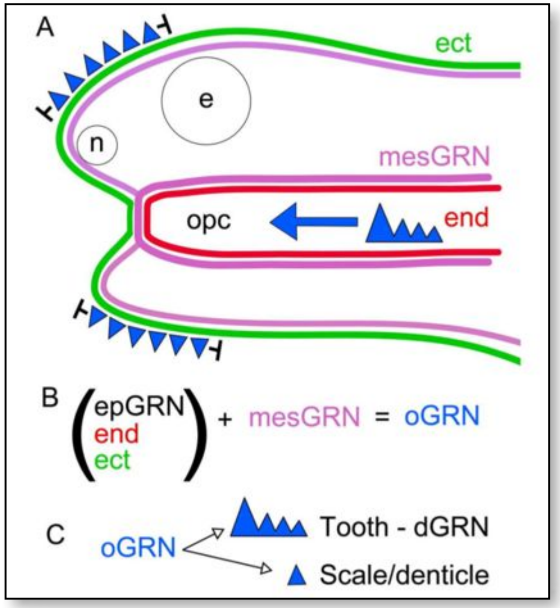
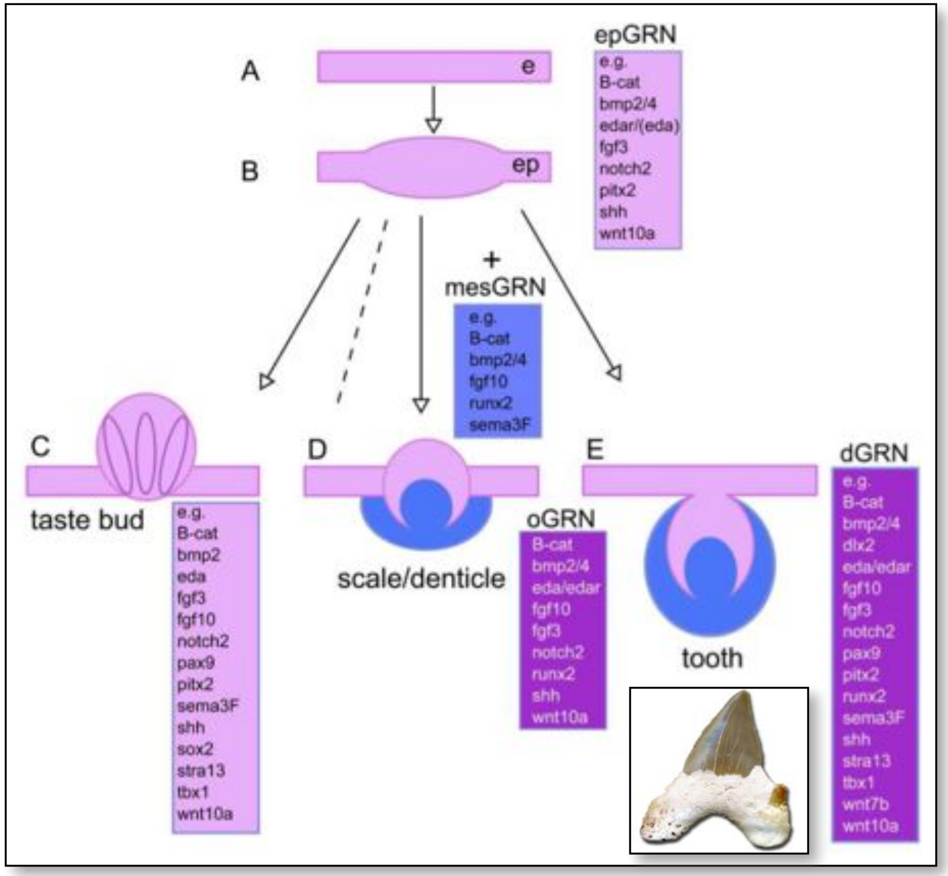


Fig. 1. Drawing of the ventral surface of the head, showing the mouth with the lingual teeth on the extruded dental plate, the nasohypophysial opening and four pairs of barbels. The position of the palatal tooth is indicated. (× 3.)



A new perspective:
collaborative interactions of ep- & NC-GRN's





Gene networks, neural crest and the advent of vertebrate dentitions

G.Fraser, R.Cerny, V.Soukup, J.Streelman: subm)

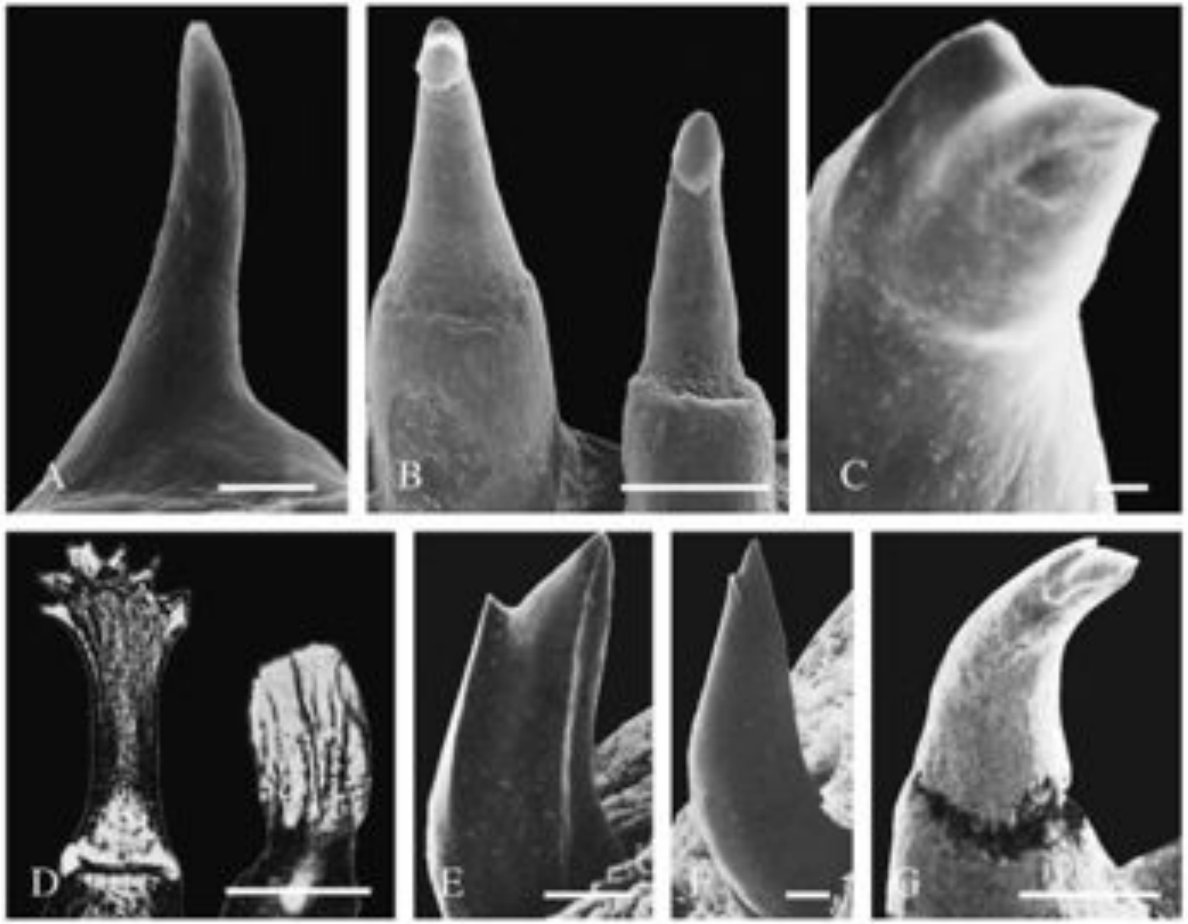


Fig. 3. Examples of tooth morphology in lissamphibians. (A, B, C) Tooth shape throughout ontogeny in the caudate, *Pleurodeles waltl*. (A) First-generation tooth in a larva, stage 44. The tooth is monocuspid and the dividing zone is lacking. (B) Third- (left) and fourth- (right) generation tooth in a five-month-old, postmetamorphosed specimen. The teeth are bicuspid and the dividing zone is visible. (C) Detail of the tooth tip in an adult showing the two cusps. The main cusp is lingually oriented. (D, E, F) Teeth in Gymniophona. (D) Typical tooth morphology in an embryo of *Geotrypetes seraphini* (left) and in a foetus of *Nectocaecilia petersi* (right). (E) Adult tooth in *Hypogeophis rostratus*. (F) Adult tooth in *Geotrypetes seraphini*. (G) Adult tooth in the anuran *Bombina bombina* (Linnaeus, 1761). D modified from Parker & Dunn (1964); E, F from Wake & Wurst (1979): G from Clemen & Greven (1980). Scale bars: A, B, D-G = 100 µm; C = 10 µm.

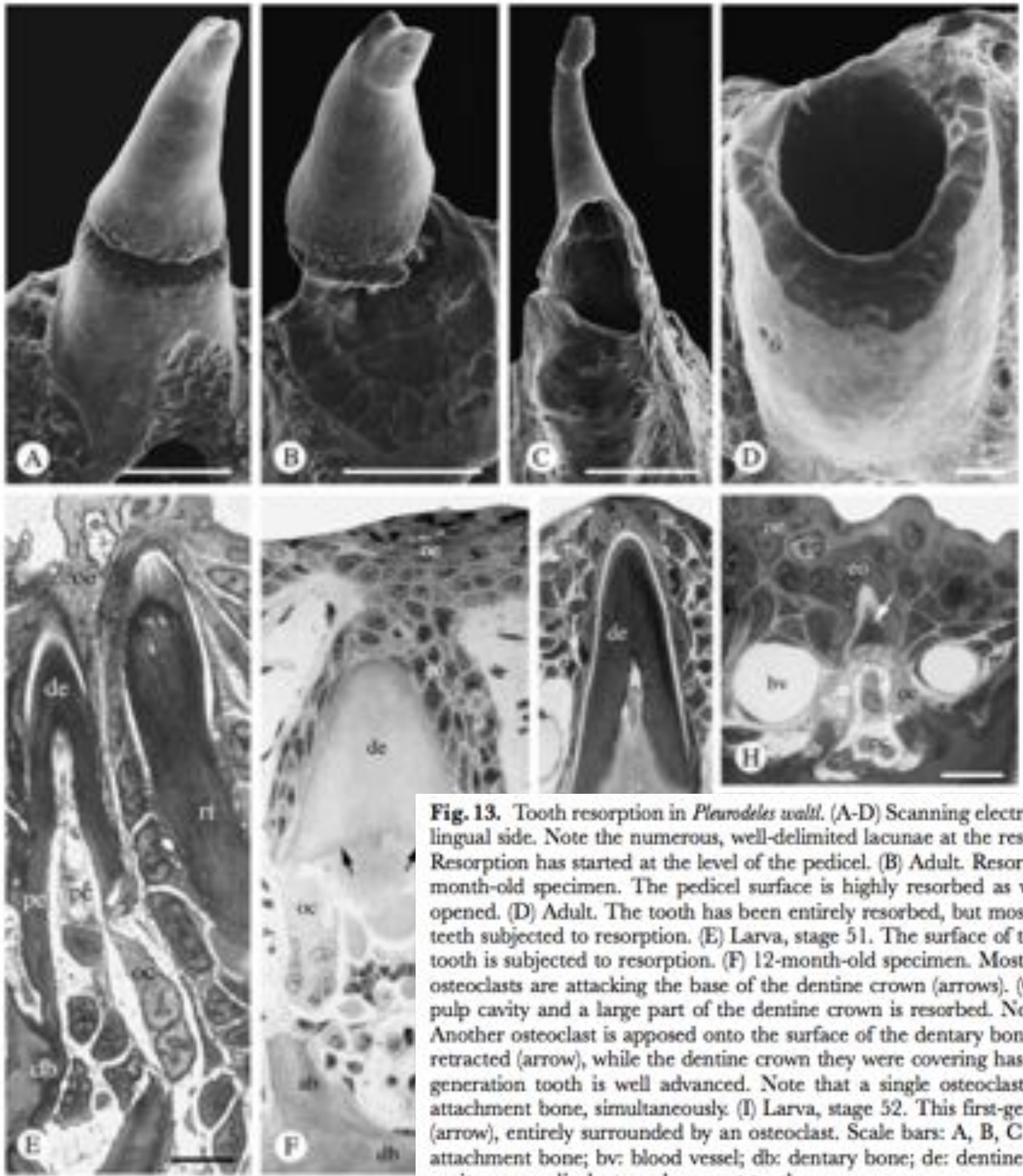


Fig. 13. Tooth resorption in *Pleurodeles waltl*. (A-D) Scanning electron micrographs of teeth subjected to resorption, viewed from the lingual side. Note the numerous, well-delimited lacunae at the resorption sites, revealing the location of the osteoclasts. (A) Adult. Resorption has started at the level of the pedicel. (B) Adult. Resorption has extended to the whole surface of the pedicel. (C) Ten-month-old specimen. The pedicel surface is highly resorbed as well as the base of the crown, where the pulp cavity has been opened. (D) Adult. The tooth has been entirely resorbed, but most of the pedicel remains. (E-I) One µm-thick, vertical sections of teeth subjected to resorption. (E) Larva, stage 51. The surface of the pedicel located close to the enamel organ of the replacement tooth is subjected to resorption. (F) 12-month-old specimen. Most of the pedicel has been resorbed and two large, multinucleated osteoclasts are attacking the base of the dentine crown (arrows). (G) Eight-month-old specimen. An osteoclast has penetrated the pulp cavity and a large part of the dentine crown is resorbed. Note the decalcification of the dentine matrix prior to resorption. Another osteoclast is apposed onto the surface of the dentary bone. The cells of the enamel organ of the resorbed tooth have not retracted (arrow), while the dentine crown they were covering has been resorbed. (H) Larva, stage 48. The resorption of this first-generation tooth is well advanced. Note that a single osteoclast is involved in the resorption of the dentine cone and of the attachment bone, simultaneously. (I) Larva, stage 52. This first-generation tooth has been resorbed, but its tooth tip is still visible (arrow), entirely surrounded by an osteoclast. Scale bars: A, B, C = 100 µm; D, H = 20 µm; E, I = 10 µm; F, G = 50 µm. ab: attachment bone; bv: blood vessel; db: dentary bone; de: dentine; eo: enamel organ; oc: osteoclast; oe: oral epithelium; pc: pulp cavity; pe: pedicel; rt: replacement tooth.

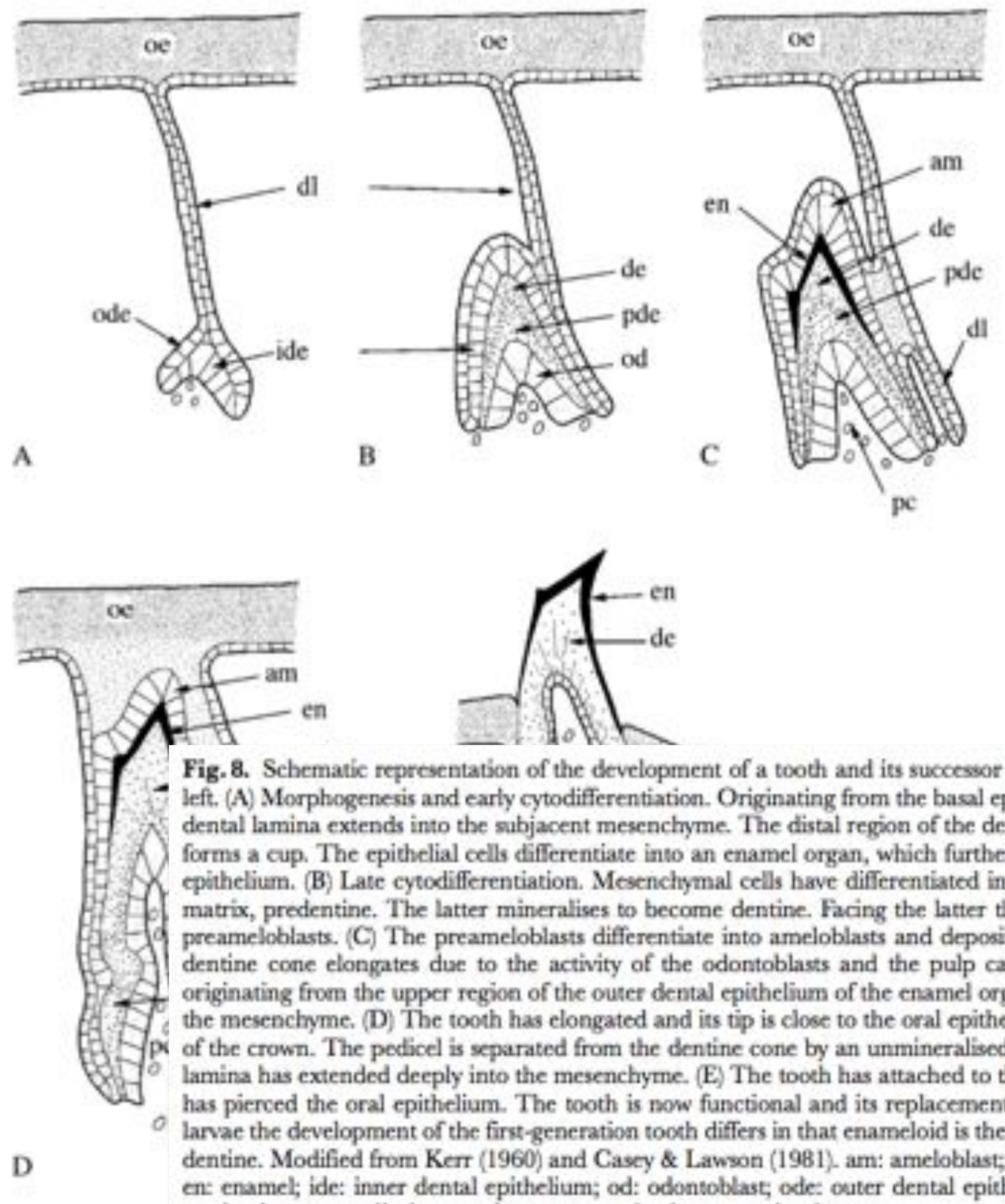
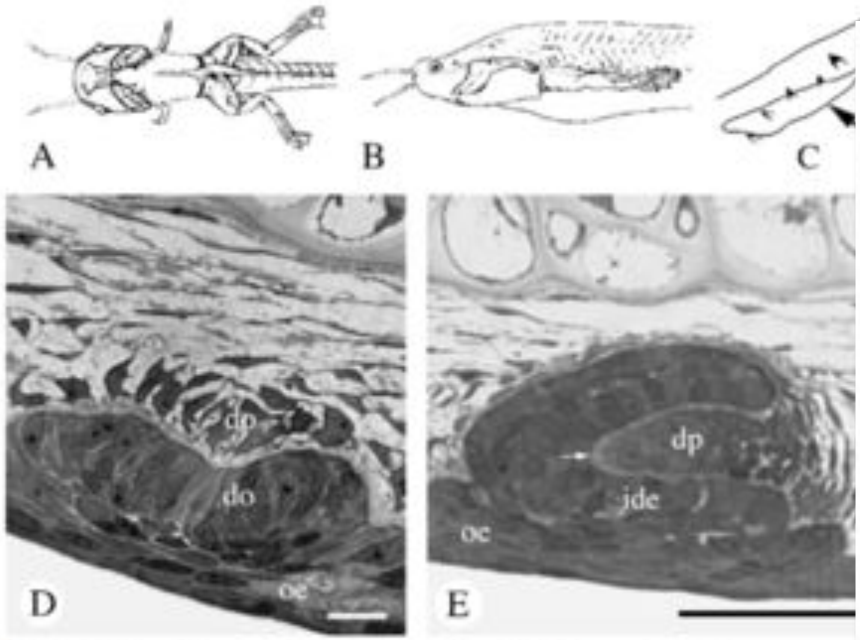


Fig. 8. Schematic representation of the development of a tooth and its successor in a generalised lissamphibian. Anterior is to the left. (A) Morphogenesis and early cytodifferentiation. Originating from the basal epidermal layer of the oral epithelium, the primary dental lamina extends into the subjacent mesenchyme. The distal region of the dental lamina interacts with mesenchymal cells and forms a cup. The epithelial cells differentiate into an enamel organ, which further differentiates into an inner and an outer dental epithelium. (B) Late cytodifferentiation. Mesenchymal cells have differentiated into odontoblasts, which deposit an unmineralised matrix, predentine. The latter mineralises to become dentine. Facing the latter the inner dental epithelium cells differentiate into preameloblasts. (C) The preameloblasts differentiate into ameloblasts and deposit the enamel matrix on the dentine surface. The dentine cone elongates due to the activity of the odontoblasts and the pulp cavity starts to form. A secondary dental lamina, originating from the upper region of the outer dental epithelium of the enamel organ at the posterior side of the tooth, extends into the mesenchyme. (D) The tooth has elongated and its tip is close to the oral epithelium. The pedicel has started to form at the base of the crown. The pedicel is separated from the dentine cone by an unmineralised region, the dividing zone. The secondary dental lamina has extended deeply into the mesenchyme. (E) The tooth has attached to the supporting bone through its pedicel and its tip has pierced the oral epithelium. The tooth is now functional and its replacement tooth has started to form. Note that in caudate larvae the development of the first-generation tooth differs in that enameloid is the first matrix deposited by the odontoblasts, before dentine. Modified from Kerr (1960) and Casey & Lawson (1981). am: ameloblast; de: dentine; dl: dental lamina; dz: dividing zone; en: enamel; ide: inner dental epithelium; od: odontoblast; ode: outer dental epithelium; oe: oral epithelium; pc: pulp cavity; pde: predentine; pe: pedicel; rt: replacement tooth; sb: supporting bone.



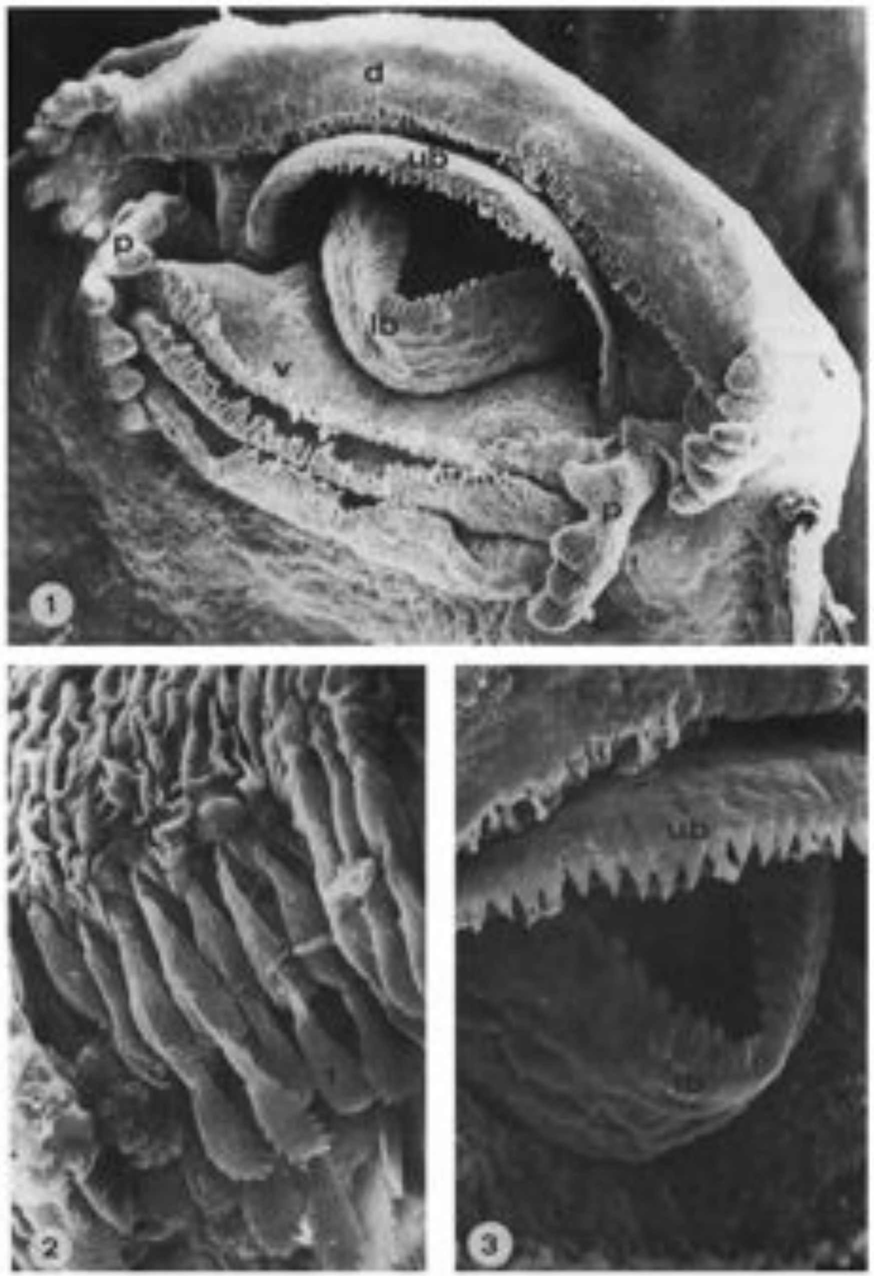
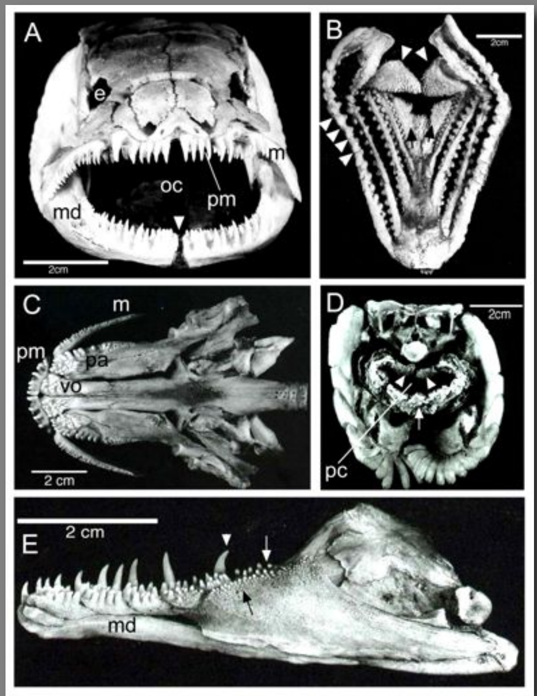


Fig. 11. Tooth development in an anuran, the pipid *Xenopus laevis*. In contrast to
metamorphosis. (A, B) Tadpole, stage 59, ventral and lateral views, respectively. T
at this stage. (C) Tooth pattern in a tadpole, stage 59. As in most anuran species
μm-thick vertical sections of the upper jaw of tadpoles (stages 54, 58, 63 and 65,
of first-generation teeth, from initiation (D) to attachment (G). The arrow in E
The arrows in F and G indicate the previous location of the enamel in th
Developmental stages are as in Nieuwkoop & Faber (1956). A, B modified from N
Scale bars: C = 250 μm; D = 10 μm; E-G = 50 μm. de: dentine; do: dental org
dental epithelium; mb: maxillary bone; od: odontoblast; oe: oral epithelium; p

Plesiomorfní stav: zuby na mnoha lokacích



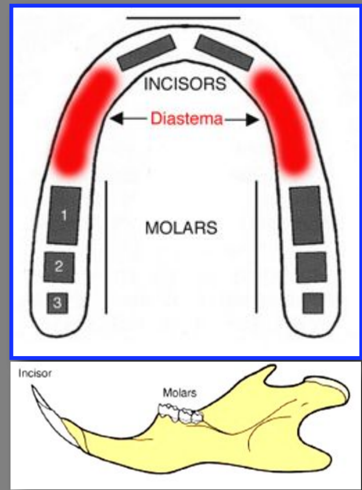
Bowfin (Amia calva) represents a 'primitive' dental system

Rainbow Trout..

- Teeth present in multiple locations
- Homodont dentition
- Single row of oral teeth

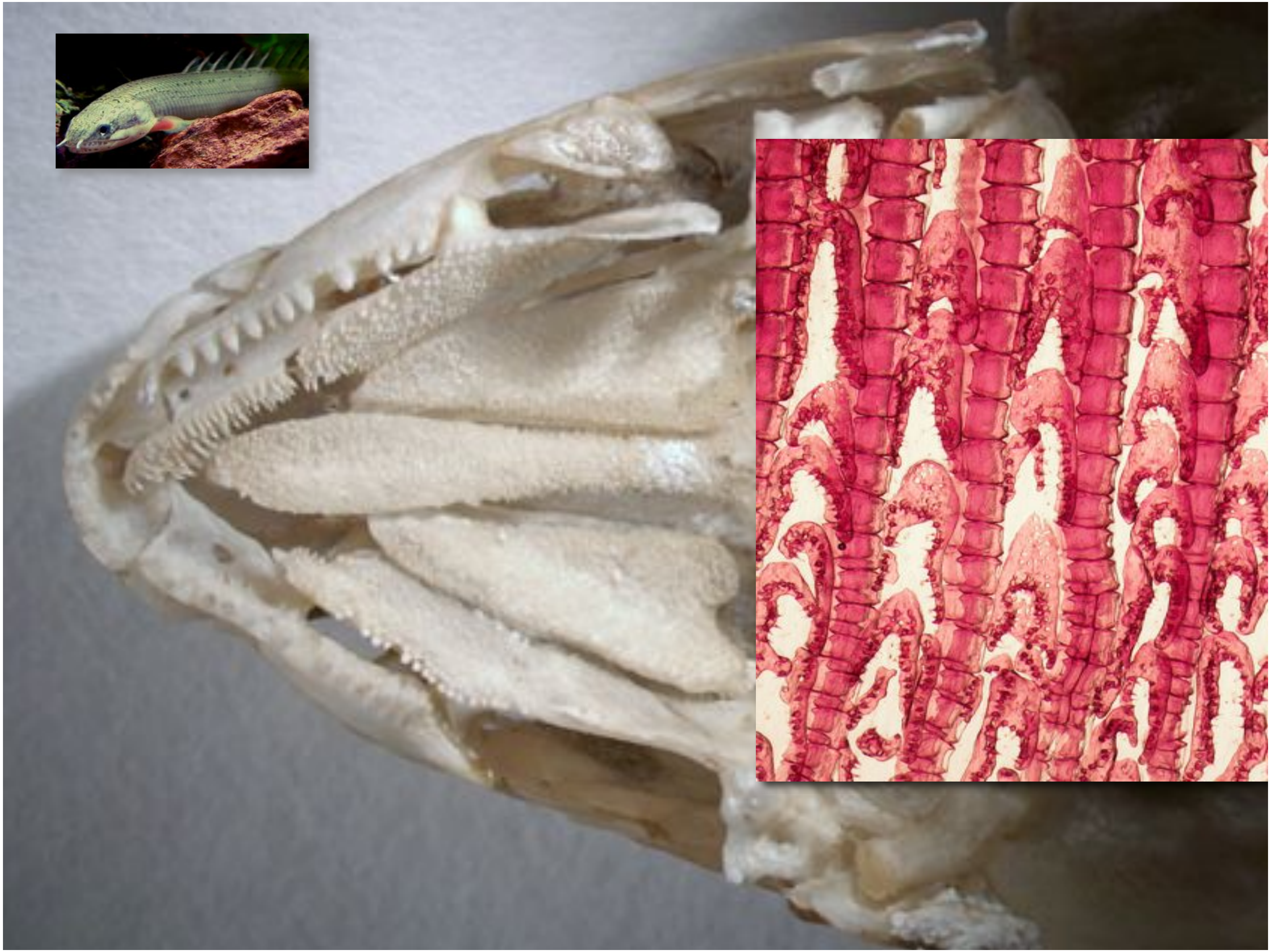
Zebrafish..

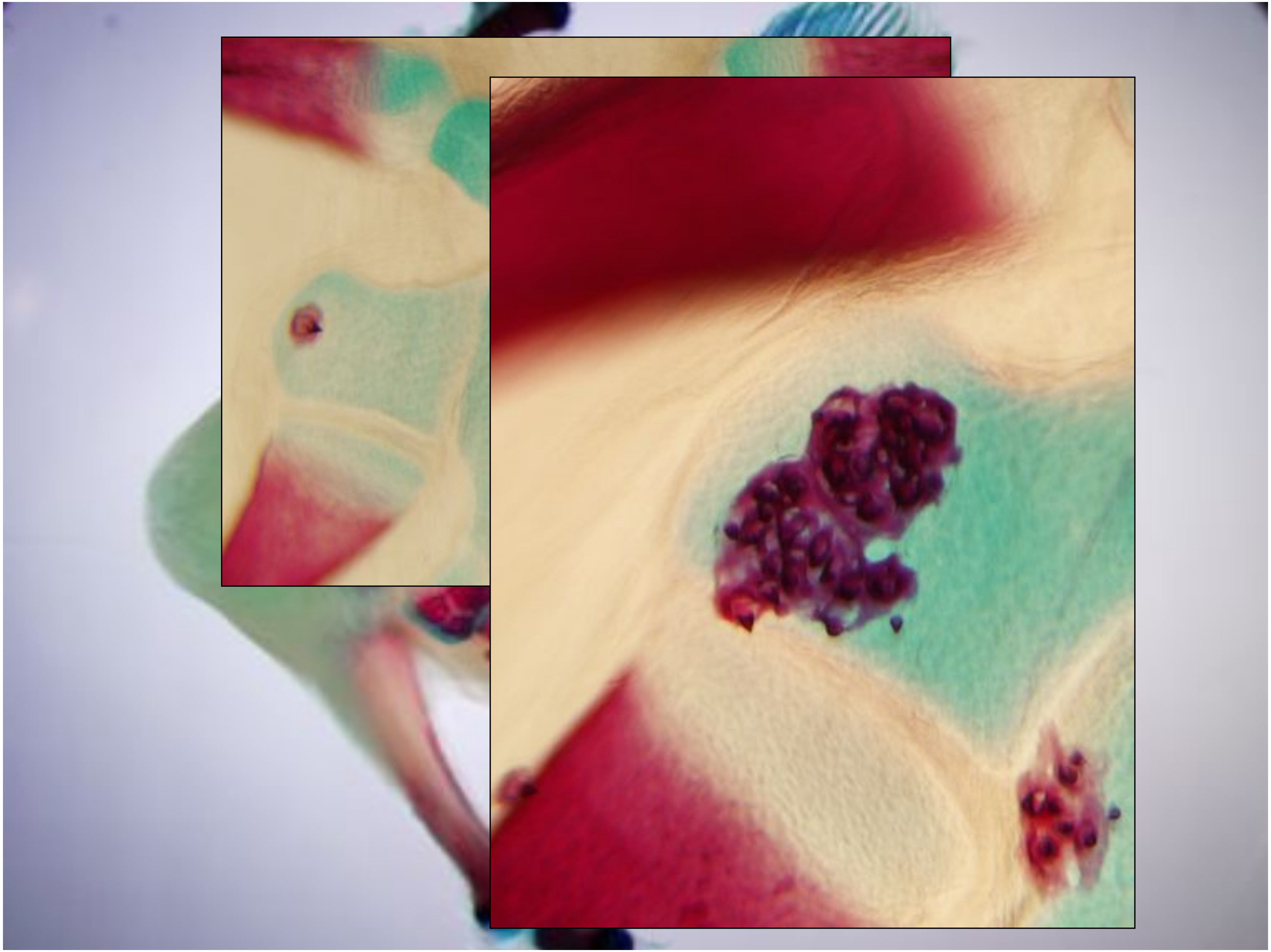
- Homodont dentition
- No oral teeth- teeth restricted to posterior pharynx

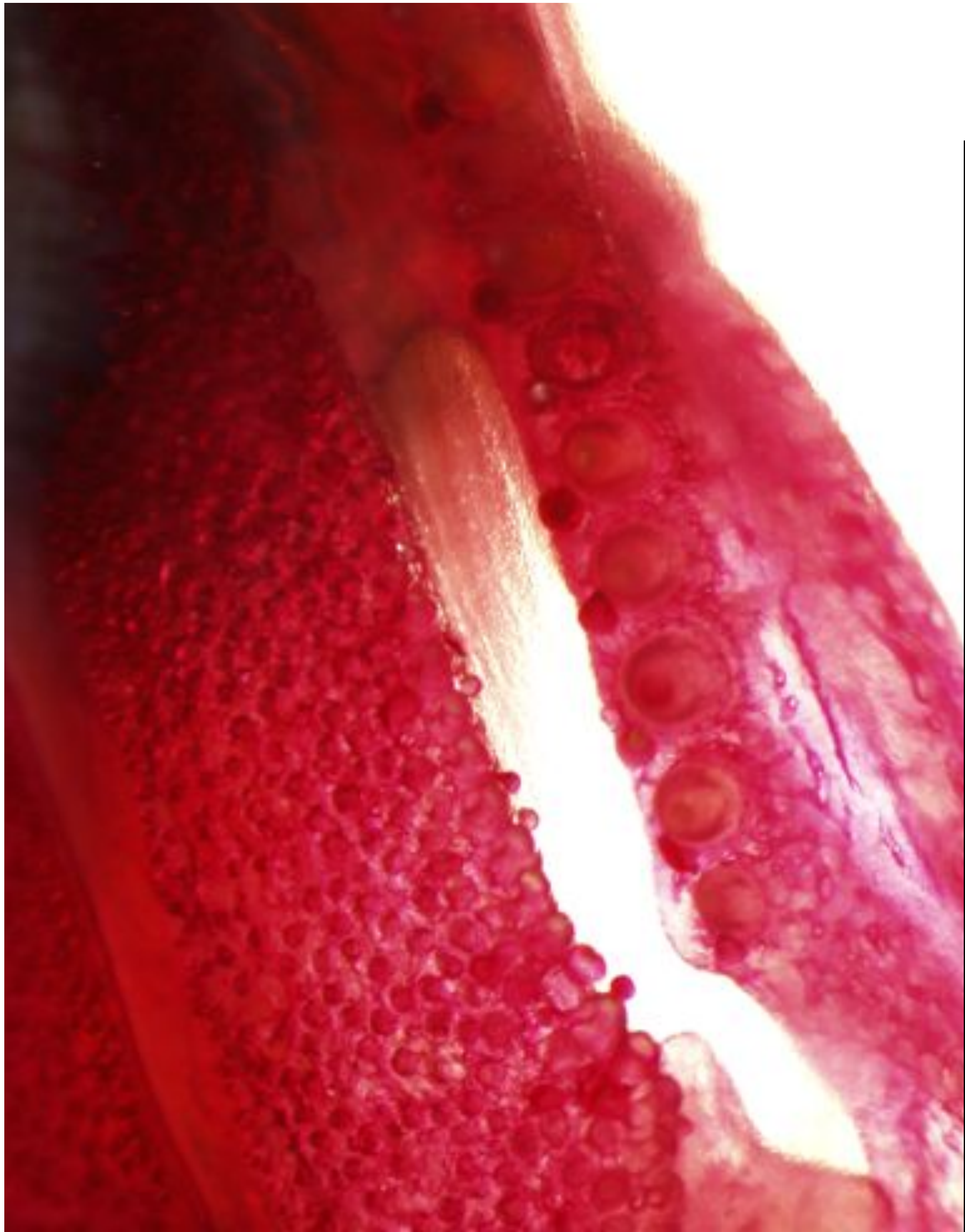


Mouse..

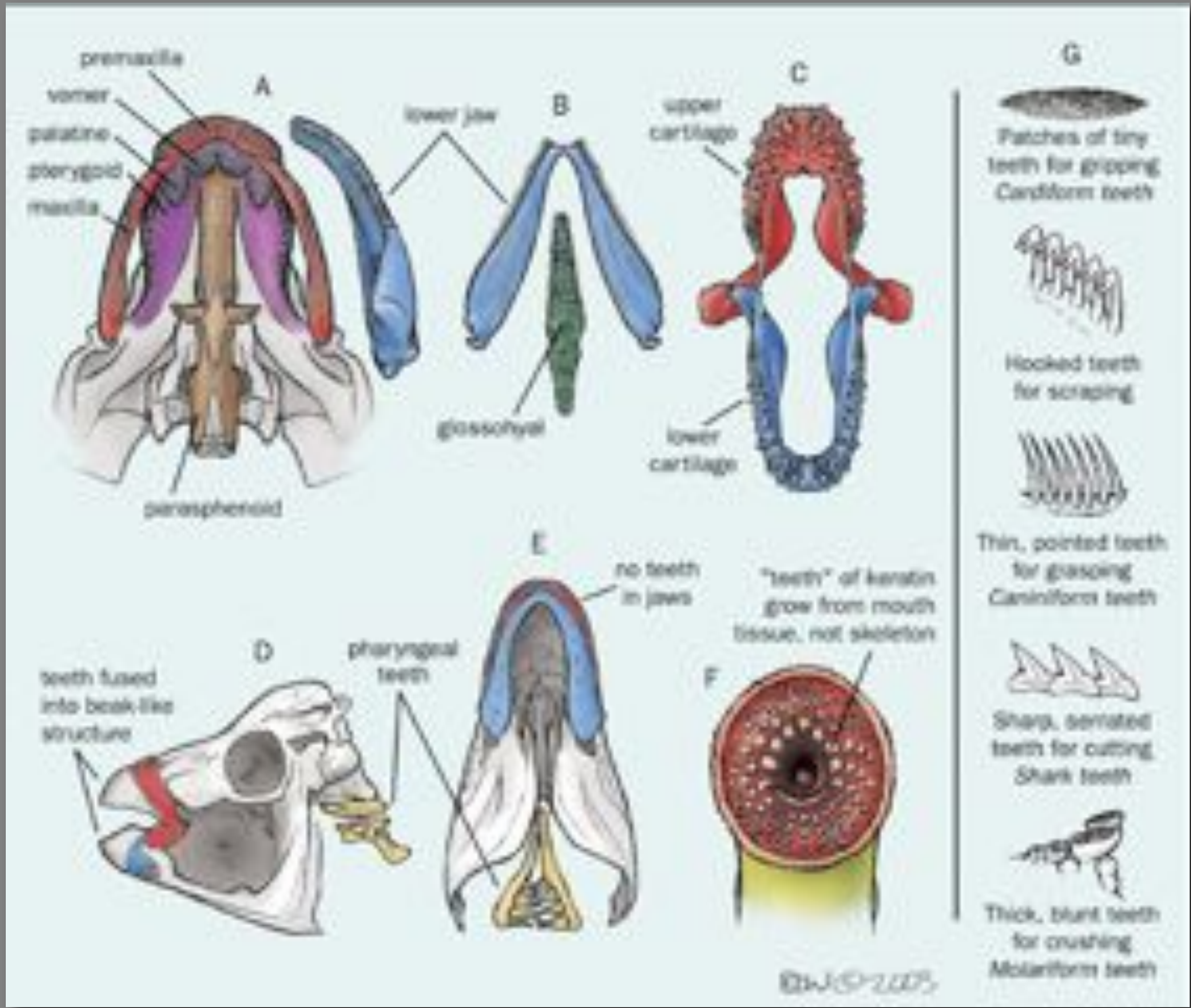
- A well studied model for initiation of heterodont odontogenesis: no replacement teeth
- How applicable is the mouse data to



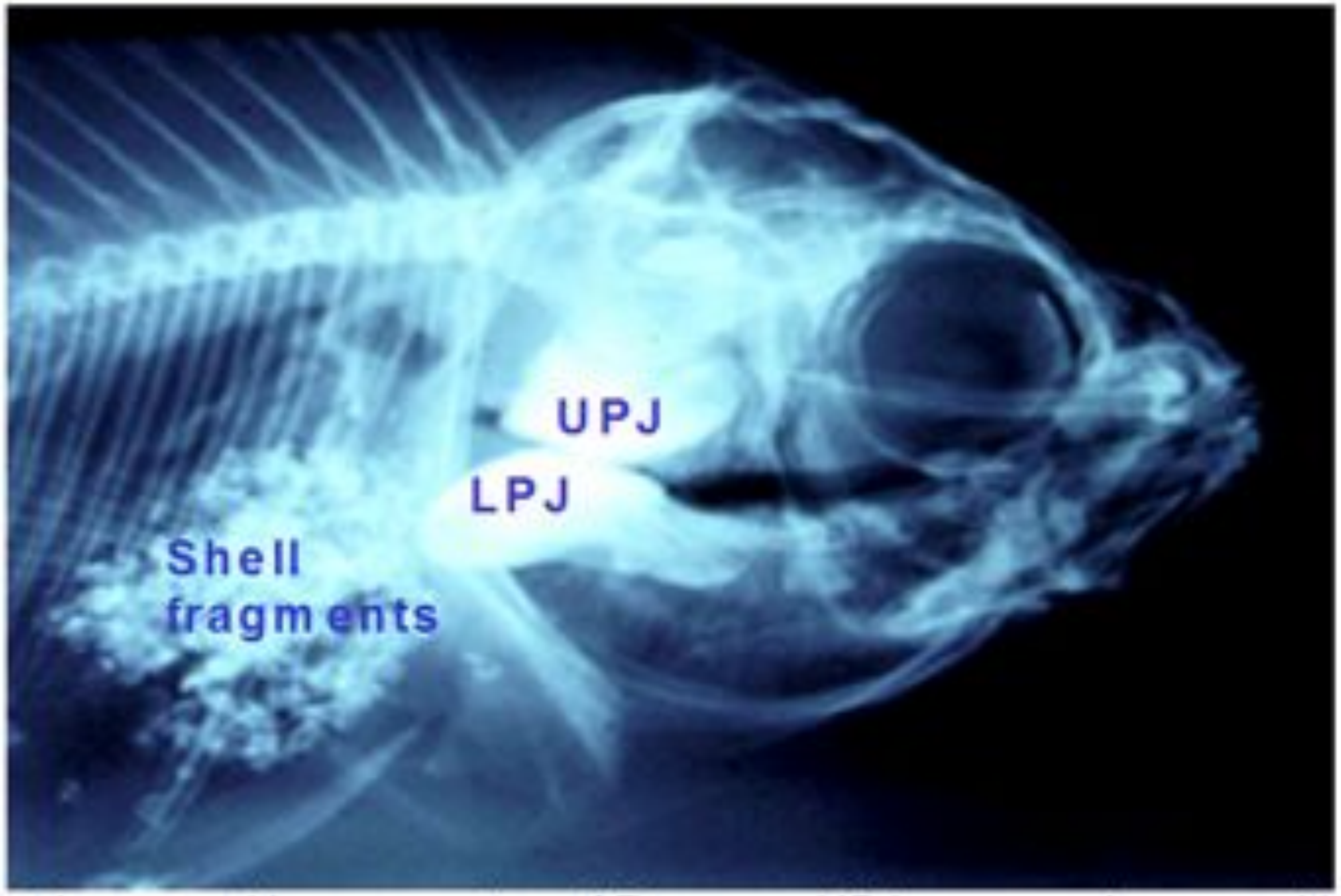




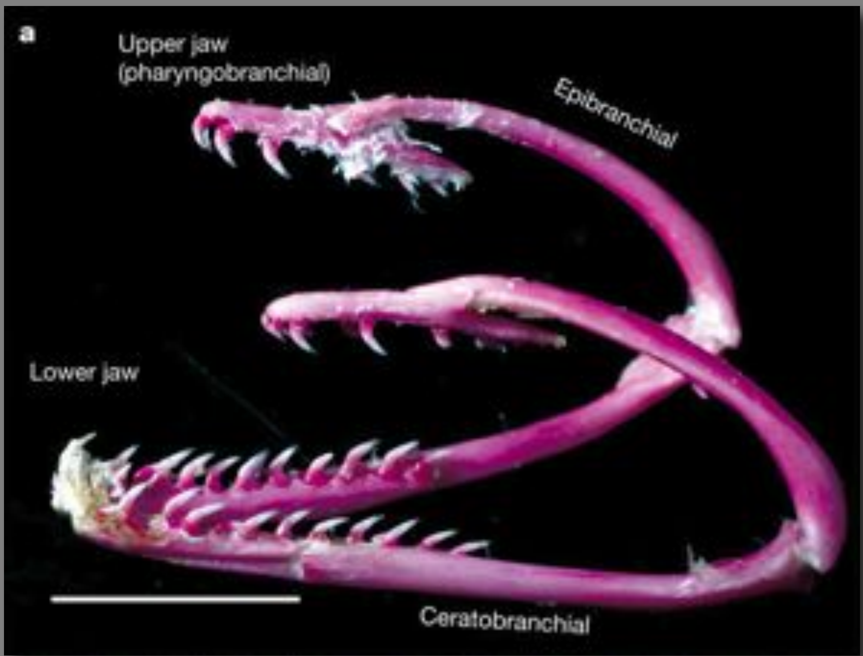
Pozice zubů a čelistí

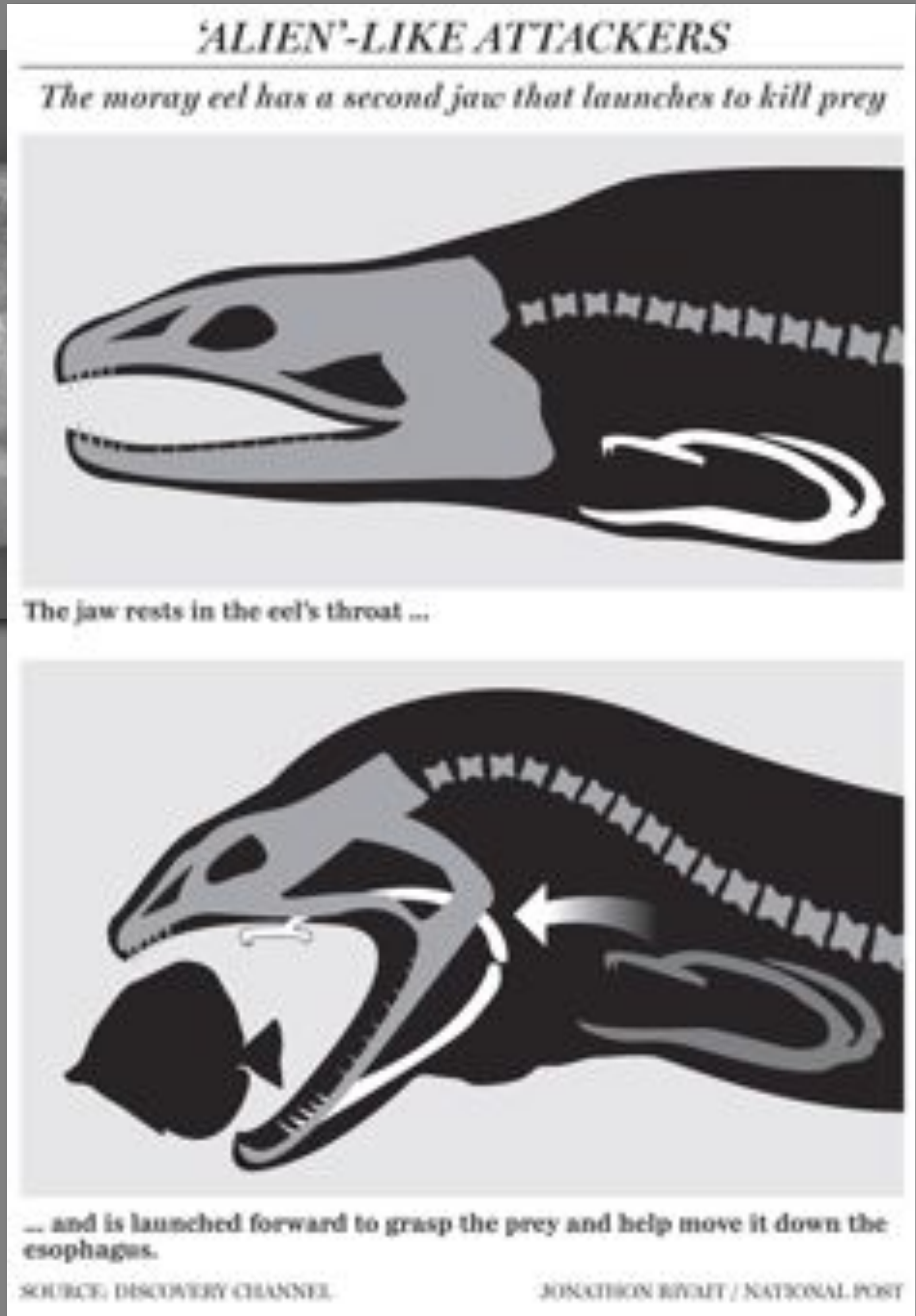


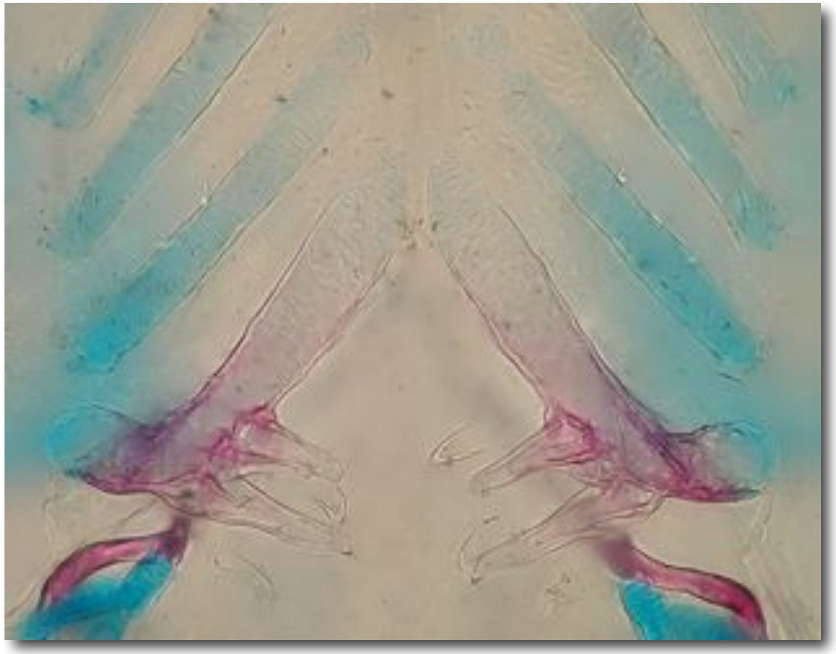
Faryngeální čelisti a dentice



The pharyngeal jaw apparatus of R. vacca. UPJ = upper pharyngeal jaw. LPJ = lower pharyngeal jaw. Together, the UPJ and LPJ shear gastropod shells into tiny fragments, allowing digestive enzymes to break down food, which would otherwise be protected by an intact shell and operculum. Photo by Jeff Jensen.

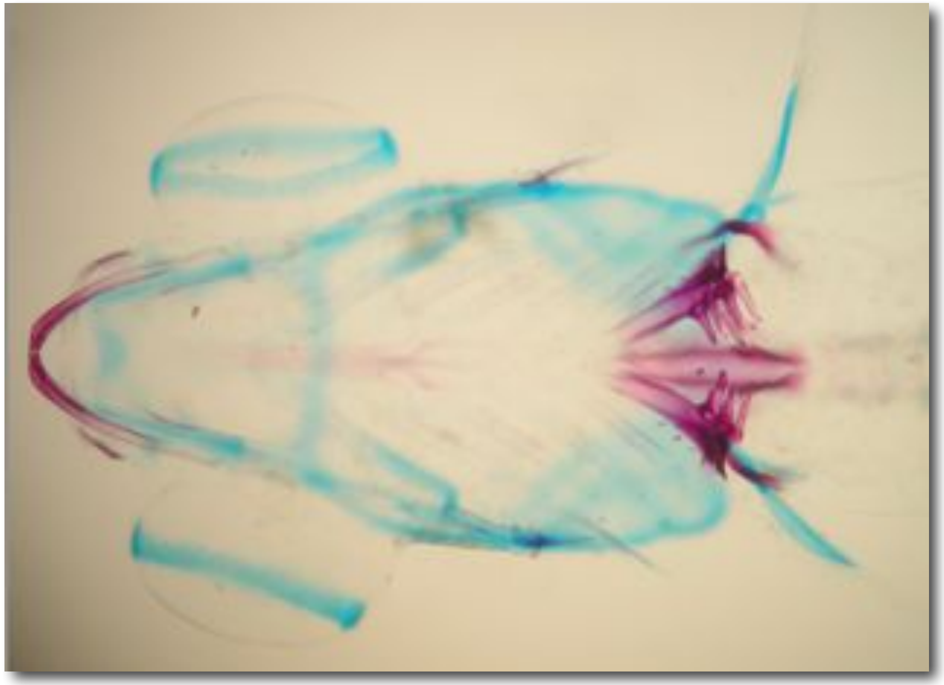

a
Upper jaw
(pharyngobranchial)
Epibranchial
Lower jaw
Ceratobranchial

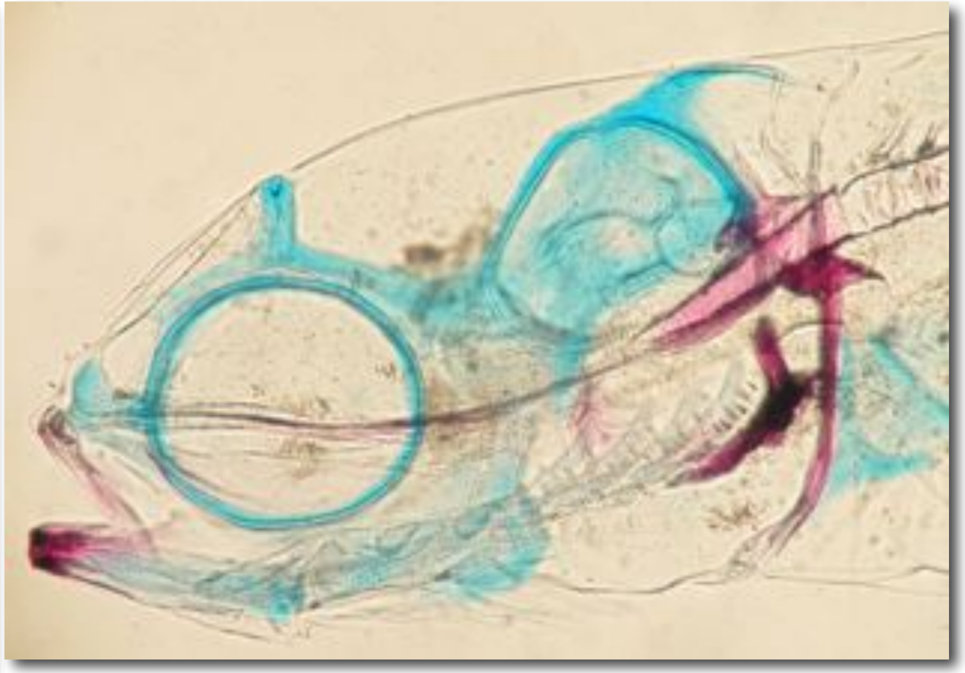

'ALIEN'-LIKE ATTACKERS
The moray eel has a second jaw that launches to kill prey
The jaw rests in the eel's throat ...
... and is launched forward to grasp the prey and help move it down the esophagus.
SOURCE: DISCOVERY CHANNEL
JONATHON RIVAIT / NATIONAL POST



Kde všude jsou zuby?

Bolen: zuby faryngeální





Research article

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Independent evolution of the specialized pharyngeal jaw apparatus in cichlid and labrid fishes

Kohji Mabuchi[1], **Masaki Miya**[2], **Yoichiro Azuma**[1] and **Mutsumi Nishida**[1]

[1]Ocean Research Institute, The University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164-8639, Japan
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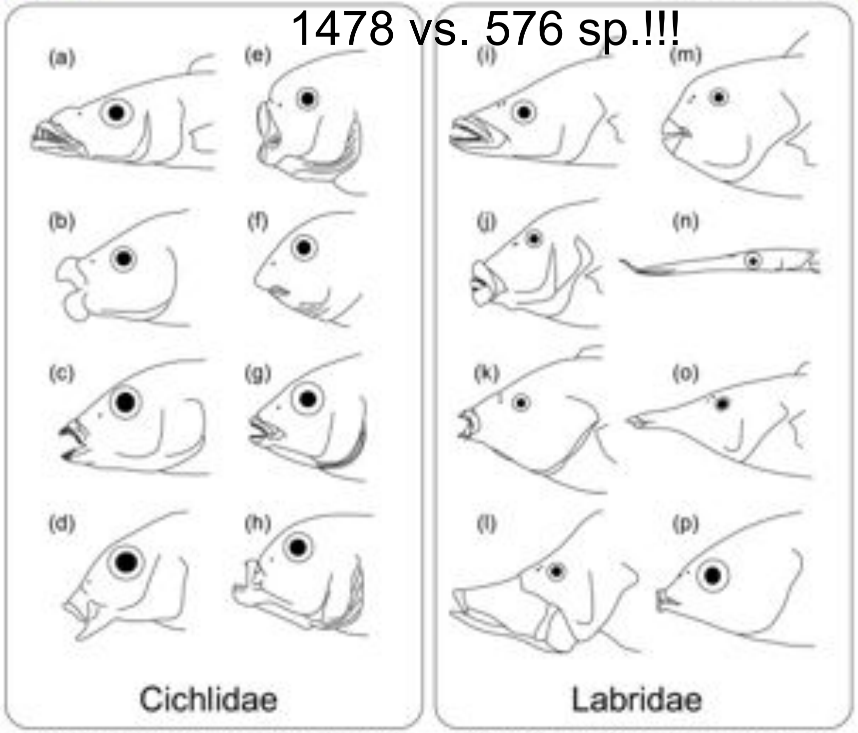
BMC Evolutionary Biology 2007, **7**:10 doi:10.1186/1471-2148-7-10

Figure 1. Resolution: **standard** / high

1478 vs. 576 sp.!!!



Diversity of the skull in the Cichlidae (a-h) and Labridae (i-p). (a) *Rhamphochromis macrophthalmus*, a piscivore, (b) *Haplochromis euchilus*, a digger in sand, (c) *Labidochromis vellicans*, a picker of small arthropods, (d) *Lethrinops brevis*, a digger in sand, (e) *Petrotilapia tridentiger*, a rock scraper, (f) *Labeotropheus fuelleborni*, an algal-eating rock scraper, (g) *Haplochromis similis*, a leaf chopper, (h) *Genyochromis mento*, a scale eater, (i) *Cheilinus celebicus*, feeds on small fishes and invertebrates, (j) *Hemigymnus melapterus*, feeds on invertebrates in sand, (k) *Anampses geographicus*, feeds on small hard-shelled invertebrates, (l) *Epibulus insidiator*, engulfs crustaceans and small fishes, (m) *Chlorurus microrhinos*, feeds on the epilithic algal matrix of coral reefs, (n) *Siphonognathus argyrophanes*, feeds on small invertebrates picked from weeds or the substratum, (o) *Gomphosus varius*, feeds on small benthic crustaceans, (p) *Labrichthys unilineatus*, a coral-polyp eater. Drawings of cichlids modified from Fryer & Iles [59].

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- Cichlidae + Labridae (suborder Labroidei)
- obrovská druhová diversita
- klíčová inovace: specialisovaný faryngeální aparatus

Research article

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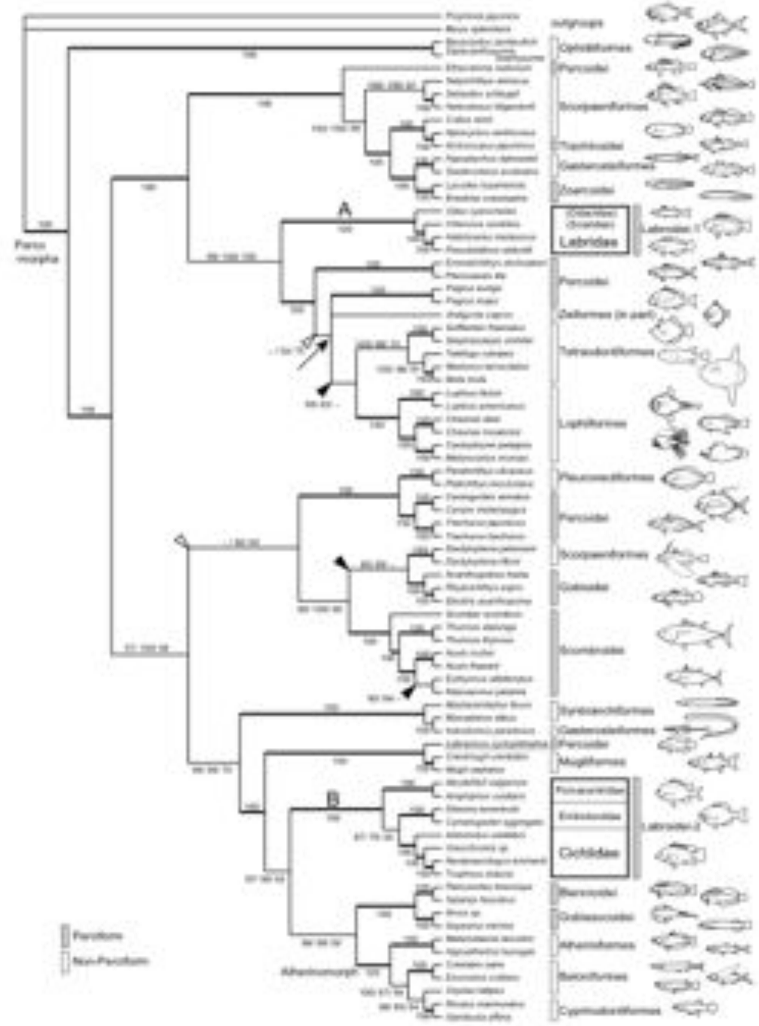
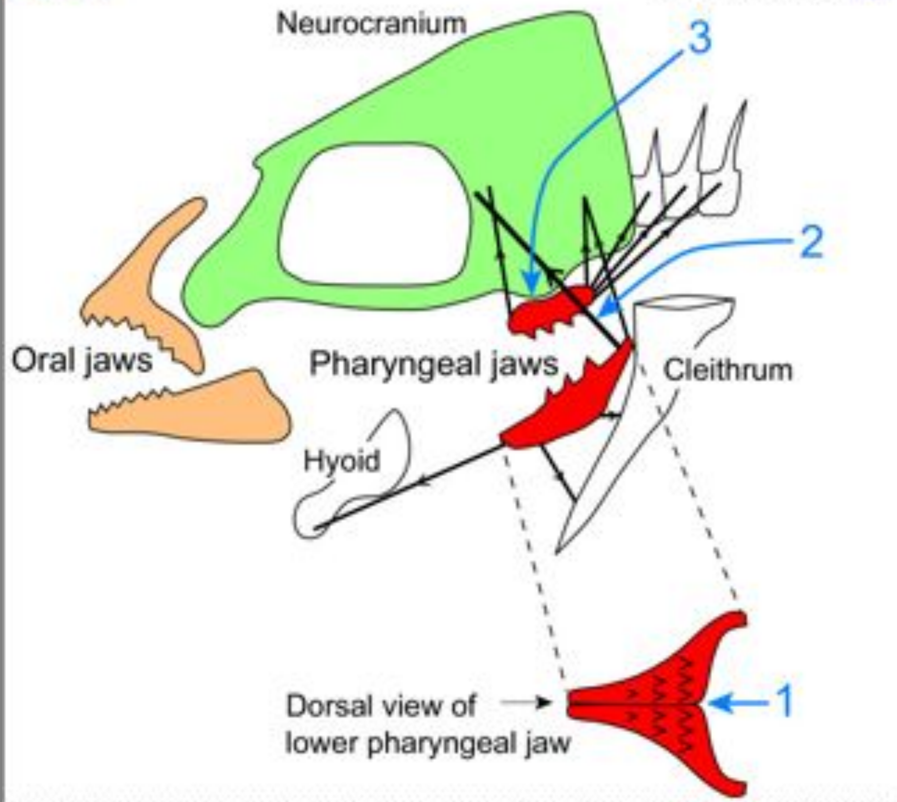


Figure 3
Phylogenetic relationships among Labroid families, based on whole mitochondrial DNA sequences

Figure 2.

Resolution: **standard** / high



Diagrammatic representation of the principal components of the specifically modified PJA of cichlids. Red elements are the upper and lower pharyngeal jaws. The muscles organizing the PJA (pharyngeal jaw apparatus) are represented as black thick lines, and the principal directions of force has been indicated by arrows. The drawing modified from Liem & Greenwood [32]. Numbers indicate three major features of the specialized "labroid" PJA: 1) the left and right lower jaw elements are fused into a single structure, 2) the lower jaw is suspended in a muscular sling that runs from the neurocranium to the posterior muscular arms of the lower jaw, and 3) the upper jaw elements have a diarthrotic articulation with the underside of the neurocranium.

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Mechanika čelistních struktur Teleostei: svaly, kosti, zuby a klouby tvoří (překvapivě kinetický) modulární systém se vzájemně propojenými prvky

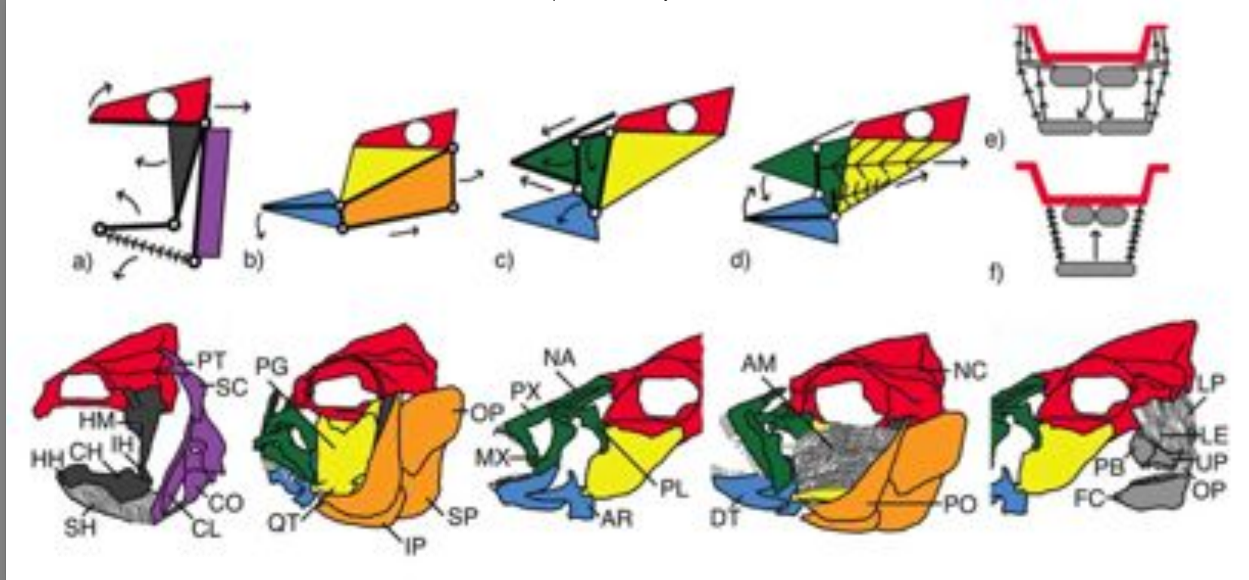
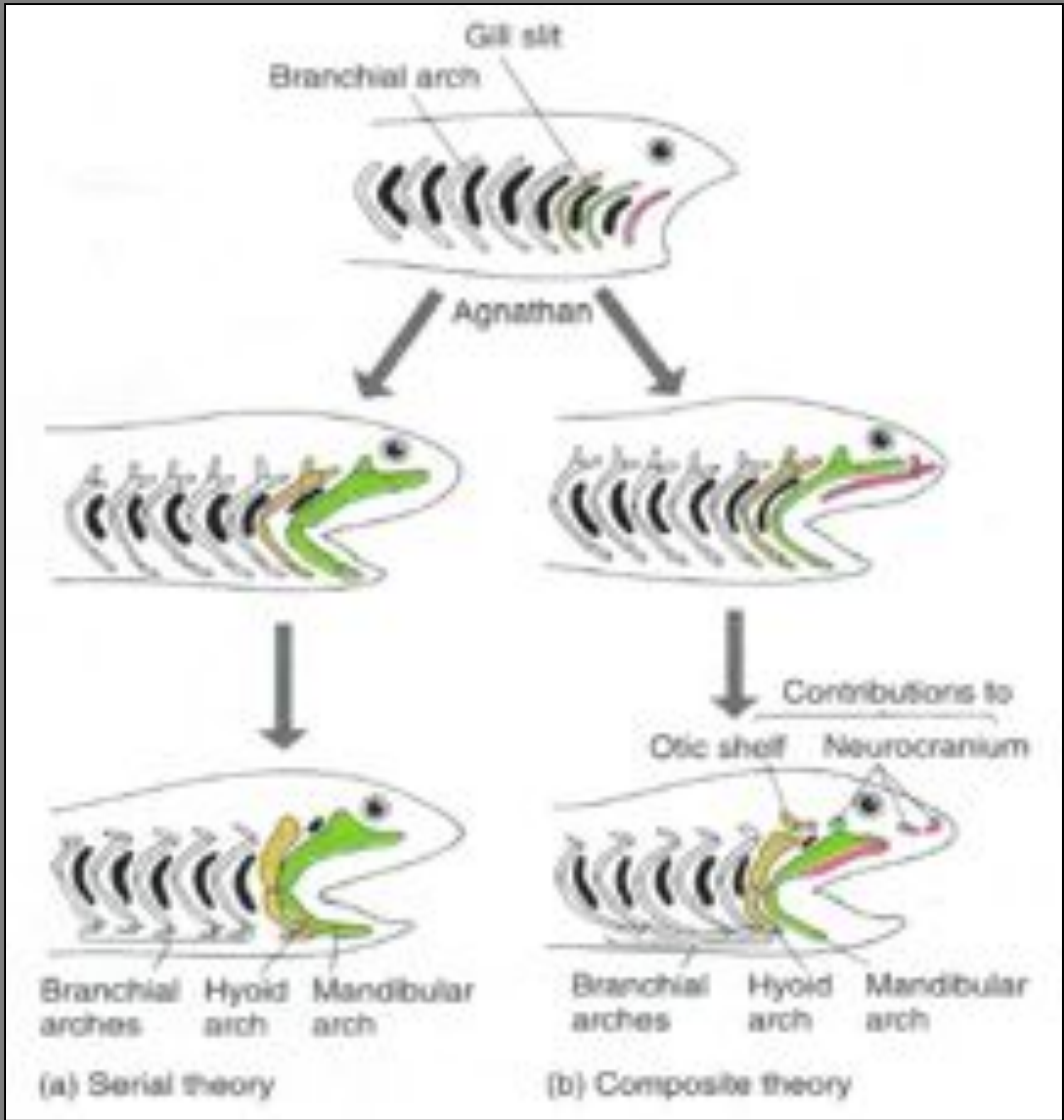
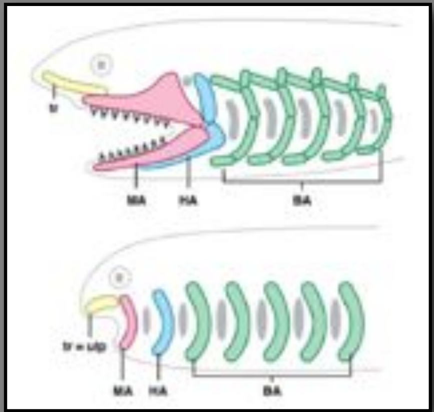


FIG. 2. The bones and muscle that operate during an adult teleost feeding strike can be thought of as functioning like a series of fairly modular but inter-connected mechanical systems. A map of the numerous links (*heavy bars*), joints (*open circles*), muscles (*hashed lines*), and the general direction particular elements move (*arrows*) during the strike for several mechanical levers and linkages in the teleost skull are diagrammed. The morphology of the neurocranium (*red*), hyoid (*dark gray*), pectoral girdle (*purple*), opercular series (*orange*), suspensorium (*yellow*), lower jaw (*light blue*), anterior jaw elements (*dark green*), and pharyngeal jaw elements (*light gray*) are depicted in different colors. Although the elements comprising the particular links and muscles are described in more detail in the text, a basic overview of how the lever systems operate is given here. The feeding strike is initiated (**a**) as the skull is pulled posteriorly via the simple lever-like cranial levation system. As the neurocranium rotates upwards it pulls open the hyoid four-bar linkage system, and the sternohyoideus muscle fires resulting in depression of the hyoid linkage. The depression of the hyoid results in expansion of the buccal cavity and in many fishes (**b**) the initiation of the movement in the opercular linkage. As the opercular series is pulled posteriorly, tension is applied to the interopercular ligament connecting the opercular series to the lower jaw. The lower jaw opening lever system is then depressed and rotates ventrally. The rotation of the lower jaw inputs motion into the anterior jaw four-bar linkage (**c**) resulting in maxillary

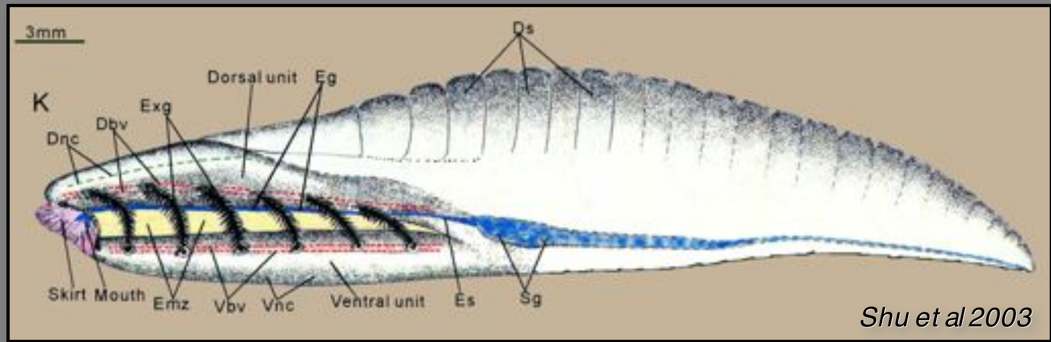
Jaw evolution





Viscerocranium:

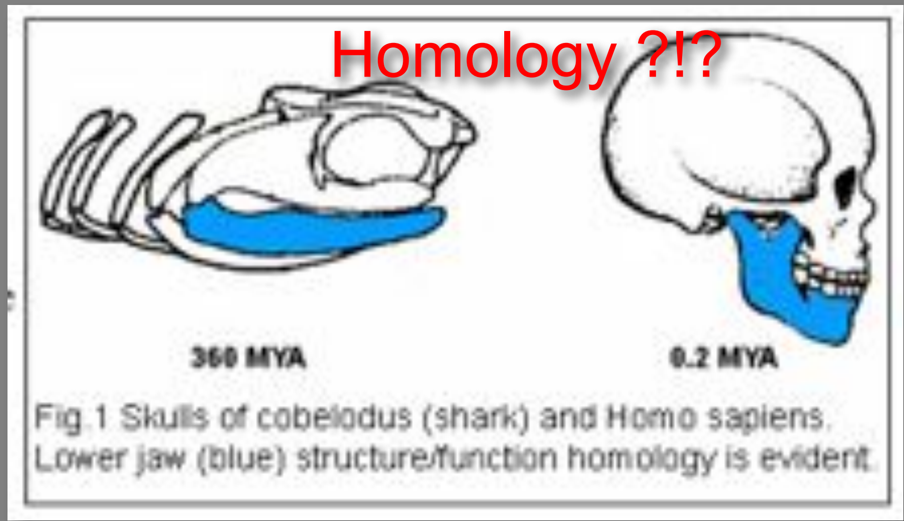
A segmented and ancient part of the skeleton



Shu et al 2003

Pharyngeal arches are serially homological across vertebrates

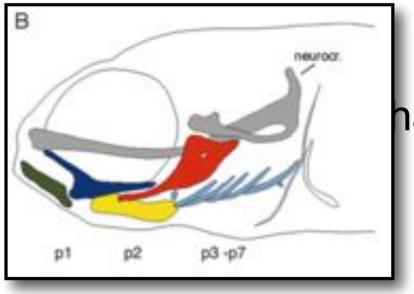
Single elements inside arches are considered to be serial homologous too



Dissmilarity vs. Sameness:

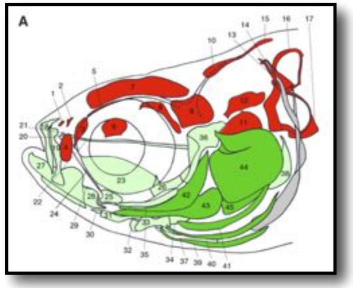
Homology: **continuity of information from an ancestor to descendants**

!!! Cranial skeletal systems are independent and non-interchable !!!



Viscerocranium (Pharyngeal arch skeleton)
haryngeal cartilages from NC cells that later ossify

Dermatocranium (Dermal skeleton)
- elements that arise directly from dermis
(either of NC or mesodermal origin)



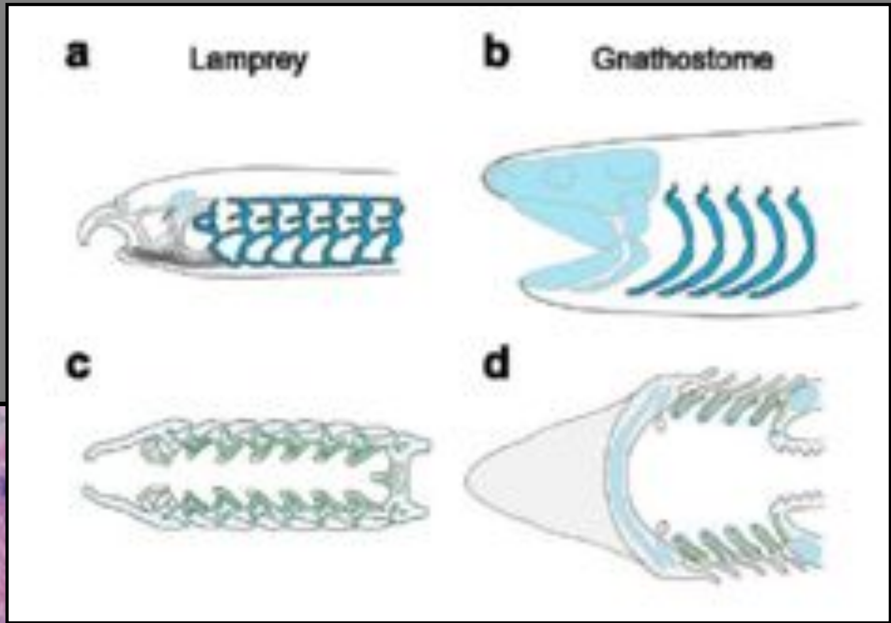
Chondrocranium
- cartilage and later bones from paraxial mesoderm

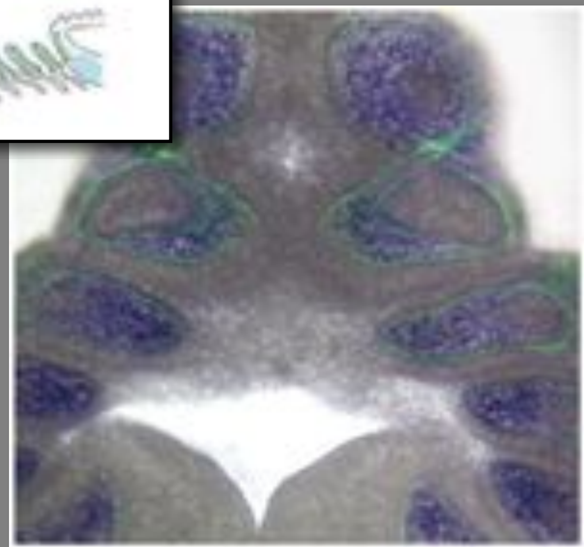
Dentition:
- teeth developing from epithelium/mesenchyme interface

In development - embryonic cells are non-interchangeable
In evolution - they are non-interchangeable skeletons

Location of induction and patterning information:
from ectoderm, endoderm or notochord - mesoderm ?

Questioned homology between agnathan and gnathostome pharyngeal arch elements





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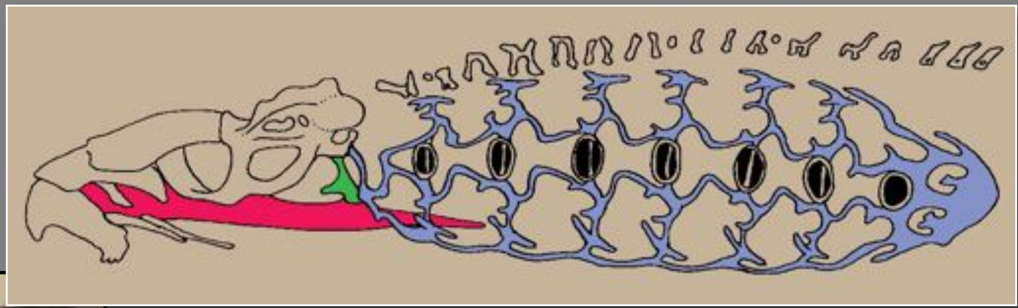
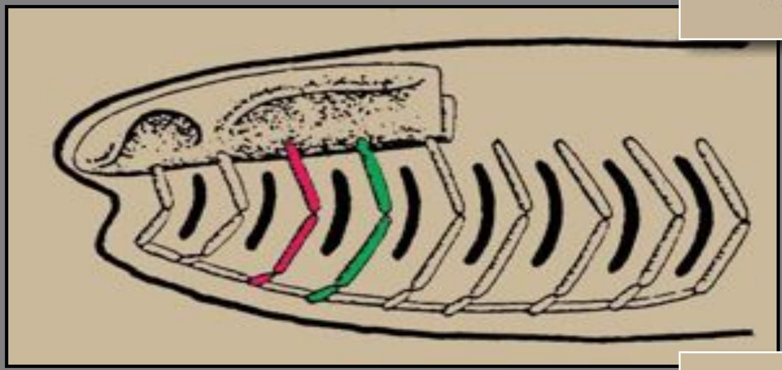
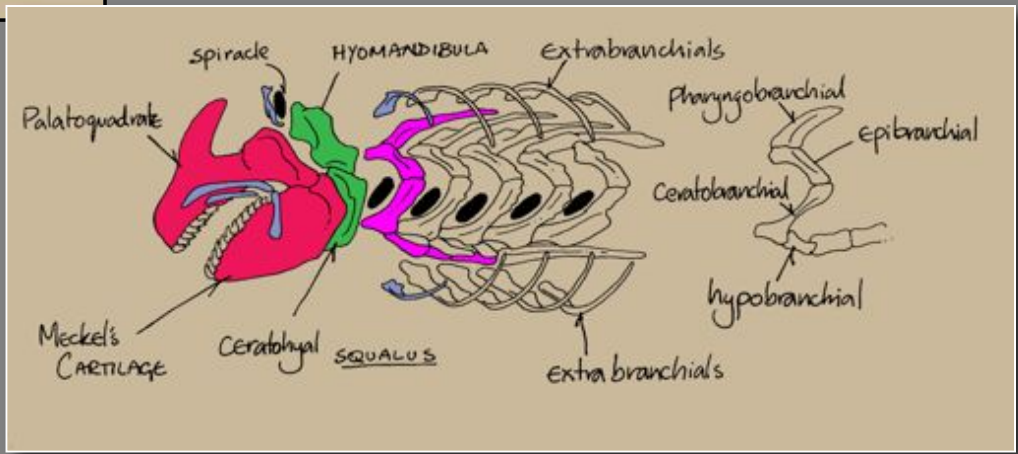
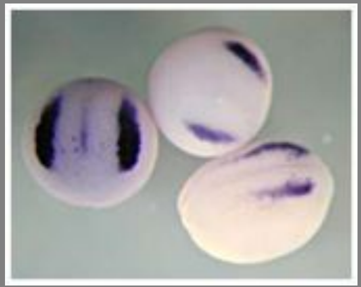
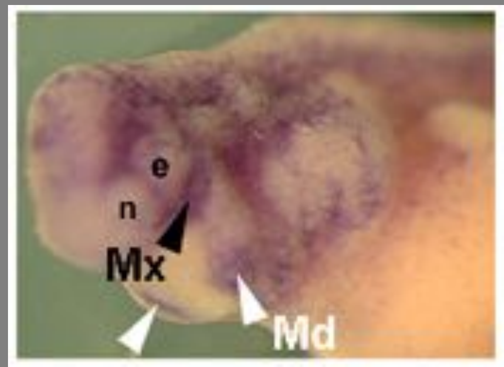


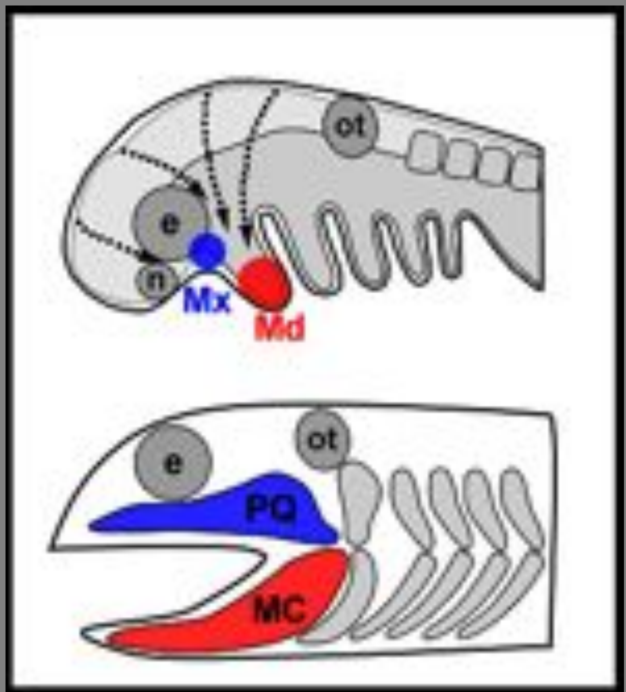


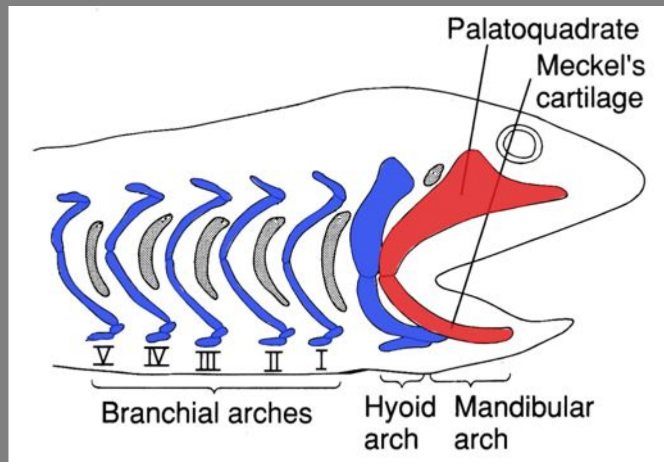


Jaw development: from neural crest cells to cartilages

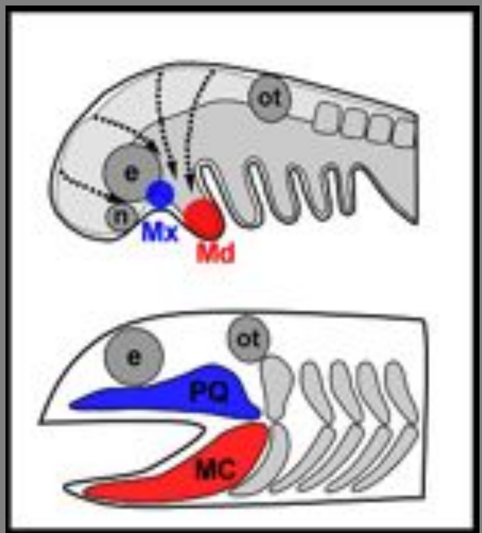


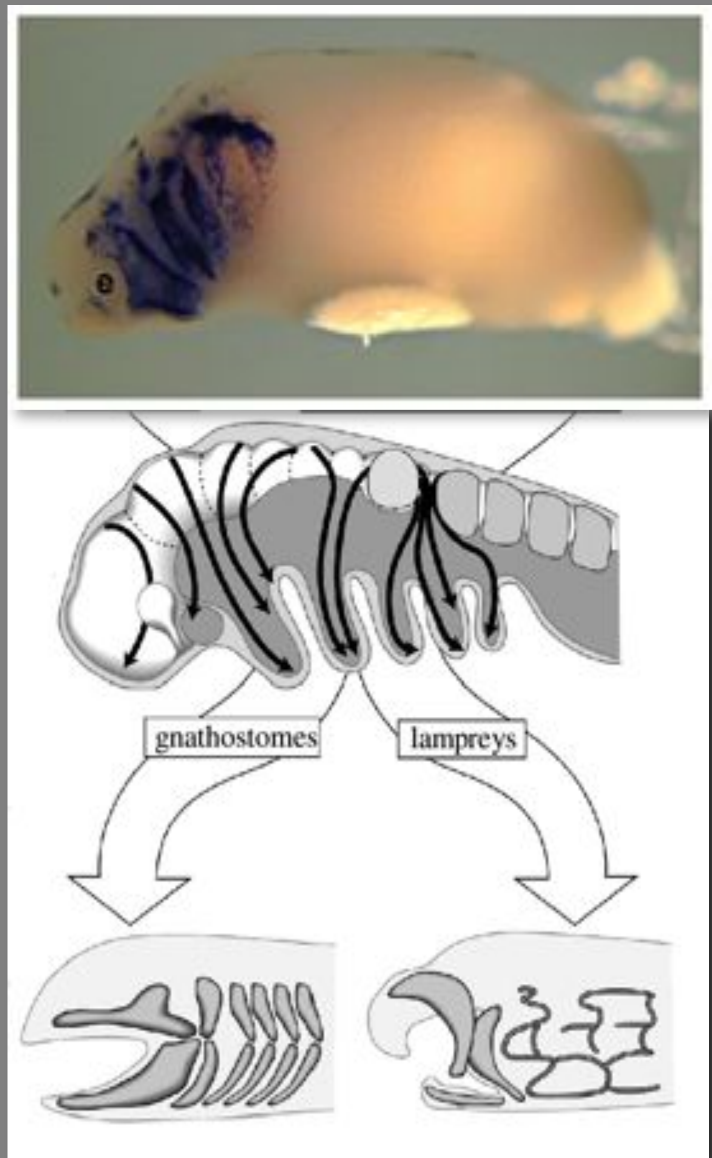




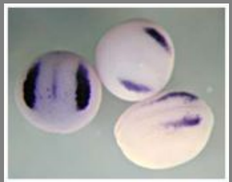


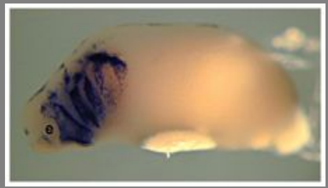
Migration of cranial neural crest cells and the phylotypic stage

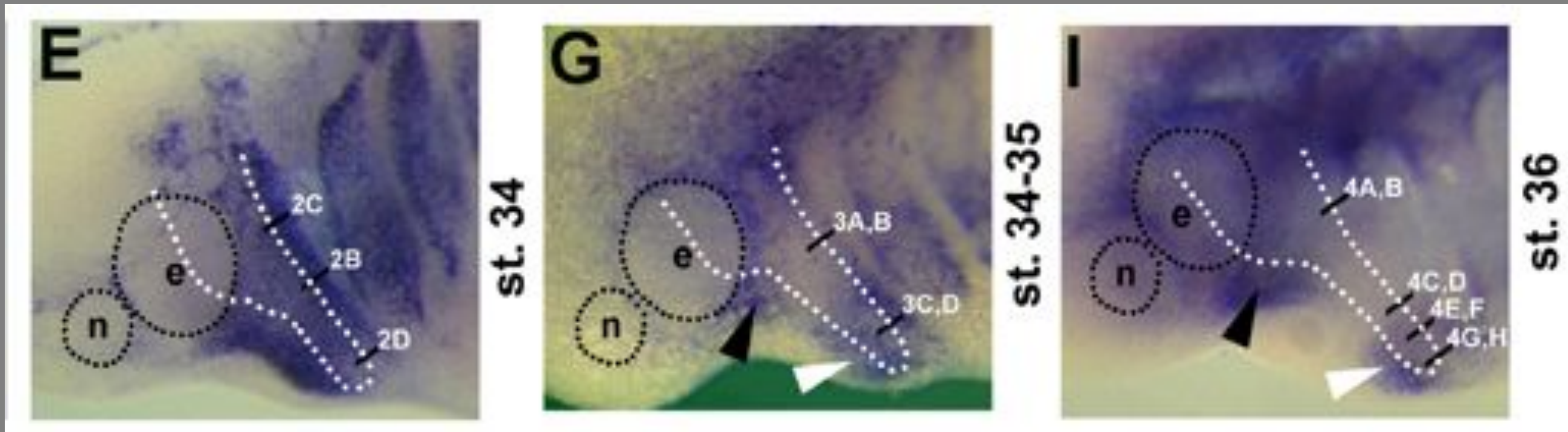


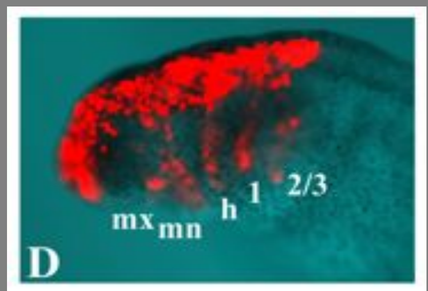


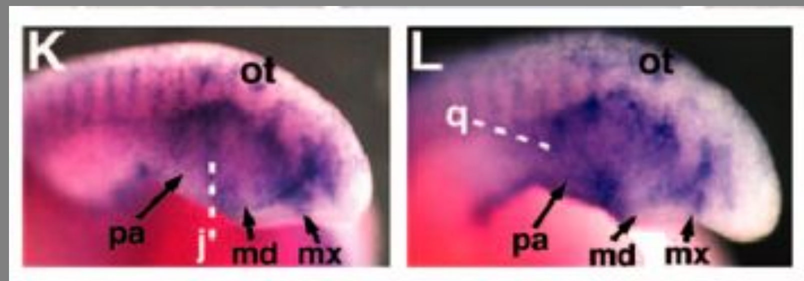
Initially, the first arch is colonized homogeneously; however, soon later, CNC cells condense into two centres: dorsal „maxillary“ and ventral „mandibular“





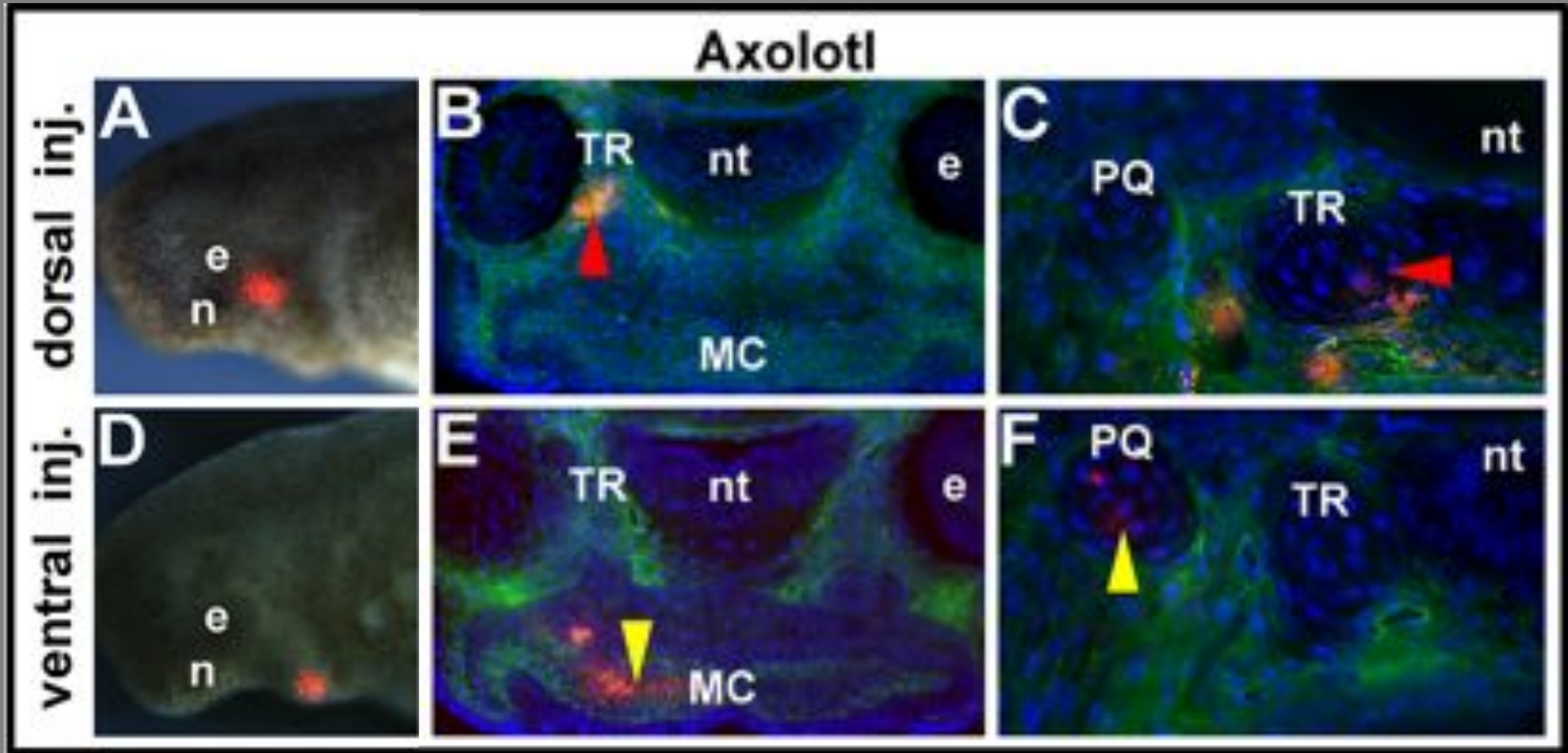






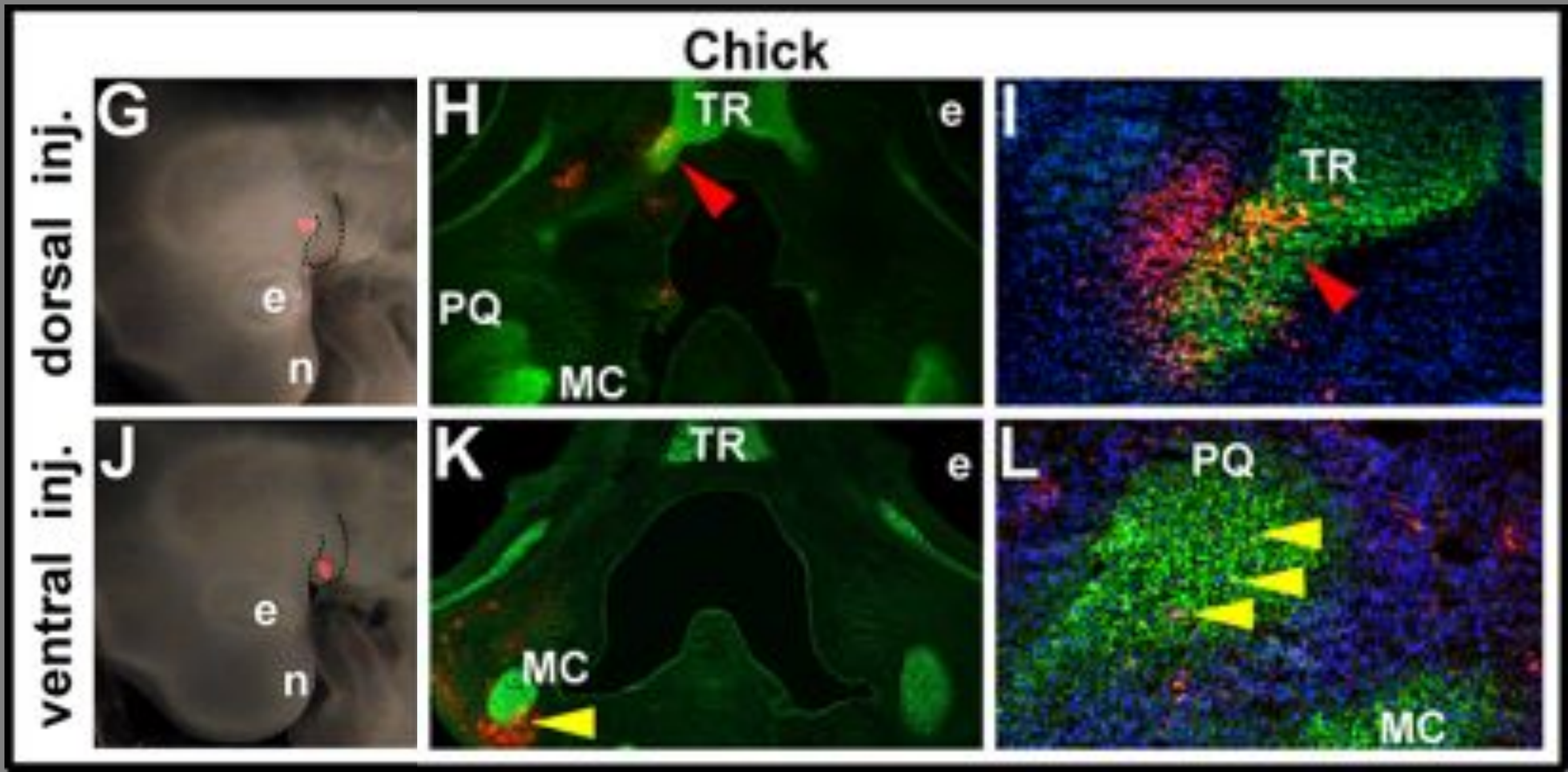
axolotl, Development 2000; lamprey, Development 2002

Experimental approach: tracing of cells from dorsal „maxillary“ or ventral „mandibular“ centres



RED: NC cells stained by DiI; BLUE: DAPI (cell nuclei); GREEN: a-fibronectin (cell borders)

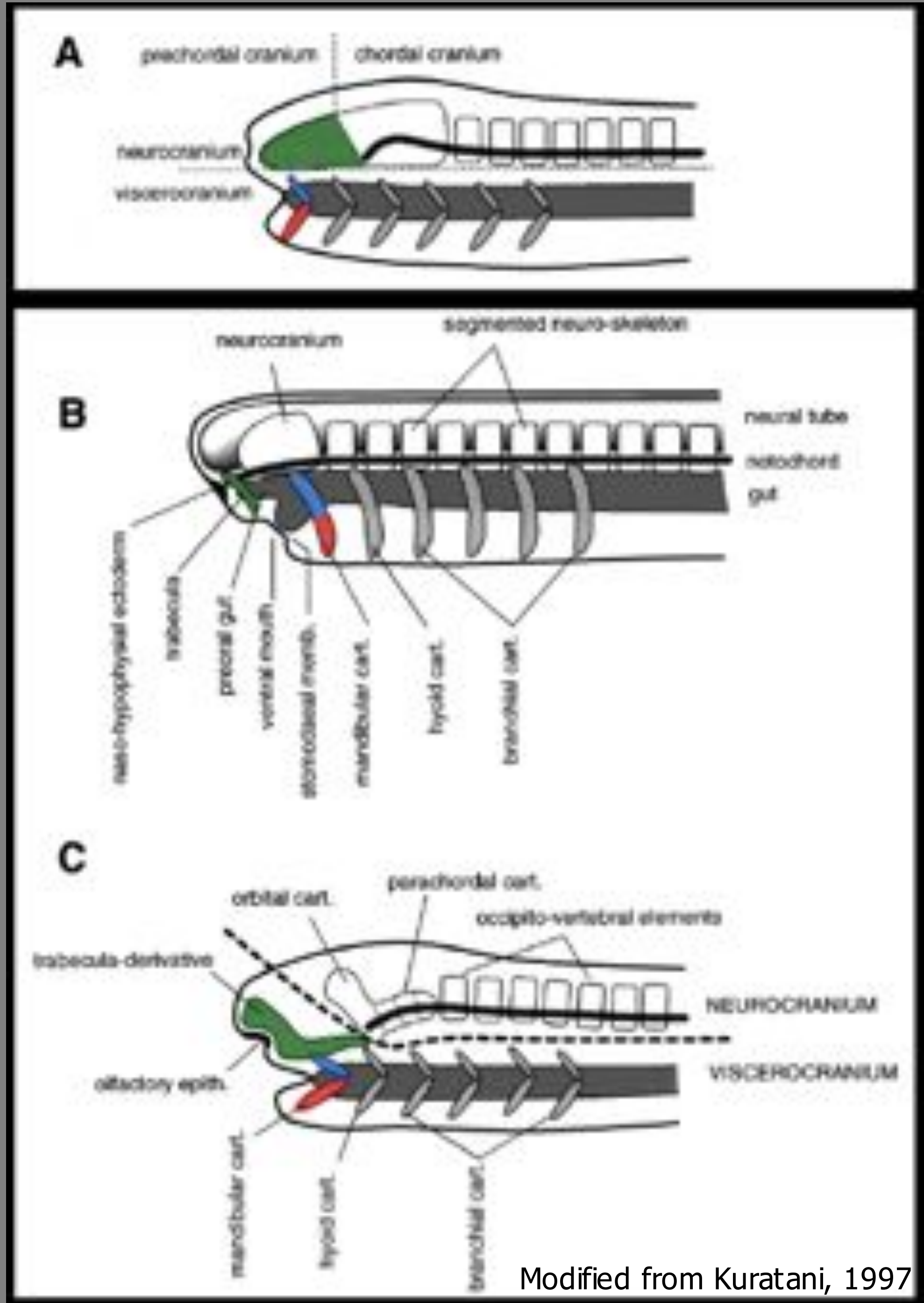
Experimental approach: tracing of cells from dorsal „maxillary“ or ventral „mandibular“ centres



RED: NC cells stained by DiI; GREEN: collagen II (cartilages); BLUE: DAPI (cell nuclei)

Trabecular cartilage:

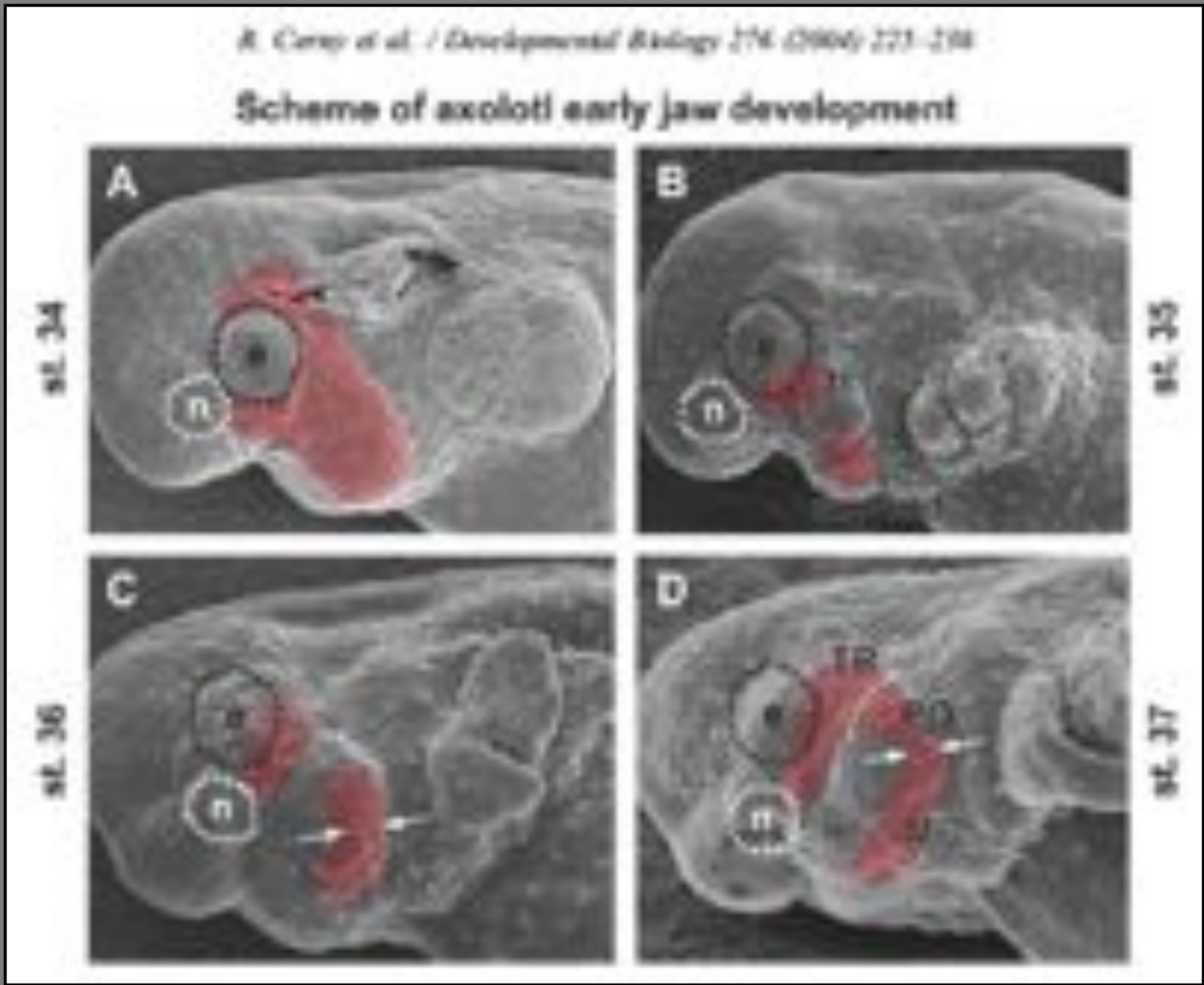
a main element of the pre-chordal neurocranium, but with true viscerocranial (neural crest) origin

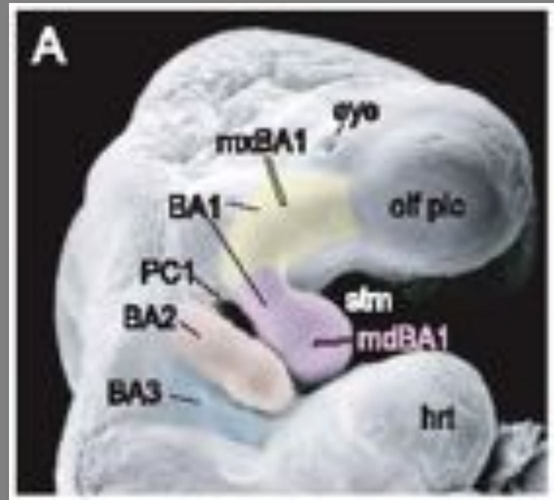


Modified from Kuratani, 1997

One arch = One stream = One condensation:

Mandibular „area“ problem

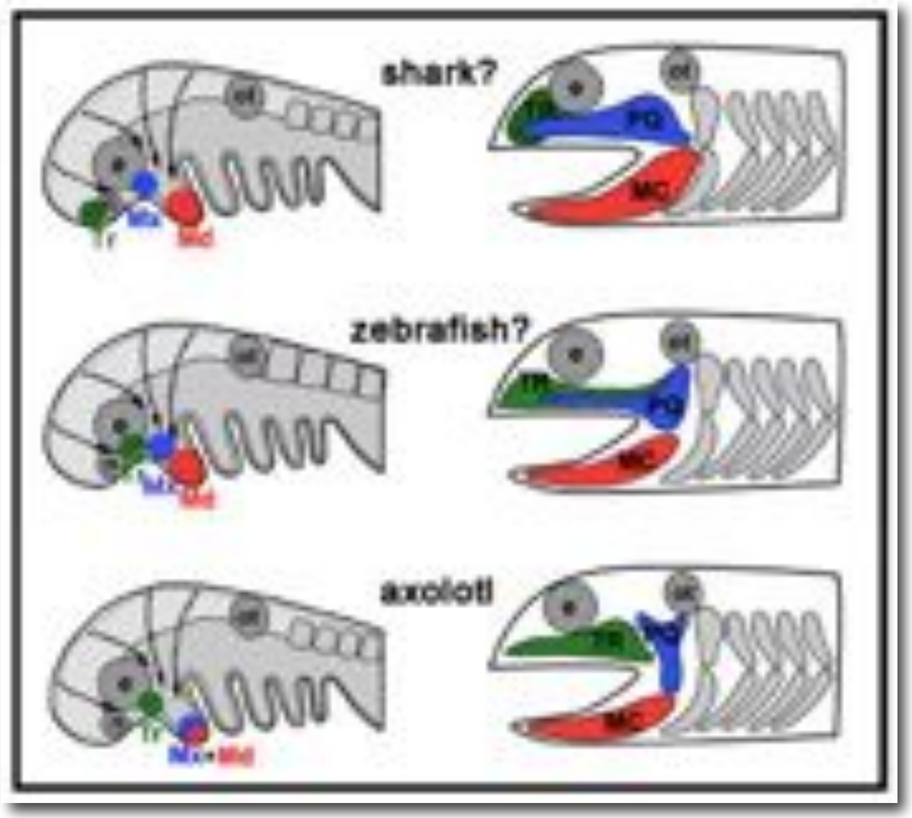


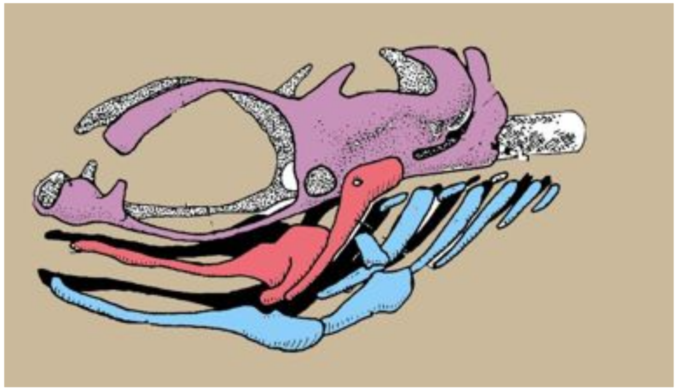


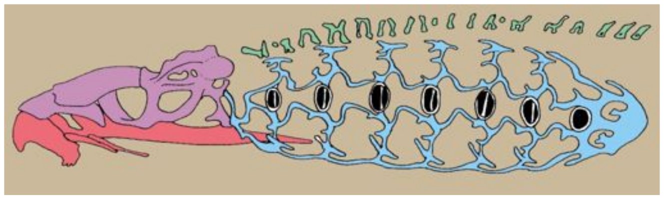
Depew: J. Anatomy 2005

Evo-Devo aspekty onto/fylogeneze
čelistních/bezčelistních elementů

Různé druhy čelistnatců s odlišnými variacemi čelistních elementů mají zřejmě odlišné topografické konfigurace kondensačních center buněk n. lišty.

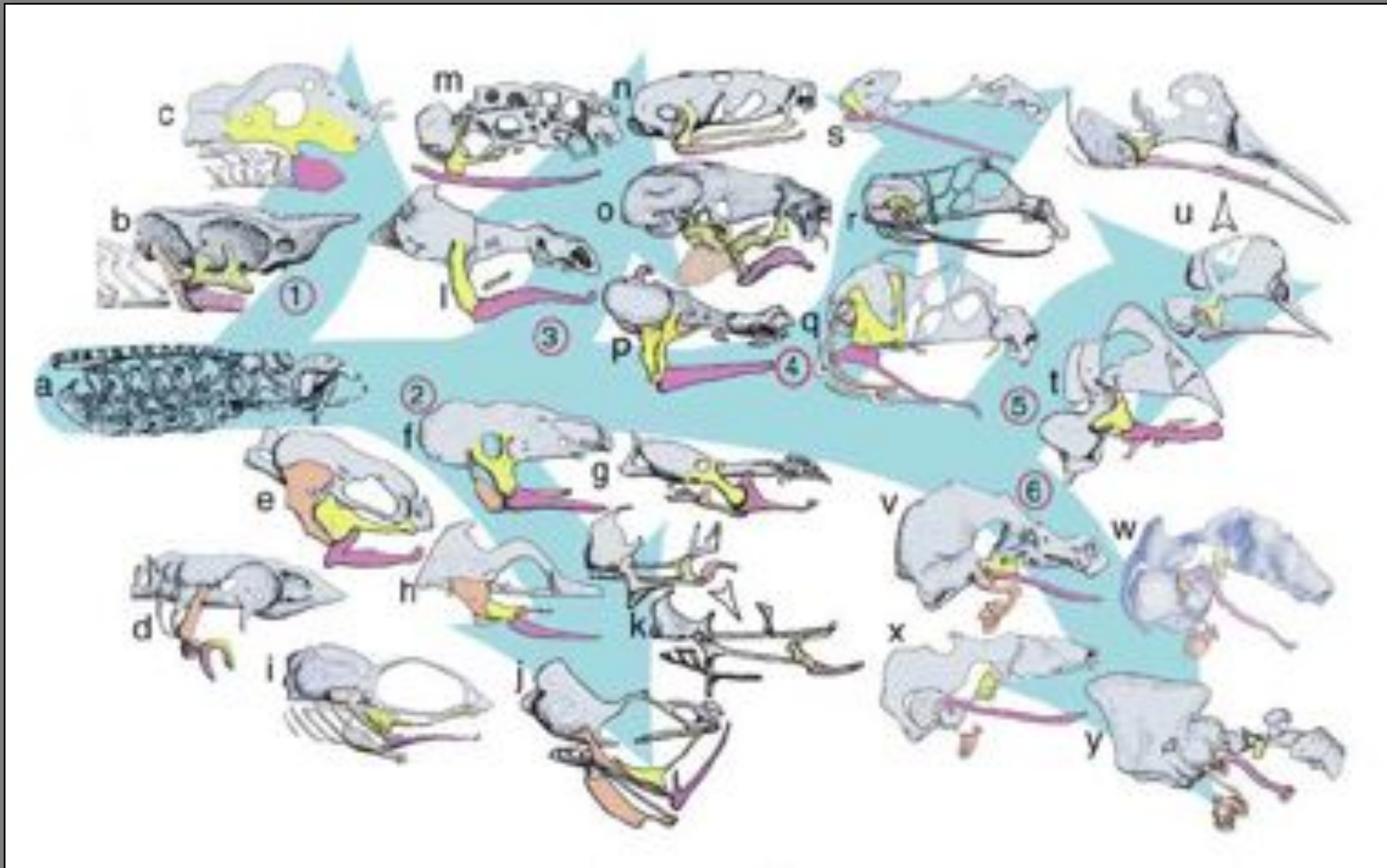






Topography of jaw elements

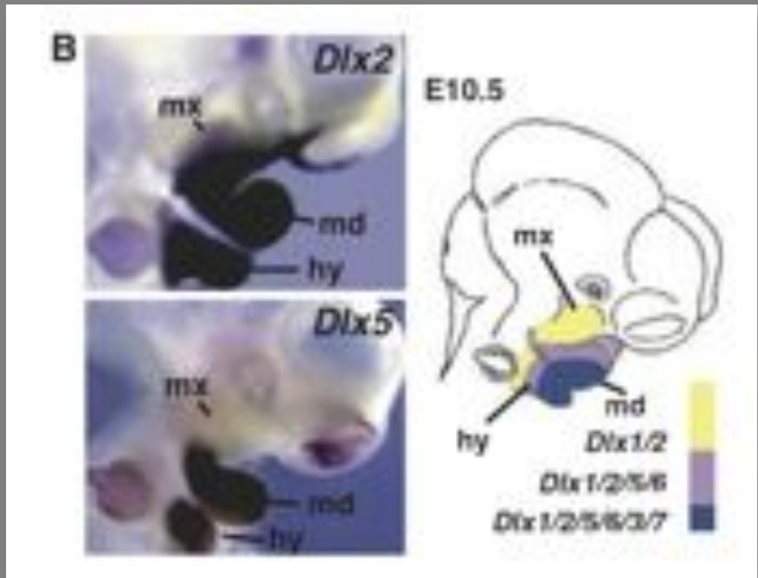
Whereas the lower jaw is prefigured by MC in all gnathostomes, elements of the upper jaw (as PQ) and their topography is very different.

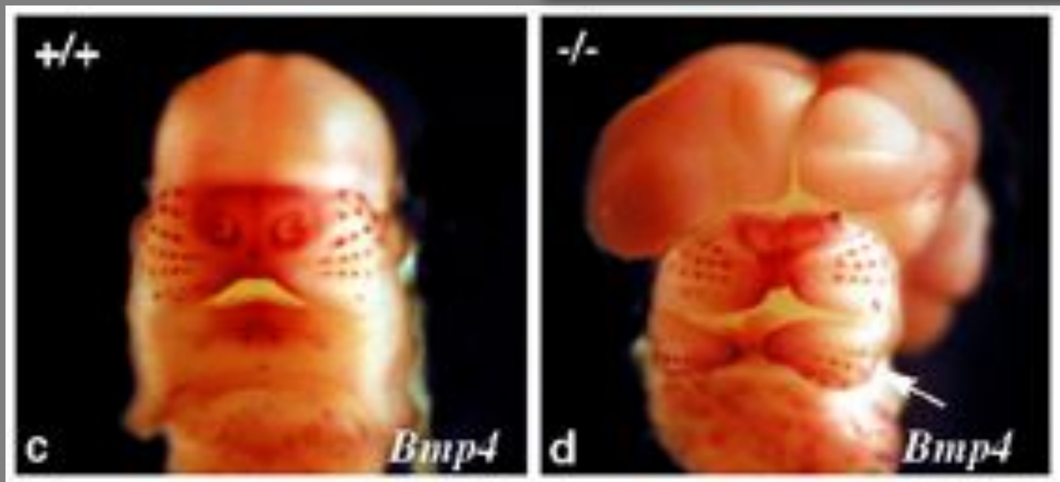


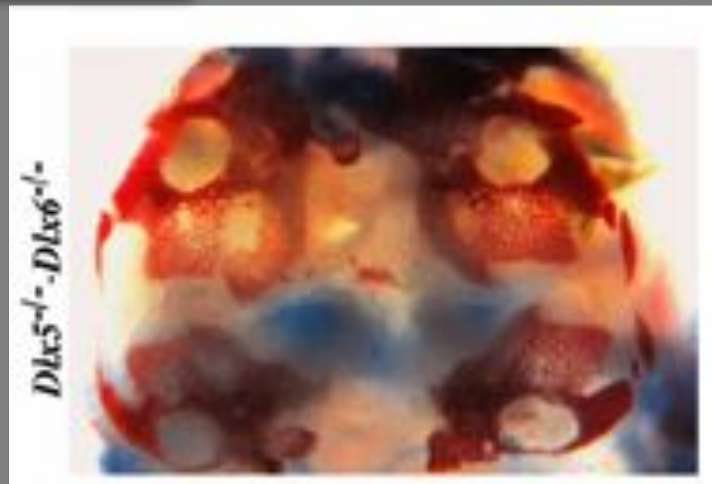
Schematics of vertebrate chondrocrania demonstrating different topological positioning of MC, PQ and TR; according to many authors, from Depew: J. Anat. 2005

Dlx genes and jaw subdivision:

Transformation of the lower into an upper jaw after simultaneous inactivation of *Dlx5* + 6







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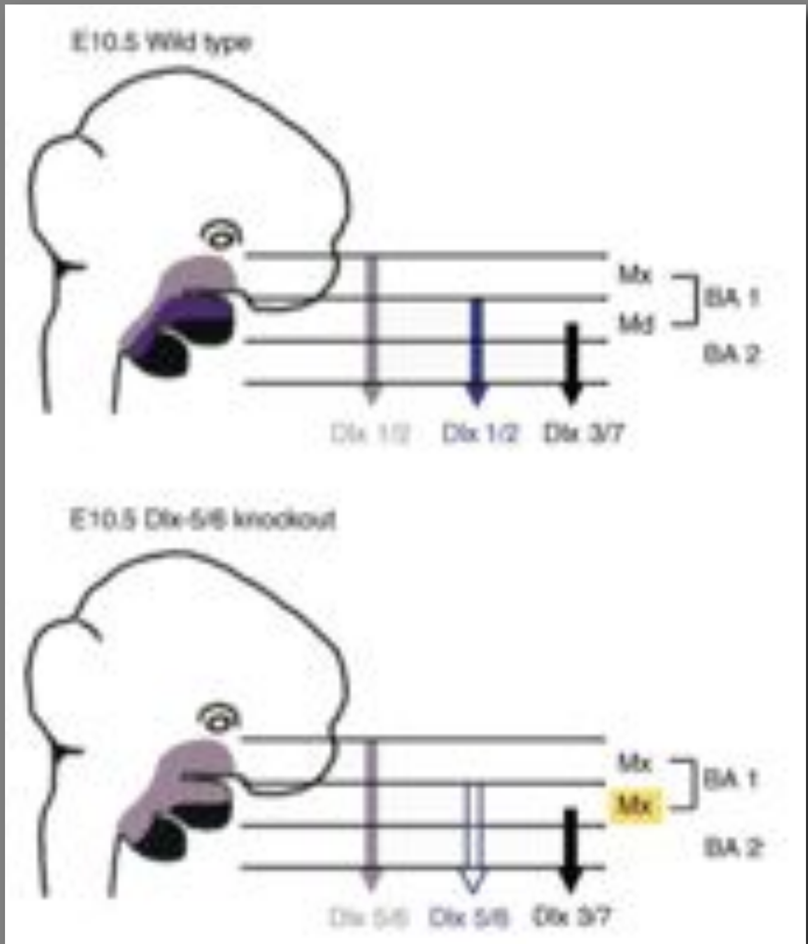
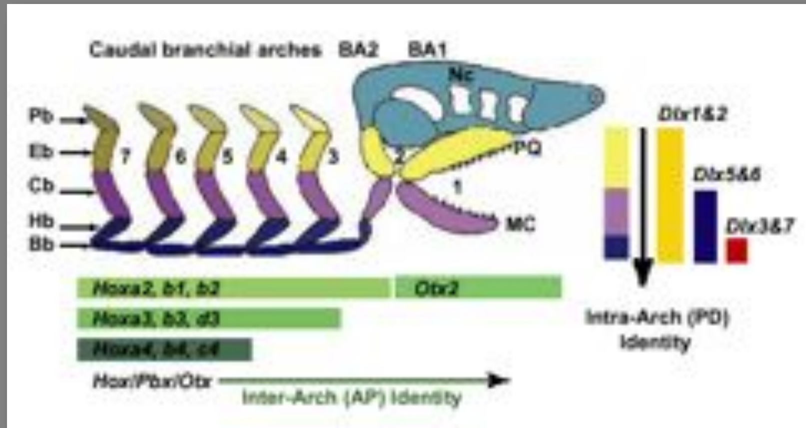
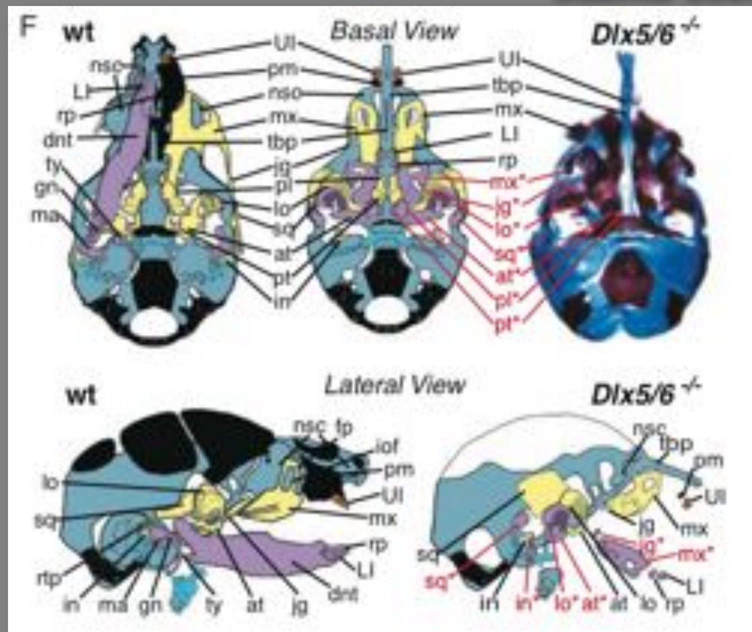


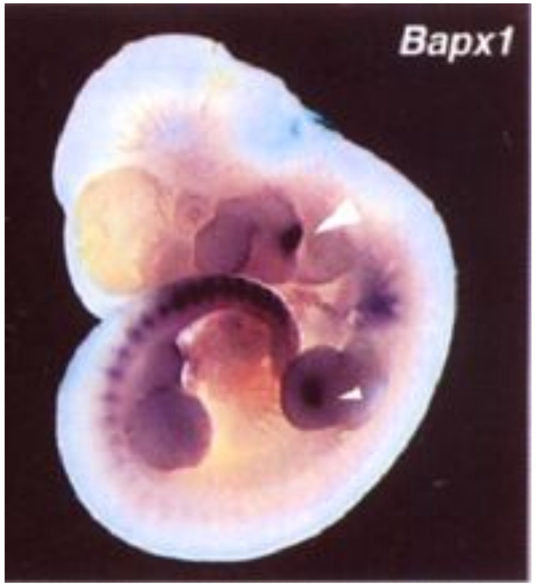


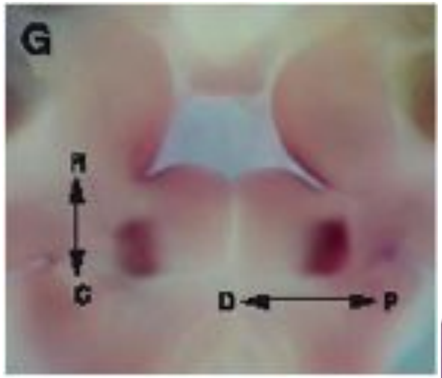
Science 2002

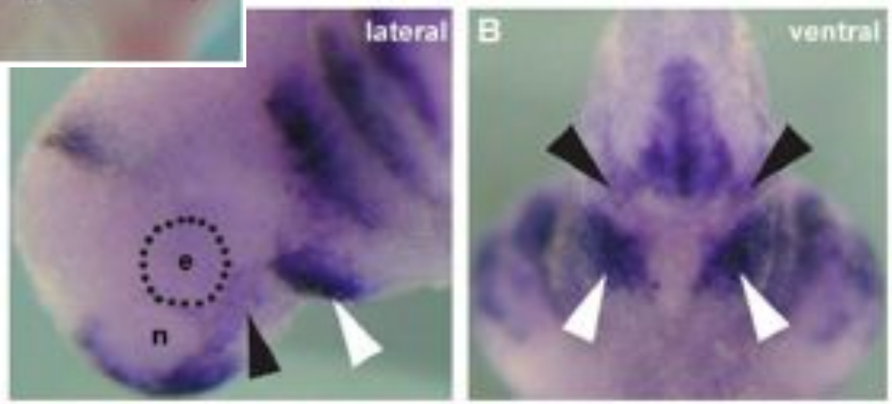


Evo-Devo aspekty onto/fylogeneze **čelistních elementů**

Klíčová vývojová synapomorfie čelistnatců bude zřejmě vznik čelistního kloubu mezi dorsálním a ventrálnjím elementem, nicméně VŽDY v rámci ventrální domény (kompletní set Dlx genů; Bapx1, Gsc, apod)







Axolotl, FGF8, Cerny et al, Dev. Biol 2004b