

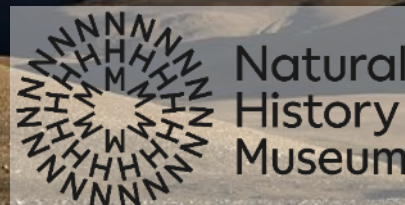
From Tethys to the Himalaya:

Fossil Fishes Witnessed the Qinghai-Tibet Plateau's Dramatic Transformation

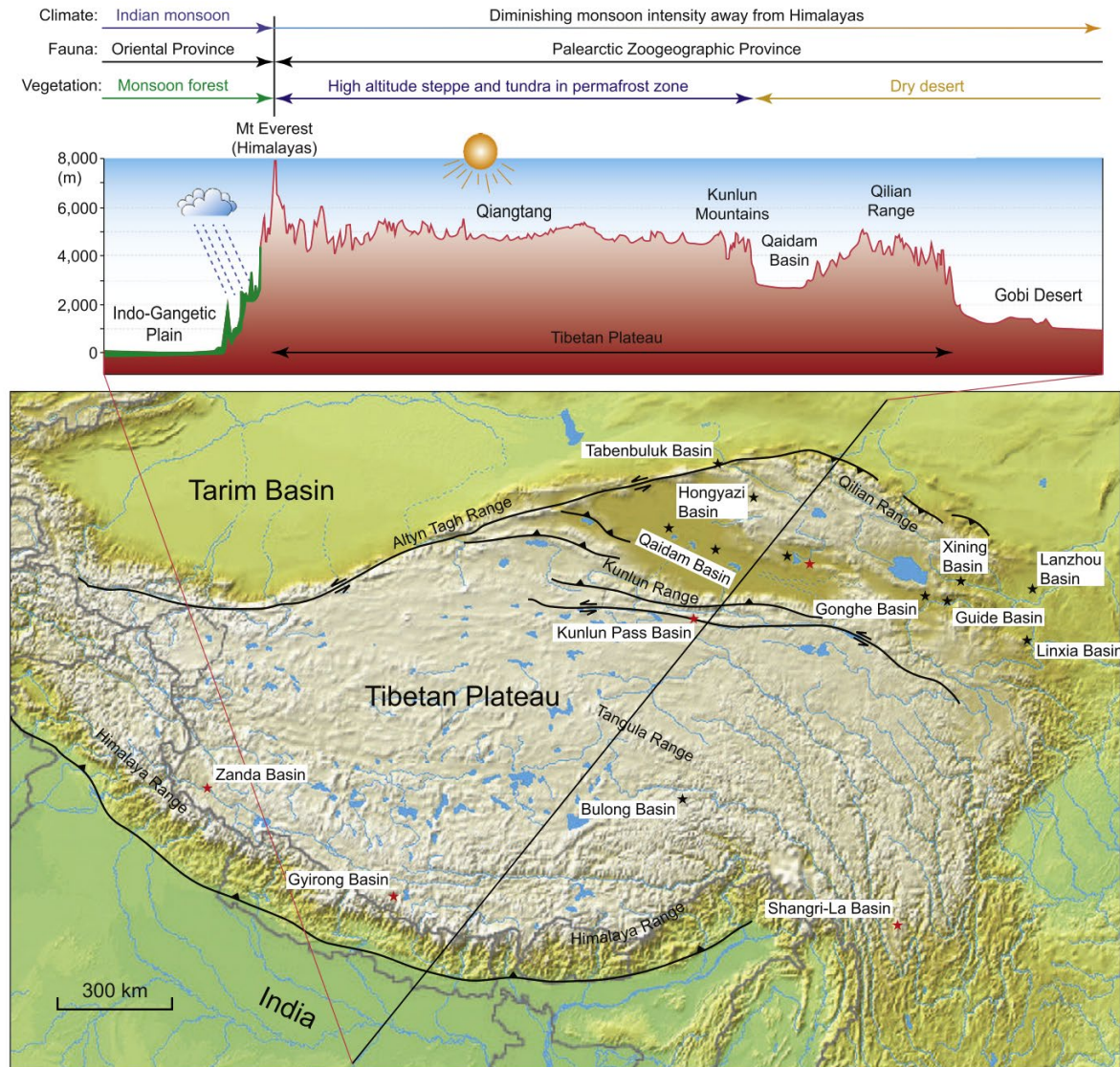
FANG Gengyu^{1,2}

1 Palaeobiology Research Group, University of Bristol, Bristol, UK

2 Natural History Museum, London, UK



The Qinghai-Tibet Plateau (QTP)



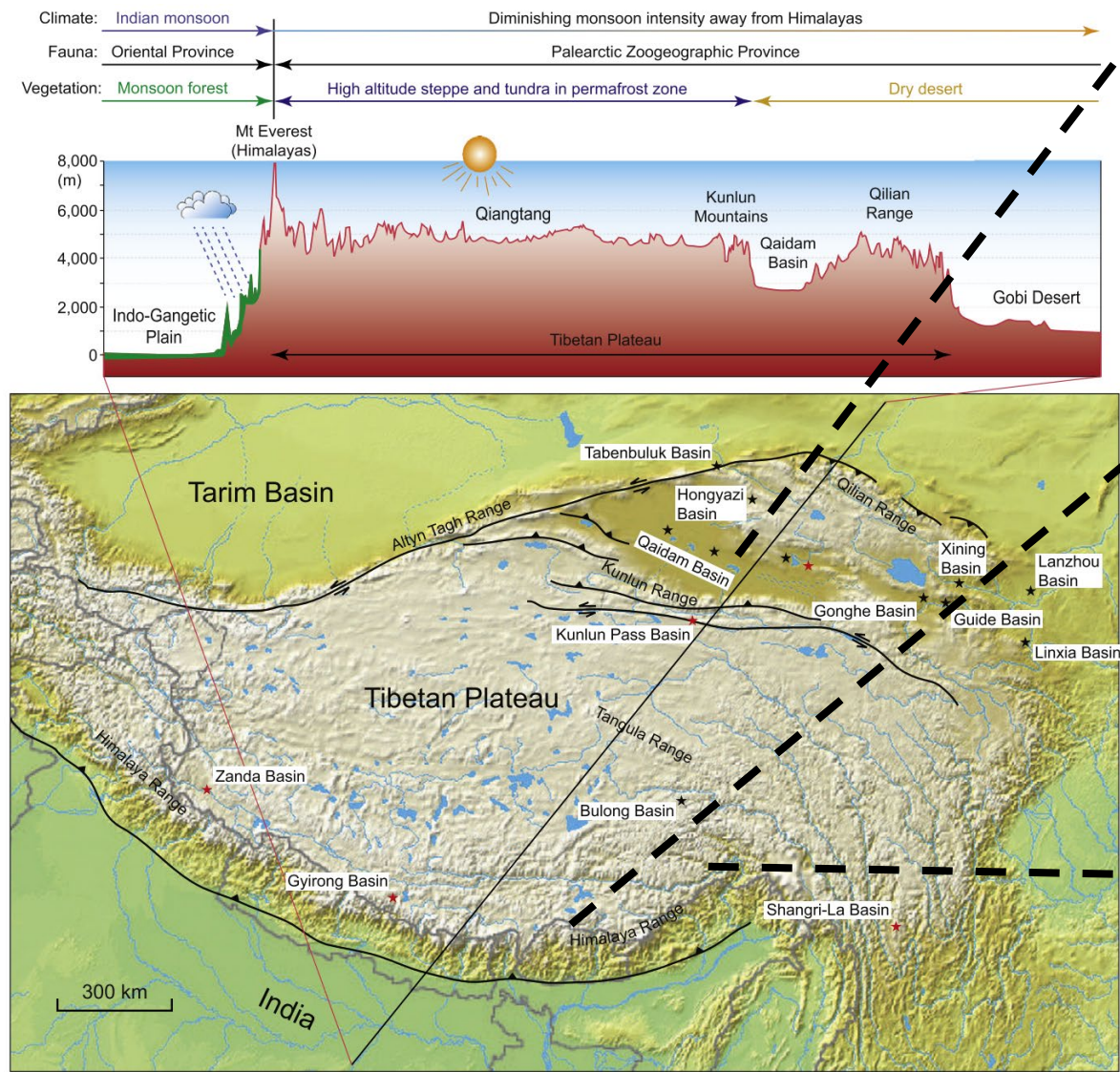
Wang et al., 2015



The Qinghai-Tibet Plateau

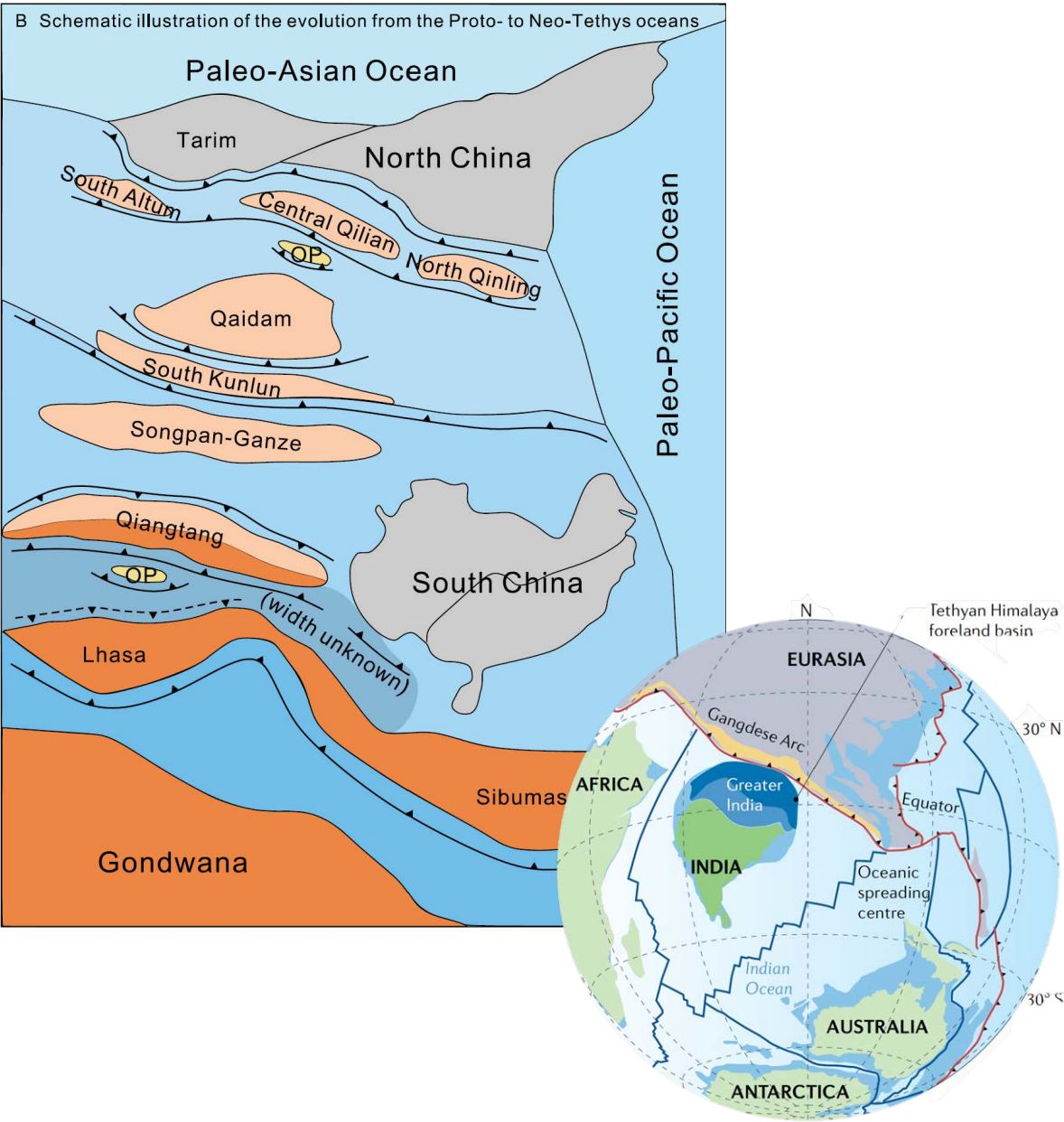
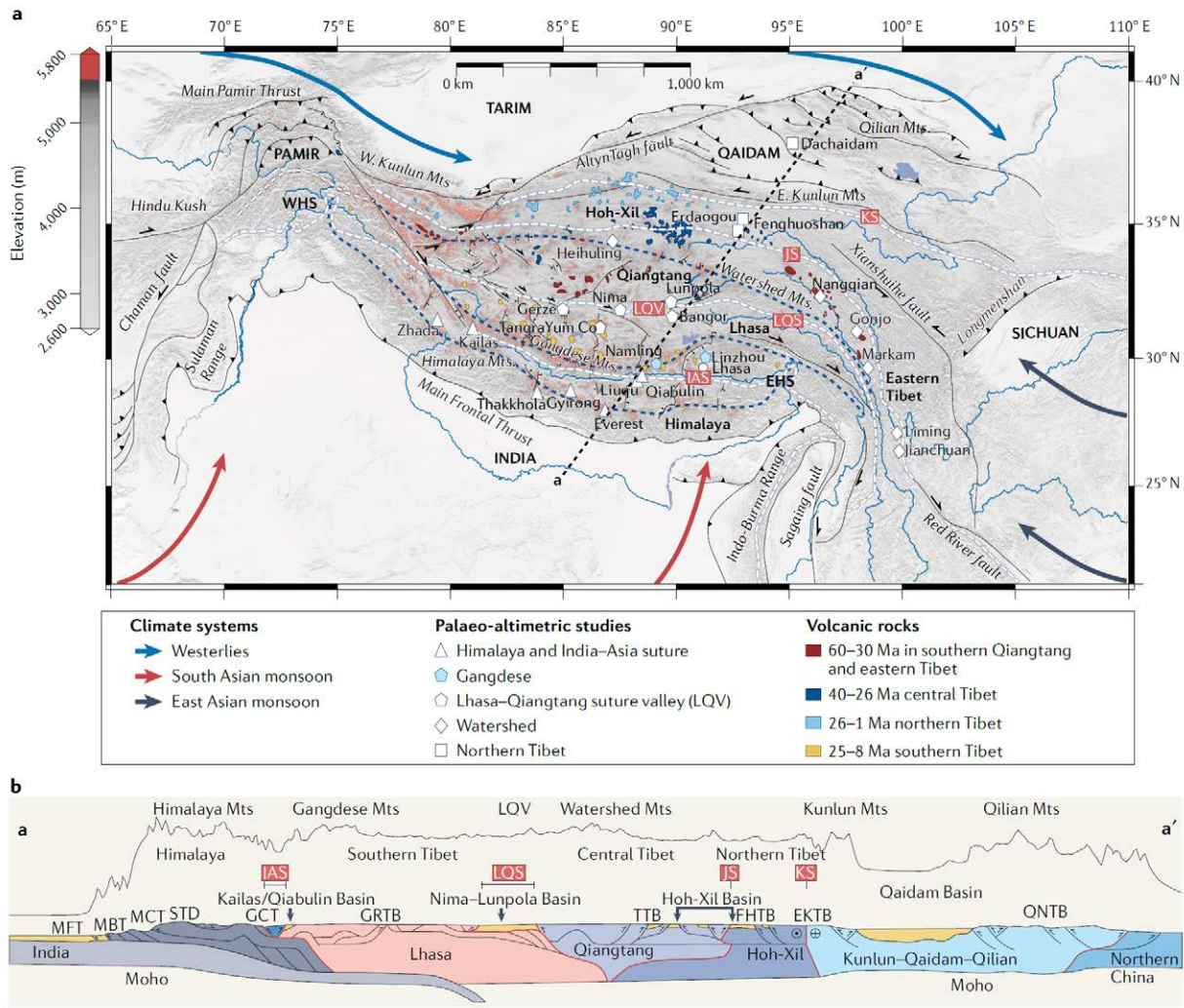
- **Lies** in the heart of Asia
- **Covers** ~ 2.5 million km²
- **Averages** >4,500 m in elevation
- **Anchors** the headwaters of major Asian rivers (Yangtze, Yellow, Mekong, Indus, Brahmaputra)

The Qinghai-Tibetan Plateau

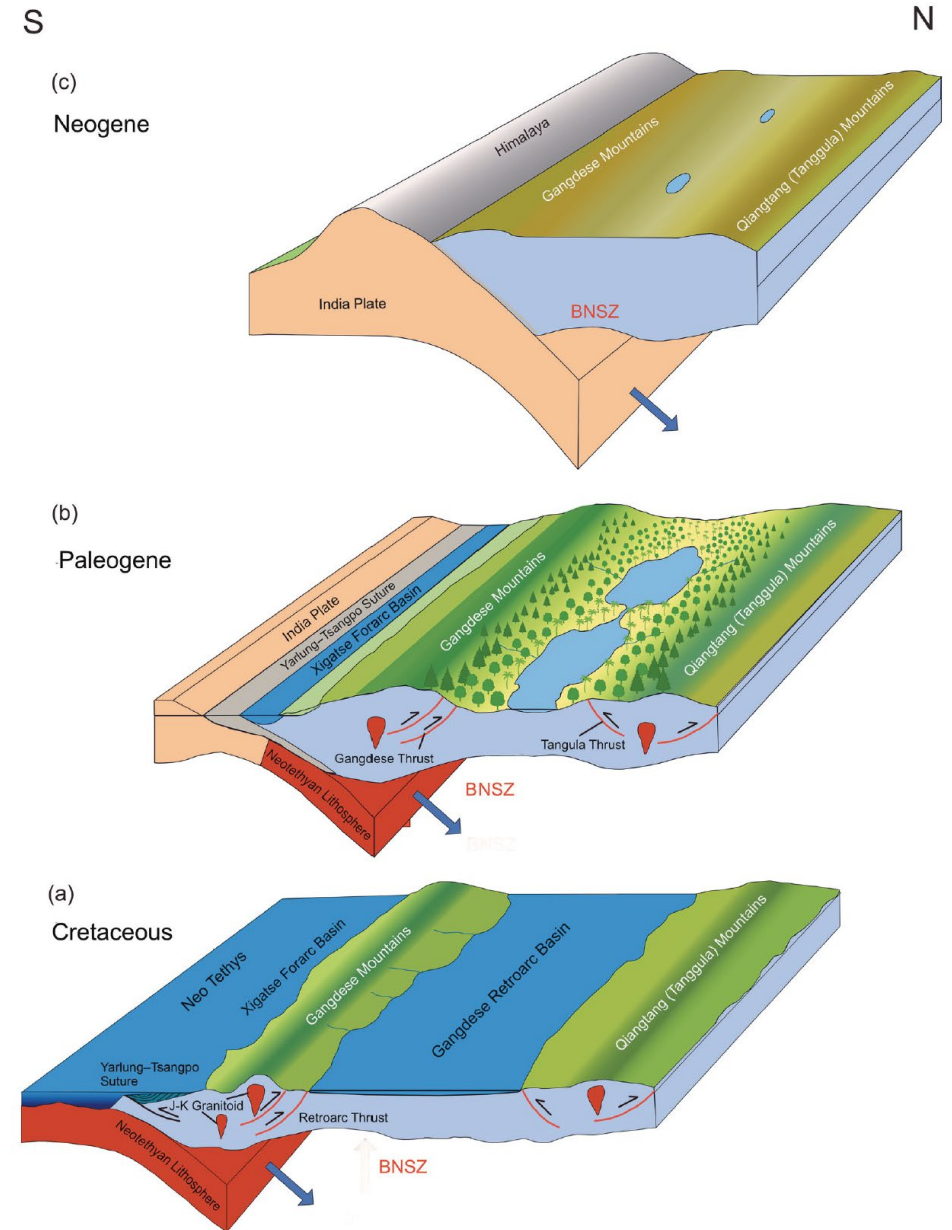
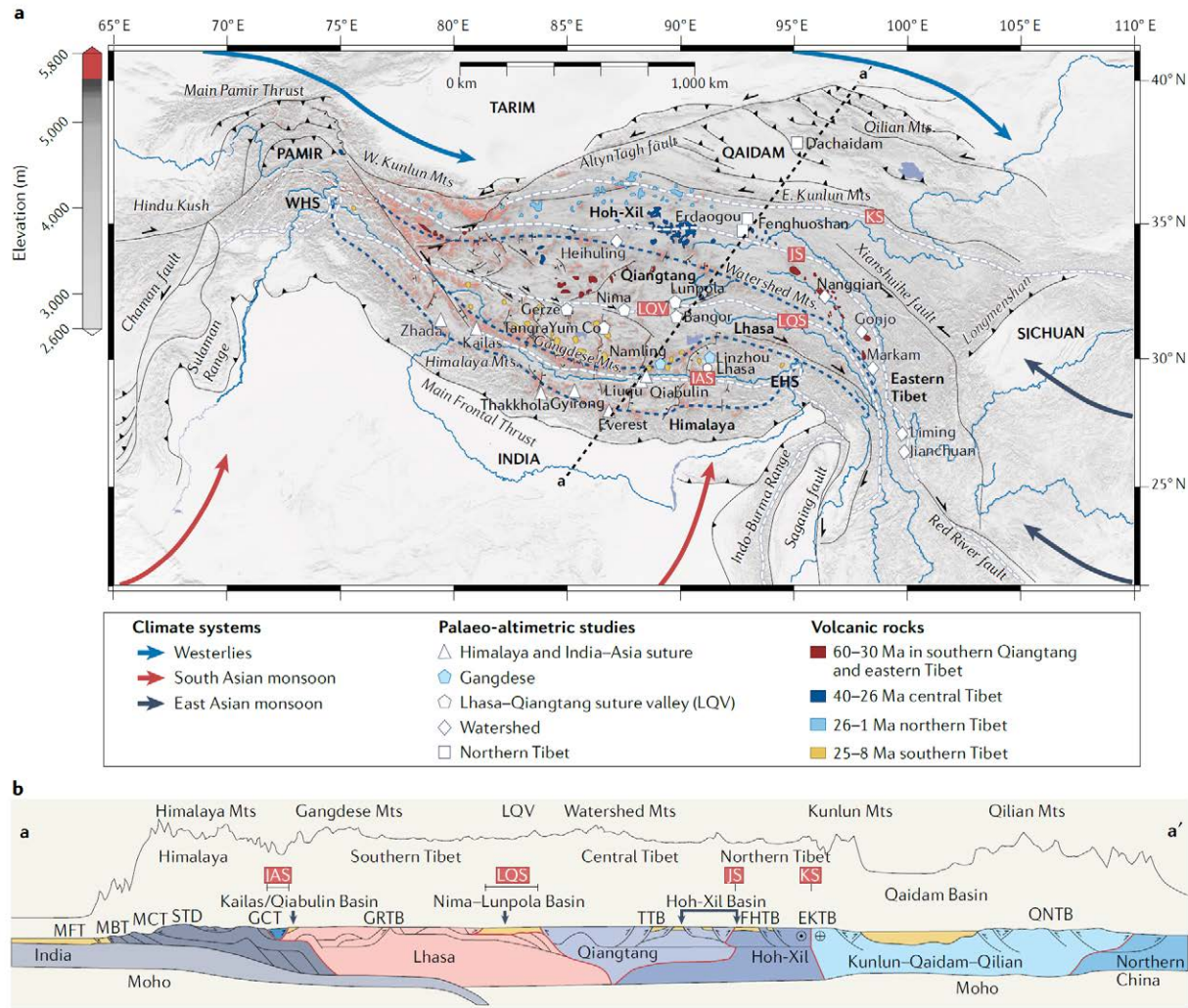


Wang et al., 2015

Building the Plateau



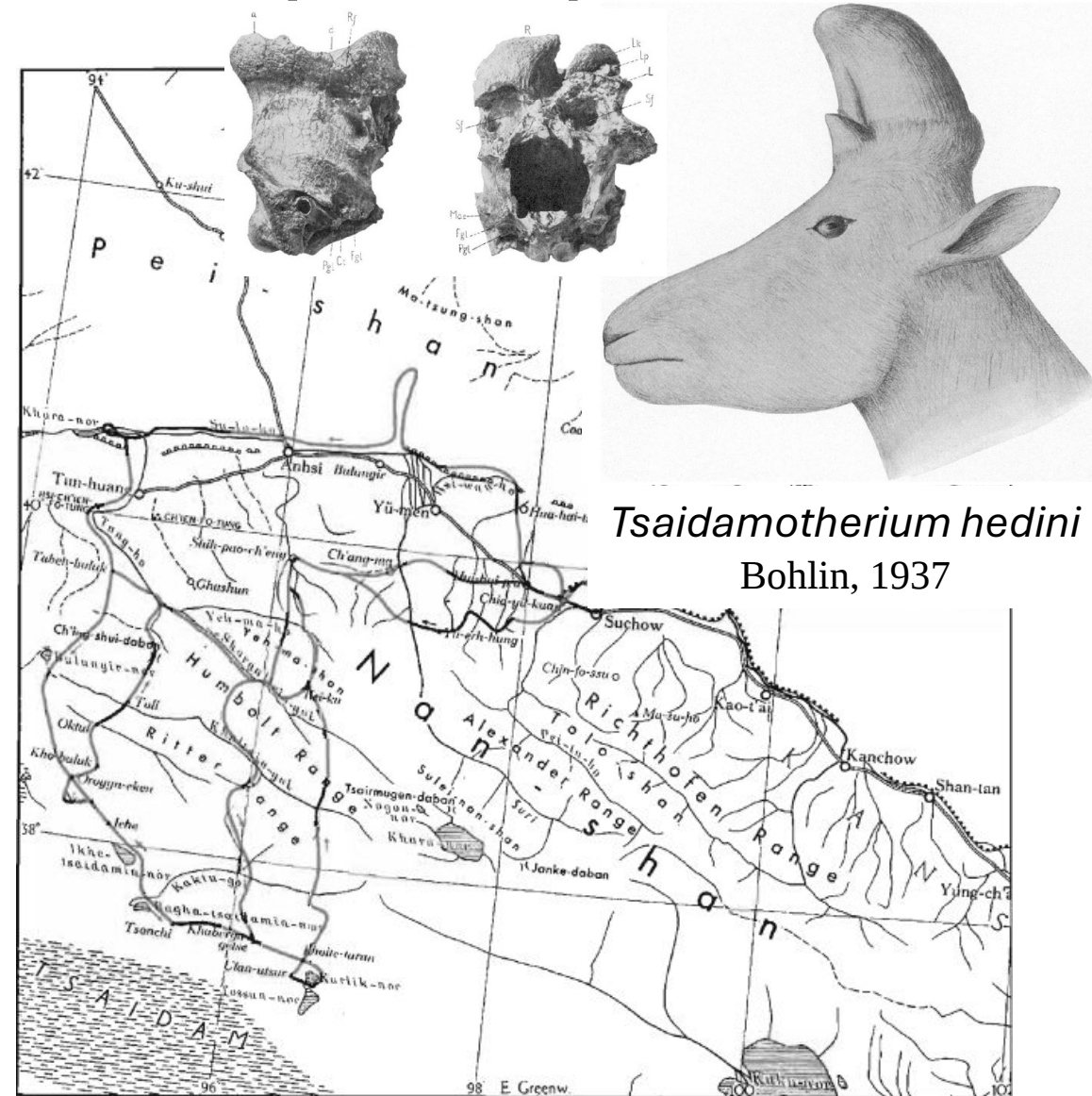
The Uplift: From Tethys to the Himalaya



Palaeontology on the QTP: The Sino-Swedish Expedition (1927-1933)



At work in the field in Inner Mongolia, 1927
The Sven Hedin Foundation



Tsaidamotherium hedini
Bohlin, 1937

Map of Expedition Routes (1929-1932)
Bohlin, 1945

Ascent with Modification

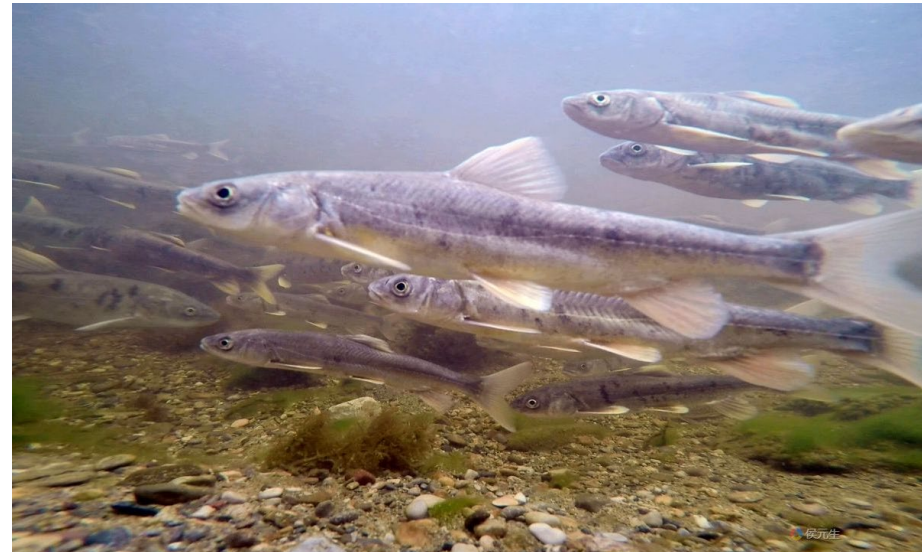
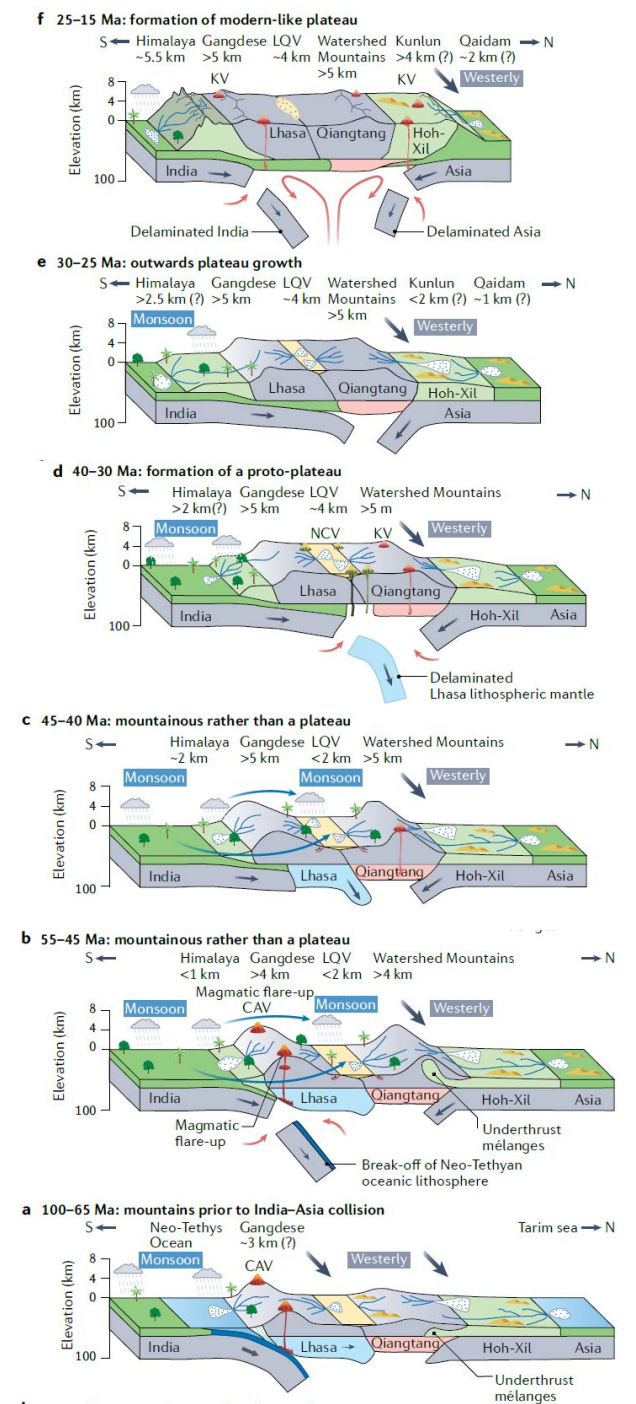
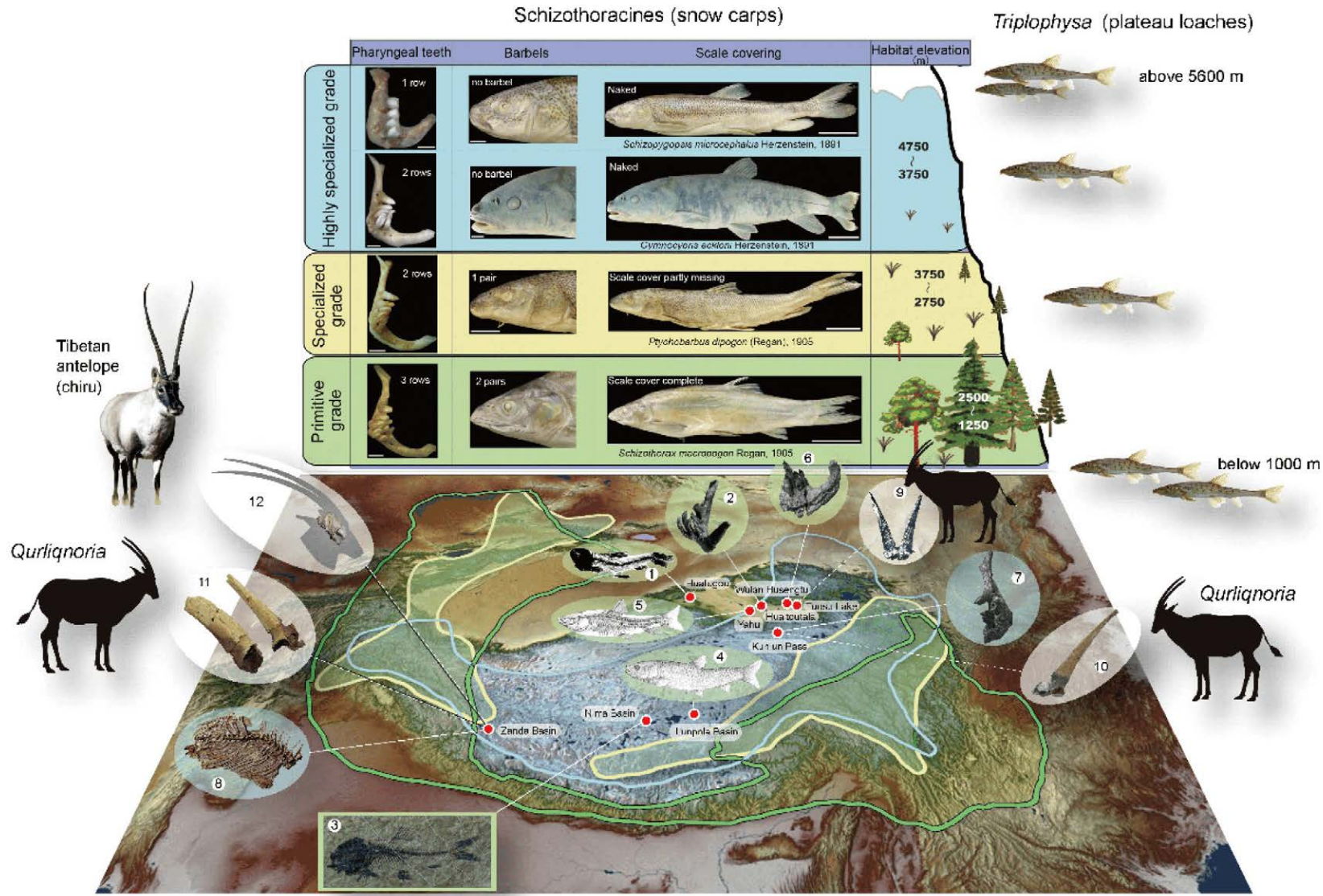
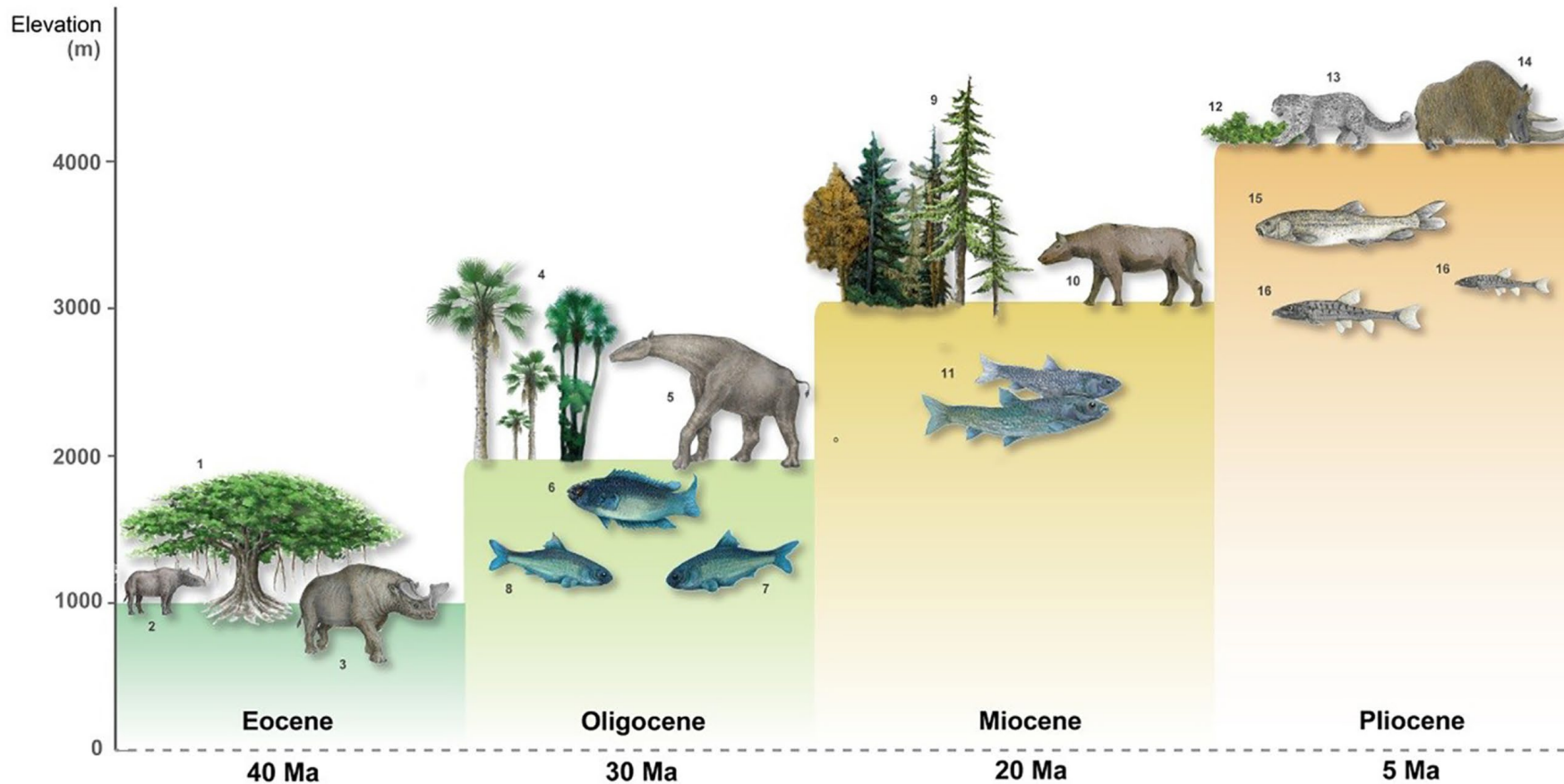


Image source: the internet.

Ascent with Modification

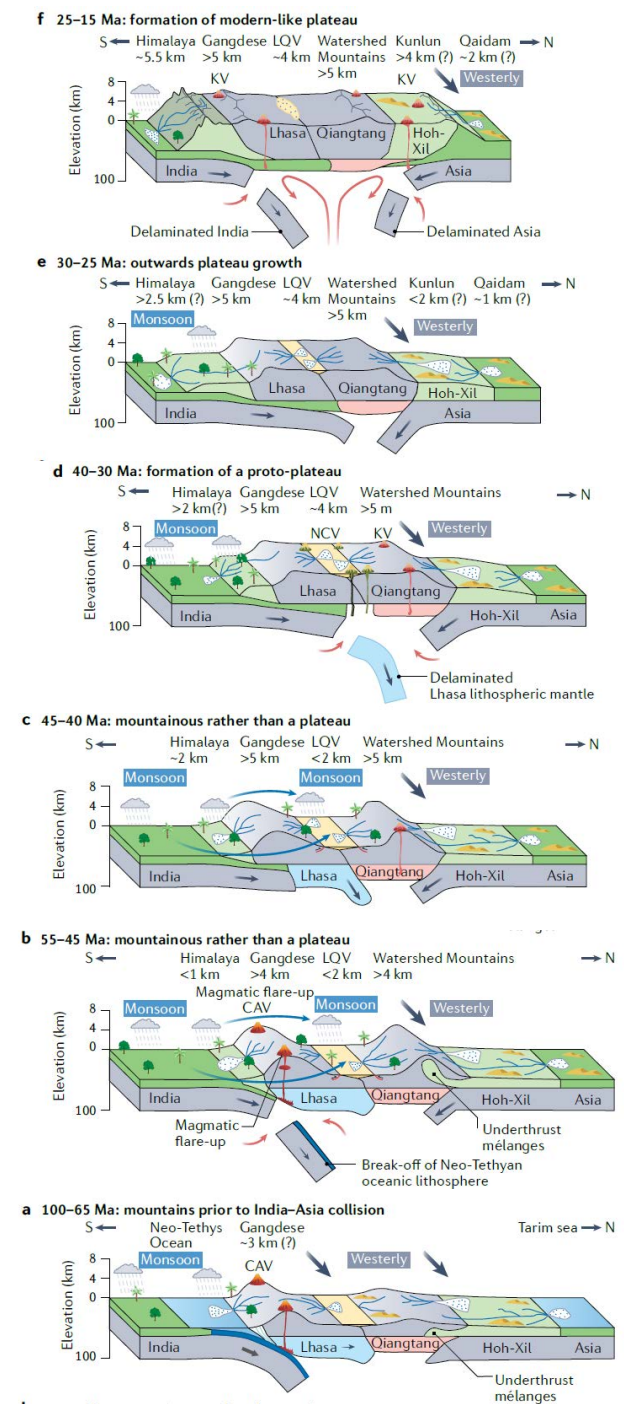


Ascent with Modification



1. Banyan tree (*Ficus*); 2. Aynodont; 3. Titanotherium; 4. Palm (*Sabalites tibetensis*); 5. Giant rhino (*Paraceratherium*); 6. Climbing perch (*Eoanabas thibetana*); 7. Cyprinid fish (*Tchunglinus tchangii*); 8. A cyprinid fish; 9. Coniferous forest; 10. Hornless rhino (*Plesiaceratherium*); 11. Primitive schizothoracine fish (*Plesioschizothorax macrocephalus*); 12. Shrubs (*Cotoneaster*, *Spiraea*, *Caragana*); 13. Primitive snow leopard (*Panthera blytheae*); 14. Primitive wholly rhino (*Coelodonta thibetana*); 15. Highly specialized schizothoracine fish (naked carp, *Gymnocypris*); 16. Plateau loach (*Triplophysa*).

Deng et al., 2021; Ding et al., 2022

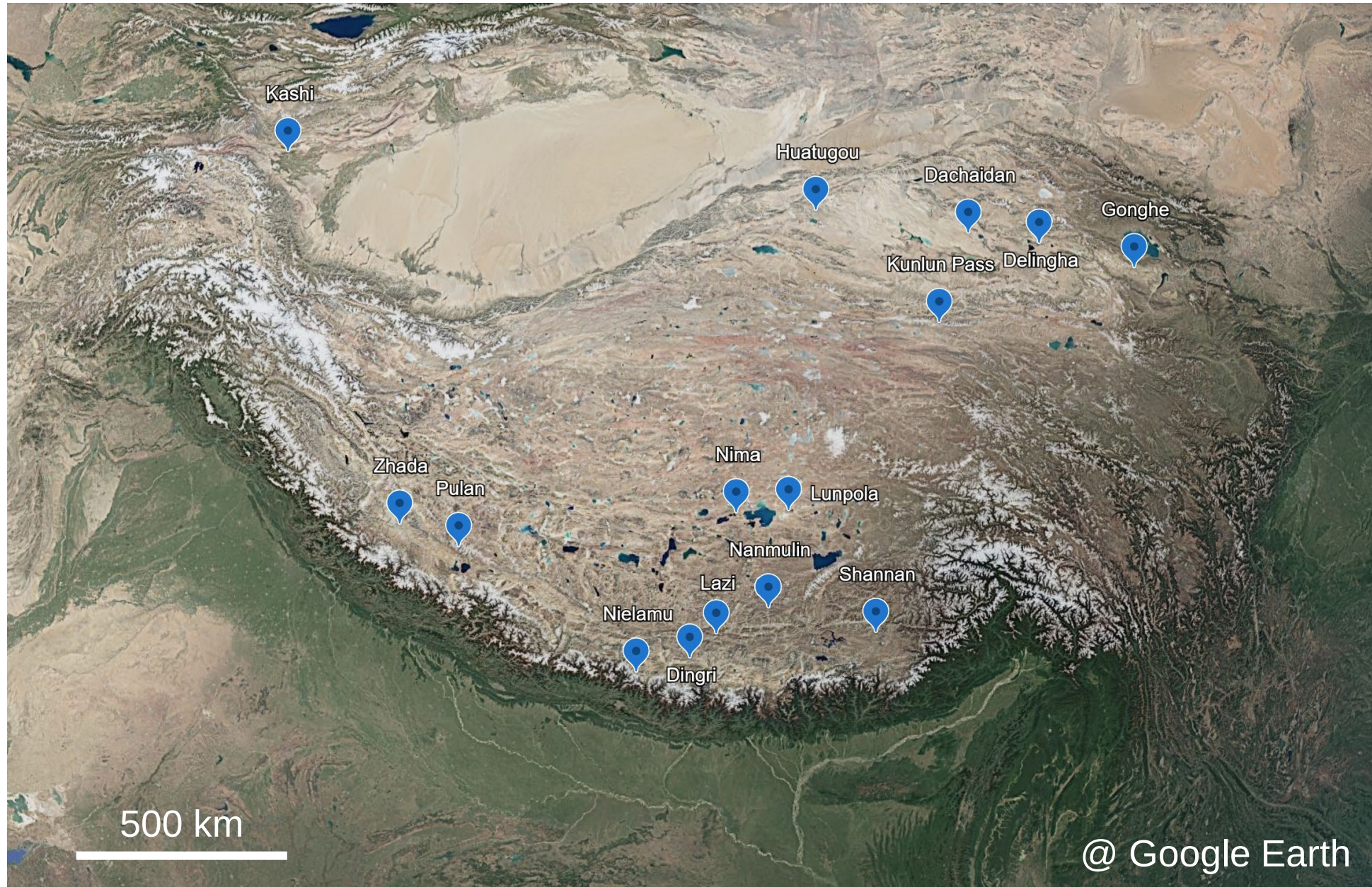


Out of Tibet: a zoogeographic hypothesis



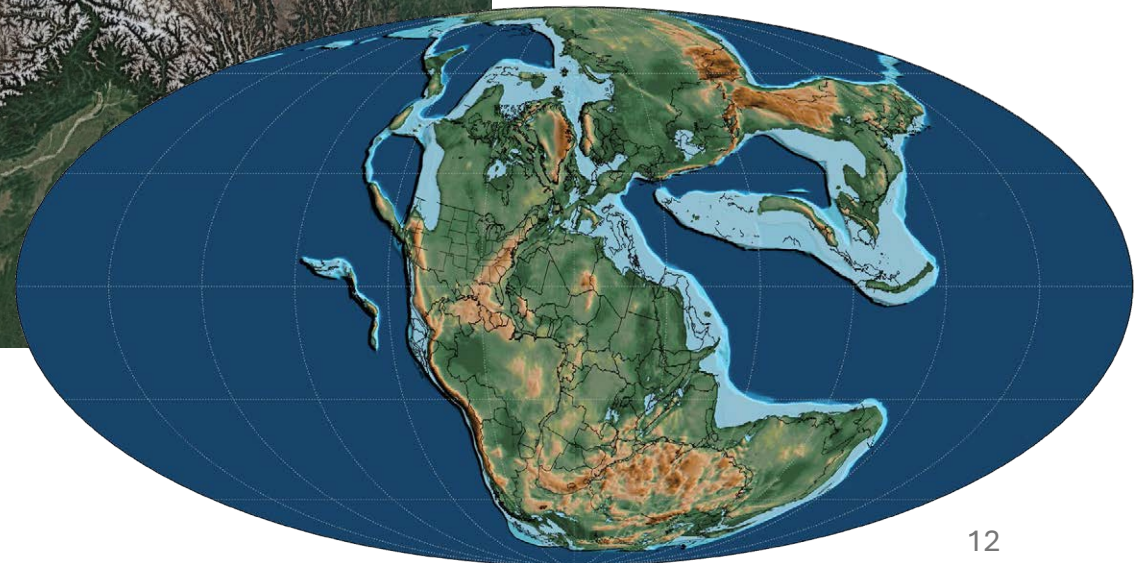
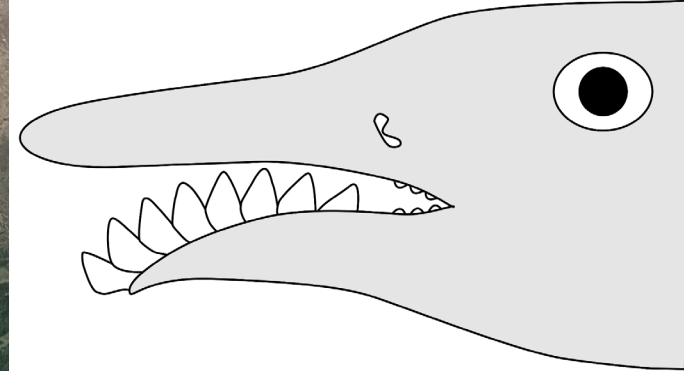
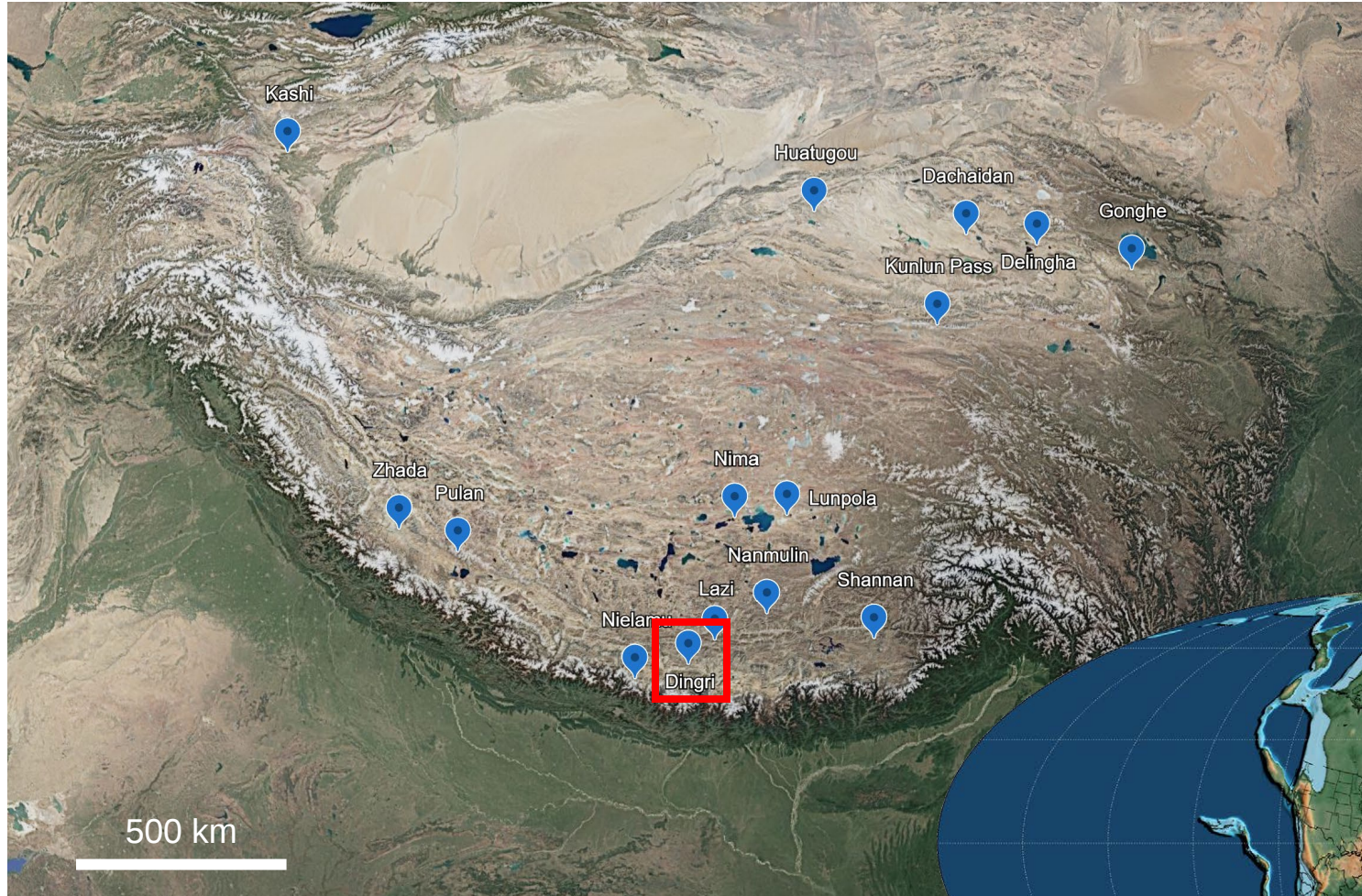
Wang et al., 2015

The Second Tibetan Plateau Scientific Expedition and Research (STEP)

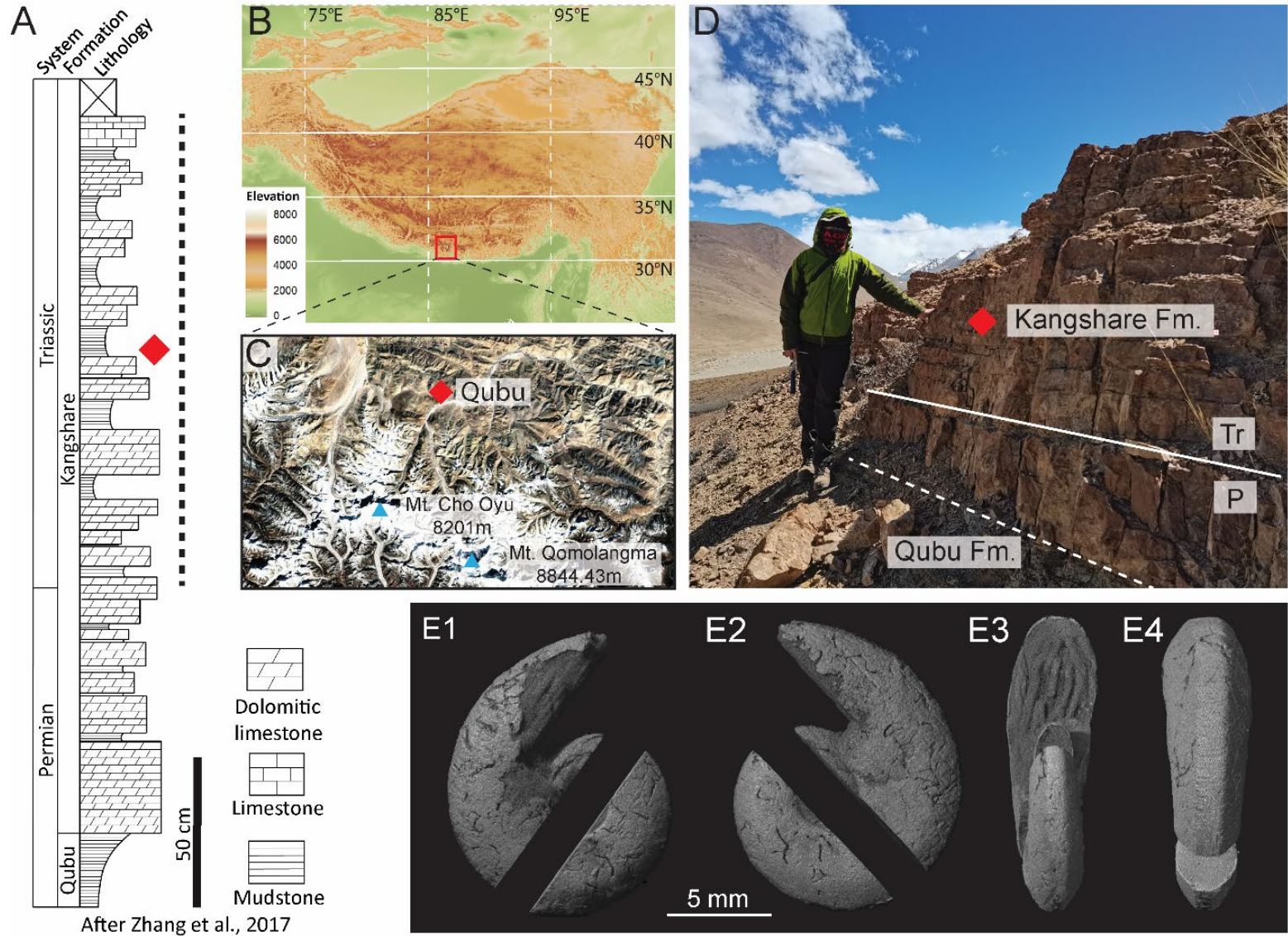


Mesozoic

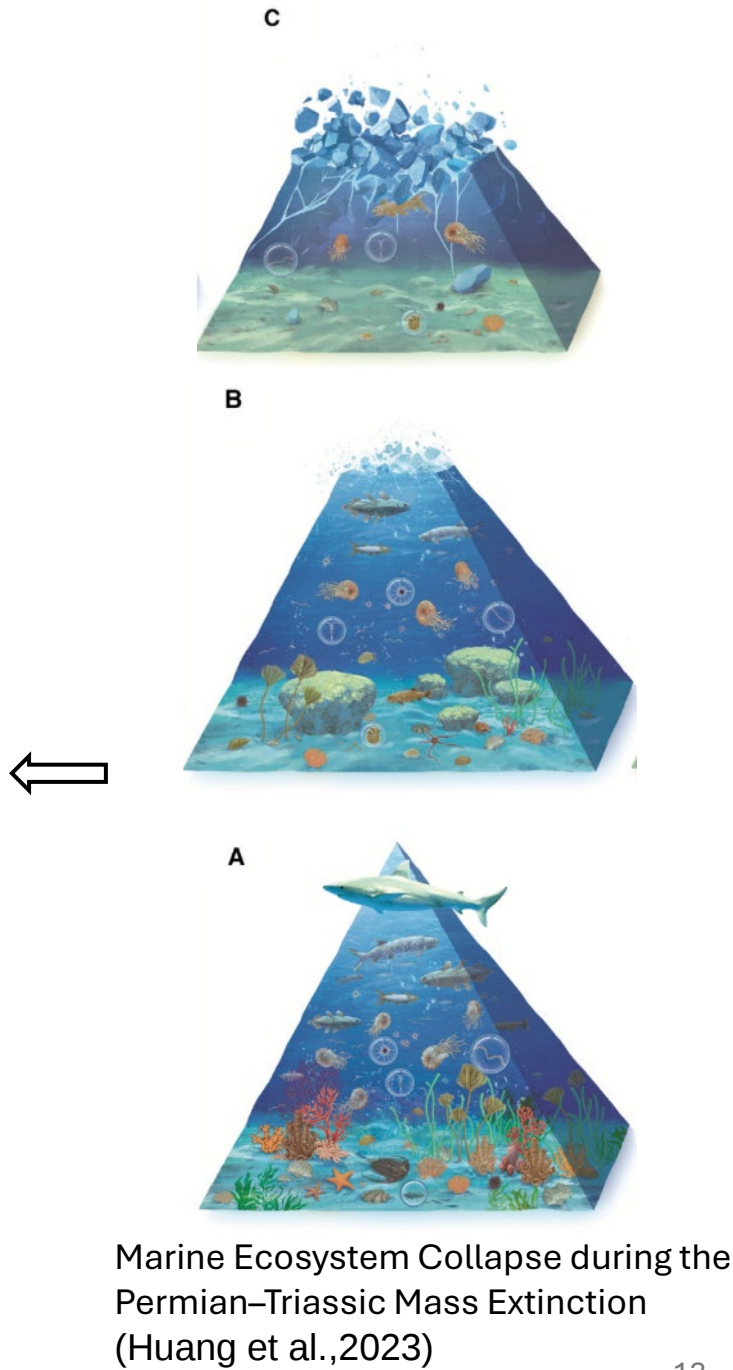
Cenozoic	Quaternary	Holocene	Meghalayan
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			Greenlandian
	Pleistocene	Upper	
			Chibanian
			Calabrian
	Pliocene		Gelasian
			Piacenzian
			Zanclean
	Miocene		Messinian
			Tortonian
			Serravallian
			Langhian
			Burdigalian
			Aquitanian
	Oligocene		Chattian
			Rupelian
	Eocene		Priabonian
			Bartonian
			Lutetian
			Ypresian
	Paleocene		Thanetian
			Selandian
			Danian
Mesozoic	Cretaceous	Upper	Maastrichtian
			Campanian
			Santonian
			Coniacian
			Turonian
			Cenomanian
		Lower	Albian
			Aptian
			Barremian
			Hauterivian
			Valanginian
			Berriasian
	Jurassic	Upper	Tithonian
			Kimmeridgian
			Oxfordian
		Middle	Callovian
			Bathonian
			Bajocian
			Aalenian
		Lower	Toarcian
			Pliensbachian
Triassic	Triassic	Upper	Sinemurian
			Hettangian
			Rhaetian
		Middle	Norian
			Carnian
		Lower	Ladinian
			Anisian
		Lower	Olenekian
			Induan



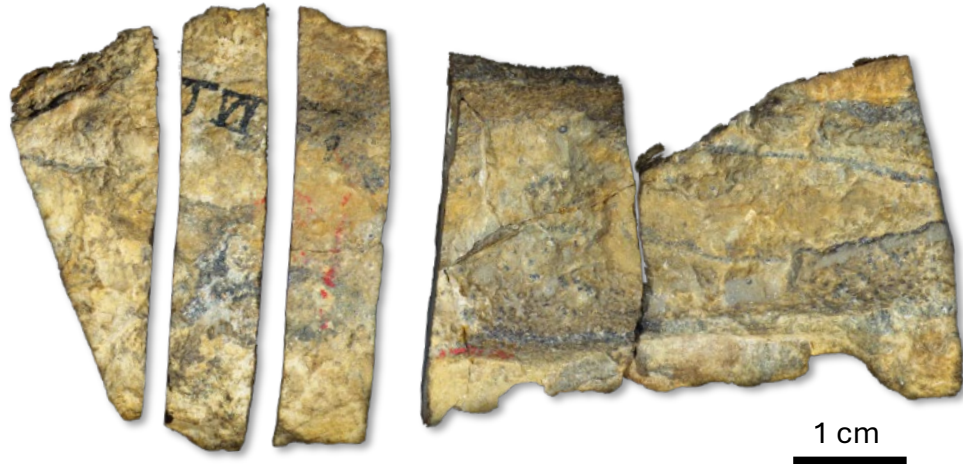
Geological Setting



Meekoceratidae or Gyronitidae (Early Triassic)



Sinohelicoprion qomolangma Chang, 1976



Preorbital Portion of the Skull (V. 4752.1 a-e)



Tooth Whorl (V.4752.2)



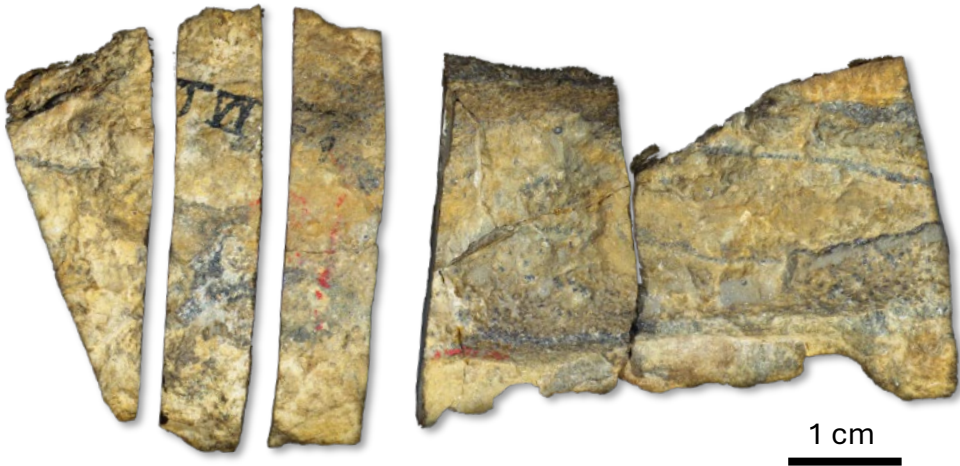
1975 Mount Qomolangma Scientific Mountaineering Expedition

Sinohelicoprion qomolangma Chang, 1976

A NEW SPECIES OF HELICOPRIONID SHARK FROM XIZANG

Zhang Miman

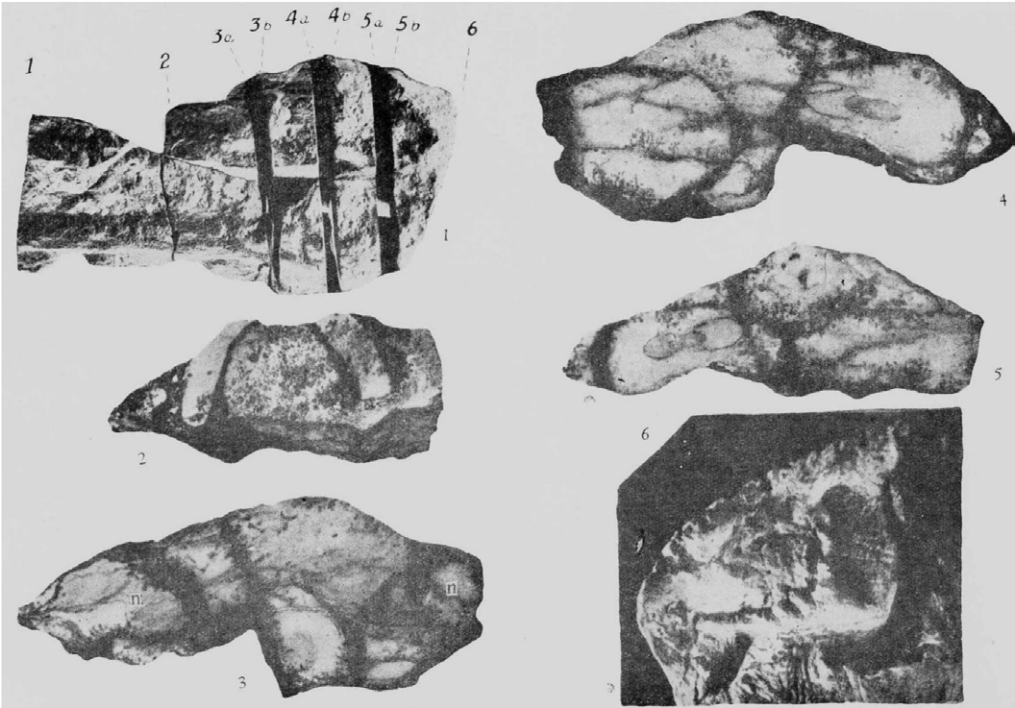
(Institute of Vertebrate Palaeontology and Palaeoanthropology, Academia Sinica)



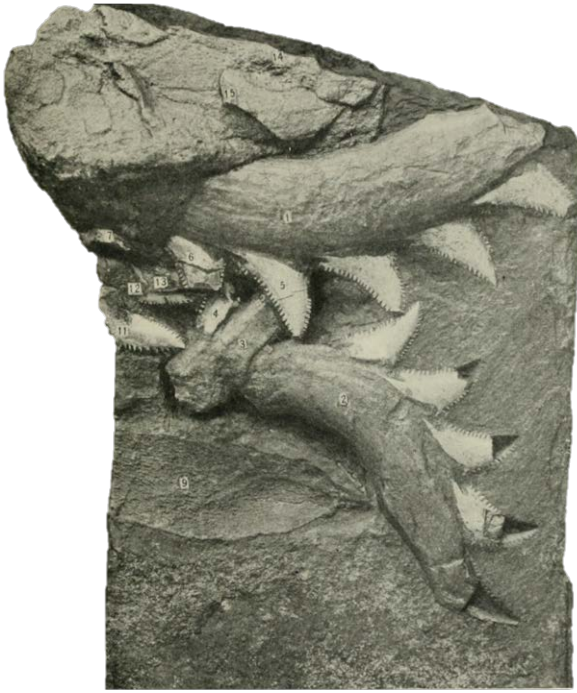
Preorbital Portion of the Skull (V. 4752.1 a-e)



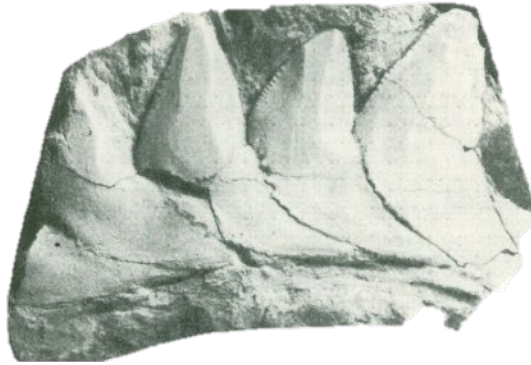
Tooth Whorl (V.4752.2)



Background: Eugeneodontiformes



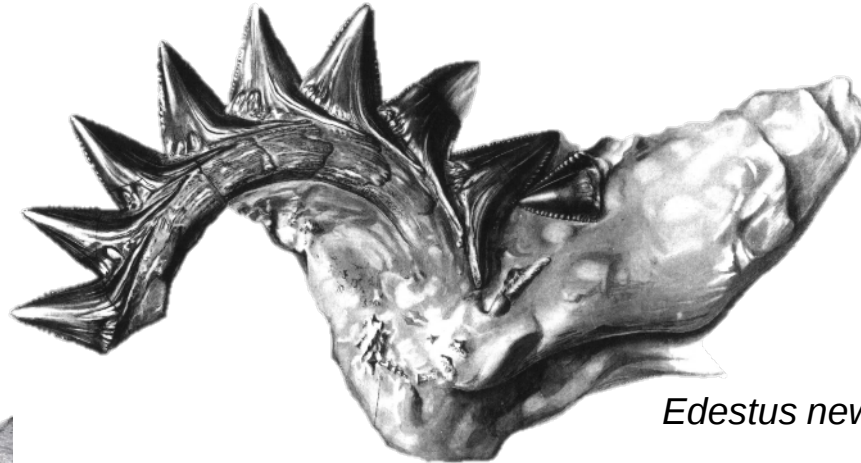
Edestus mirus



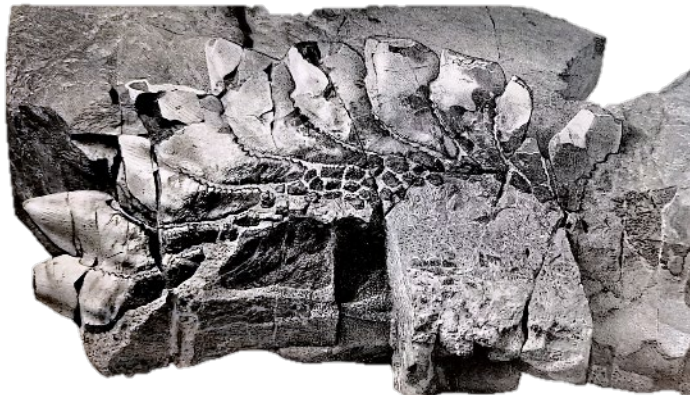
Helicampodus kokeni



Campyloprion annectans



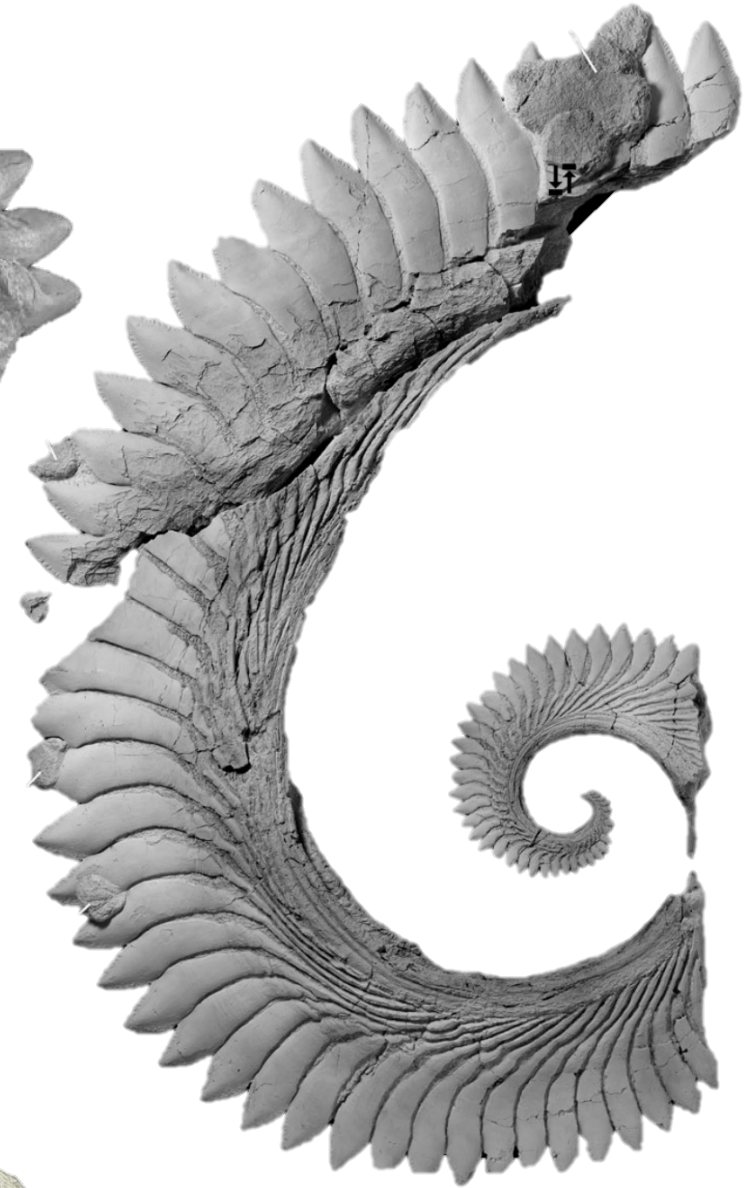
Edestus newtoni



Sarcoprion edax



Edestus heinrichi

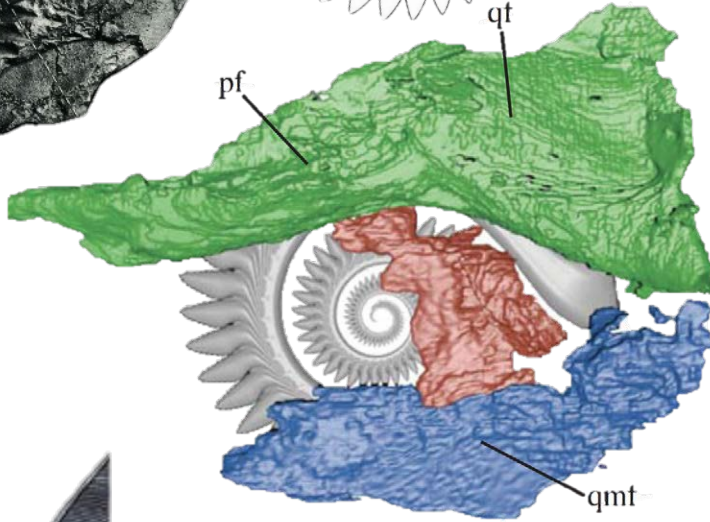
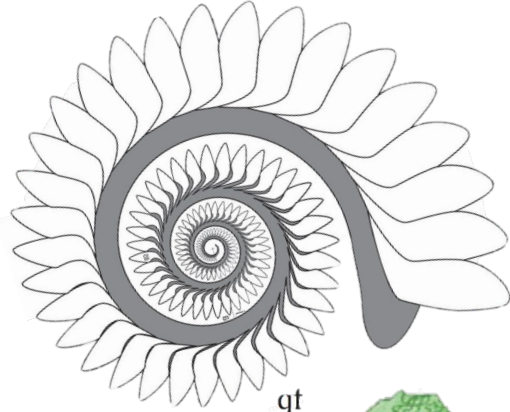


Campyloprion ivanovi

Background: *Helicoprion*

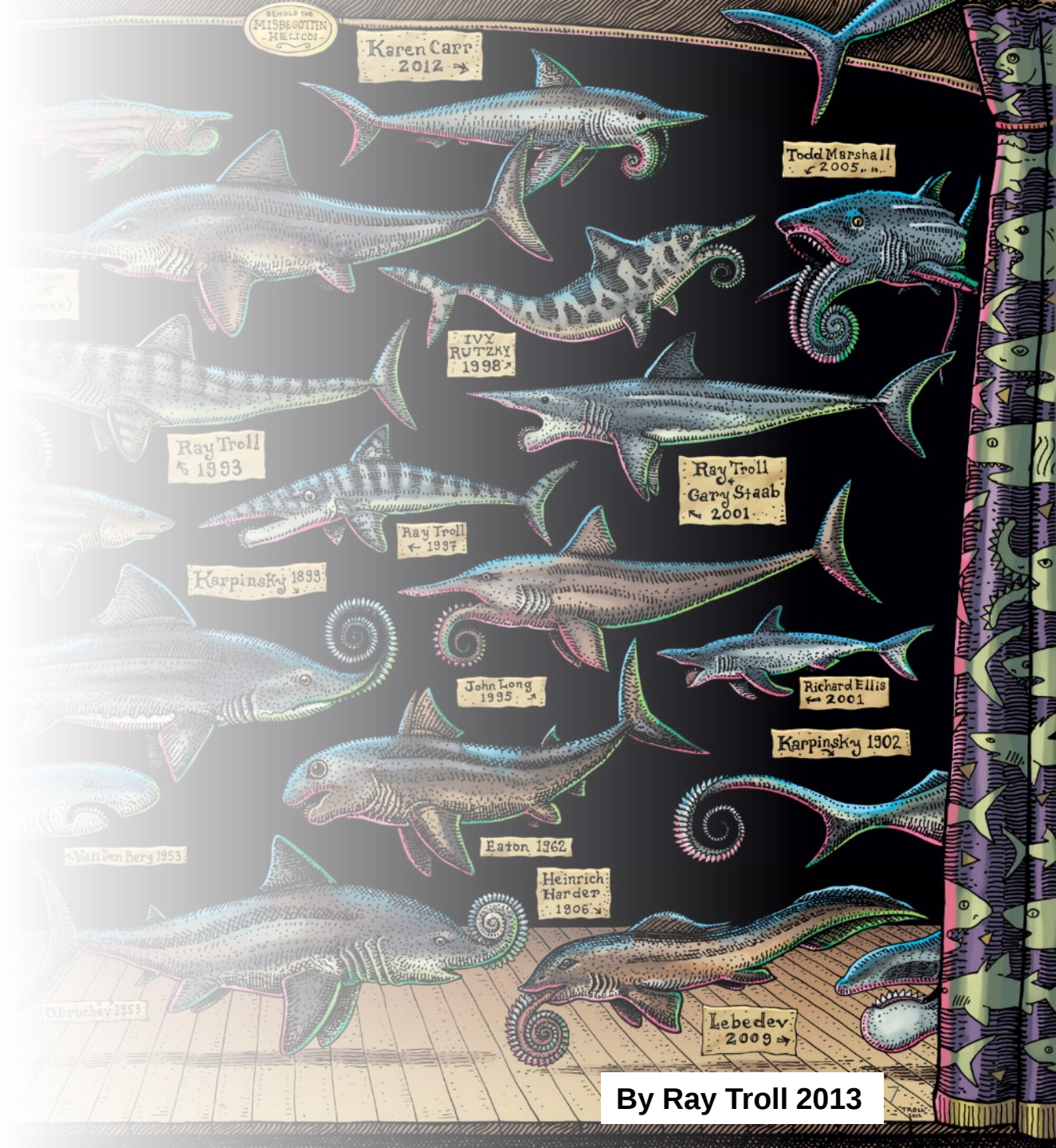
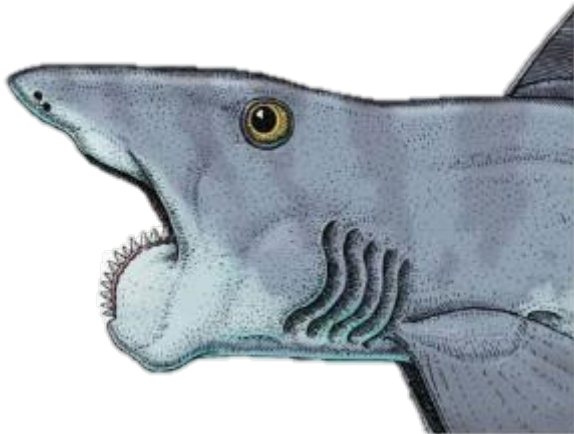


Bendix-Almgreen, 1966



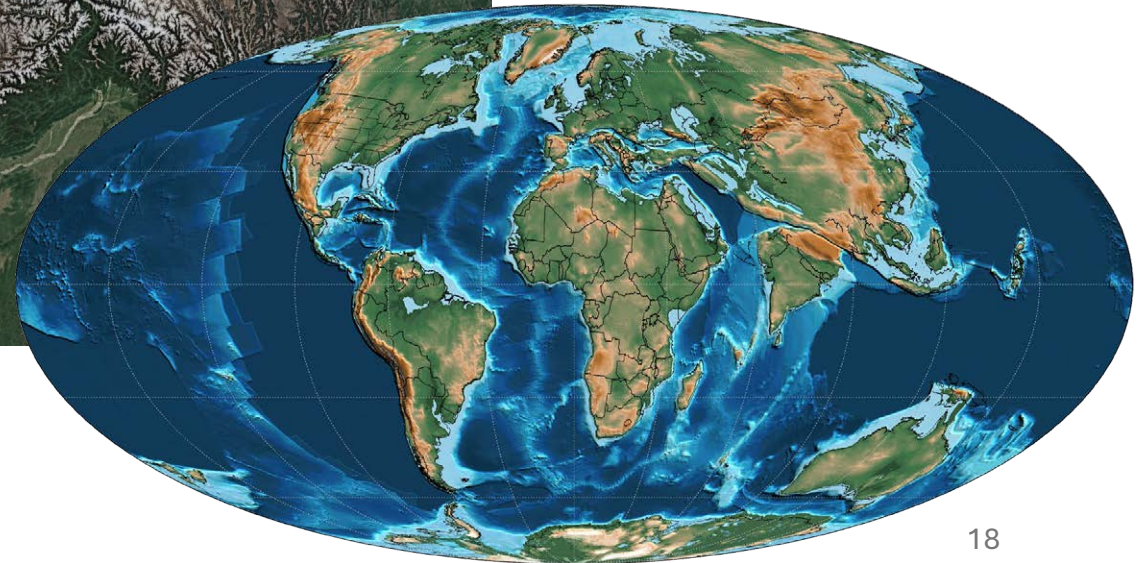
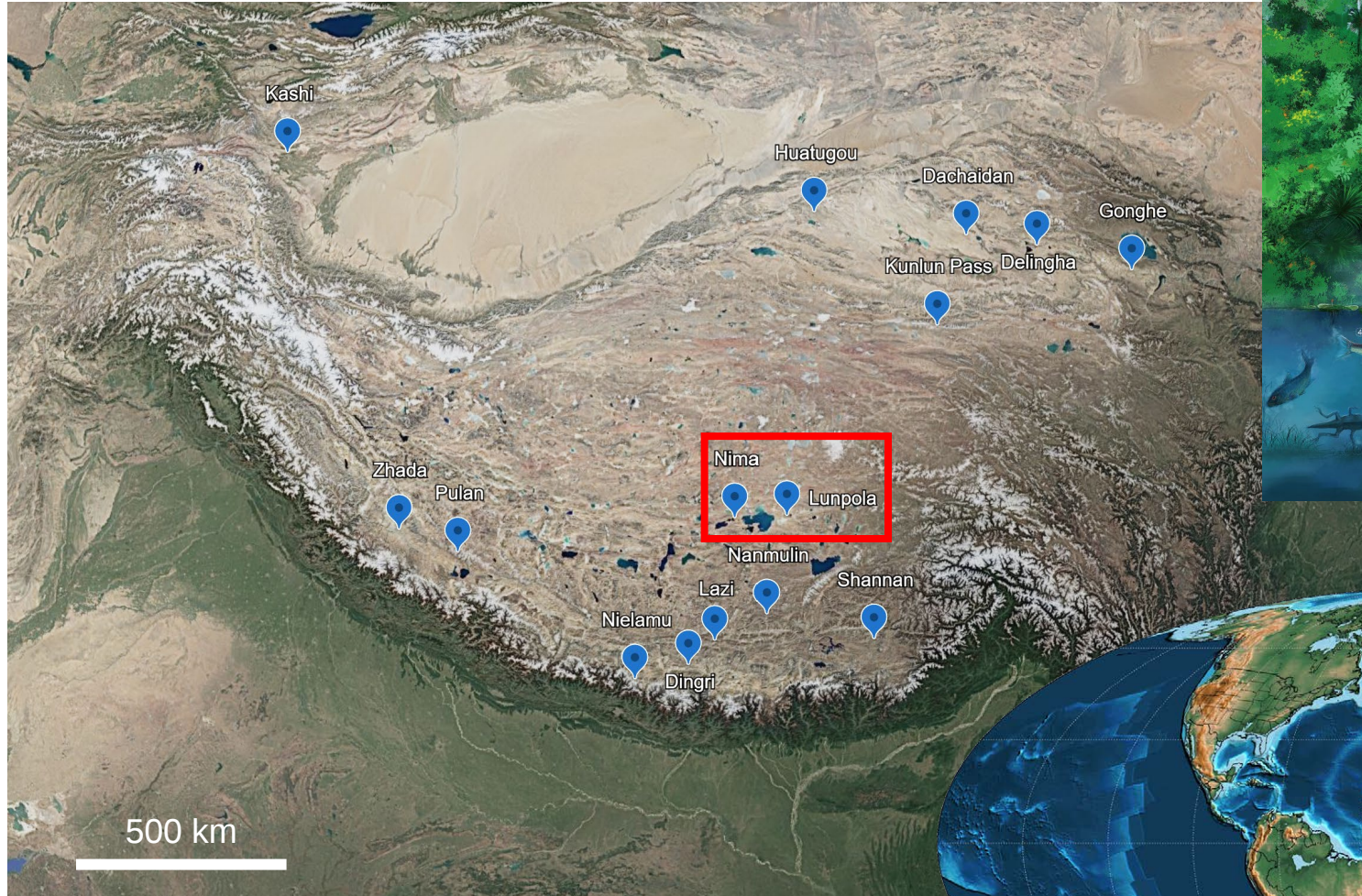
Tapanila et al., 2013

- mandibular symphysis
- folding into the ventral side of the mandible

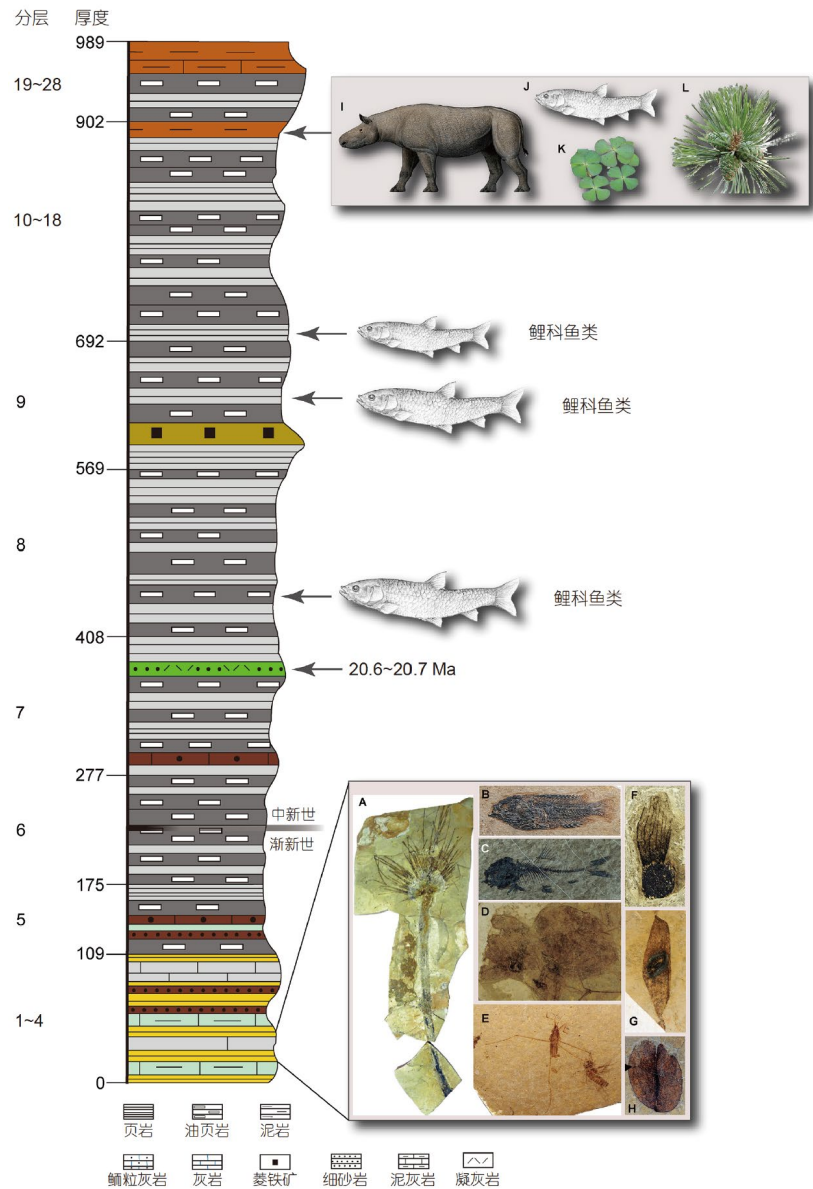


Paleogene

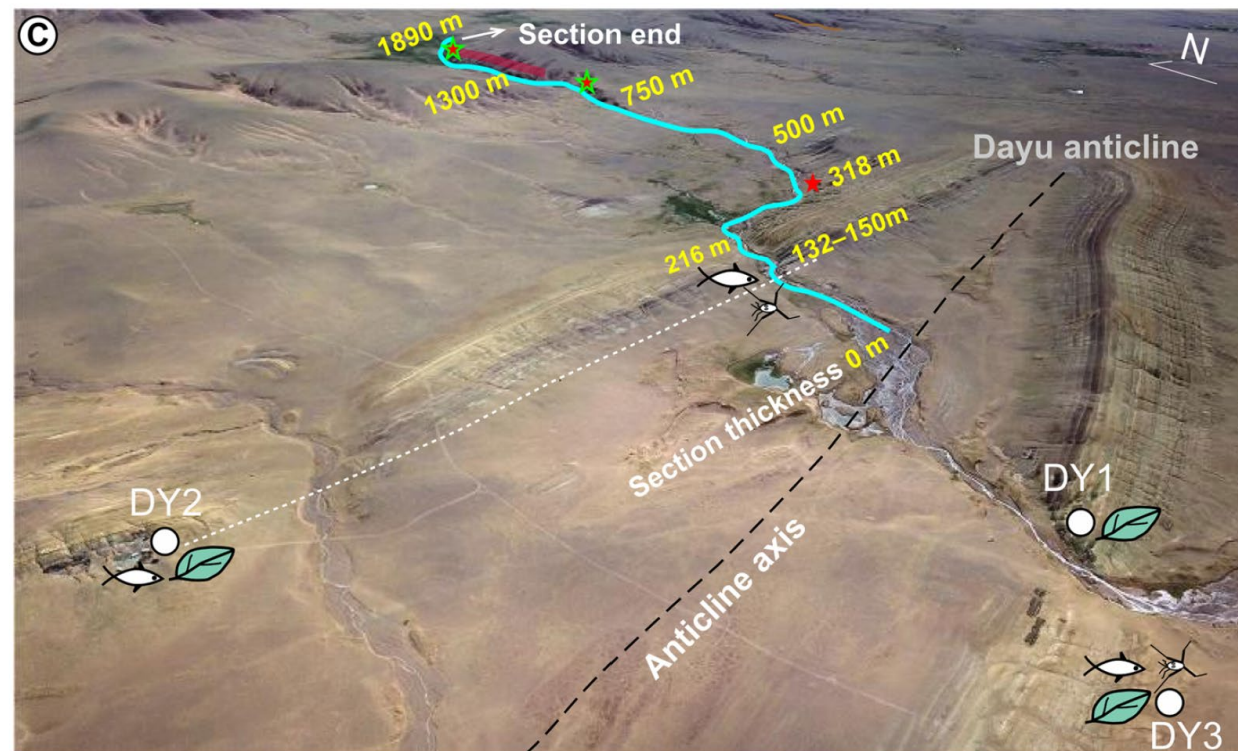
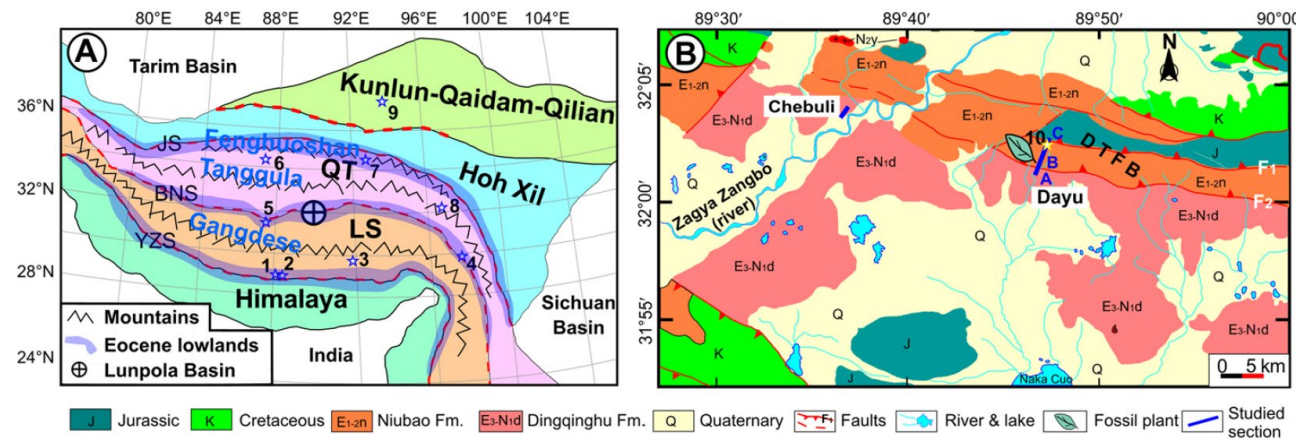
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			Northgrippian
			Greenlandian
	Pleistocene	Upper	
			Chibanian
			Calabrian
	Pliocene	Gelasian	
			Piacenzian
			Zanclean
	Miocene	Messinian	
			Tortonian
			Serravallian
			Langhian
			Burdigalian
			Aquitania
	Oligocene	Chattian	
			Rupelian
	Eocene	Priabonian	
			Bartonian
			Lutetian
			Ypresian
	Paleocene	Thanetian	
			Selandian
			Danian
Mesozoic	Cretaceous	Upper	Maastrichtian
			Campanian
			Santonian
			Coniacian
			Turonian
			Cenomanian
		Lower	Albian
			Aptian
			Barremian
	Jurassic		Hauterivian
			Valanginian
			Berriasian
		Upper	Tithonian
			Kimmeridgian
			Oxfordian
		Middle	Callovian
			Bathonian
			Bajocian
	Triassic		Aalenian
		Lower	Toarcian
			Pliensbachian
			Sinemurian
			Hettangian
		Upper	Rhaetian
			Norian
			Carnian
		Middle	Ladinian
			Anisian
		Lower	Olenekian
			Induan



Lunpola Basin



Deng et al., 2019

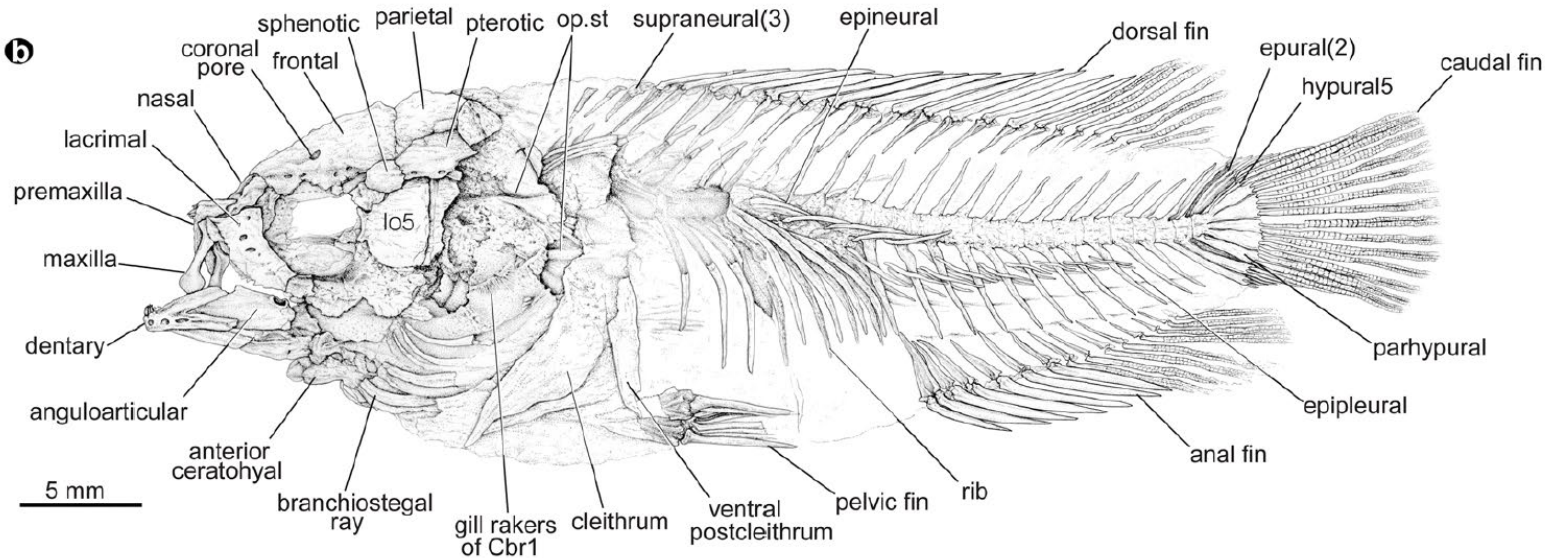


Fang et al., 2020

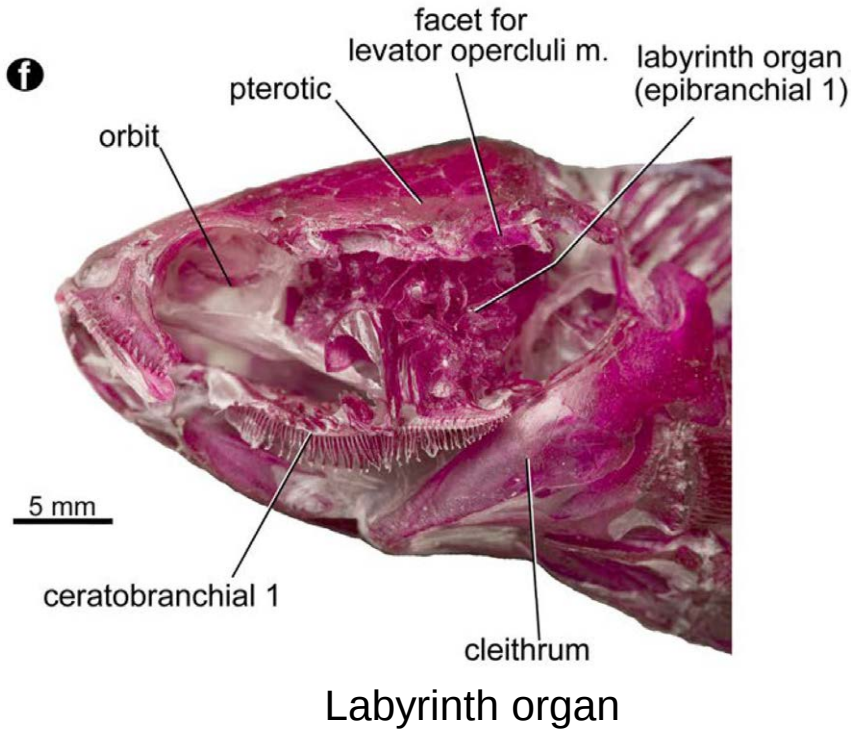
Eoanabas thibetana: a fossil climbing perch



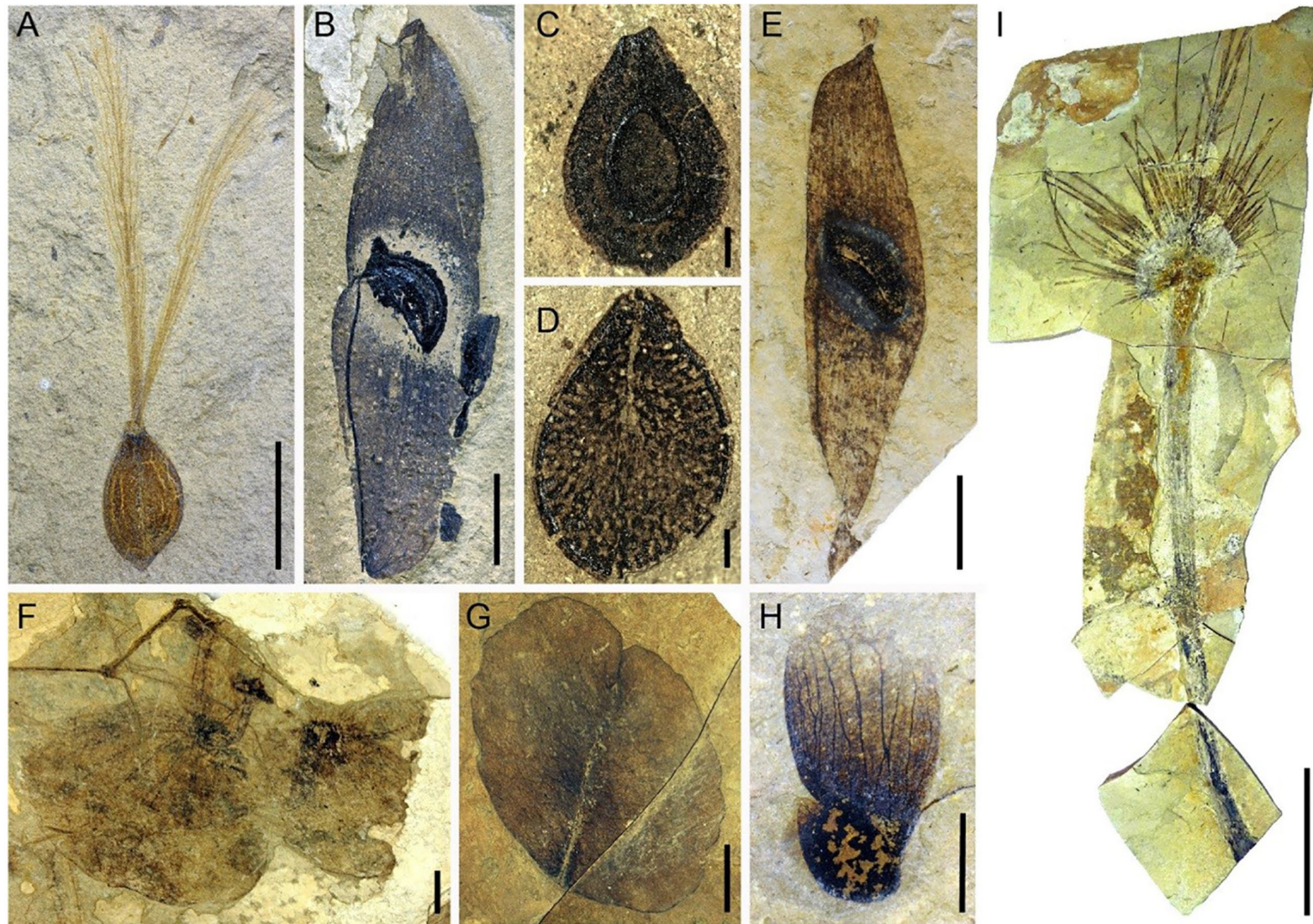
Living climbing perch (Photo: Shutterstock)



Wu et al., 2017



Plant Fossil Species from the Lunpola Basin

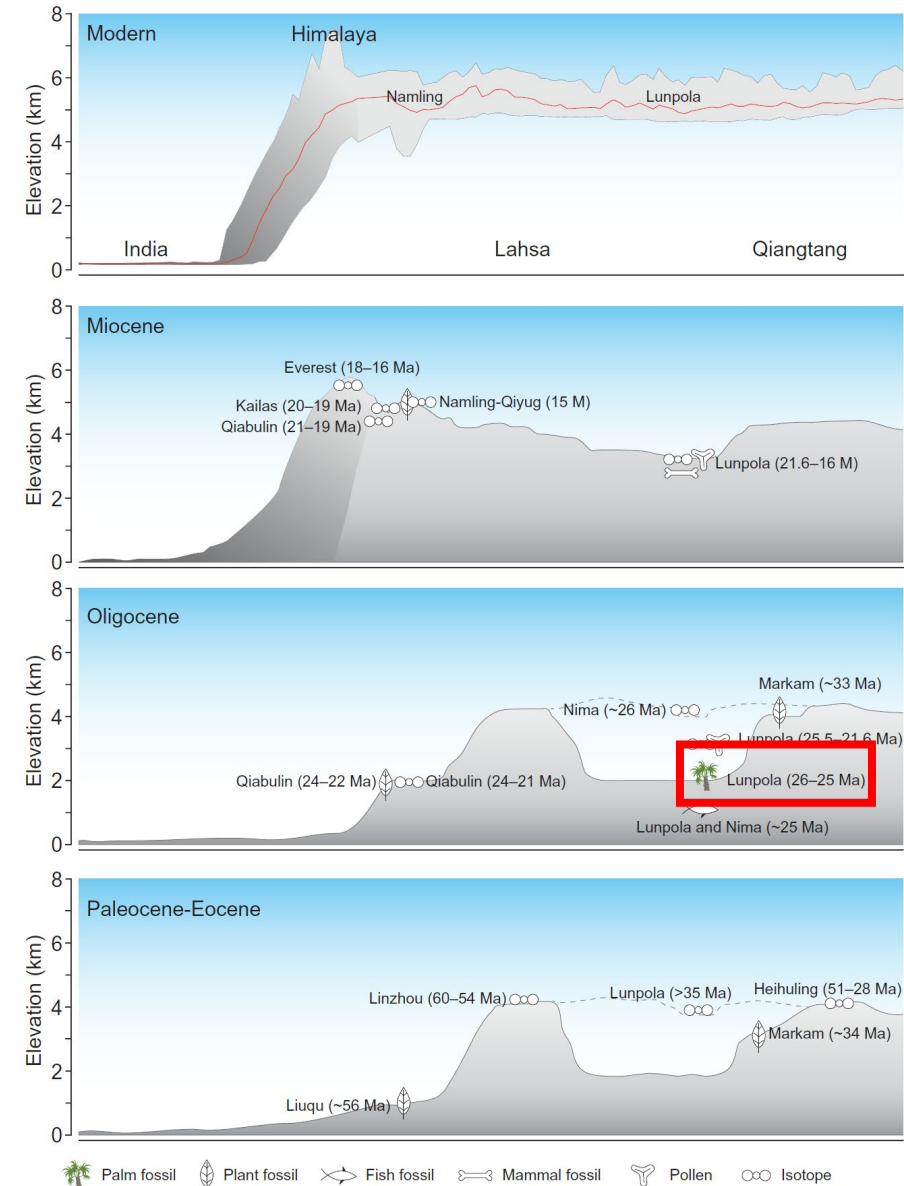


- A. *Lagokarpos tibetensis* (unknown family);
B, E. *Ailanthus maximus* (Simaroubaceae);
C. *Asclepiadospermum marginatum* (Apocynaceae);
D. *Asclepiadospermum ellipticum* (Apocynaceae);
F. *Limnobiophyllum pedunculatum* (Araceae);
G. *Koelreuteria lunpolaensis* (Sapindaceae);
H. *Cedrelospermum tibeticum* (Ulmaceae);
I. *Sabalites tibetensis* (Arecaceae).
Scale bars: A, B, E, F, G = 1 cm, C, D = 1 mm; H = 5 mm; I = 10 cm.

A Warm and Humid Tropical or Subtropical Lowland



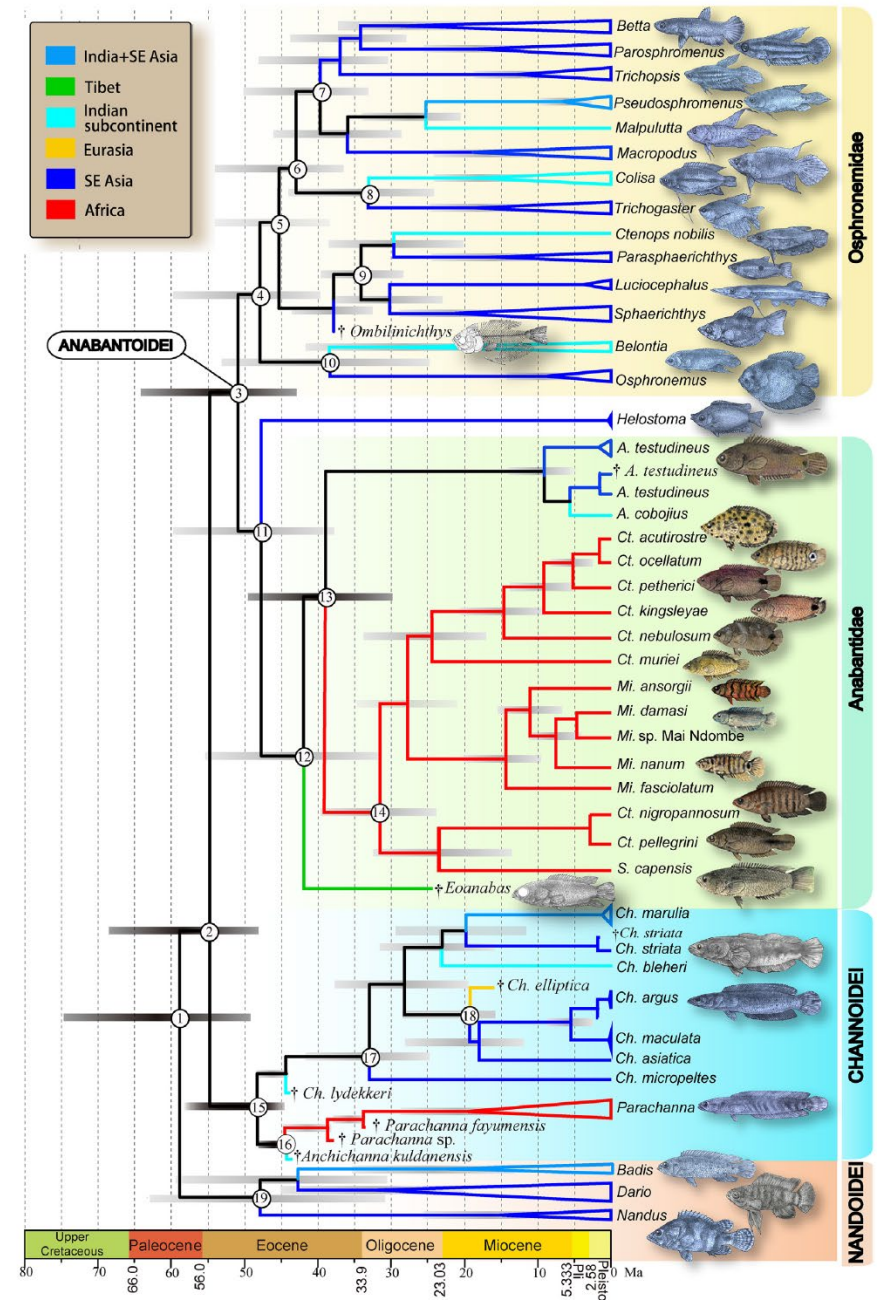
Reconstruction of the latest Paleogene ecosystem in the central Tibetan Plateau. ① *Tchunglinius tchangii*; ② *Eoanabas thibetana*; ③ new cyprinid form A; ④ new cyprinid form B; ⑤ raptor and cuckoo; ⑥ *Aquarius lunpolaensis*; ⑦ *Koelreuteria lunpolaensis*; ⑧ *Sabalites tibetensis*; ⑨ *Ailanthus maximus*; ⑩ *Limnobiophyllum pedunculatum* (Art by Feixiang Wu)



Lunpola Basin

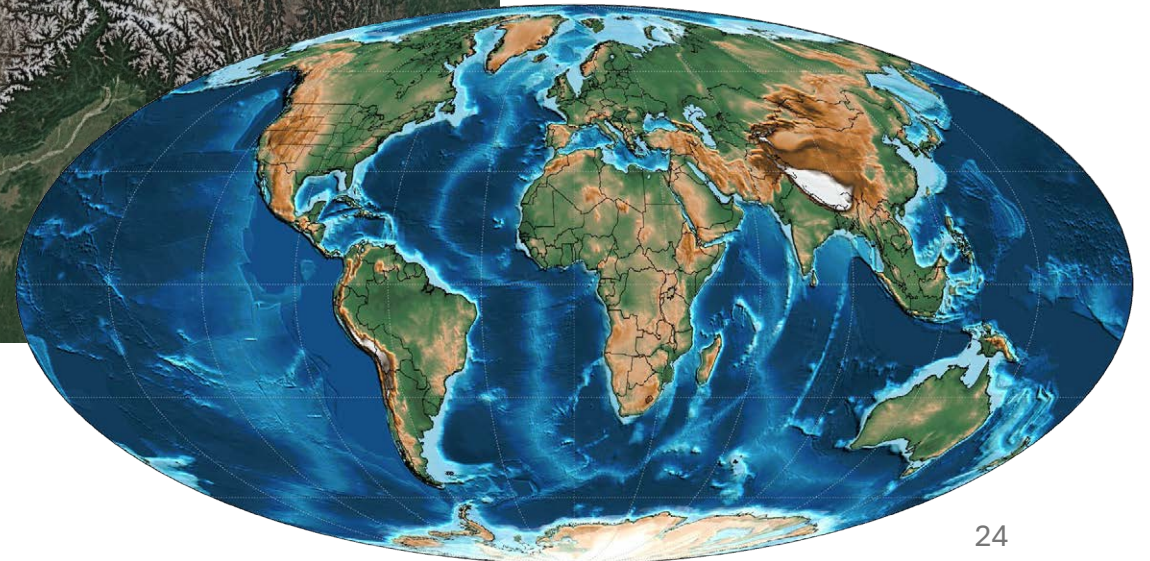
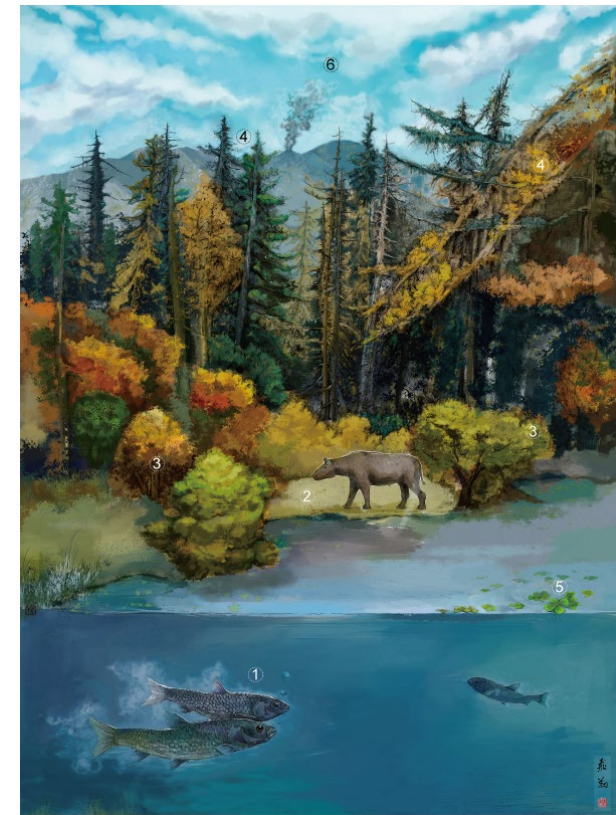
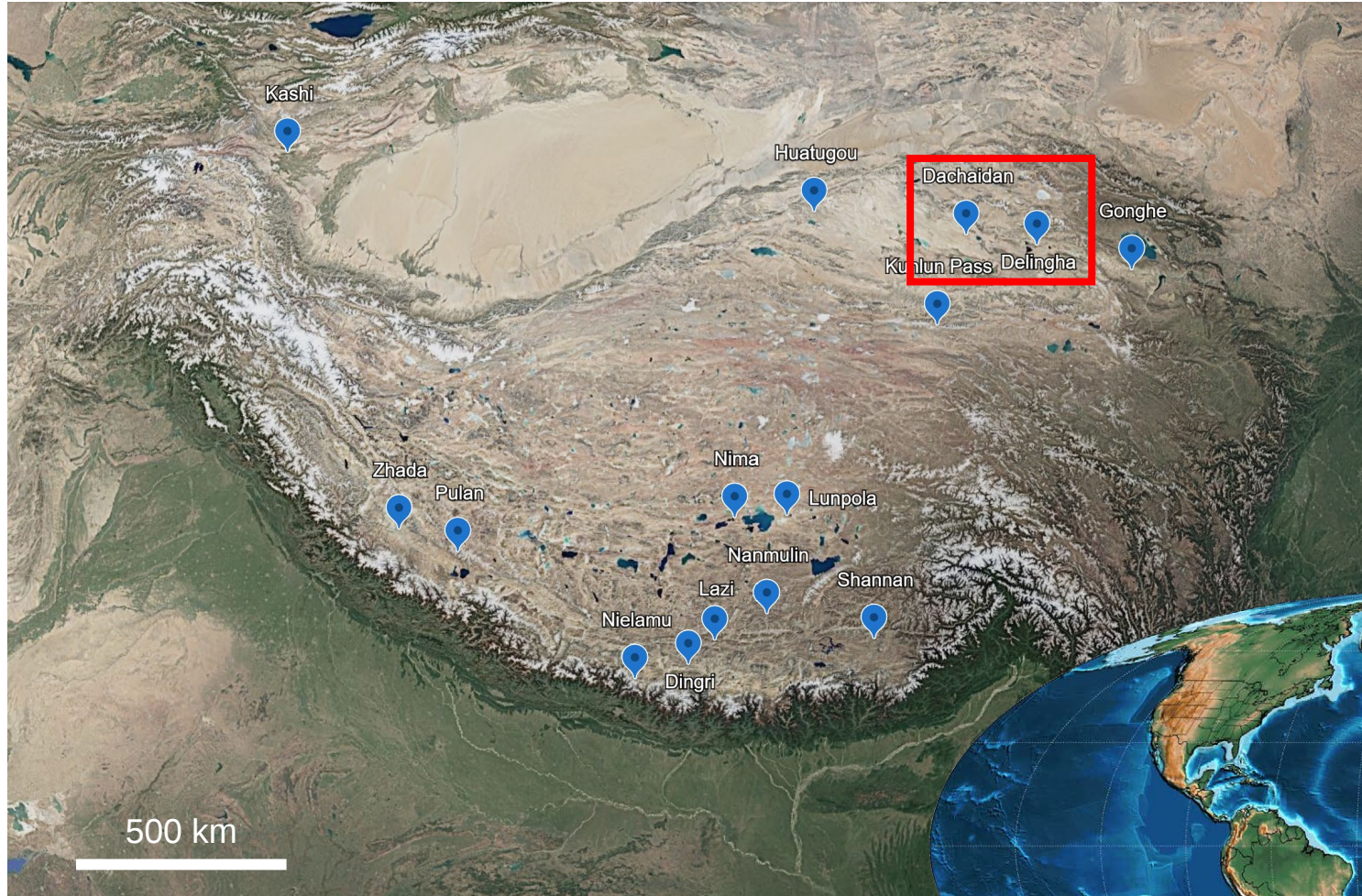


Current distribution(blue shading) of climbing perches
(from Berra, 2007)

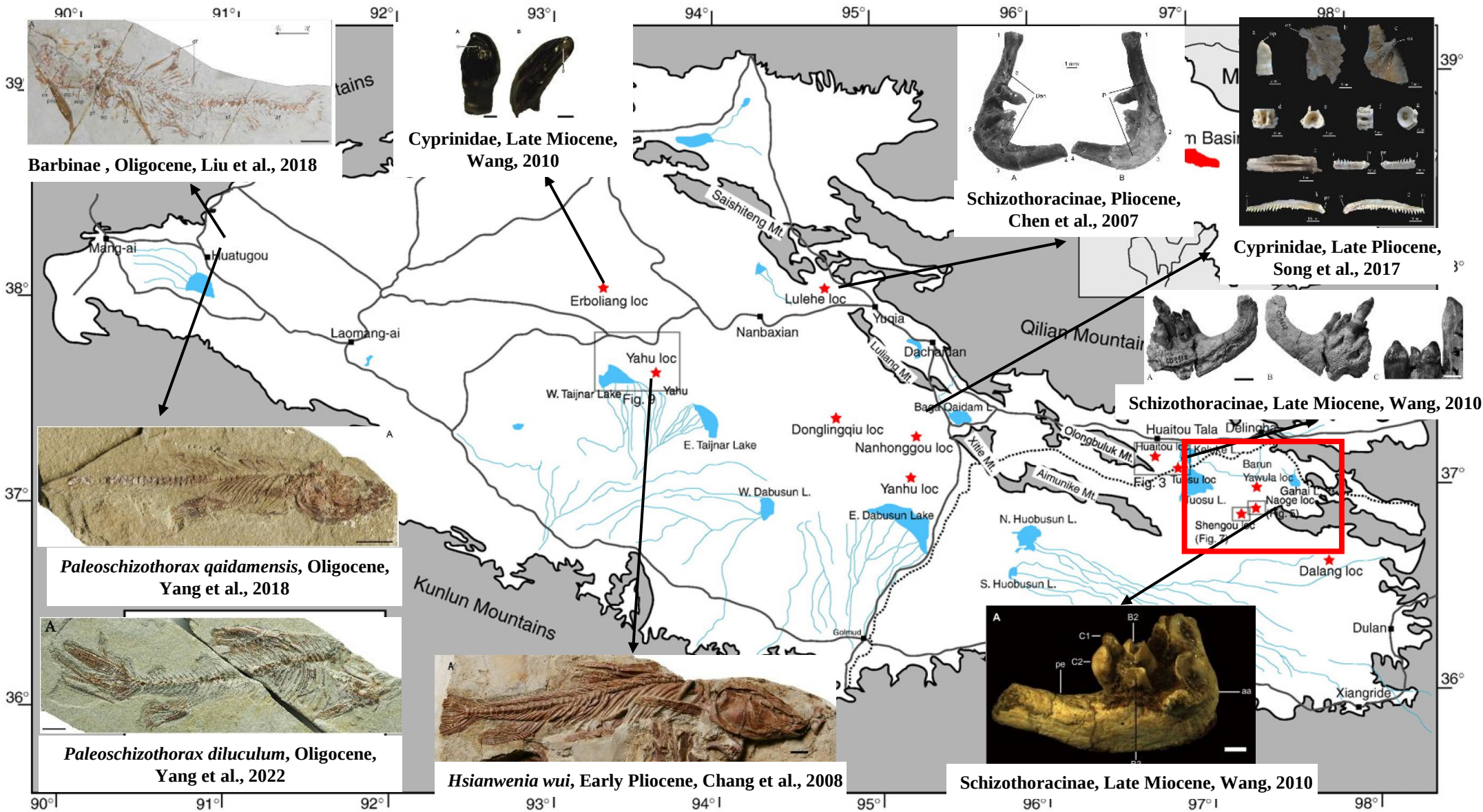


Miocene

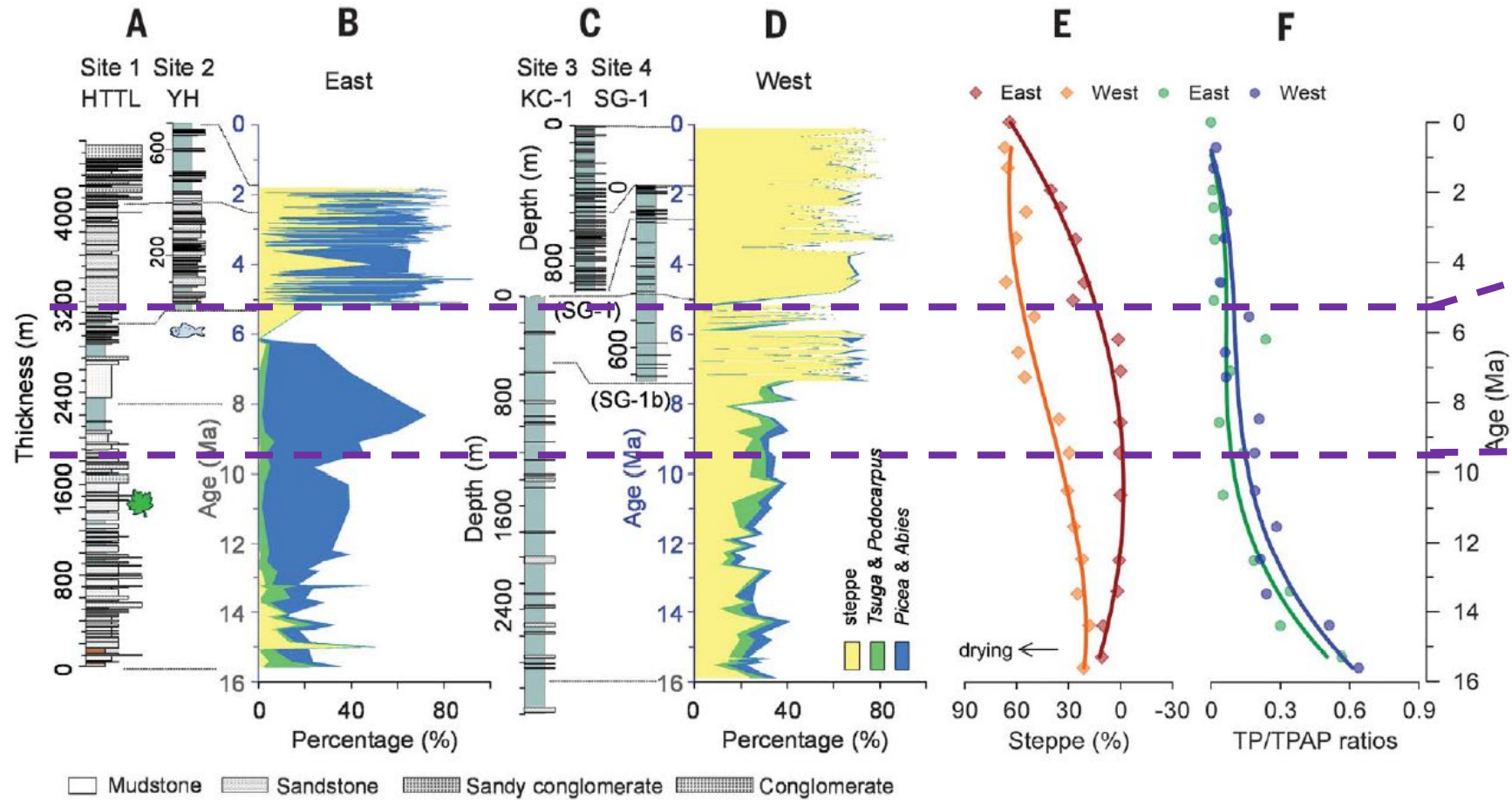
Cenozoic	Quaternary	Holocene	Meghalayan
			Northgrippian
			Greenlandian
	Pleistocene	Upper	
			Chibanian
			Calabrian
	Neogene	Pliocene	Gelasian
			Piacenzian
			Zanclean
		Miocene	Messinian
			Tortonian
			Serravalian
			Langhian
			Burdigalian
			Aquitanian
		Oligocene	Chattian
			Rupelian
Mesozoic	Paleogene	Eocene	Priabonian
			Bartonian
			Lutetian
			Ypresian
		Paleocene	Thanetian
			Selandian
			Danian
	Cretaceous	Upper	Maastrichtian
			Campanian
			Santonian
		Lower	Coniacian
			Turonian
			Cenomanian
			Albian
			Aptian
			Barremian
Mesozoic	Jurassic	Upper	Hauterivian
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			Bajocian
		Lower	Aalenian
			Toarcian
			Pliensbachian
Triassic		Upper	Sinemurian
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			Carnian
			Ladinian
		Lower	Anisian
			Olenekian
			Induan



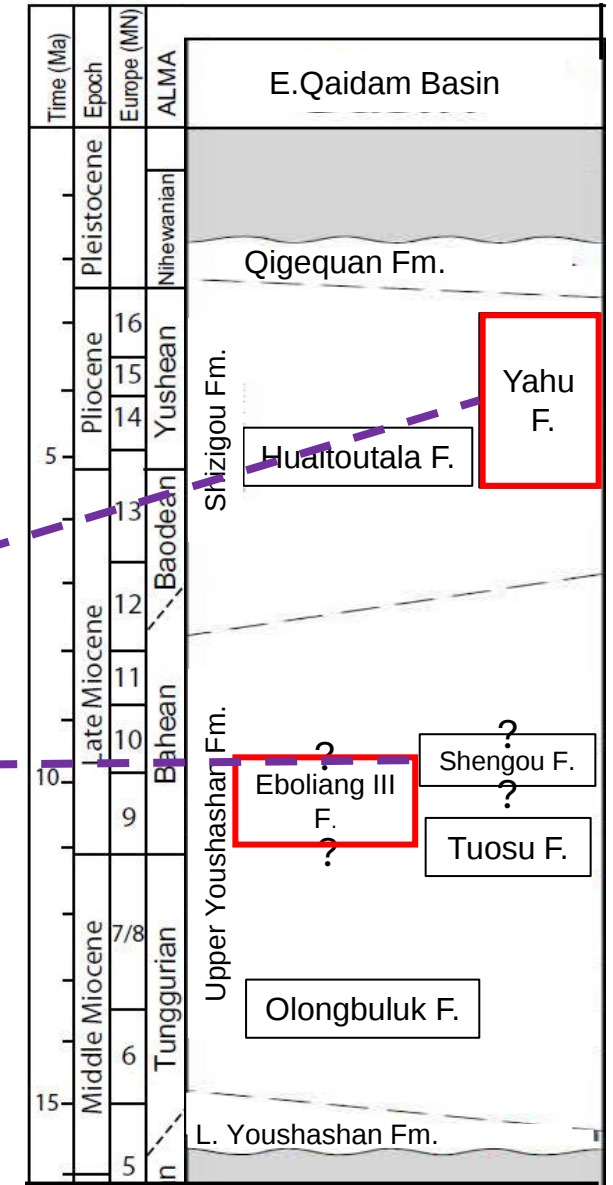
Qaidam Basin Fossil Fishes



The Climate Turning Point of the QTP



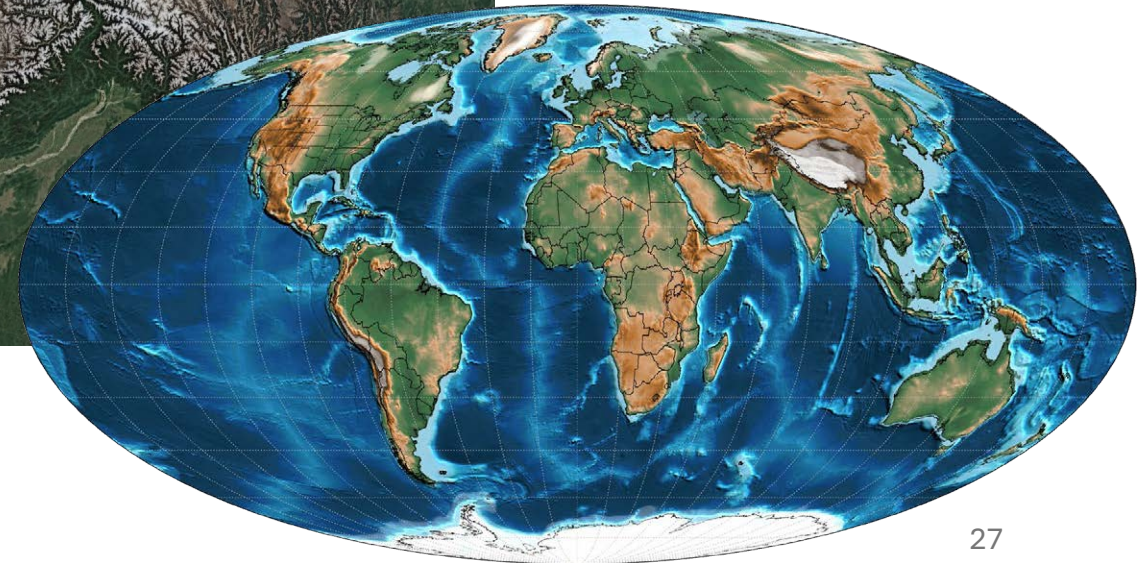
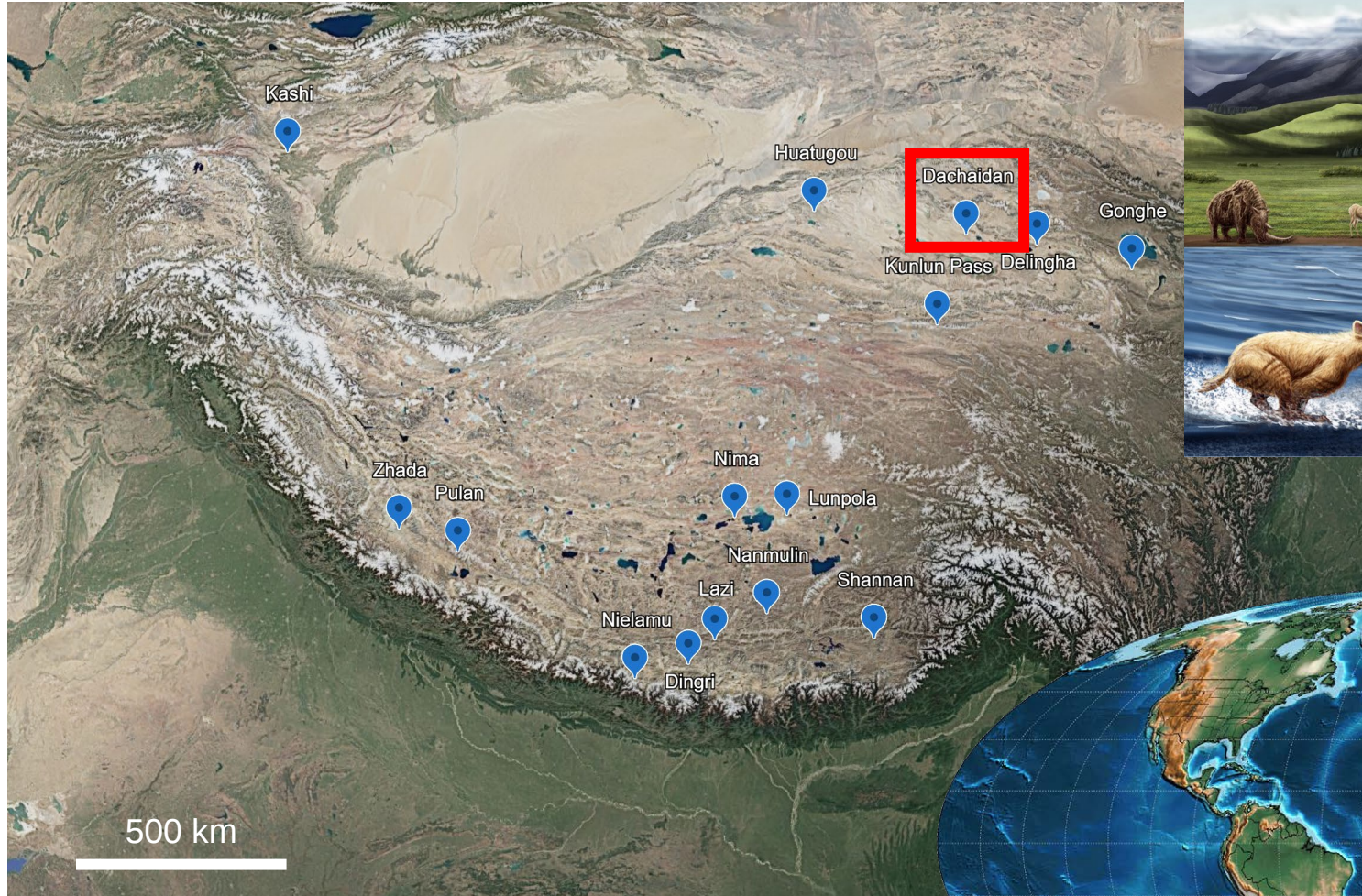
Miao et al., 2022



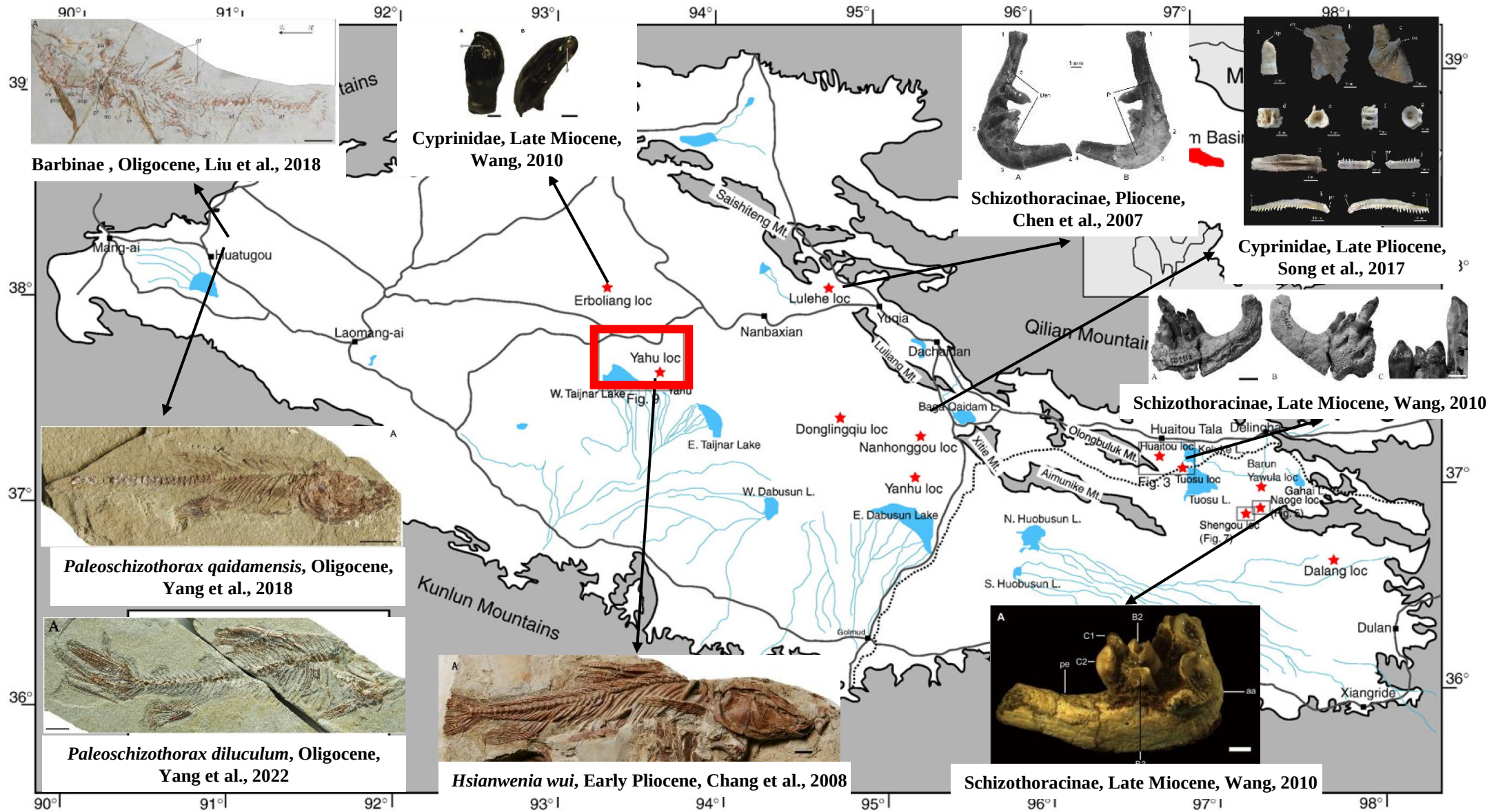
Modified from Wang et al., 2013

Pliocene

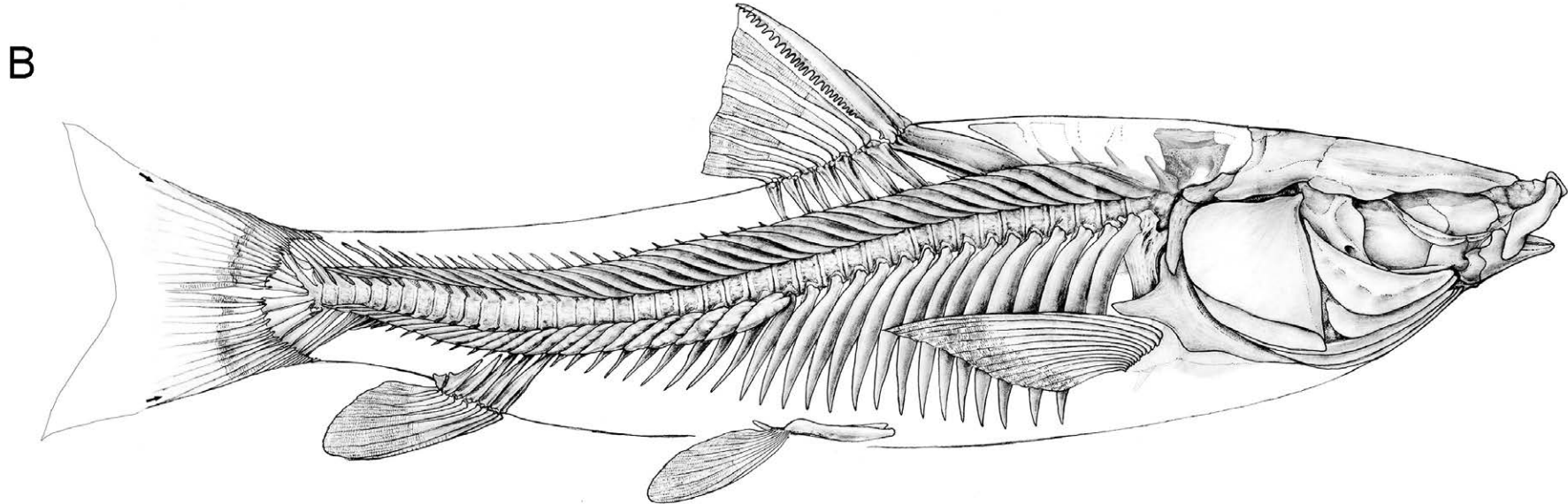
Cenozoic	Quaternary	Holocene	Meghalayan Northgrippian Greenlandian					
		Pleistocene	Upper Chibanian Calabrian Gelasian Piacenzian Zanclean					
			Pliocene					
	Miocene	Messinian Tortonian Serravallian Langhian Burdigalian Aquitanian						
		Paleogene		Oligocene	Chattian Rupelian			
				Eocene	Priabonian Bartonian Lutetian Ypresian			
		Paleocene			Thanetian Selandian Danian			
				Mesozoic	Cretaceous	Upper	Maastrichtian Campanian Santonian Coniacian Turonian Cenomanian	
			Lower				Albian Aptian Barremian Hauterivian Valanginian Berriasian	
	Jurassic	Upper					Tithonian Kimmeridgian Oxfordian	
							Middle	Callovian Bathonian Bajocian Aalenian Toarcian
								Lower
		Triassic						
Middle						Ladinian Anisian		
						Lower	Olenekian Induan	



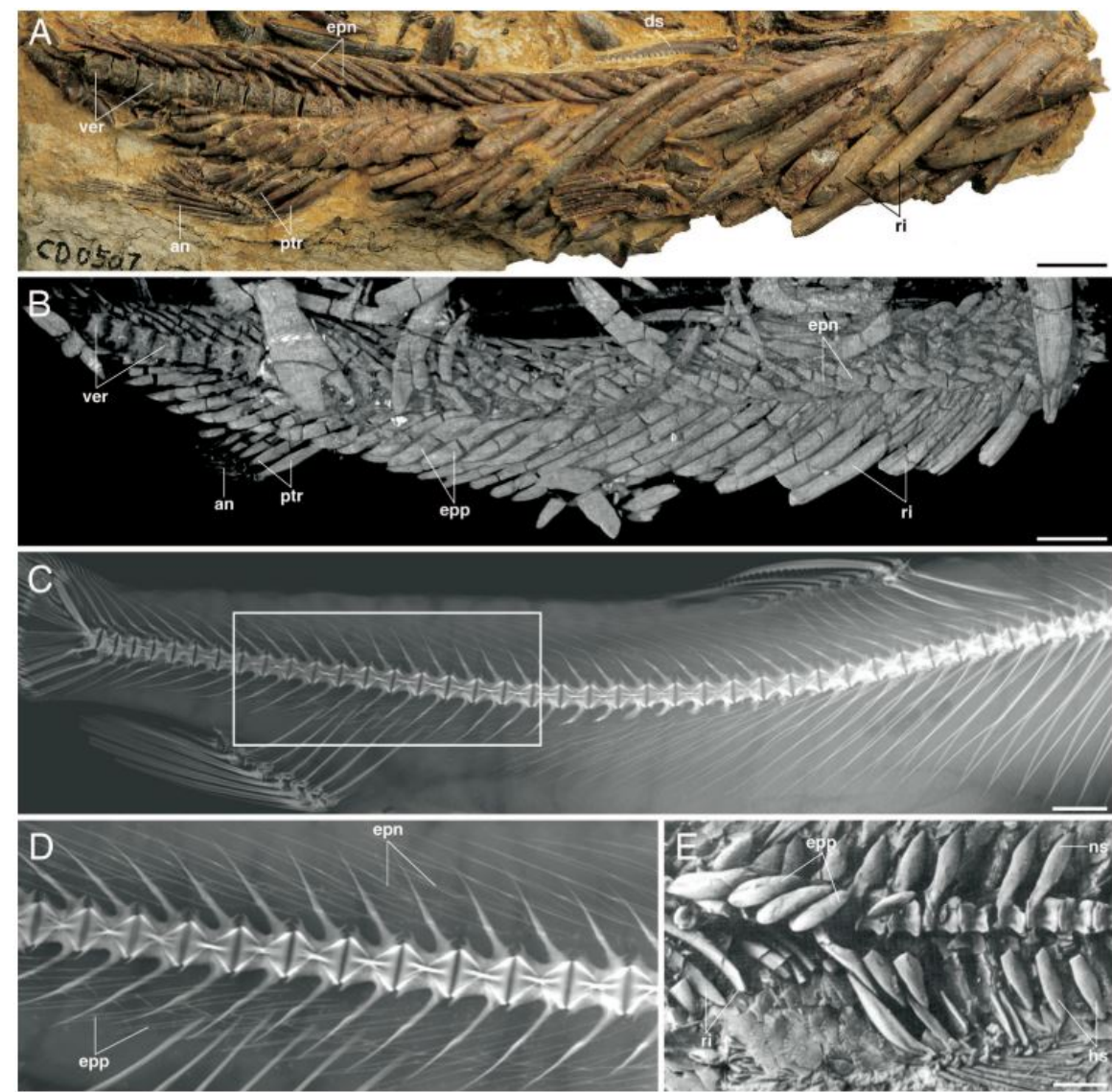
Pliocene Yahu Biota



†*Hsianwenia wui* (Cyprinidae: Schizothoracinae)



†*Hsianwenia wui* (Cyprinidae: Schizothoracinae)



Chang et al., 2008

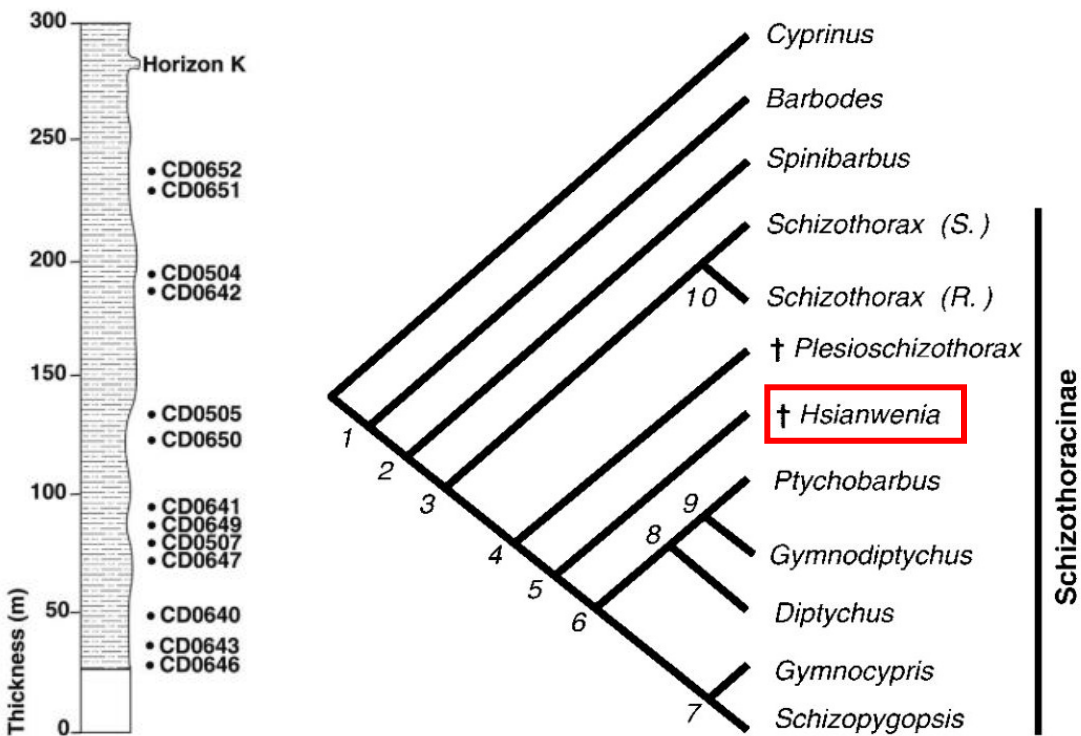
PNAS

Extraordinarily thick-boned fish linked to the aridification of the Qaidam Basin (northern Tibetan Plateau)

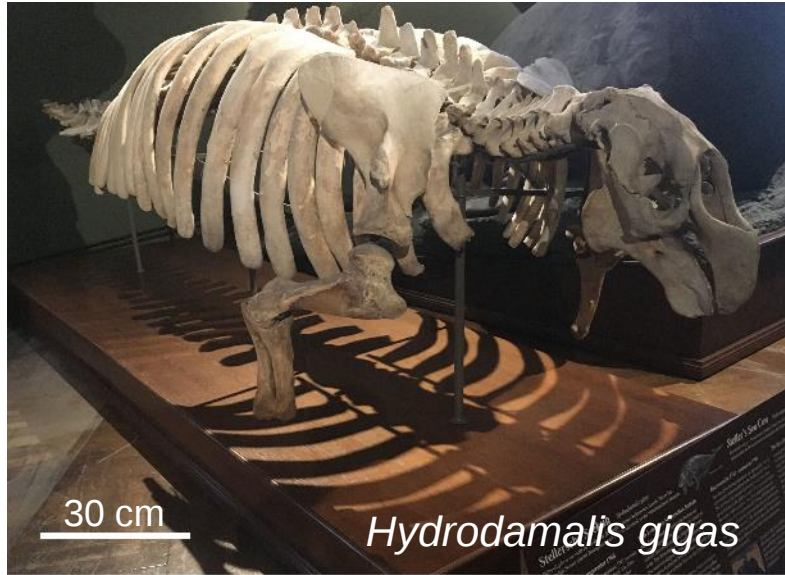
Meemann Chang^{*,†}, Xiaoming Wang[‡], Huanzhang Liu[§], Desui Miao[¶], Quanhong Zhao^{||}, Guoxuan Wu^{||}, Juan Liu^{*}, Qiang Li^{*}, Zhencheng Sun^{**}, and Ning Wang^{*}

^{*}Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, P.O. Box 643, Beijing 100044, China; [†]Department of Vertebrate Paleontology, Natural History Museum of Los Angeles County, Los Angeles, CA 90007; [‡]Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan 430072, China; [§]Natural History Museum and Biodiversity Research Center, University of Kansas, Lawrence, KS 66045; [¶]Laboratory of Marine Geology, Tongji University, Shanghai 200092, China; and ^{**}Department of Earth Sciences, China University of Petroleum–Beijing, Beijing 102249, China

Communicated by Peter R. Crane, University of Chicago, Chicago, IL, June 27, 2008 (received for review October 10, 2007)



Hyperossification: non-pathological Bone Hypertrophy

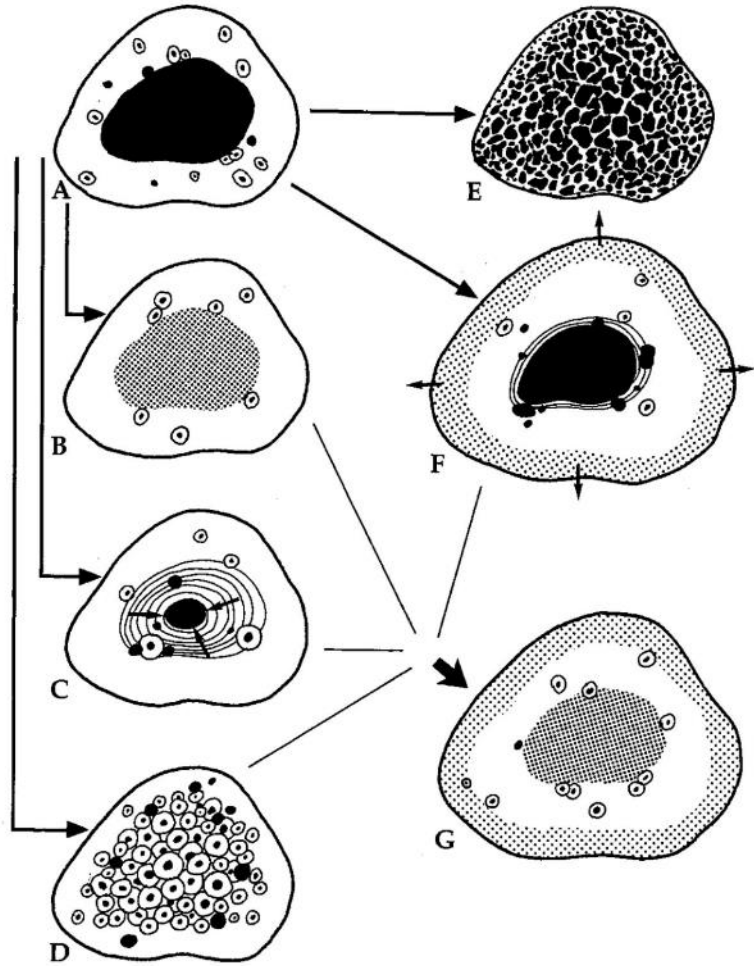


Naturhistorisches Museum Wien



Van Mesdag et al., 2020₃₁
Wikipedia

Hyperossification among Tetrapods



de Ricqlès & de Buffrénil, 2001

- Pachyostosis: Increasing in periosteal deposits, affected the bone **outer** shape.
- Osteosclerosis: Increasing of bone **inner** compactness by incomplete endochondral ossification, inhibition of remodelling (bone resorption and deposition), and/or the filling of inner cavities, with no effect on the bone's external morphology.
- Pachyosteosclerosis: **Both**

Houssaye, 2009

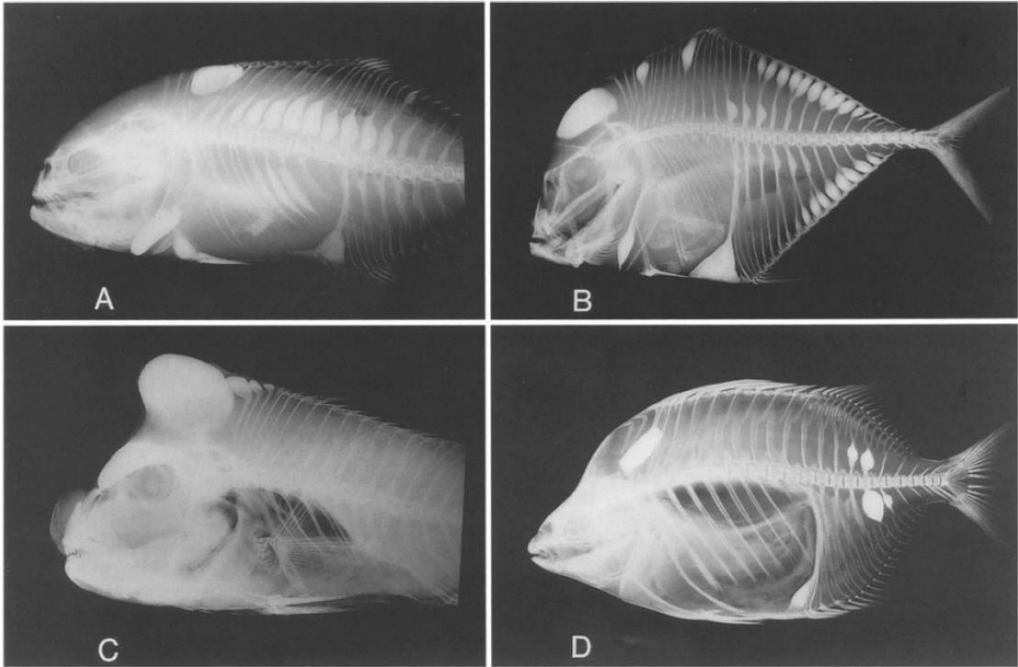
Hyperossification among Teleosts: Hyperostosis



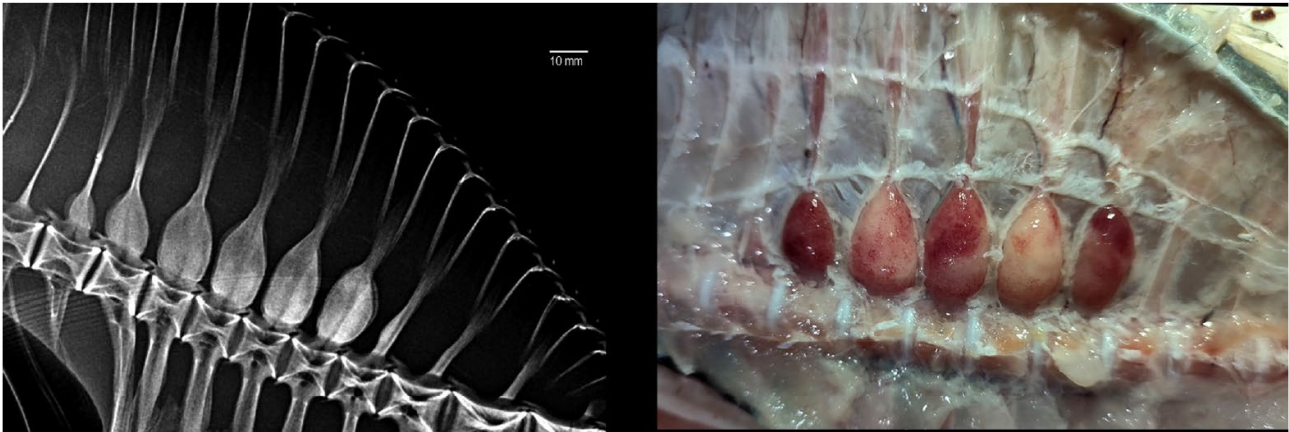
Platax teira (Australian Museum)



Agassiz, 1833

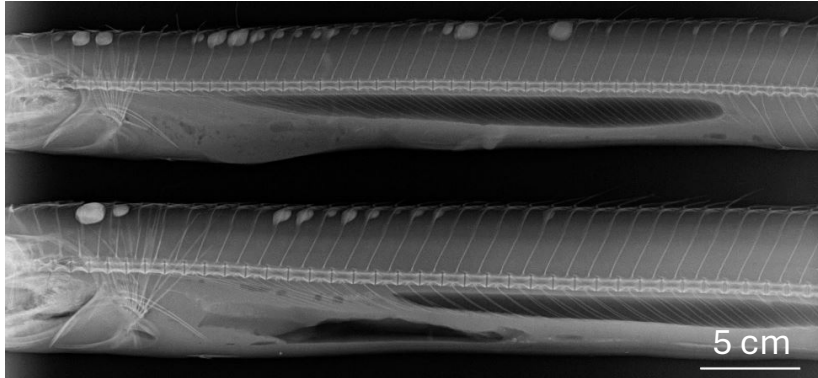


Smith-Vaniz et al., 1995

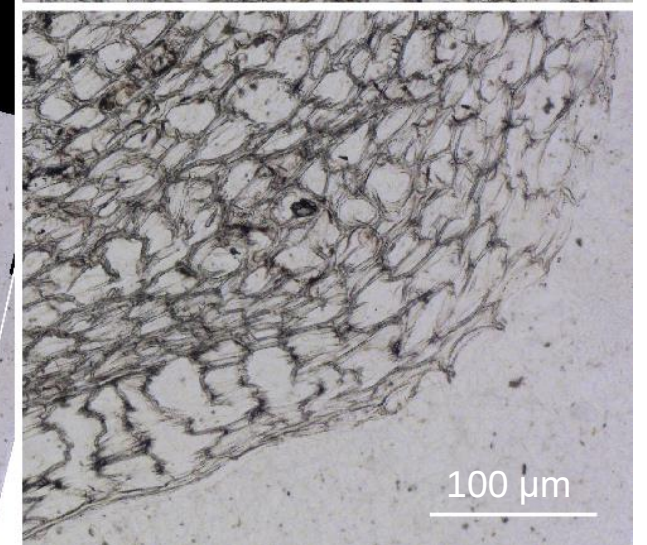
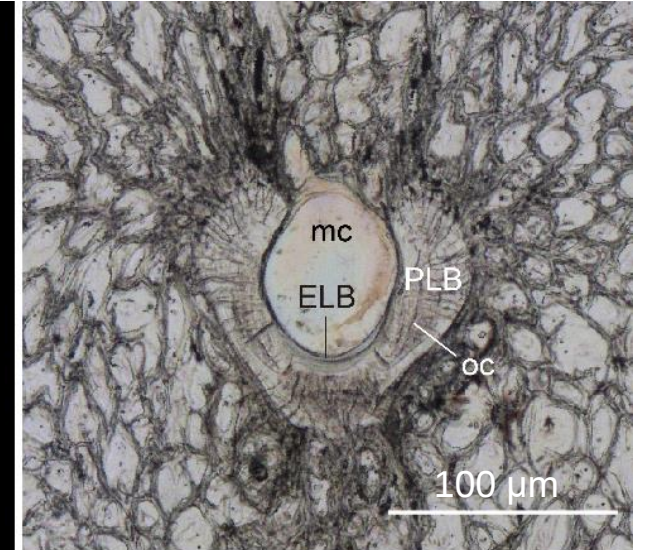
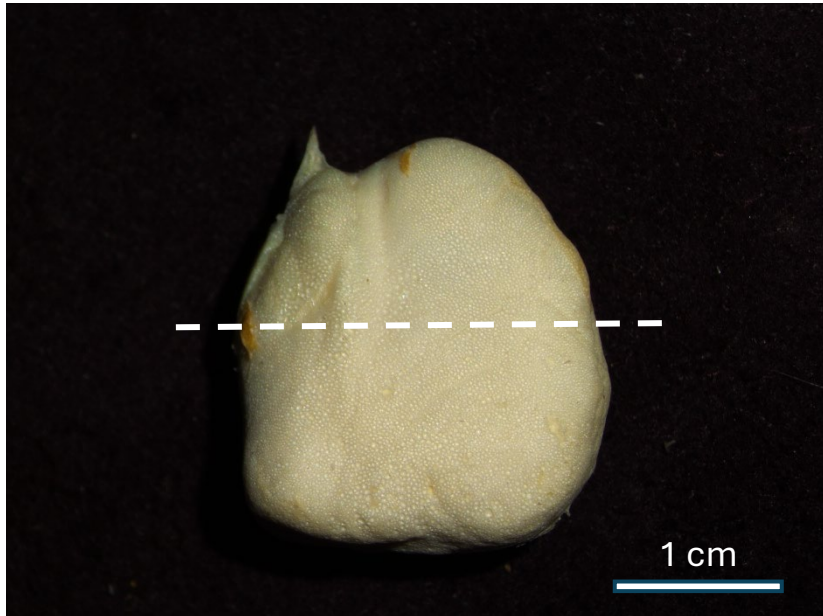


Tuna et al., 2023

Dorsal-fin Pterygiophore of *Trichiurus* sp.

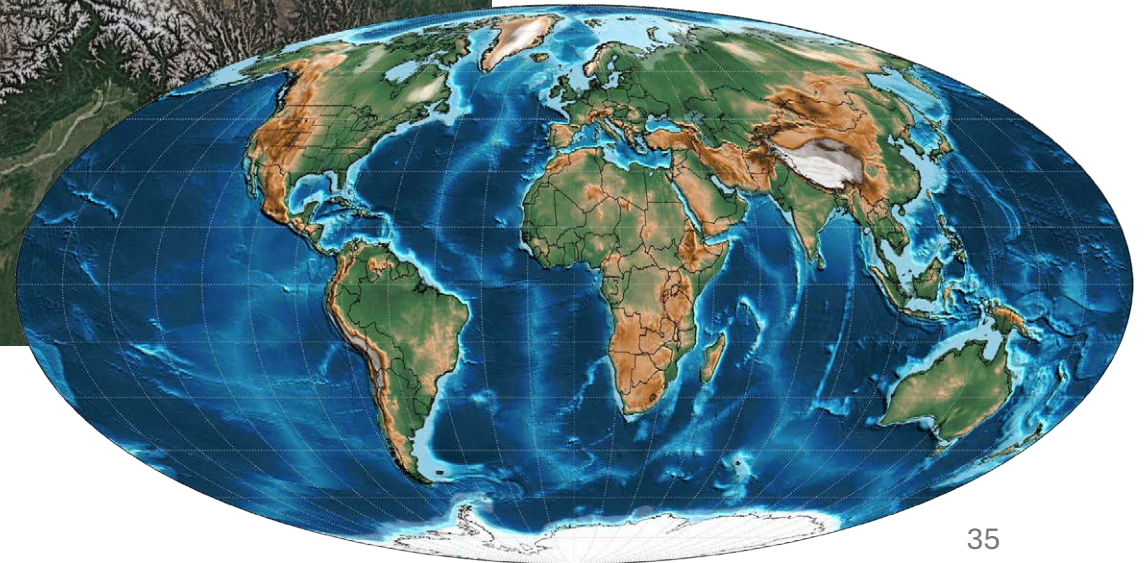
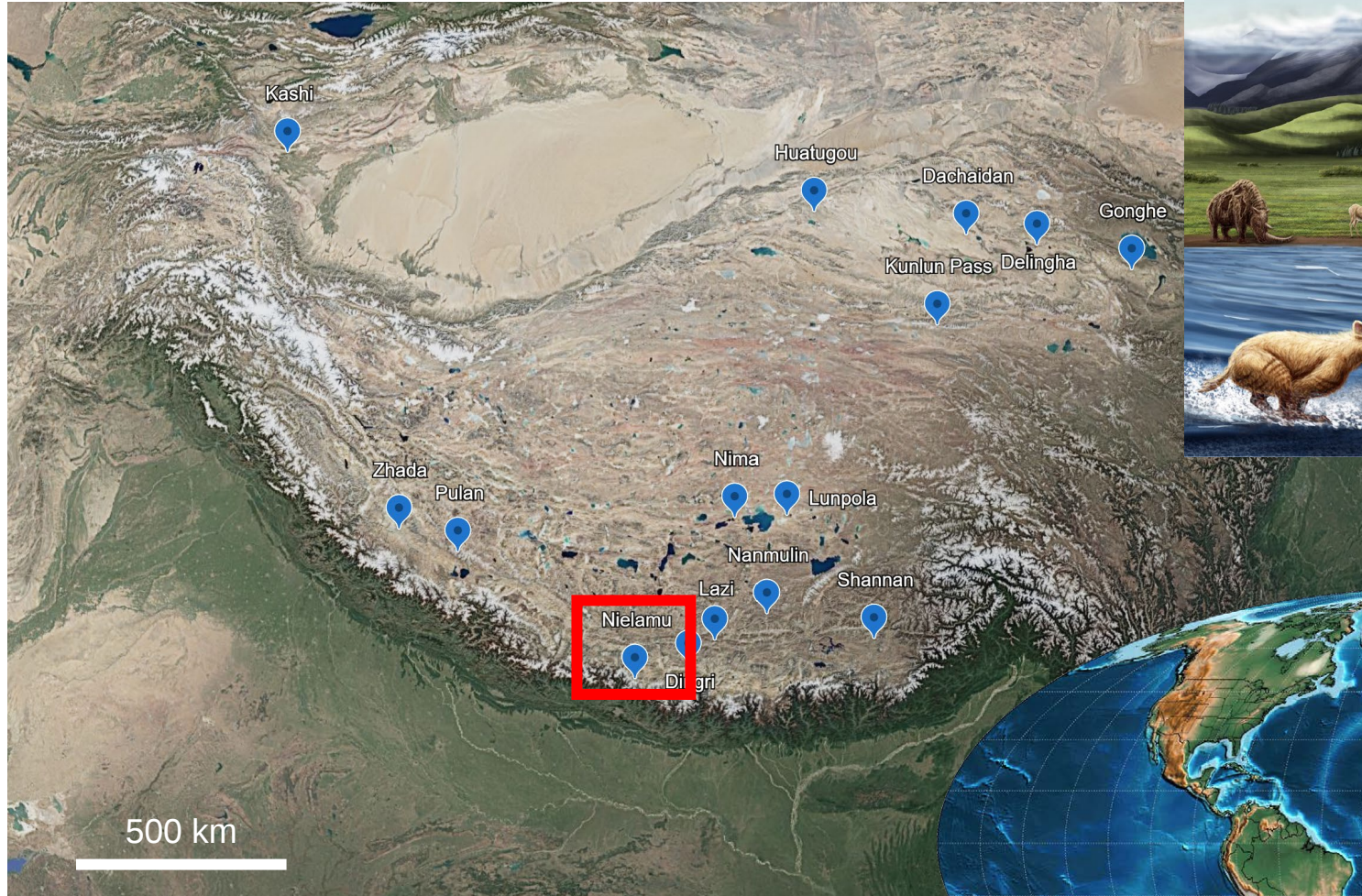


Giarratana et al., 2012



Pliocene

Cenozoic	Quaternary	Holocene	Meghalayan
			Northgrippian
			Greenlandian
	Pleistocene	Upper	
		Chibanian	
		Calabrian	
		Gelasian	
		Piacenzian	
	Neogene	Pliocene	Zanclean
			Miocene
		Miocene	Messinian
			Tortonian
			Serravallian
			Langhian
			Burdigalian
			Aquitanian
		Oligocene	Chattian
			Rupelian
	Paleogene	Eocene	Priabonian
			Bartonian
			Lutetian
		Paleocene	Ypresian
			Thanetian
		Cretaceous	Selandian
			Danian
			Maastrichtian
			Campanian
			Santonian
Mesozoic	Cretaceous	Upper	Coniacian
			Turonian
			Cenomanian
			Albian
			Aptian
		Lower	Barremian
			Hauterivian
			Valanginian
			Berriasian
			Tithonian
	Jurassic	Upper	Kimmeridgian
			Oxfordian
			Callovian
		Middle	Bathonian
			Bajocian
			Aalenian
			Toarcian
	Triassic	Lower	Pliensbachian
			Sinemurian
			Hettangian
			Rhaetian
		Upper	Norian
			Carnian
			Ladinian
		Middle	Anisian
			Olenekian
		Lower	Induan

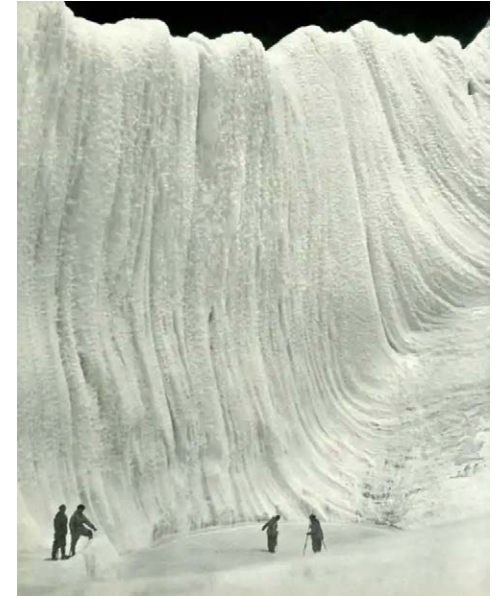


Mt. Shishapangma Expedition



Mt. Shishapangma, 8027 m

Expedition History



Himalayasaurus tibetensis
wikipedia



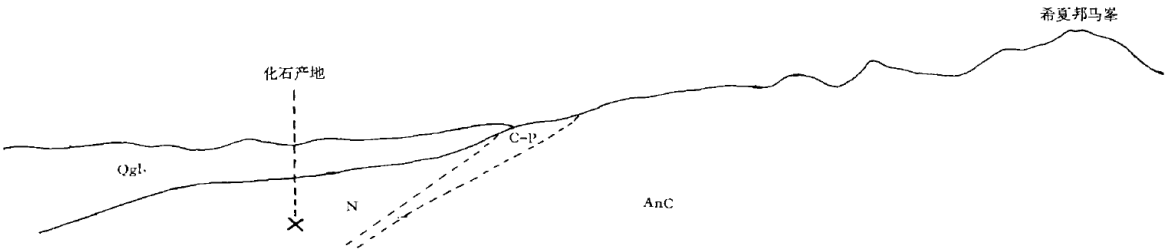
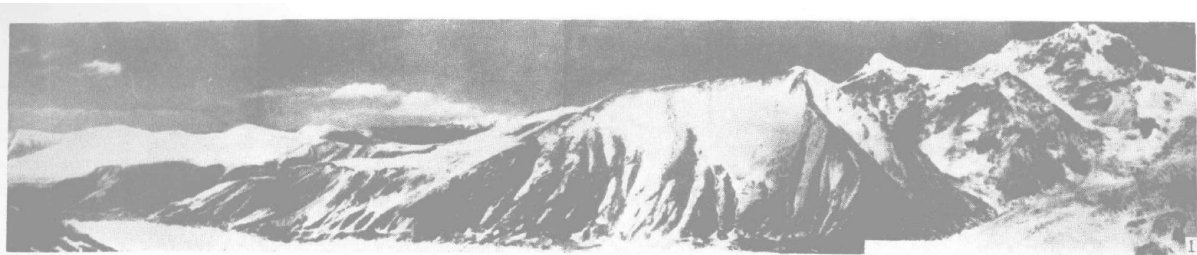
Alpine Oak and Paleoelevation Reconstruction

1 期 徐 仁等：希夏邦马峰高山栎化石层的发现及其在植物学和地质学上的意义 119

ON THE DISCOVERY OF A *QUERCUS SEMICARPIFOLIA* BED IN MOUNT SHISHA PANGMA AND ITS SIGNIFICANCE IN BOTANY AND GEOLOGY

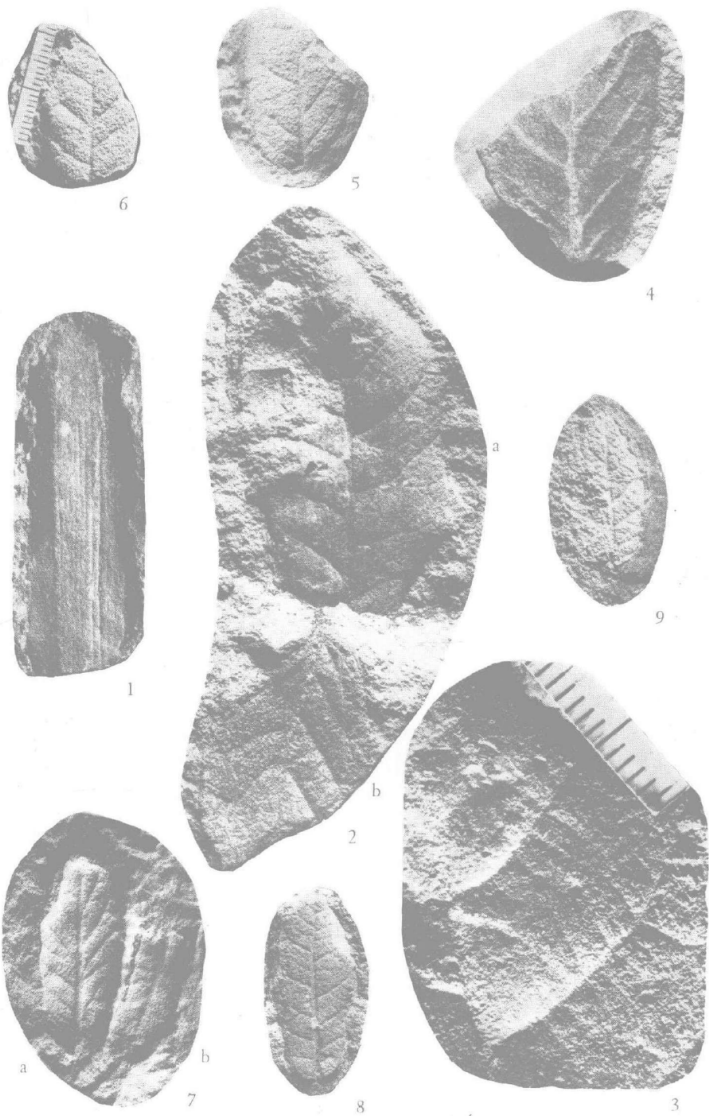
Hsü JEN, TAO JUN-RONG AND SUN XIANG-JUN
(Institute of Botany, Academia Sinica)

ABSTRACT



上. 希夏邦马峰北坡远景；下. 希夏邦马峰北坡地质剖面。
Qgl. 第四纪冰碛物；N. 产树叶化石的上第三系，不整合在石炭-二迭系之上；C—P. 石炭-二迭系，可能假整合于前石炭系之上；AnC. 前石炭系，构成希夏邦马峰的变质岩。

Xv et al., 1973



1. 莎草科(?) (*Cyperaceae*) 植物，长叶的一段 (TB 640208)；2a—b, 4, 5, 6. 高山栎(*Quercus semicarpifolia* Sm.) (TB 640205, TB 640201, TB 640202, TB 640207)；3. 高山栎部分放大图，示二、三级叶脉排列式样 (TB 640205)；7a—b, 9. 黄背栎 (*Quercus* cf. *pannosa* Hand.-Mzt.) (TB 640203)；8. 灰背栎 (*Quercus* cf. *senescens* Hand.-Mzt.) (TB 640204)。
(除图 3. × 2 $\frac{1}{2}$ 外，其他均为原大。)

New finding

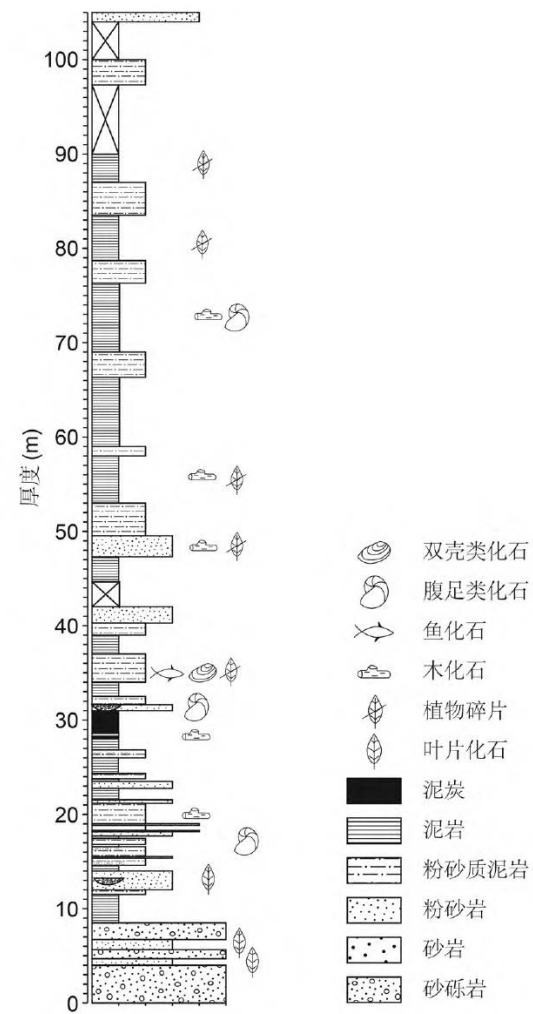


图 3 化石点的地层剖面柱状图
Fig. 3 Stratigraphic column of the fossil site

Su et al., 2023



Quercus preguajavifolia

