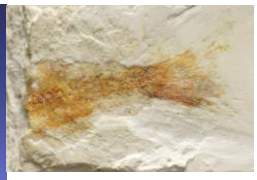


Hong Kong's first identified dinosaur-era fish
– *Paralycoptera*

香港首次鑑定恐龍時代的副狼鰭魚化石

Edison Tse Tze-kei 謝子旗

University of Hong Kong 香港大學
Vertebrate Palaeontology Laboratory古脊椎動物實驗室

GEO, CEDD 土力工程處

Content 內容

Introduction 引言

- 2012-2013 Summer Research Fellowship (SRF)
  暑期研究
  - Review of the Stephen Hui Geological Museum fossil collection and vertebrate fossils from Hong Kong
    許士芬地質博物館化石收藏與香港有脊椎動物化石檢閱
- 2013-2014 Earth Sciences Final Year Project
  地球科學系畢業專題研習
  - Hong Kong's first Mesozoic fish: osteological description and implications
    香港首個中生代魚化石研究

Introduction 引言

- 2015 PeerJ open-access journal article
  科學期刊 PeerJ
  - A specimen of *Paralycoptera* Chang & Chou 1977 (Teleostei: Osteoglossoidei) from Hong Kong (Guangdong, China) with a potential Late Jurassic age that extends the temporal and geographical range of the genus
    香港首個中生代魚化石研究

Fossil specimen 化石標本

Photo credit:
Tse Tze-kei

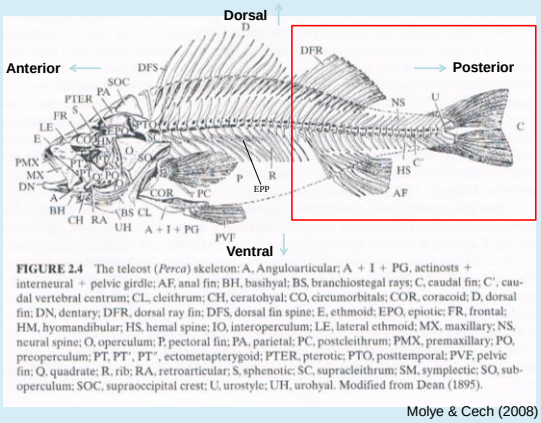
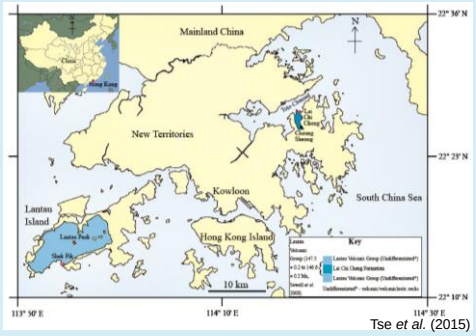


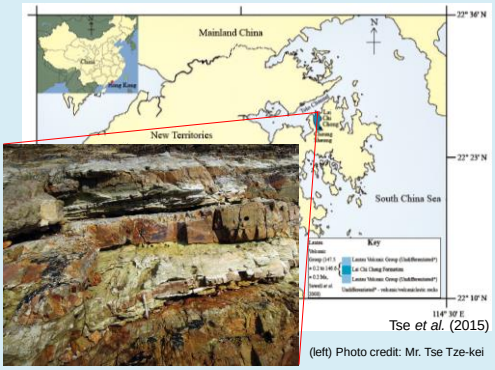
FIGURE 2.4 The teleost (*Perca*) skeleton: A, Anguloarticular; A + I + PG, actinosts + interneural + pelvic girdle; AF, anal fin; BH, basihyal; BS, branchiostegal rays; C, caudal fin; C', caudal vertebral centrum; CL, cleithrum; CH, ceratohyal; CO, circumorbitals; COR, coracoid; D, dorsal fin; DN, dentary; DFR, dorsal ray fin; DFS, dorsal fin spine; E, ethmoid; EPO, epiotic; FR, frontal; HM, hyomandibular; HS, hemal spine; IO, interoperculum; LE, lateral ethmoid; MX, maxillary; NS, neural spine; O, operculum; P, pectoral fin; PA, parietal; PC, postcleithrum; PMX, premaxillary; PO, preoperculum; PT, PT', PT'', ectometapterygoid; PTER, pterotic; PTO, posttemporal; PVF, pelvic fin; Q, quadrate; R, rib; RA, retroarticular; S, sphenotic; SC, supracleithrum; SM, symplectic; SO, subopercular; SOC, supraoccipital crest; U, urostyle; UH, urohyal. Modified from Dean (1895).

Molye & Cech (2008)



Tse *et al.* (2015)

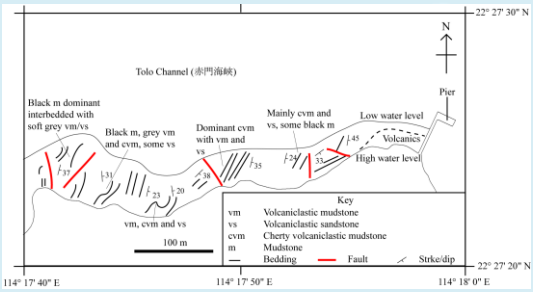
8



Tse *et al.* (2015)

(left) Photo credit: Mr. Tse Tze-kei

9



Tse *et al.* (2015)

10

Study 研究

- Fossil ID 化石鑑定
  - To understand the ecology of the species
    了解該物種的生態
  - To add information to the biogeography
    為生物地理學提供新資料

11

Study 研究

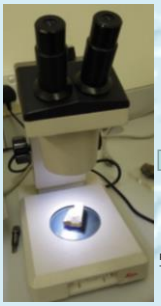


Photo credit: Tse Tze-kei

Photo credit: Leica Microsystems (2015)

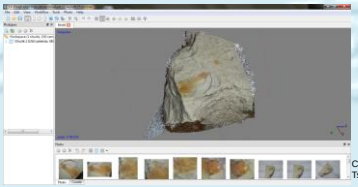
Leica Zoom 2000 stereomicroscope (x10.5-45)

Leica S8APO stereomicroscope (x10-80)

12

Study 研究

- Photo-taking through microscope
  透過顯微鏡拍攝
  - Stacking 堆疊(By *Combine ZP*)
  - 3D Modelling 模型製造 (By *Photoscan*)

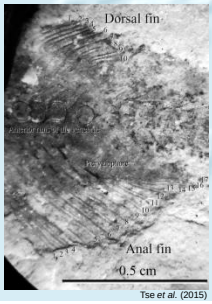


Credit: Tse Tze-kei

13

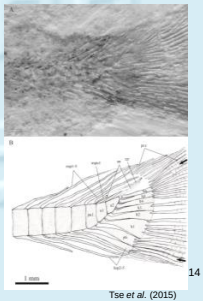
Study 研究

Anal and dorsal fins
臀鰭和背鰭



Tse *et al.* (2015)

Caudal skeleton
尾部骨骼

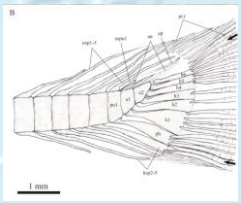


Tse *et al.* (2015)

14

Study 研究

- General description
  一般描述
  - 18mm
  - 20 vertebra 椎骨
    - 19 caudal vertebra 尾椎
    - 1 abdominal vertebrae 腰椎
  - Vertebral centra deeper than long

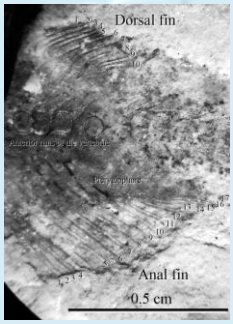


Tse *et al.* (2015)

15

Study 研究

- Anal fin 臀鰭
  - 17 fin rays 鰭條
- Dorsal fin 背鰭
  - 10 fin rays 鰭條
- Length of the fin ray anteriorly longer
  前端鰭條較長
- Sub-triangular fins
  鰭呈三角形

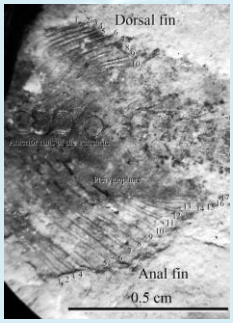


Tse *et al.* (2015)

16

Study 研究

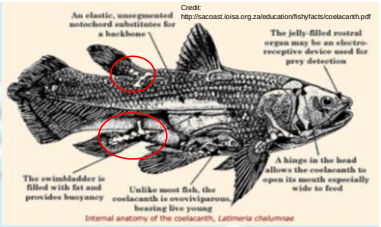
- Anal fin opposite to dorsal fin
  臀鰭和背鰭位置相對
- Fins supported by pterygiophores
  鰭由鰭支持骨支撐



Tse *et al.* (2015)

17

Sarcopterygian (Lobe-fin) 肉鰭魚



Credit: http://sacoast.ioisa.org.za/education/fishyfacts/coelacanth.pdf

VS

Actinopterygian (Ray-fin) 輻鰭魚

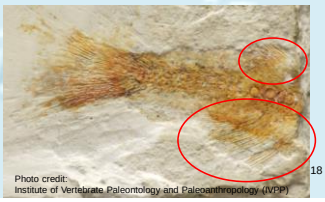


Photo credit: Institute of Vertebrate Paleontology and Paleoanthropology (IVPP)

Mirror image for comparison
反轉影像作比較用

18

Study 研究

- Anterior circular rims of the vertebrae
  脊椎前方的圓邊

Photo credit: flickr.com

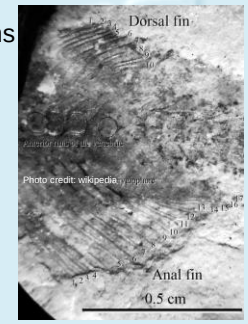
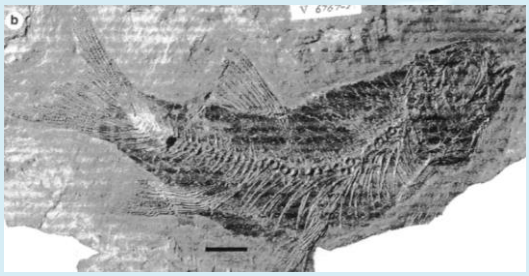


Photo credit: wikipedia

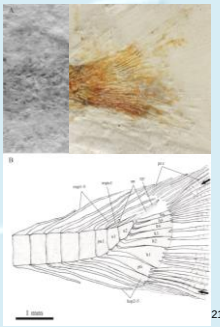
Tse *et al.* (2015)



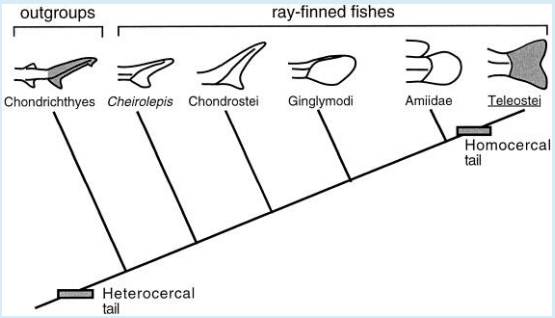
Yanbiania, Wilson & Murray (2008)

Study 研究

- Caudal Skeleton
  尾部骨骼
  - Homocercal tail
    正型尾
  - 15 branched caudal fin rays
    15 主要分叉尾鰭條數



Tse *et al.* (2015)

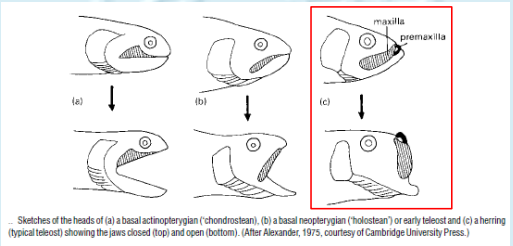


Credit: Lauder (2000)

Teleost in action

- https://www.youtube.com/watch?v=h64FplMVJmE

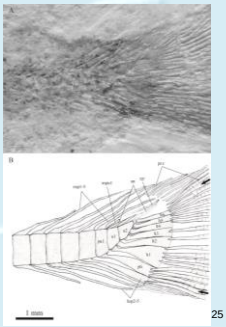
Teleost in action



... Sketches of the heads of (a) a basal actinopterygian ('chondrostean), (b) a basal neopterygian ('holostean') or early teleost and (c) a herring (typical teleost) showing the jaws closed (top) and open (bottom). (After Alexander, 1975, courtesy of Cambridge University Press.)

Study 研究

- Caudal Skeleton
  尾部骨骼
  - Homocercal tail
    正型尾
  - 15 branched caudal fin rays
    主要分叉尾鰭條數

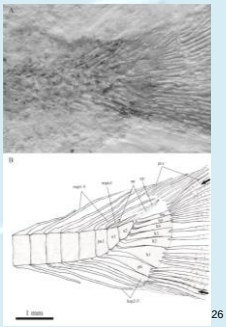


25

Tse *et al.* (2015)

Study 研究

- Caudal Skeleton
  尾部骨骼
  - 6 independent hypurals 獨立尾下骨
  - 2 or 3 uroneurals
    尾神經骨
  - 1 epural 尾上骨
  - Triangular second ural centrum
    三角形第二尾椎



26

Tse *et al.* (2015)

Identification 鑑定

Anatomical features were compared with similar specimens and existing publications.
記錄特徵後進行比較研究

真骨魚組 SUBDIVISION TELEOSTEI MÜLLER, 1846

骨舌魚超目 SUPERORDER OSTEOGLOSSOMORPHA GREENWOOD *ET AL.*, 1966

骨舌魚目 ORDER OSTEOGLOSSIFORMES REGAN, 1909

骨舌魚亞目 SUBORDER OSTEOGLOSSOIDEI REGAN, 1909

副狼鰭魚屬 GENUS †*PARALYCOPTERA* CHANG & CHOU,1977

副狼鰭魚 †*PARALYCOPTERA* sp. CHANG & CHOU, 1977

27

Specimens studied first hand	*Paralycoptera wui*: IVPP V2989.20, .24, .31, .65, .100, .105, .137 *Sinoglossus lushanensis*: IVPP V6354. 2
Specimens studied in the literature	*Singida jacksonoides*: WM 490/96, 311/96, 241/96 *Mesoclupea showchangensis*: IVPP V2685.13 *Lycoptera davidi*: IVPP V2328.1, .7, .34 *Yanbiania wanggingica*: IVPP V6767-1 *Tongxinichthys microdus*: IVPP 2332.1 *Hiodon consteniorum*: UALVP 38875 *Huashia gracilis*: IVPP V2996.1 *Jinanichthys longicephalus*: IVPP V10149-51 *Paraclupea chetungensis*: IVPP V816
Genus compared	*Leptolepis* *Elops* *Odaxothrissa* *Hiodon* *Lycoptera* *Paralycoptera* *Singida* *Phareodus* *Arapaima* *Heterotis* *Scleropages* *Osteoglossum* *Pantodon* *Gnathonemus* *Notopterus* etc.

28

Phylogenetic studies系統發育研究

Four tables showing SHGM L275 coded for applicable characters from the phylogenetic analyses Shen (1996), Zhang (2006), Wilson & Murray (2008) and Xu & Chang (2009) as well as the codings of the most similar taxon/taxa.

Shen (1996)

Character #	28	29	30	31	33	34	35	36
SHGM L275	1	0	0	?	2	1	0	2
Paralycoptera	1	1	0	0	2	1	0	2

→ **6 out of 8 the same**

Zhang (2006)

Character #	46	47	48	49	50	51	52	53	54	55	56	60	61
SHGM L275	1	1	0	2	1	0?	1?	1	0	0	1	0	2
Paralycoptera	1	1	?	?	?	0	1	1	0	0	1	0	2
Singida	1	1	1	2	1	0	1	1	0	0	1	0	2

→ **10 out of 13 the same for *Paralycoptera*;**
~~**12 out of 13 the same for *Singida***~~

Wilson & Murray (2008)

Character #	64	65	66	67	68	69	70	71	77	79	80
SHGM L275	0	2	?	0	1	0	0	1	0	0	0
Paralycoptera	?	2	0	0	?	0	0	1	0	0	0
Singida	0	2	1	1	2	0	0	1	0	0	0

→ **8 out of 11 the same for *Paralycoptera*;**
~~**8 out of 11 the same for *Singida***~~

Xu & Chang (2009)

Character #	54	55	56	57	59	60	61	62
SHGM L275	1	0	1	1	1	0	0	2
Paralycoptera	0*	1	1	1	1	0	0	2
Singida	0	1	1	1	1	0	0	2

→**6 (7 as for ch 54, the state should be 1) out of 8 the same for *Paralycoptera***
~~**6 out of 8 the same for *Singida***~~

29

Wilson & Murray (2008)

Appendix 3. Character–taxon matrix

Taxon	Character																			
	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	86–87		
†*Cladocyclus*	07007	00700	00777	77770	70000	07070	70007	70700	07770	70707	77770	70777	77770	00001	00077	70000	00-07	07		
Clupeoidei	27007	10711	10777	77770	70000	07070	70007	70700	07777	70707	77771	70777	77770	00000	10210	00000	00-00	00		
Elops	00000	00110	00000	00000	00000	00100	00000	00000	00000	00000	00000	20000	00000	00050	00777	07007	77-77	72		
†*Lycoptera*	77001	10210	00777	77777	00000	07070	70000	00000	07717	70007	77770	00077	07001	0B100	00277	00100	00-07	02		
†*Paralycoptera*	07007	77700	07777	77777	71777	07077	70001	70700	07777	70777	77777	70777	77772	00700	10777	70700	01-17	77		
†*Tanolepis*	00007	17770	07777	77771	71077	07770	70000	70700	07777	70777	77777	70777	77777	00700	10277	70200	01-17	77		
†*Singidasiaz*	70007	27777	10777	77771	71177	07777	70007	70711	07777	77777	77777	70777	77772	77770	77277	07221	10007	71		
†*Eohoidon*	20001	11210	10770	07771	01000	17200	70010	11001	00017	70107	07770	00000	0-001	001B0	00177	20100	00-07	12		
Hoidon	20001	11210	B0000	00001	01000	11200	10010	11001	00010	00100	00000	01000	01001	001BB	00111	20100	00-00	12		
†*Aglicichthys*	77007	23211	30777	77771	01101	07077	72000	70011	07777	77777	77770	0-777	07702	71700	10777	07167	70777	71		
Heterotis	22201	23001	10101	00001	01101	00111	00001	11011	02002	11-1	11000	10101	00002	11200	12201	01121	10000	02		
Arapaima	32001	23201	10101	01011	01101	00111	10001	10011	02002	01–2	11000	00110	00002	11200	12201	01121	11000	01		
†*Phareodus*	72210	13700	10010	77771	01001	00017	72101	10001	02107	70017	77770	00771	17002	71700	12277	00121	00127	01		
Pantodon	22101	13200	10111	01001	11001	00001	10102	10101	01002	00011	101-0	01001	10102	11200	11201	01110	01120	00		
†*Singida*	22101	03000	00777	77771	02001	00077	72102	7–01	07177	77777	77770	00071	10102	11200	10277	00100	01027	00		
Scleropages	32100	23301	11100	00101	01001	00011	B2101	11001	01102	10011	10000	00101	10102	11200	12201	01021	01120	00		
Osteoglossum	32100	23301	11100	00101	01001	00011	12101	11001	01102	10011	10000	00101	10102	11200	12201	01021	01120	00		
†*Chanoistoma*	27000	77710	10777	77771	07010	07777	73000	71701	01777	77777	77770	04177	07001	10100	17277	00100	01-07	70		
Mormyroidea	10008	02200	10001	1D111	11010	22002	10000	11111	13702	1B772	C0010	07011	00001	10200	11211	11200	00001	B2		
Petrocephalus	10000	02200	10001	12111	11010	22002	10000	11111	13702	10002	10010	07011	00001	10200	11777	77207	77777	77		
Gnathonemus	10001	02200	10101	13111	11010	22002	10000	11111	13712	11–2	20010	07011	00001	10200	11777	77707	77777	77		
Campylomormyrus	10000	02200	10101	12111	11010	22002	10000	11111	13712	11–2	20010	07011	00001	10200	11777	77207	77777	77		
Notopteridae	11C00	22C11	10B10	00011	11010	03001	12002	10001	11101	10101	10B71	00101	00712	21200	10211	11211	00001	00		
Chitala	11200	22111	10010	00011	11010	03001	12002	10001	11101	10101	101-1	00101	00012	21200	10777	17217	71777	70		
Xenomystus	11100	22211	10010	00011	11010	23001	12002	10001	11101	10101	101-1	00101	00012	21200	10777	17217	70777	70		
Papyrocranus	11100	22211	10110	00011	11010	23001	12002	10001	11101	10101	10001	00101	00-12	21200	10777	17217	70777	70		
†*Palaeonotopterus*	10007	77210	10070	01107	17777	70007	77777	77777	77777	77777	77777	7-717	77777	77777	77777	77777	77-77	77		
†*Chanlioperesion*	20200	03-01	00777	77771	01000	00077	72101	71011	07177	77777	77770	01071	10101	7-770	10277	07170	00007	11		
†*Xiniaichthys*	07100	13277	00077	77771	71100	77007	00102	10001	02777	70777	07770	01707	07000	01200	00177	00100	00027	71		

Note: The data matrix was analysed with multistate characters entered in the format required by PAUP; however, for ease of aligning the matrix, we have replaced these codes with the following letters: A = states 0, 1, and 2 present; B = states 0 and 1 present; C = states 1 and 2 present; D = states 2 and 3 present; E = states 0 and 2 present. The following standard symbols are also used: ? = state unknown; - = character inapplicable.

Wilson & Murray (2008)

Phylogenetic studies系統發育研究

Four tables showing SHGM L275 coded for applicable characters from the phylogenetic analyses Shen (1996), Zhang (2006), Wilson & Murray (2008) and Xu & Chang (2009) as well as the codings of the most similar taxon/taxa.

Shen (1996)

Character #	28	29	30	31	33	34	35	36
SHGM L275	1	0	0	?	2	1	0	2
Paralycoptera	1	1	0	0	2	1	0	2

→ 6 out of 8 the same

Zhang (2006)

Character #	46	47	48	49	50	51	52	53	54	55	56	60	61
SHGM L275	1	1	0	2	1	0?	1?	1	0	0	1	0	2
Paralycoptera	1	1	?	?	?	0	1	1	0	0	1	0	2
Singida	1	1	1	2	1	0	1	1	0	0	1	0	2

→ 10 out of 13 the same for *Paralycoptera*;
~~12 out of 13 the same for *Singida*~~

Wilson & Murray (2008)

Character #	64	65	66	67	68	69	70	71	77	79	80
SHGM L275	0	2	?	0	1	0	0	1	0	0	0
Paralycoptera	?	2	0	0	?	0	0	1	0	0	0
Singida	0	2	1	1	2	0	0	1	0	0	0

→ 8 out of 11 the same for *Paralycoptera*;
~~8 out of 11 the same for *Singida*~~

Xu & Chang (2009)

Character #	54	55	56	57	59	60	61	62
SHGM L275	1	0	1	1	1	0	0	2
Paralycoptera	0*	1	1	1	1	0	0	2
Singida	0	1	1	1	1	0	0	2

→6 (7 as for ch 54, the state should be 1) out of 8 the same for *Paralycoptera*
~~6 out of 8 the same for *Singida*~~

32

Mismatch and discrepancy 差異

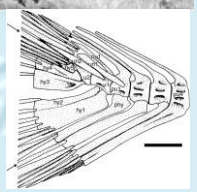
- *Singida*?
- Condition of the neural spine on ural centrum 1
  尾椎1上的神經棘狀態
  – Complete or rudimentary
    完整或不發育
- Number of epurals
  尾上骨的數量

33

Singida

- Eocene 始新世
- African 非洲

- Falcate fin 鐮刀狀鰭
- Partially fused hypurals 1 & 2
  尾下骨1 & 2 部分融合



Murray & Wilson (2005)

34

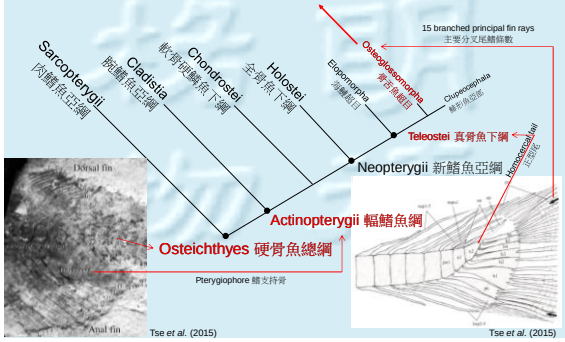
Mismatch and discrepancy 差異

- *Singida*?
- Condition of the neural spine on ural centrum 1
  尾椎1上的神經棘狀態
  – Complete or rudimentary
    完整或不發育
- Number of epurals
  尾上骨的數量

35

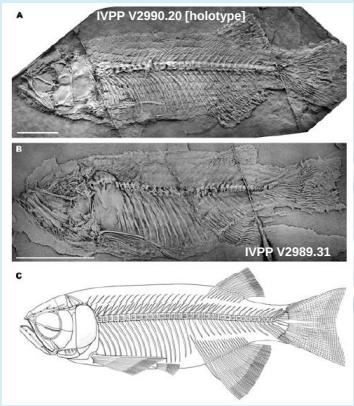
Identification 鑑定

副狼鰭魚 †*PARALYCOPTERA* sp. CHANG & CHOU, 1977



Tse *et al.* (2015)

Tse *et al.* (2015)



†*Paralycoptera wui*

A, B: two complete specimens, showing the body shape, fin shape and vertebral column

C: Restoration of the skeleton of †*P. wui* mainly based on the holotype, modified from Chang & Chou (1977: Fig. 5).

Scale bars = 1 cm

Xu & Chang (2009)

37

38
Photo credit:
Tse Tze-kei

Credit: Dr. Wu Feixiang, IVPP
復原圖由古脊椎動物與古人類研究所吳飛翔博士提供

39
Photo credit:
Tse Tze-kei

Ecology 生態環境

- Freshwater lake 淡水湖
- Close to regions with volcanic activities
  火山活動活躍的地區
  - Nutrient input from eruptions?
    火山活動帶來營養?
  - Promoted fossilization?
    有利保存化石?

40

Chang & Jin (1996)

Ecology 生態環境

- Unstable water body?
  不穩定湖水?
  - Tolerance to sediment stress?
    能適應高沈積物湧入的環境?
- May resist a wide range of climatic conditions?
  能適應不同的氣候環境?

41

Ecology 生態環境

- Sedimentary facies 沈積相
  - Tranquil water as habitat
    平靜的湖水生境

Credit: ryanphotographic.com

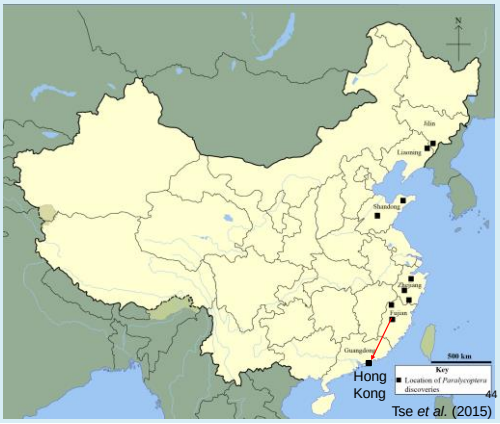
- Geochemical weathering indices 風化指數
  - Tropical-to-subtropical
    熱帶至亞熱帶
- Oxygen isotope data 氧同位素分析
  - Between 5 ºC and 25 ºC
    5度至25度

42

Implications 影響

- Extension of *geographical* and *temporal* range
  地理範圍與年代擴展
  - Southward by ~700 km: from Fujian to HK
    向南~700km: 福建至香港
  - Back by ~40 Myrs (Early Cretaceous back to Late Jurassic)
    向前~4千萬年 (早白堊紀至晚侏羅紀)

→ **Use this new knowledge to evaluate our understanding of Chinese fish from those times, particularly of osteoglossomorph fish.**
幫助了解恐龍時代的魚類 (尤其骨舌魚)



Tse *et al.* (2015)

Implications 影響

- Extension of *geographical* and *temporal* range
  地理範圍與年代擴展
  - Southward by ~700 km: from Fujian to HK
    向南~700km: 福建至香港
  - Back by ~40 Myrs (Early Cretaceous back to Late Jurassic)
    向前~4千萬年 (早白堊紀至晚侏羅紀)

→ **Use this new knowledge to evaluate our understanding of Chinese fish from those times, particularly of osteoglossomorph fish.**
幫助了解恐龍時代的魚類 (尤其骨舌魚)

Ma, million years ago 百萬年前	Period 紀	Examples of HK localities 香港地點例子	Fossil types 代表化石
~2.6 - 0	Quaternary 第四紀	-	-
~23 - 2.6	Neogene 晚第三紀	-	-
~65.5 - 23	Palaeogene 早第三紀	Tung Ping Chau 東平洲	Plants 植物, insects 昆蟲
~145.5 - 65.5	Cretaceous 白堊紀	Port Island 赤洲	- 
~201.6 - 145.5	Jurassic 侏羅紀	Lai Chi Chong 荔枝莊	Plants 植物, *Paralycoptera* 副狼鰭魚
~251 - 201.6	Triassic 三疊紀	-	-
~299 - 251	Permian 二疊紀	Ma Shi Chau 馬屎洲	Plants 植物, Shells 貝殼
~359 - 299	Carboniferous 石炭紀	Yuen Long 元朗	Spores 胞子
~416 - 359	Devonian 泥盆紀	Pak Sha Tau Chau 白沙頭洲	Placoderm fish 盾皮魚

Implications 影響

- Extension of *geographical* and *temporal* range
  地理範圍與年代擴展
  - Southward by ~700 km: from Fujian to HK
    向南~700km: 福建至香港
  - Back by ~40 Myrs (Early Cretaceous back to Late Jurassic)
    向前~4千萬年 (早白堊紀至晚侏羅紀)

→ **Use this new knowledge to evaluate our understanding of Chinese fish from those times, particularly of osteoglossomorph fish.**
幫助了解恐龍時代的魚類 (尤其骨舌魚)

Implications 影響

- Late Jurassic age reinforces an East Asian origin for osteoglossomorph fish.
  晚侏羅紀年代支持東亞為骨舌魚的起源地
- **HK's first Mesozoic (dinosaur-era) vertebrate fossil**
  香港首次鑑定侏羅紀(恐龍時代)的有脊椎動物化石
  - **Potential for more exciting discoveries: dinosaurs?!**
    未來會否發現恐龍化石?

Experience 經驗

- Chance to work with CAS Academician, Prof. Chang Mee-mann
  與中國科學院專家學者 - 張彌曼教授合作

Credit: people.pku.edu.cn

- Chance to publish the results
  發表研究成果
  - Learnt how to write a paper and to produce high-quality images
    提升論文和圖像質素
  - Appreciated the hard work of scientists
    明白和欣賞科學家的研究工作

49

Conclusions 結論

- A *Paralycoptera* sp.specimen (SHGM L275) is identified
  - first studied and identified Mesozoic fossil fish from Hong Kong
- L275 extends the temporal and geographic range of the *P.* sp. *and* possibly the Southeastern *Mesoclupea* Fish Fauna too
- Exciting future opportunities to improve our knowledge of local and regional paleontological evolution

50

Acknowledgements

Dr. Michael Pittman 文嘉棋博士
Prof. Chang Mee-mann 張彌曼教授

Thank you!

https://peerj.com/articles/865/

51