Report of A New Fossil Soft-shelled Turtle, *Trionyx liupani* from Taiwan, with Comparative Study to the Living Species, *Trionyx sinensis* (Wiegmann).

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摘　要

陶錫珍　一新種化石鼈，劉潘氏鼈 *Trionyx liupani* n. sp. 與現生鼈 *Trionyx sinensis* (Wiegmann) 的比較解剖　臺灣省立博物館半年刊　39　(2)：21－41　December　1986

本報告是描述台灣一新種化石鼈，劉潘氏鼈*Trionyx liupani* n. sp.的構造，與台灣現生鼈*Trionyx sinensis* (Wiegmann)的比較解剖。劉潘氏鼈是在台灣首次採到的鼈化石，採集自台灣海峽的澎湖水道中。該化石標本有頭骨一個及腹甲兩片(舌腹甲hyoplastron及下腹甲hypoplastron)共三件，其最大長度，依序爲132.9mm，243mm，及211mm。頭骨前端完整，後端略損，腹甲兩片，爲右側骨板。背甲，四肢骨及其他腹甲不明。復原後的劉潘氏鼈體形碩大，全長約122公分。約等於一個書桌面大。(現在鼈全長約19公分)。

在分類上，此化石鼈屬於龜鼈目(Order Chelonia)，鼈科(Family Trionychidae)，鼈屬(Genus *Trionyx*)的動物。鼈科在中國現生種只有一種，稱中國鼈*Trionyx sinensis* (Wiegmann)，與此化石鼈同屬不同種。在比較解剖上，此化石鼈的特徵爲：1.外鼻孔較寬。2.上頷口角較大。3.上頷骨較寬。4.基蝶骨的前端較寬。5.頭骨的深度較大(在方骨處)。6.舌腹甲的內緣呈弧形彎曲。

綜合上述，鑑定此種化石鼈爲一新種，而與此化石鼈一齊採獲的還有許多大型哺乳類的化石標本，如牛，鹿，象等。可見當時台灣海峽爲一陸地。因而台灣與大陸緊密相連又多一有力的證據：此三塊珍貴的化石標本是由兩位化石採集及收藏家，嘉義市的劉猛松先生及台南市的潘富武先生所提供。故命名爲劉潘氏鼈以誌紀念。

關鍵字：化石龜，鼈科，鼈的比較解剖。

Abstract

The present paper deals with a new fossil soft-shelled turtle, *Trionyx liupani*, from Penghu (Pescadores) channel of Taiwan Strait. In comparative study to the living species, *Trionyx sinensis* (Wiegmann), this new fossil species possesses the characteristics as such: 1. Large external nares, 2. larger maxillary angle, 3. wider maxillae, 4. wider anterior end of basisphenoid, 5. deeper cranium, 6. arched inner margin of the hyoplastron. The geological age of this turtle is late Pleistocene.

Key words: Fossil turtle, Trionychidae, Comparative anatomy of turtle.

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Introduction

This study describes a new fossil soft-shelled turtle: *Trionyx liupani* n. sp. and compares to the only living species *Trionyx sinensis* (Wiegmann) (=*Amyda sinensis* Wiegmann) (Romer 1956) in Taiwan.

Maternals were collected from the bottom sediments of Penghu (Pescadores) Channel in Taiwan Strait (Fig. 1), the bones were associated with numerous mammalian bones (Hwang, 1984), fish teeth, mollusks, etc. Three turtle specimens are available: a nearly complete cranium, a right hyoplastron and a right hypoplastron. The maximum length of the cranium is 132.9 mm. The maximum widths of hyoplastron and hypoplastron is 243 mm and 211 mm perpendicular. Therefore, it appears that this was a quite large turtle in life.

The taxonomic study of living turtles of Taiwan were well known by Pope (1935), Wang and Wang (1956), Mao (1971), Chen and Yu (1984) etc. A fossil box turtle, *Chinemys pani* Tao, was reported from Taiwan recently by Tao (1985). The present report will be the second one on this subject. This two fossil turtles contribute important knowledge to our Chelonia study and to the recent Geologic history of Taiwan.

According to Lin and Chou (1974) the Geologic age of Penghu Channel deposits is late Pleistocene, where the present materials were collected.

Materials and Methods

Materials:

The studied materials comprised a nearly complete cranium, a hyoplastron and a hypoplastron. They were collected in 1982 (Fig. 1) from the Penghu Channel in the Taiwan Strait by fishermen, from a depth of about 150 to 200 m.

Methods:

1. The fossil specimens were studied by the following methods.
   a. washing and cleaning the specimens in water.
   b. drying.
   c. measuring each specimen with dial calipers and needle point dividers (Table 1, 2, and 3).
   d. coating the specimens with ammonium chloride powder (NH_4Cl) for photography (Figs, 2, 4, 6, 9, 10, 11, 12).
   e. washing off the coated portion (i.e. ammonium chloride powder).
   f. measuring the volume of the cranium, hyoplastron and hypoplastron by displaced in water.
2. Comparing the homologous parts with the living and other fossil turtles and noting their morphological similarities and differences.
3. Standarized the volume of living turtles and calculate the volume of the homologous parts of the fossil form. (refer p. 25)

Abbreviations:

Anatomical:
- C, cranium
- FL, forelimb
- H, head
- HL, hindlimb
- T, Tail

Cranial elements:
- BO, basioccipital
- BS, basisphenoid
- EN, external nares
- EO, exoccipital
- F, frontal
- IN, internal nares
- J, jugal
- M, maxilla
- O, orbit
- OP, opisthotic
- P, parietal
- PF, prefrontal
- PL, palatine
- PM, premaxilla
- PO, postorbital
- PR, prootic
- PT, pterygoid
- Q, quadrate
- QJ, quadratojugal
- SOC, supraoccipital
- SQ, squamosal

V, vomer
Plastral elements:
AMP, anterior median process
EP, epiplastron
ET, entoplastron
HYO, hyoplastron
HYPO, hypoplastron
LP1, lateral process of hyoplastron
LP2, lateral process of hypoplastron
MP, median process
PLP, posterior lateral process
PMP, posterior median process
XP, xiphiplastron
a,b,c,d, measured points
Institutional:
NTUM, National Taiwan University, Museum of Zoology
Measuring: (Text-fig. 5)
$\overline{ab}$: the distance between a point to b point
$\overline{ad}$: the distance between a point to d point
$\overline{bc}$: the distance between b point to c point
$\overline{cd}$: the distance between c point to d point
M. L.: Maximum length
M. W.: Maximum width
Maxillary angle: The cross angle between lateral lines of maxillary bones.

Systematic Description

Order	Testudines (Chelonia)	Linnaeus, 1758
Suborder	Casichelydia	Gaffney, 1975a
Infraorder	Cryptodira	(Cope, 1868)
Parvorder	Eucryptodira	Gaffney, 1975a
Superfamily	Trionychoidea	Gray, 1870
Family	Trionychidae	Bell, 1828
Genus	*Trionyx*	Geoffroy, 1809
	Trionyx liupani n. sp.	

Holotype and Cotype:

The figured cranium and hypoplastron are stored in the personal museum of Mr. Pan, Chung-Wu (潘常武), Tainan City, Taiwan; the hyoplastron is stored in the personal museum of Mr. Liu, Mong-Song (劉猛松) Chia-Yi City, Taiwan. The plaster models of the cranium and hypoplastron are in the Museum of Zoology, National Taiwan University, Taipei. The specimens number are NTUM FR 0002, FR 0003.
Locality: Penghu Channel in the Taiwan Strait
Depth: about 150 to 200 meters
Geologic age: late Pleistocene (10,000 to 30,000 years ago)

Diagnosis:

Cranium arrow-shaped, convex in dorsal view, and rather deep in lateral view. Maxillaries and maxillary angle wide. Anterior part of basisphenoid wide. External nares wide and oblique. Postorbitals small, triangular (Tables 1, 3; Text-figs. 1, 3, 5).

Hyoplastron and hypoplastron flat and large. Hyoplastron triangular to transverse tetragonal in outline with arched lower portion. Hypoplastron having an irregularly triangular to trapezoidal in outline. PMP well preserved, Mp unknown. Outer margins of the hyo- and hypoplastron thicker than in inner margins. Dorsal surface irregularly reticulate.

Description:

Text-figs. 1, 3, 5, 7, 9, 10; figs. 2, 4, 6, 9, 10, 11, 12; Tables 1, 2, and 3.

Cranium: The well preserved cranium is arrow-shaped and convex in dorsal view. The premaxillaries are vertical and small. The paired external nares exit through a pore at the hind end of the premaxillaries. (Text-figs. 1, 7). The maximal width of external nares is 2.15 cm

and the maximal length 1.94 cm (Text-fig. 1; Table 1). Premaxillaries, maxillaries and prefrontal surround the external nares. The prefrontal is a long and narrow bone situated on the median dorsum of the cranium, between the external nares and frontals. The length of prefrontal is about 2.5 times its width.

The maxillaries are thick and wide from lateral and ventral view (Text-figs. 1, 3, 5; figs. 4, 6). The maximal width is 2.31 cm, and the maximal length is 5.46 cm. The length of maxilla is 2.36 times the width. The ventral sides of the median portion of the maxillae are incomplets (Table 1; Text-fig. 3).

The orbits are elongate ovals, (Text-fig. 1). The right orbit is 2.70 cm in maximum length, and 2.21 cm in maximum width. As usual in *Trionyx*, prefrontal, maxilla, frontal, postorbital and jugal surround the orbit.

The tetragonal frontal lies behind of the prefrontal, on the median dorsum of the cranium. Its posterior end is wider than the anterior end. The frontal is 2.56 cm in maximum length and 1.34 cm in maximum width. Its length is 1.9 times th width (Table 1)

The postorbital is a small triangular bone, which furnishes the posterior border of orbit. Its maximum length is 1.12 cm, and maximum width is 1.34 cm. The jugal is a strong and broad bone, however, its posterior end is badly broken (Text-figs. 1, 3; figs. 2, 4).

The two parietals are separated by oblique ridges from the anterolateral margins to the posterior mid-end, which makes the anterior half and the posterior half of the parietals look like two pairs of wings. The anterior half of the parietals is triangular and is narrow and elongate. The posterior half is broad and nearly subtrapezoidal (Text-fig. 1; Fig. 2). The maximum length of the parietal is 4.73 cm, and the maximum width 2.22 cm. The maximum length of parietal is almost 2.13 times the maximum width. The supraoccipital, opisthotic, prootic, quadrate, quadratojugal and squamosal were partially broken.

In ventral view (Text-fig. 3, Fig. 6; Table 1): The posterior part of the maxillaries are strong, attached to the palatines. The inner parts of maxillaries and palatines are incomplete. The vomer is missing. The posterior and lateral parts of the palatines are V shaped. The elongate pentagonal basisphenoid lies behind the palatine, its anterior end is narrower than the posterior. The maximum length of the bone is 3.63 cm and maximum width is 1.72 cm. The length of the basisphenoid is about twice its width. The lateral side of basisphenoid is connected with pterygoids. The two pterygoids with the basisphenoid form an X figure. The maximum length of the pterygoid is 4.46 cm and its maximum width is 1.70 cm at right side. The length of pterygoid is 2 times the width.

The quadrate has two small articular facets on the ventral side (Text-fig. 3, fig. 6), and it is the deepest portion of the lateral side of the cranium (Text-fig. 3, fig. 4). The basioccipital is located behind the basisphenoid and is incomplete posteriorly. A pair of fossae deeply marked the side of basioccipital (Text-fig. 3, fig. 6).

Plastron (Text-fig. 9, Figs. 10–12, Table 2):

The right hyoplastron and hypoplastron are big and flat. Their outer margins are thicker than the inner margins (3:1). The external surface is irregularly reticulate, and the internal surface is smooth.

The hyoplastron is transverso-tetragonal or fanshaped in outline. Its maximal width is 24.3 cm, maximal length 12.3 cm, and maximal thickness 1.8 cm at the "d" point. The distances $\overline{ab}$ is 11.65 cm, $\overline{bc}$ is 18.9 cm, $\overline{cd}$ is 21.8 cm, $\overline{ad}$ is 4.7 cm (Table 2). The width of hyoplastron is nearly twice the length. The lower part of inner margin of hyoplastron is arched. The AMP, LP1, part of inner margin and outer margin are broken.

The hypoplastron is the biggest bone in the plastron. It is irregularly triangular or trapezoidal in outline. Its maximum width is 21.1 cm. Its maximum length is 18.5 cm. Its maximum depth is 2.20 cm at the "a" point. The distances $\overline{ab}$ is 17.70 cm, $\overline{bc}$ is 18.4 cm, $\overline{cd}$ is 19.60 cm, and $\overline{ad}$ is 4.68 cm. The PMP is well preserved and bifurcate. The MP, PLP, LP2, inner margin, outer margin and a part of

the posterior margin are broken.

Comparasion and Discussion

The present species, *Trionyx liupani*, n. sp. is morphologically similar to *T. sinensis* (Wiegmann). Particular resemblances are as follows: 1. The external nares are on the dorsal side and gently sloping down to the anterior ventral position, forming an oblique plane (Text-figs. 1, 2, 5, 6; Figs. 2–5). 2. The orbits on the dorsal and anterior part of the cranium are obliquely oriented (Text-figs. 1, 2, 5, 6; Figs. 2–5). 3. The postorbital is small and triangular (Text-figs. 1, 2; Figs. 2, 3). 4. The jugal is large originally, although the fossil specimen is incomplete (Text-figs. 1, 2, 5, 6; Figs. 4, 5). 5. The ornamentation on ventral surface of the plastron is irregularly reticulate (Text-figs. 8, 9; Fig. 8, 11, 12). Therefore this species is clearly a member of the Genus *Trionyx*.

The present species, *Trionyx liupani* n. sp. is differentiated from *T. sinensis* (Wiegmann) by the following distinct characteristics.

1. The external nares are wider (Text-figs. 1, 2, 7; Figs. 2, 3; Table 3).
2. The maxillary angle is larger (Text-figs. 1–4; Figs. 2, 3, 6, 7; Table 3).
3. The maxilla is 1.6 times the width of *T. sinensis* (Text-figs. 1–6; Figs. 2–7; Table 3).
4. The width of anterior end of the basisphenoid is 2.1 times that in *T. sinensis* (Text-figs. 3, 4; Figs. 6, 7; Table 3).
5. The ratio of A/B is larger than in *T. sinensis* (Wiegmann) (Table 3, No. 5).
6. The inner margin of the hyoplastron is arched (Text-fig. 9; Figs. 8, 11).
7. *T. liupani* is a large size soft-shelled turtle.

Thus, these are the indications of the new member of the genus i.e. *Trionyx liupani* n. sp.

The volume of hypoplastron of present studied materials is 231.5 cc. It is 263 times larger than that of *T. sinensis*. The extraction of cube root of 263 is 6.4. The ratio of body length of *T. sinensis* vs. *T. liupani* n. sp. is 1:6.4. The total length of *T. sinensis* is 19 cm. Therefore, the total length of the fossil turtle *T. liupani* n. sp. is about 121.6 cm (19 cm x 6.4 = 121.6 cm).

Etymology

The name of this new soft-shelled fossil turtle is in honor of Mr. Liu, Mong-Song (劉猛松) and Mr. Pan, Chang-Wu (潘常武) for permission to study their valuable collection.

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Table 1. *Trionyx liupani* n. sp., measurements of the cranium and its elements (in cm).

Maximal length of cranium	13.29 cm ?		
Maximal width of cranium	10.41 cm		
Maximal thickness of cranium	5.07 (in Quadrate)		
Dorsal view		**R.**	**L.**
External nares	M. W. 2.15		
	M. L. 1.94		
Orbit	M. W.	2.21	2.13
	M. L.	2.70	2.67
Premaxilla	M. W.	0.50	0.49
	M. L.	0.53	0.51
Maxilla	M. W.	2.31	2.30
	M. L.	5.46	5.45
Prefrontal	M. W.	0.99	1.00
	M. L.	2.52	2.43
Frontal	M. W.	1.34	1.55
	M. L.	2.56	2.55
Postorbital	M. W.	1.34	1.44
	M. L.	1.12?	1.22?
Parietal	M. W.	2.22	2.34
	M. L.	4.73?	4.73?
Ventral view		**R.**	**L.**
Basisphenoid	M. W. 1.72		
	M. L. 3.63		
Pterygoid	M. W.	1.70?	2.23?
	M. L.	4.46	4.89
Maxilla	M. W.	1.95	2.05
	M. L.	6.06	5.86

? : Indicates damage; true length probably longer.
M. W., Maximum width; M. L., Maximum length.

Table 2. *Trionyx liupani* n. sp., measurements of the plastral elements (in cm).

	Hyoplastron	Hypoplastron
Maximal width	24.30	21.10
Maximal length	12.30	18.50
Maximal thickness	1.80 (in "d" location)	2.20 (in "a" location)
Length of $\overline{ab}$ (Anterior margin)	11.65	17.70
Length of $\overline{bc}$ (Inner margin)	18.90	18.40
Length of $\overline{cd}$ (Posterior margin)	21.80	19.60
Length of $\overline{ad}$ (Outer margin)	4.70	4.68

Table 3. Comparative the differences of *Trionyx liupani* n. sp. and *T. sinensis* (Wiegmann).

	T. leupani	*T sinensis*		
		Mean	No. of individuals	Range
1. External nares: M. L. / M. W.	0.962	1.0486	4	1.0322–1.0575
2. Maxillary angle	62°	48.5°	4	44.5°–51°
3. Maxilla: M. W. in orbit/M. L.	0.435	0.268	4	0.245–0.286
4. Basisphenoid: M. W. of anterior/ M. W. of posterior	0.710	0.331	4	0.3215–0.3404
5. Ratio of A*/B*	2.217	1.542	4	1.50–1.597
6. Hypolastron: shape of inner margin in lower part	arched		oblique	

A*: the vertical distance from the upper surface of parietal to the lower surface of quadrate.
B*: the vertical distance from the upper surface of prefrontal cross mid-orbit to the lower surface of maxilla.

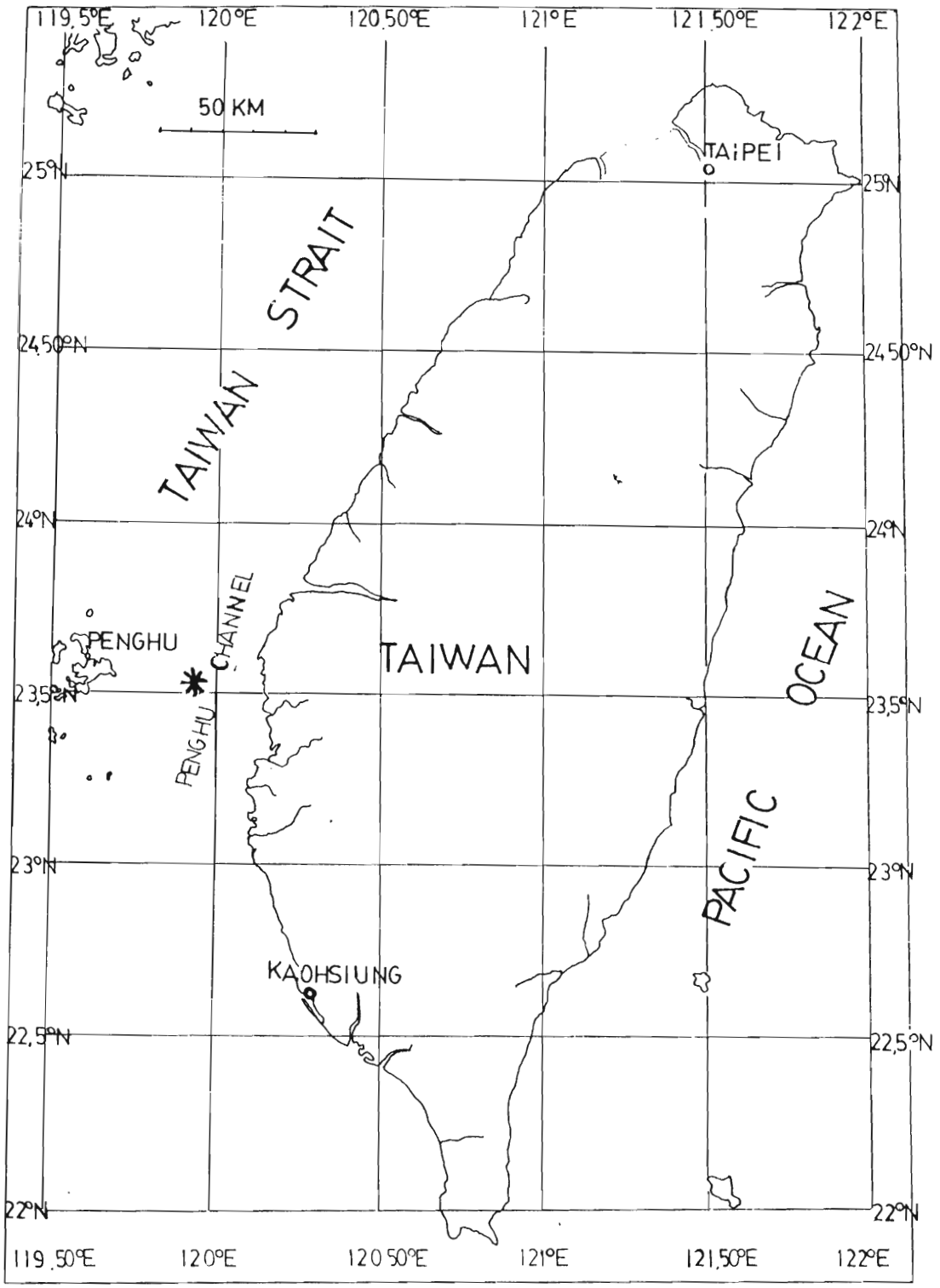
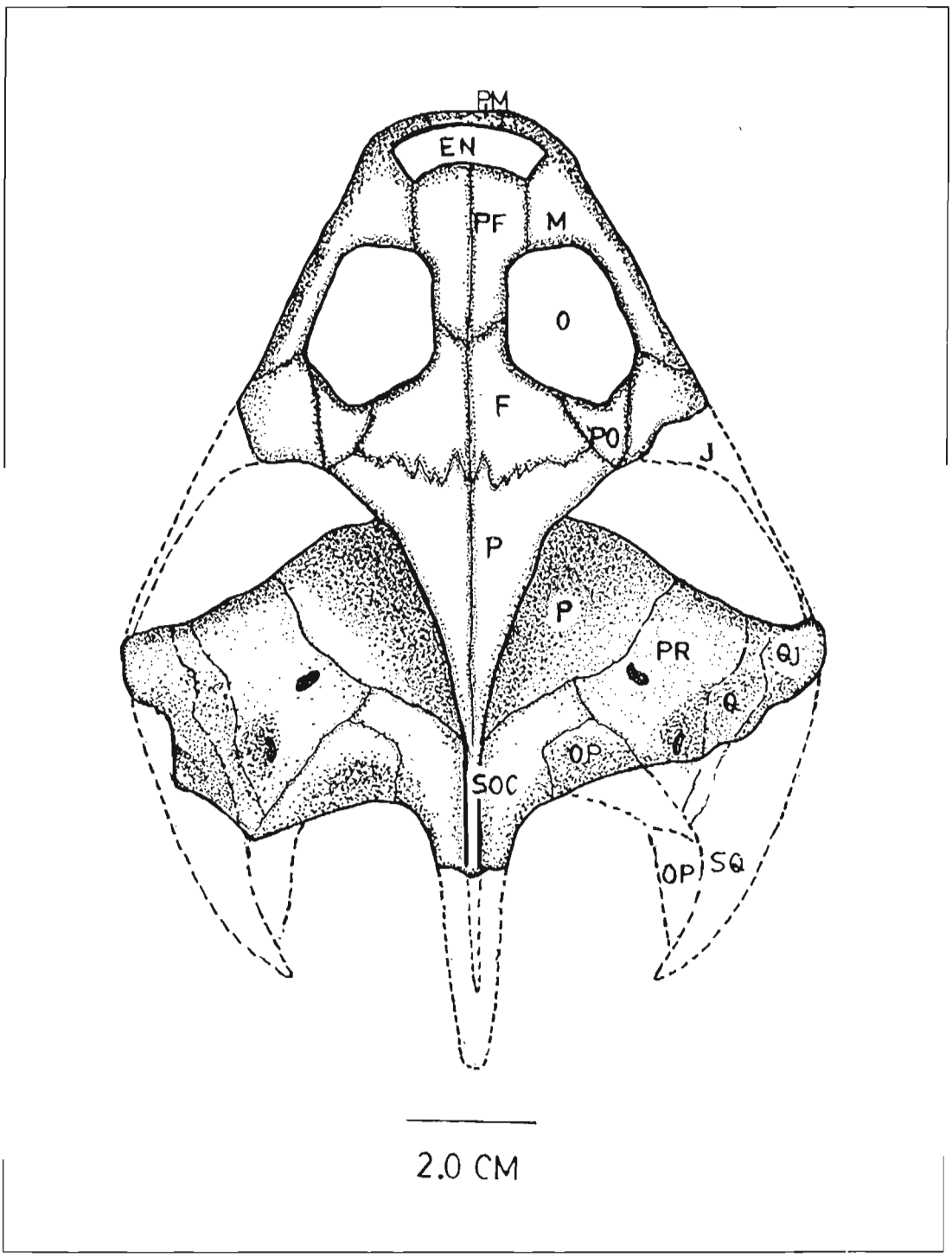
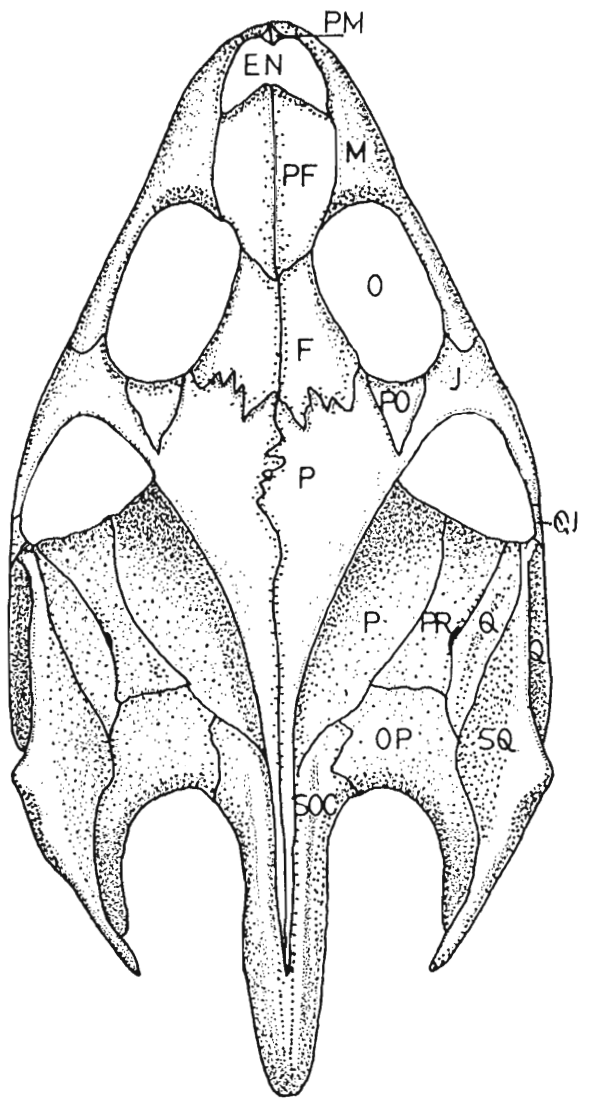


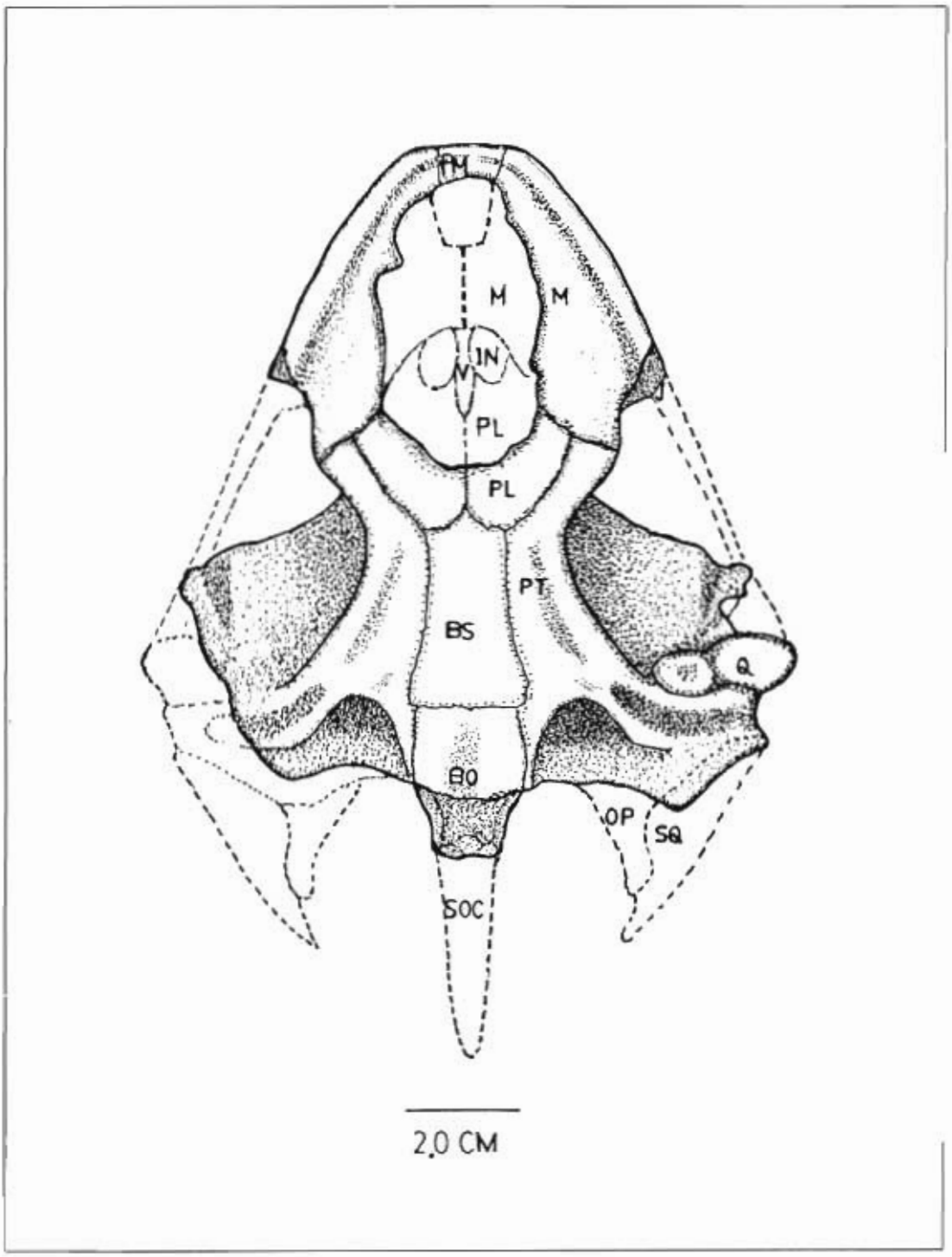
Fig. 1. Geographic map * showing the fossil locality.



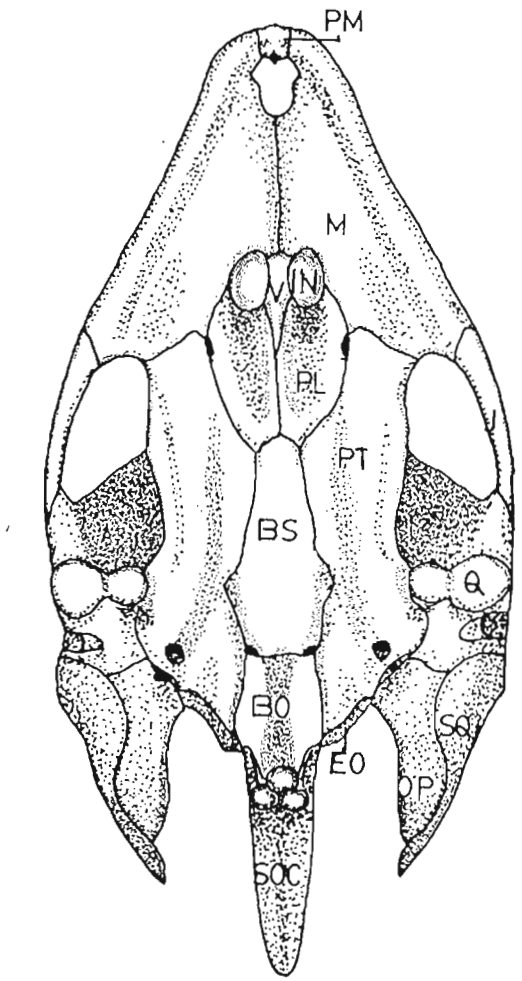
Text-fig. 1. Dorsal view of the cranium of *Trionyx liupani* n. sp.



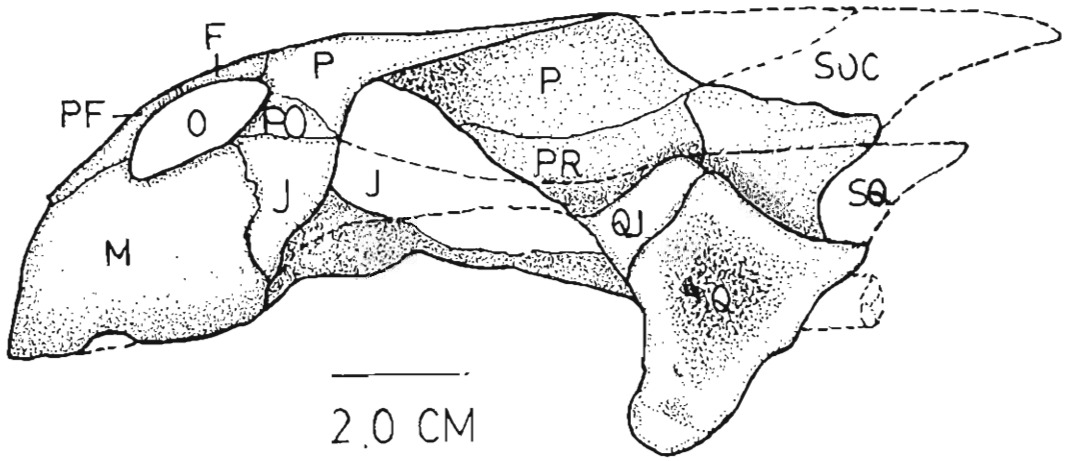
Text-fig. 2. Dorsal view of the cranium of *Trionyx sinensis* (Wiegmann)



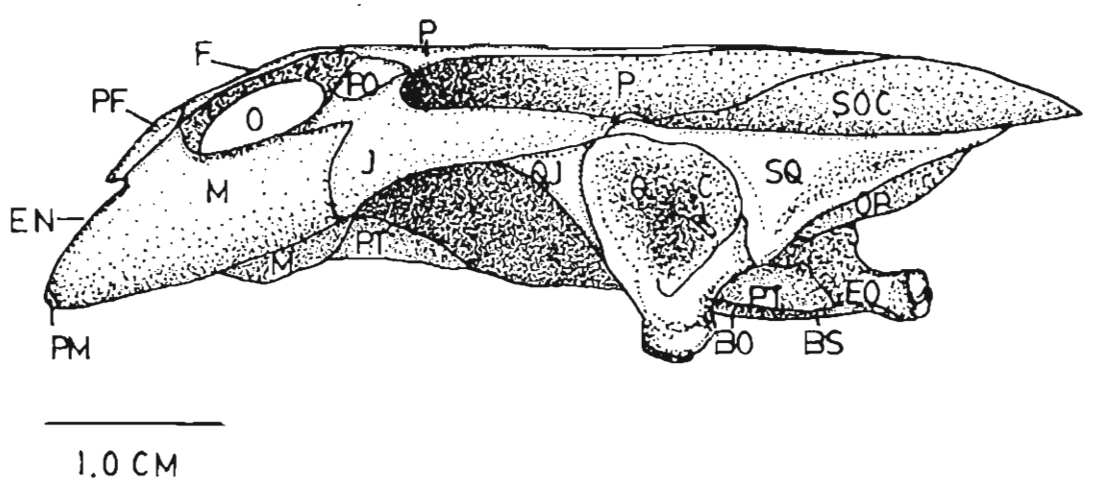
Text-fig. 3. Ventral view of the cranium of *Trionyx liupani* n. sp.



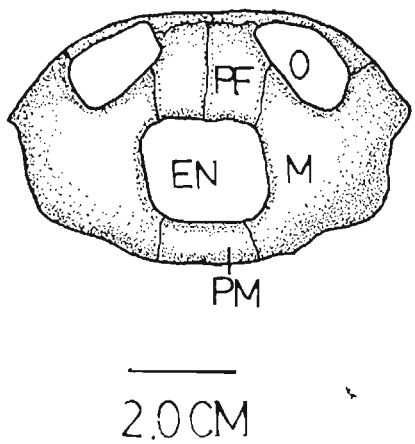
Text-fig. 4. Ventral view of the cranium of *Trionyx sinensis* (Wiegmann)



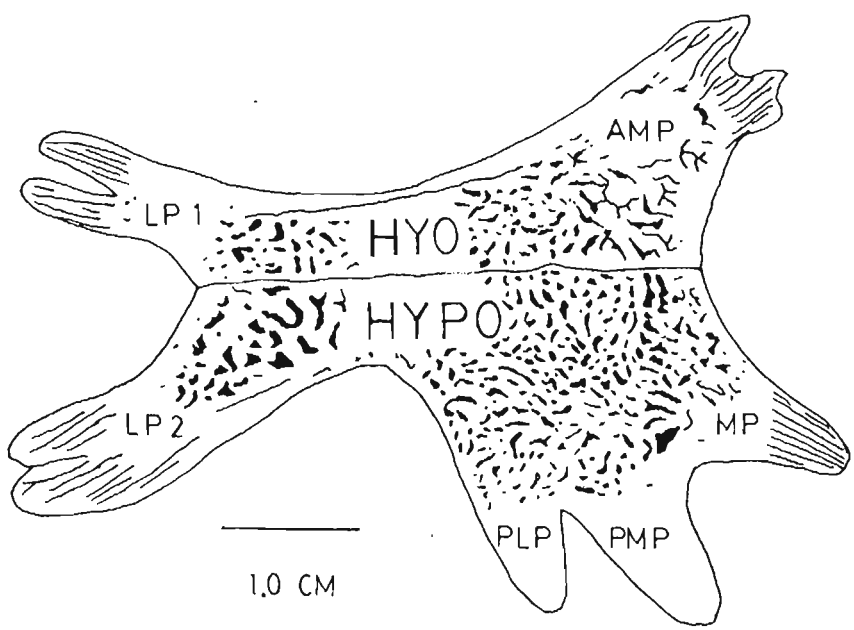
Text-fig. 5. Lateral view of the cranium of *Trionyx liupani* n. sp.



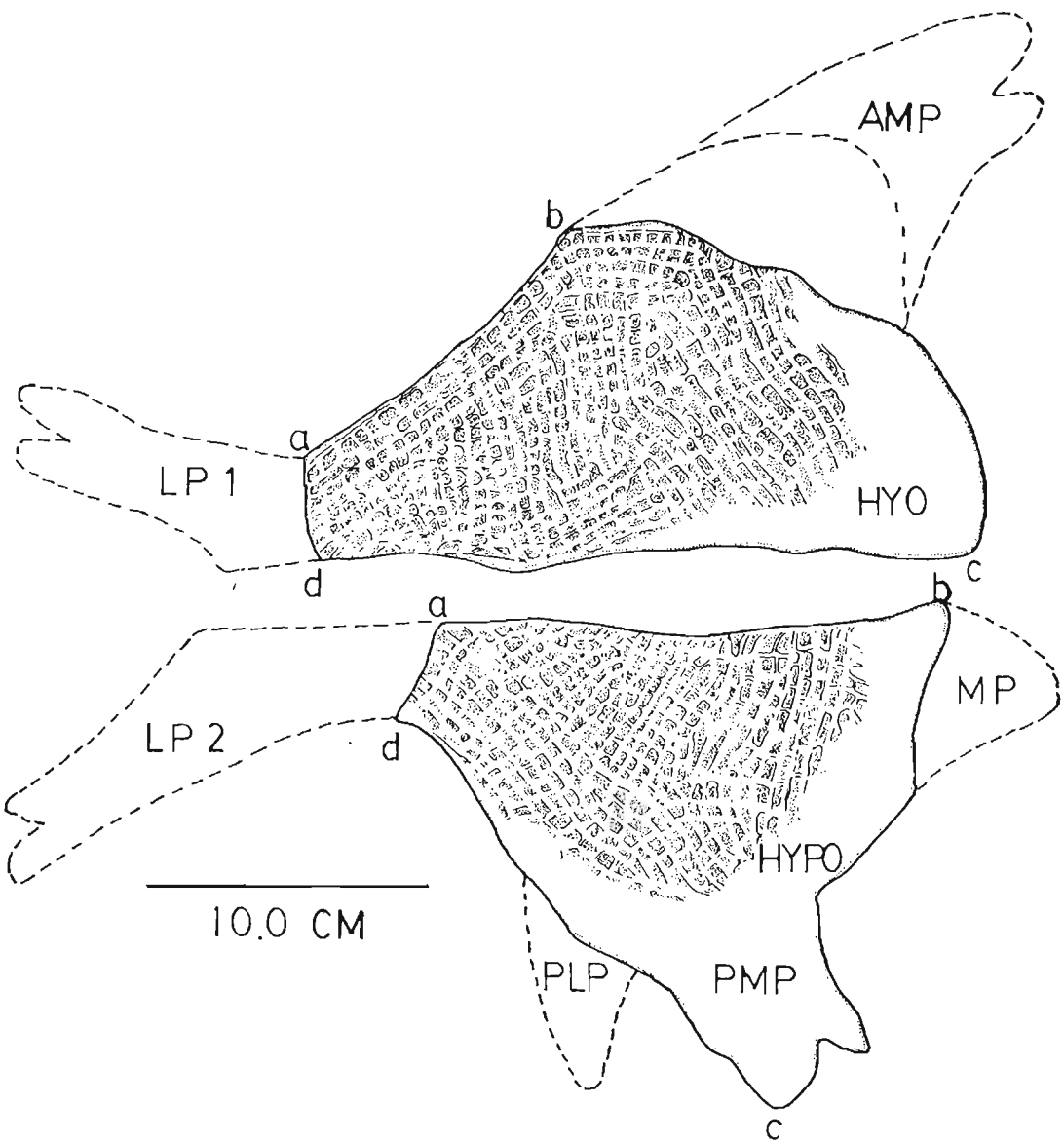
Text-fig. 6. Lateral view of the cranium of *Trionyx sinensis* (Wiegmann)



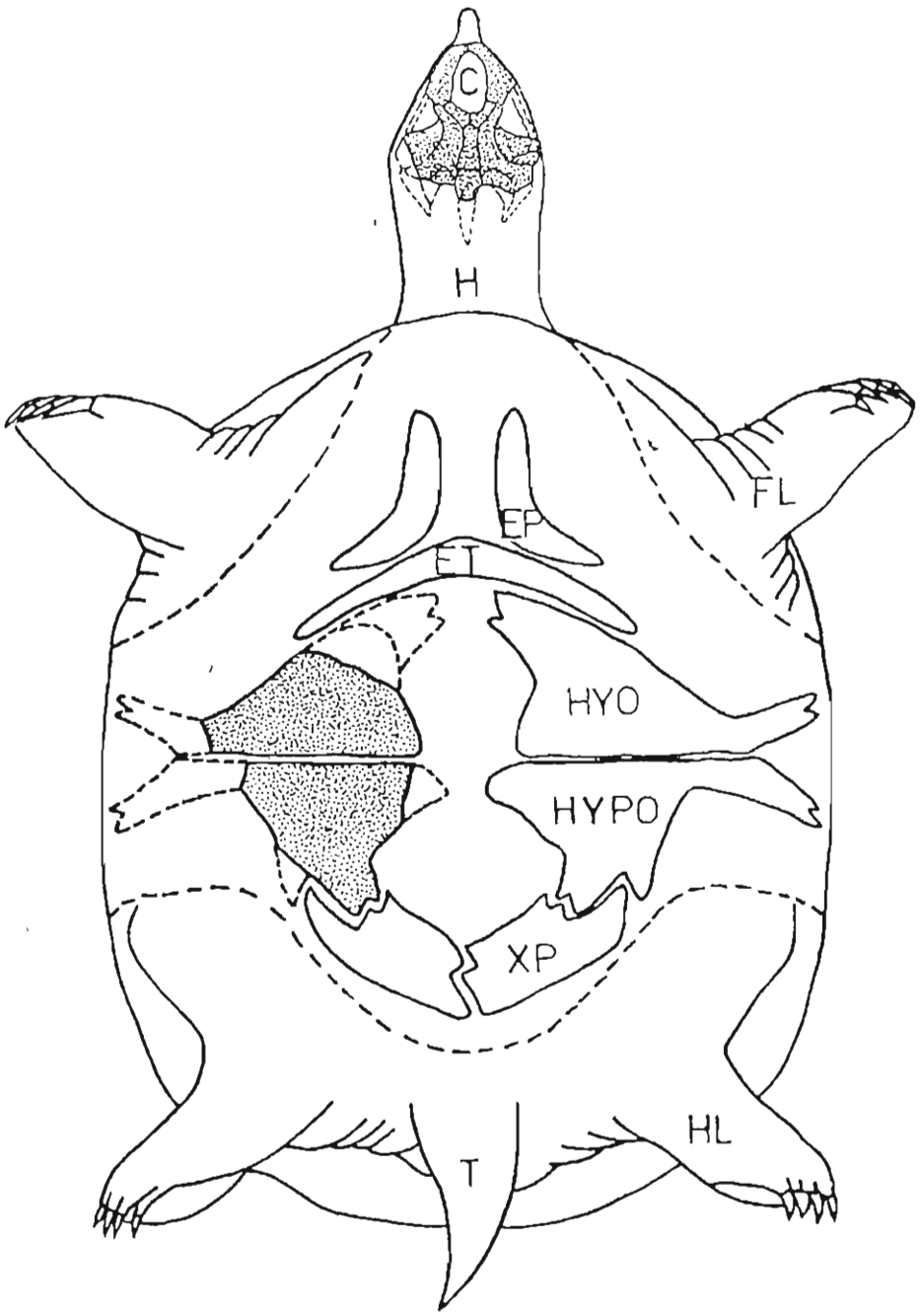
Text-fig. 7. Frontal view of the cranium of *Trionyx liupani* n. sp.



Text-fig. 8. Ventral view of hyoplastron and hypoplastron of *Trionyx sinensis* (Wiegmann)



Text-fig. 9. Ventral view of hyoplastron and hypoplastron of *Trionyx liupani* n. sp.



Text-fig. 10. Ventral view of *Trionyx liupani* n. sp. showing the proper positions of the cranium, hyoplastron and hypoplastron.

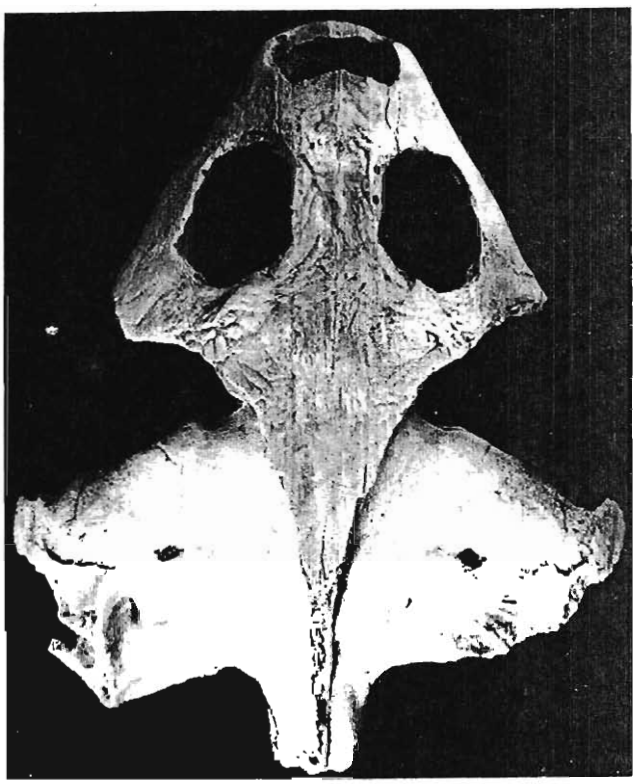


Fig. 2 Dorsal view of the cranium of *Trionyx liupani* n. sp.

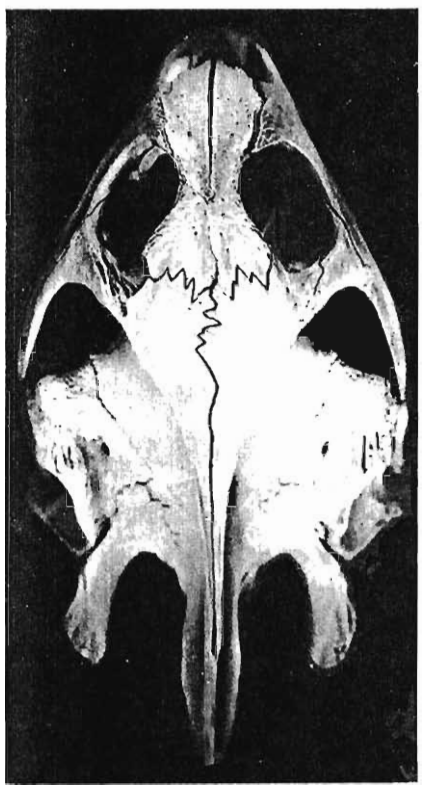


Fig. 3. Dorsal view of the cranium of *Trionyx sinensis* (Wiegmann)

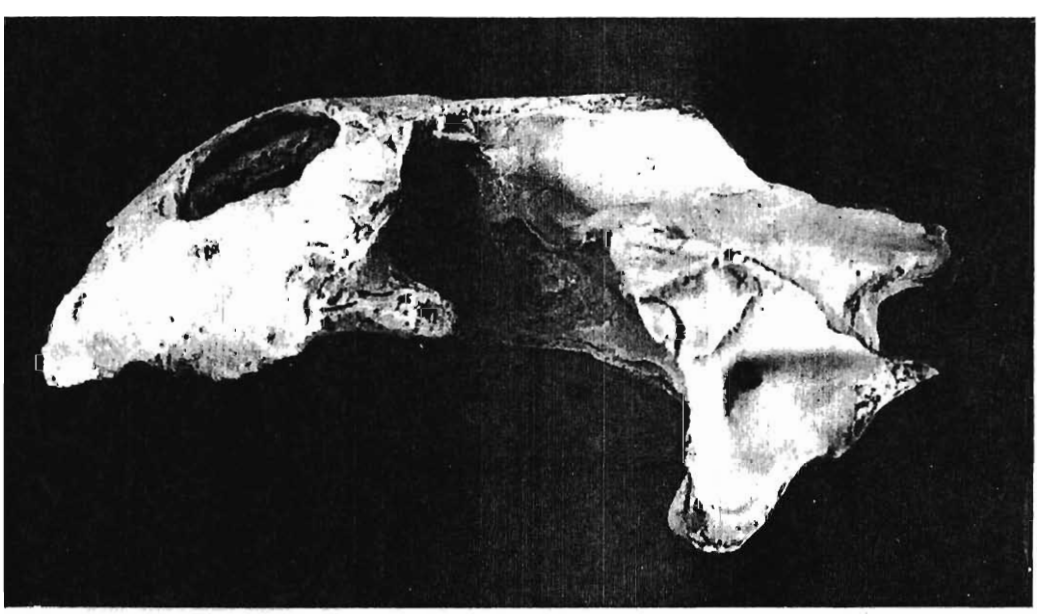


Fig. 4 Lateral view of the cranium of *Trionyx liupani* n. sp.

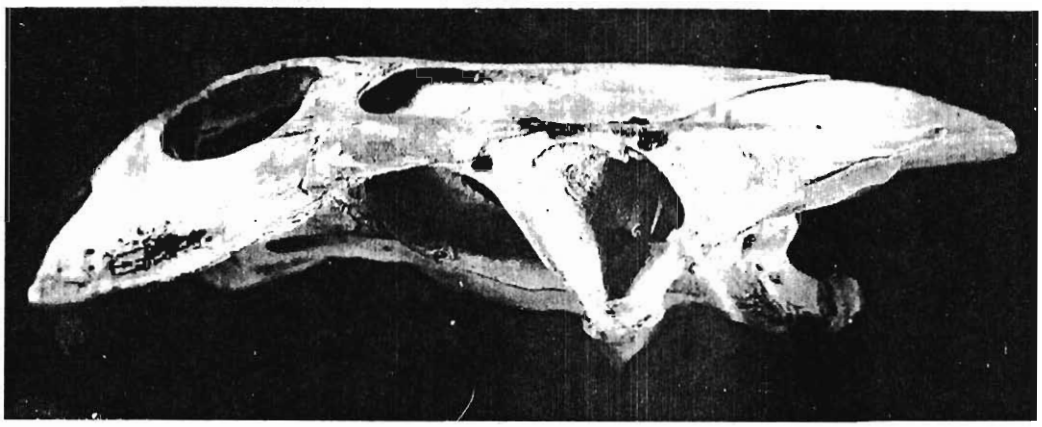


Fig. 5. Lateral view of the cranium of *Trionyx sinensis* (Wiegmann)

Fig. 6. Ventral view of the cranium of *Trionyx liupani* n. sp.

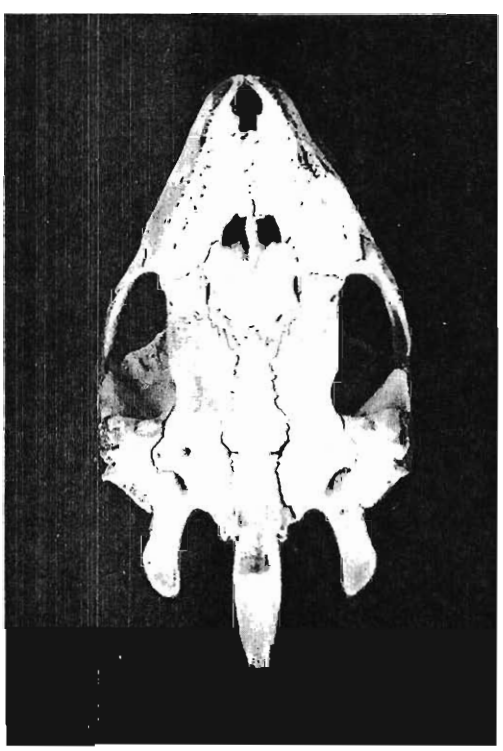


Fig. 7. Ventral view of the cranium of *Trionyx sinensis* (Wiegmann)

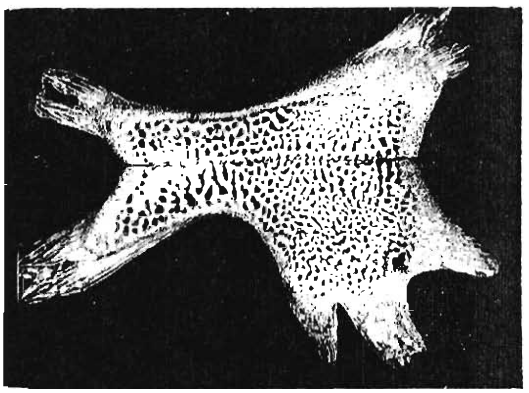


Fig. 8. Ventral view of hyoplastron and hypoplastron of *Trionyx sinensis* (Wiegmann) (Left side)

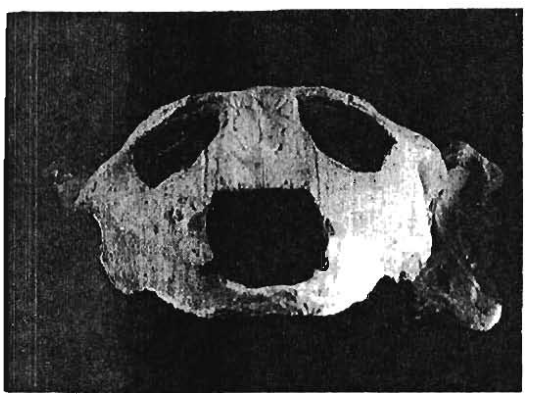


Fig. 9. Frontal view of the cranium of *Trionyx liupani* n. sp.

Fig. 10. Dorsal view of right hypoplastron of *Trionyx liupani* n. sp

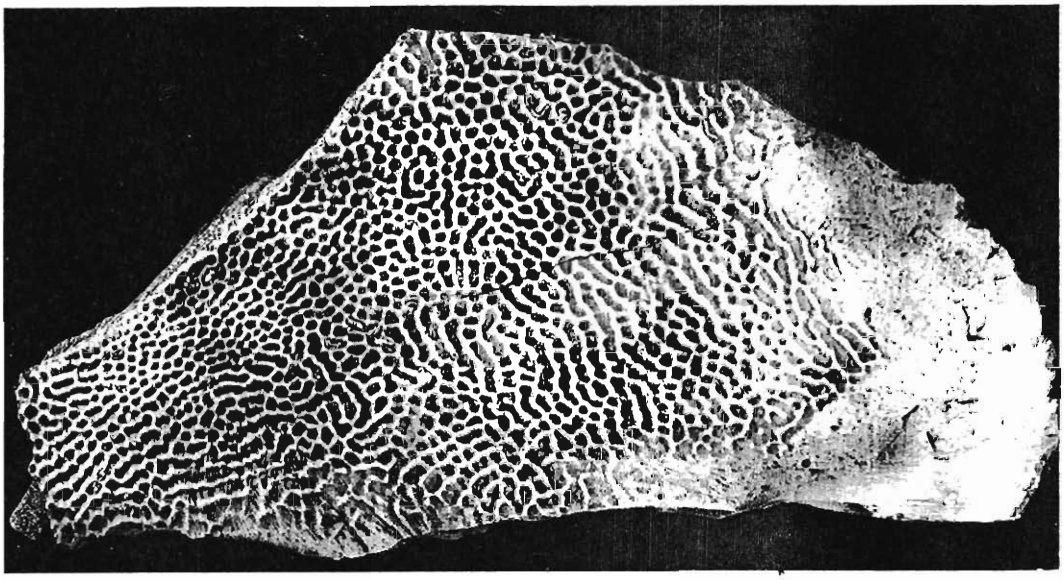


Fig. 11. Ventral view of right hyoplastron of *Trionyx liupani* n. sp.

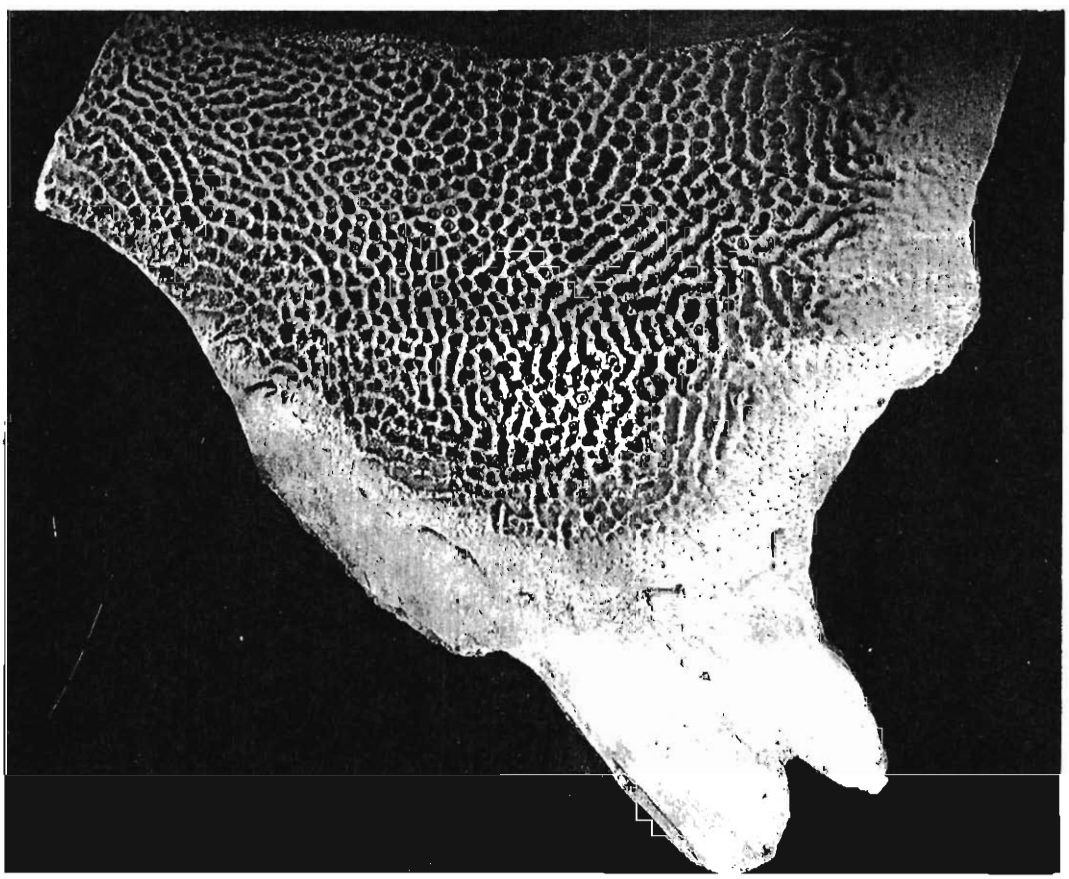


Fig. 12. Ventral view of right hypoplastron of *Trionyx liupani* n. sp.