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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 nare, 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 Pliocene.

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 (NH₄Cl) 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. Standardized 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, basiphenoid
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)
Suborder: Castchelydia
Infraorder: Cryptodira
Parvorder: Eucryptodira
Superfamily: Trionychoidea
Family: Trionychidae
Genus: Trionyx

Trionyx liupani n. sp.

Linnacus, 1758
Gaffney, 1975a
(Cope, 1868)
Gaffney, 1975a
Gray, 1870
Bell, 1828
Geoffroy, 1809

Holotype and Cotype:
The figured cranium and hypoplastron are stored in the personal museum of Mr. Pan, Chung-Wu (潘崇武), 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:
Craniun 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. Hyoplastron having an irregularly triangular to trapezoidal in outline. PMP well preserved, Mp unknown. Outer margins of the hypo- 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.

Craniun: 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 incompletes (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 its 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, quadrate jugal 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 hypaplastron and hypaplastron 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 hypaplastron is transverso-tetragonal or fan-shaped 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 a’d is 11.65 cm, b’c is 18.9 cm, c’d is 21.8 cm, a’d is 4.7 cm (Table 2). The width of hypaplastron is nearly twice the length. The lower part of inner margin of hypaplastron is arched. The AMP, LP1, part of inner margin and outer margin are broken.

The hypaplastron 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 a’d is 17.70 cm, b’c is 18.4 cm, c’d is 19.60 cm, and a’d 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 hypoplastron 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 *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 (劉銳松) and Mr. Pan, Chang-Wu (潘常武) for permission to study their valuable collection.

Acknowledgement

I am grateful to Mr. Liu, Mong-Song (劉銳松) and Mr. Pan, Chung-Wu (潘常武) for permission to study their rather rare collections. Thanks also to Professors Liang, Y. S. (梁鴻生), Shen, S. C. (沈惟傑) Zoology Department, National Taiwan University, Drs. Fox, R. C., Nelson, J. S. (Zoology Department, The University of Alberta), for reading the present manuscript. Dr. Hu, Chung-Hung (胡忠銘), Professor of Paleontology, National Taiwan Normal University, encourages me to complete this research is also appreciated.

References


Carr, A. (1952) Handbook of turtles, the turtles of the United States, Canada and Baja California. Cornell Univ. Pre. 542 pp.


Gaffney, E. S. (1975) A phylogeny and clas-
Table 1. *Trionyx tiupani* n. sp., measurements of the cranium and its elements (in cm).

<table>
<thead>
<tr>
<th>Maximal length of cranium</th>
<th>13.29 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal width of cranium</td>
<td>10.41 cm</td>
</tr>
<tr>
<td>Maximal thickness of cranium</td>
<td>5.07 (in Quadrat)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dorsal view</th>
<th>R.</th>
<th>L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>External nares</td>
<td>M. W. 2.15</td>
<td>M. L. 1.94</td>
</tr>
<tr>
<td>Orbit</td>
<td>M. W. 2.21</td>
<td>2.13</td>
</tr>
<tr>
<td>Premaxilla</td>
<td>M. W. 0.50</td>
<td>0.49</td>
</tr>
<tr>
<td>Maxilla</td>
<td>M. W. 2.31</td>
<td>2.30</td>
</tr>
<tr>
<td>Prefrontal</td>
<td>M. W. 0.99</td>
<td>1.00</td>
</tr>
<tr>
<td>Frontal</td>
<td>M. W. 1.34</td>
<td>1.55</td>
</tr>
<tr>
<td>Postorbital</td>
<td>M. W. 1.34</td>
<td>1.44</td>
</tr>
<tr>
<td>Parietal</td>
<td>M. W. 2.22</td>
<td>2.34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ventral view</th>
<th>R.</th>
<th>L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basisphenoid</td>
<td>M. W. 1.72</td>
<td>M. L. 3.63</td>
</tr>
<tr>
<td>Pterygoid</td>
<td>M. W. 1.70?</td>
<td>2.23?</td>
</tr>
<tr>
<td>Maxilla</td>
<td>M. W. 1.95</td>
<td>2.05</td>
</tr>
</tbody>
</table>

? : 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).

<table>
<thead>
<tr>
<th></th>
<th>Hyoplastron</th>
<th>Hypoplastron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal width</td>
<td>24.30</td>
<td>21.10</td>
</tr>
<tr>
<td>Maximal length</td>
<td>12.30</td>
<td>18.50</td>
</tr>
<tr>
<td>Maximal thickness</td>
<td>1.80 (in “d” location)</td>
<td>2.20 (in “a” location)</td>
</tr>
<tr>
<td>Length of $\tilde{a}b$ (Anterior margin)</td>
<td>11.65</td>
<td>17.70</td>
</tr>
<tr>
<td>Length of $\tilde{b}c$ (Inner margin)</td>
<td>18.90</td>
<td>18.40</td>
</tr>
<tr>
<td>Length of $\tilde{c}d$ (Posterior margin)</td>
<td>21.80</td>
<td>19.60</td>
</tr>
<tr>
<td>Length of $\tilde{a}d$ (Outer margin)</td>
<td>4.70</td>
<td>4.68</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th><em>T. liupani</em></th>
<th><em>T. sinensis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>No. of individuals</td>
</tr>
<tr>
<td>1. External nares: M. L. / M. W.</td>
<td>0.962</td>
<td>1.0486</td>
</tr>
<tr>
<td>2. Maxillary angle</td>
<td>62°</td>
<td>48.5°</td>
</tr>
<tr>
<td>3. Maxilla: M. W. in orbit/M. L.</td>
<td>0.435</td>
<td>0.268</td>
</tr>
<tr>
<td>4. Basisplanoid: M. W. of anterior/M. W. of posterior</td>
<td>0.710</td>
<td>0.331</td>
</tr>
<tr>
<td>5. Ratio of $A^<em>/B^</em>$</td>
<td>2.217</td>
<td>1.542</td>
</tr>
<tr>
<td>6. Hypoplastron: shape of inner margin in lower part</td>
<td>arched</td>
<td>oblique</td>
</tr>
</tbody>
</table>

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

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

Fig. 7. Ventral view of the cranium of *Trionyx sinensis* (Wiegemann)
Fig. 8. Ventral view of hypoplastron 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 hyoplastron of *Trionyx liupani* n. sp.