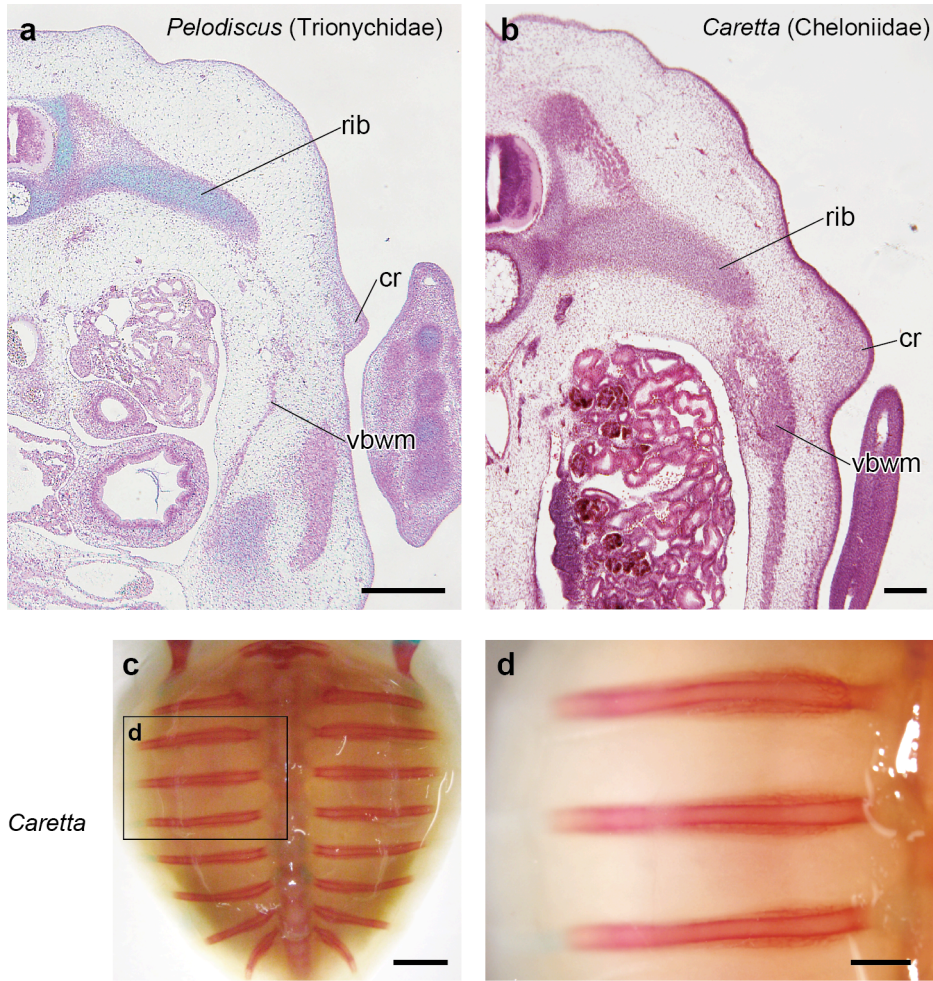


**SUPPLEMENTARY INFORMATION**

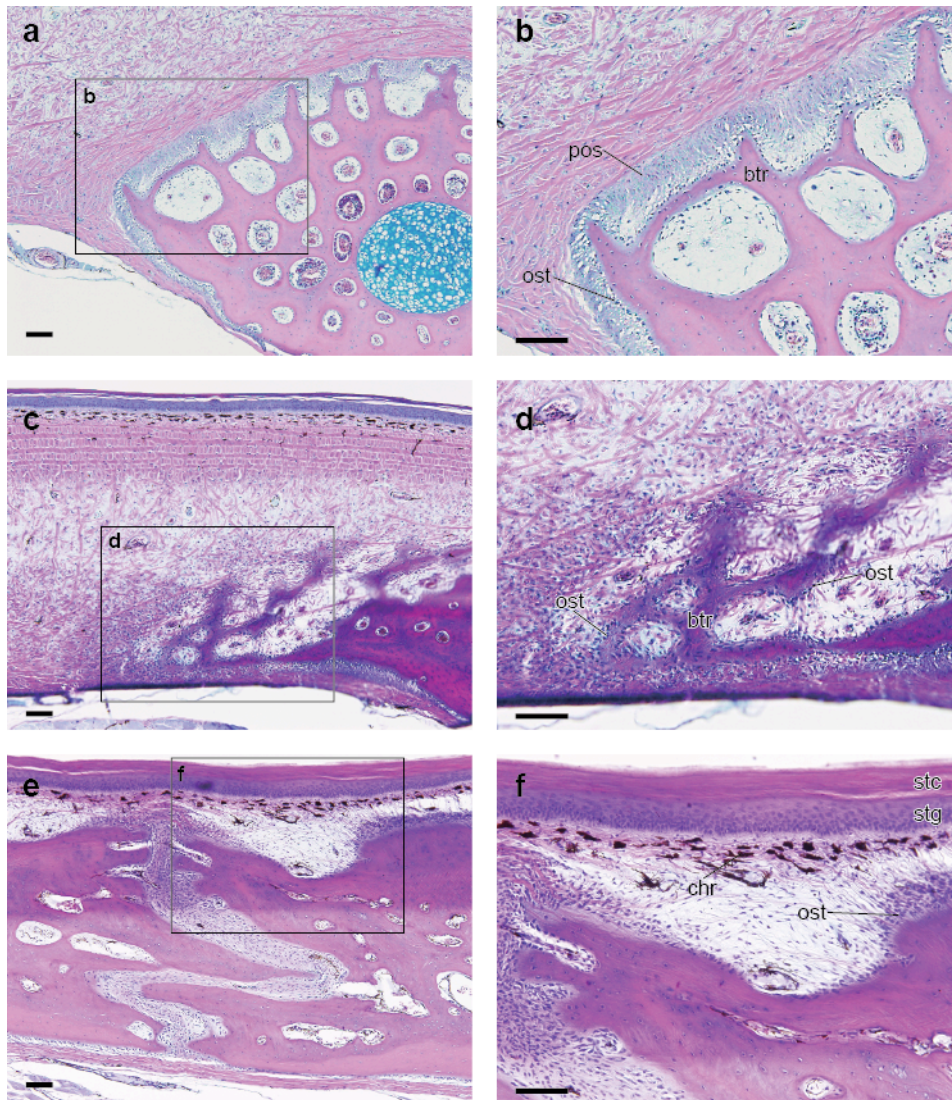
The Endoskeletal Origin of the Turtle Carapace

Hirasawa, Nagashima, and Kuratani, 2013

**Supplementary Figures**

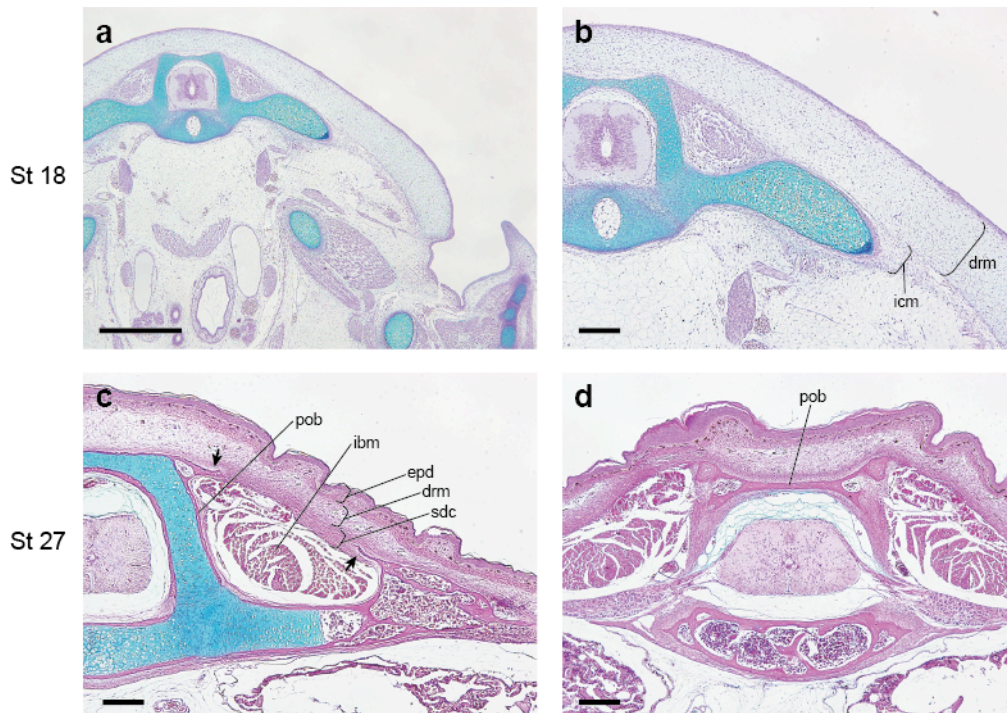


**Supplementary Figure S1. Development of the carapace in the loggerhead turtle *Caretta caretta*.** (a) Transverse section of the trunk of the Chinese soft-shelled turtle (*Pelodiscus sinensis*) embryo at stage 17. Scale bar, 200 μm. (b) Transverse section of the trunk of the loggerhead turtle embryo at stage<sup>61</sup> IV. Scale bar, 200 μm. (c) Cleared and double-stained juvenile specimen of the loggerhead turtle. Scale bar, 5 mm. (d) Enlarged image of the immature costal plates in c. Box in c indicates the positions of d. Scale bar, 2 mm. cr, carapacial ridge; vbwm, primordia of ventral body wall muscles.

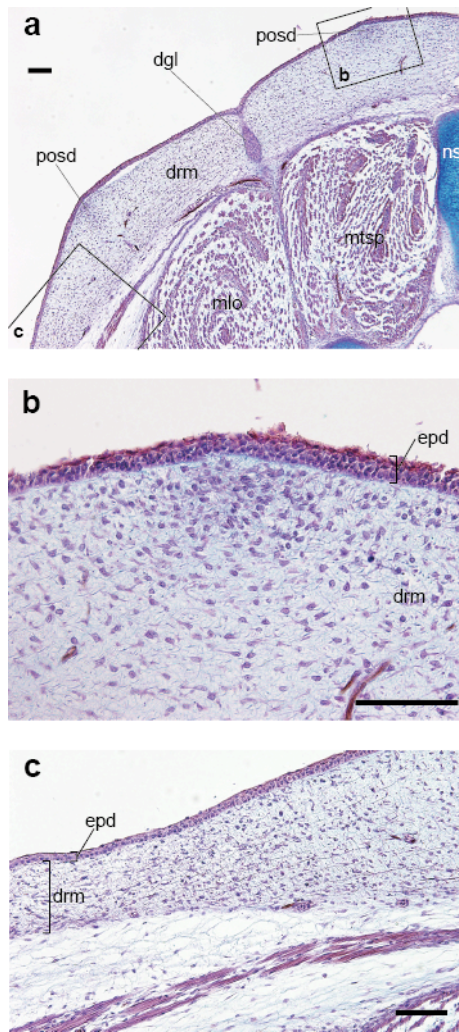


**Supplementary Figure S2. Histology of the costal plates in *P. sinensis* juvenile.** The body size of this individual is 12.8 cm in snout-to-vent length and 6.9 cm in carapace length. **(a)** Mid-part of the developing costal plate. Scale bar, 100  $\mu$ m. The bony trabeculae (btr) develop within the periosteum (pos). **(b)** Enlarged image of **a**. Box in **a** indicates the position of **b**. Scale bar, 100  $\mu$ m. **(c)** Proximal part of the costal plate. Scale bar, 100  $\mu$ m. The periosteum is dismantled to lose its clear structure. **(d)** Enlarged image of **c**. Box in **c** indicates the position of **d**. Scale bar, 100  $\mu$ m. **(e)** More proximal part of the costal plate, showing the initial stage of the suture between neighbouring costal plates. Scale bar, 100  $\mu$ m. **(f)** Enlarged image of **e**. Box in **e** indicates the position of **f**. Scale bar, 100  $\mu$ m. btr, bony trabecula; chr, chromatophore; ost, osteoblast; pos, periosteum; stc, stratum corneum; stg, stratum germinativum.



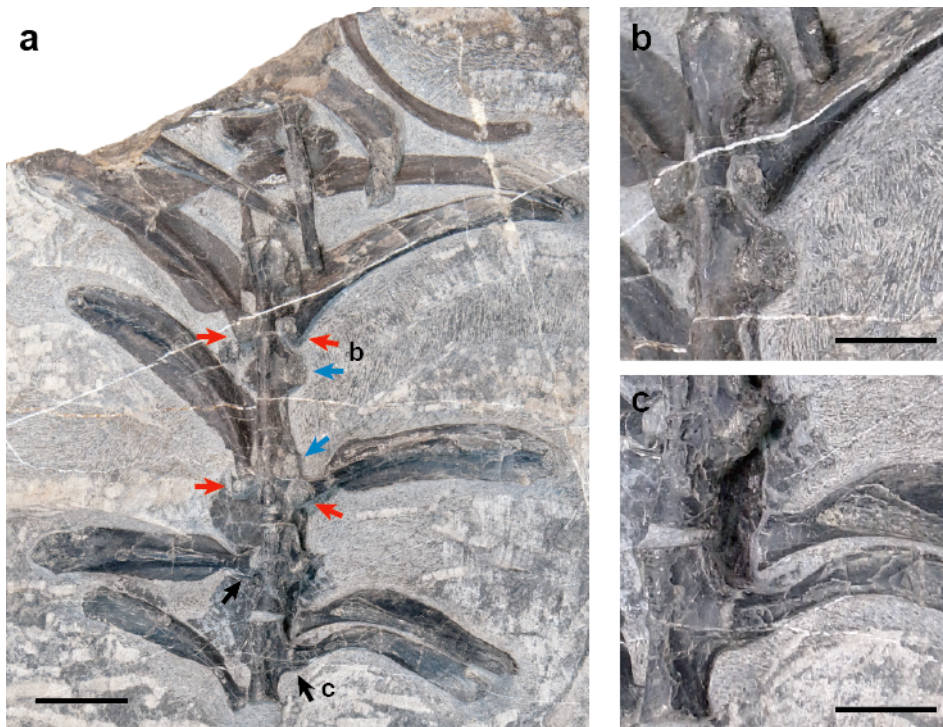


**Supplementary Figure S3. Development of neural plates in *P. sinensis* embryo.** (a) Transverse sections of the trunk at stage 18. Scale bar, 200  $\mu\text{m}$ . (b) Enlarged image of a. Scale bar, 200  $\mu\text{m}$ . (c) Transverse section of the trunk at the vertebral level at stage 27. Arrows indicate protrusion of bone trabeculae. Scale bar, 200  $\mu\text{m}$ . (d) Transverse section of the trunk at the intervertebral level at stage 27. Scale bar, 200  $\mu\text{m}$ . drm, dermis; epd, epidermis; ibm, intrinsic back muscle; icm, intercostal muscle layer; pob, periosteal bone collar; sdc, subdermal connective tissue.

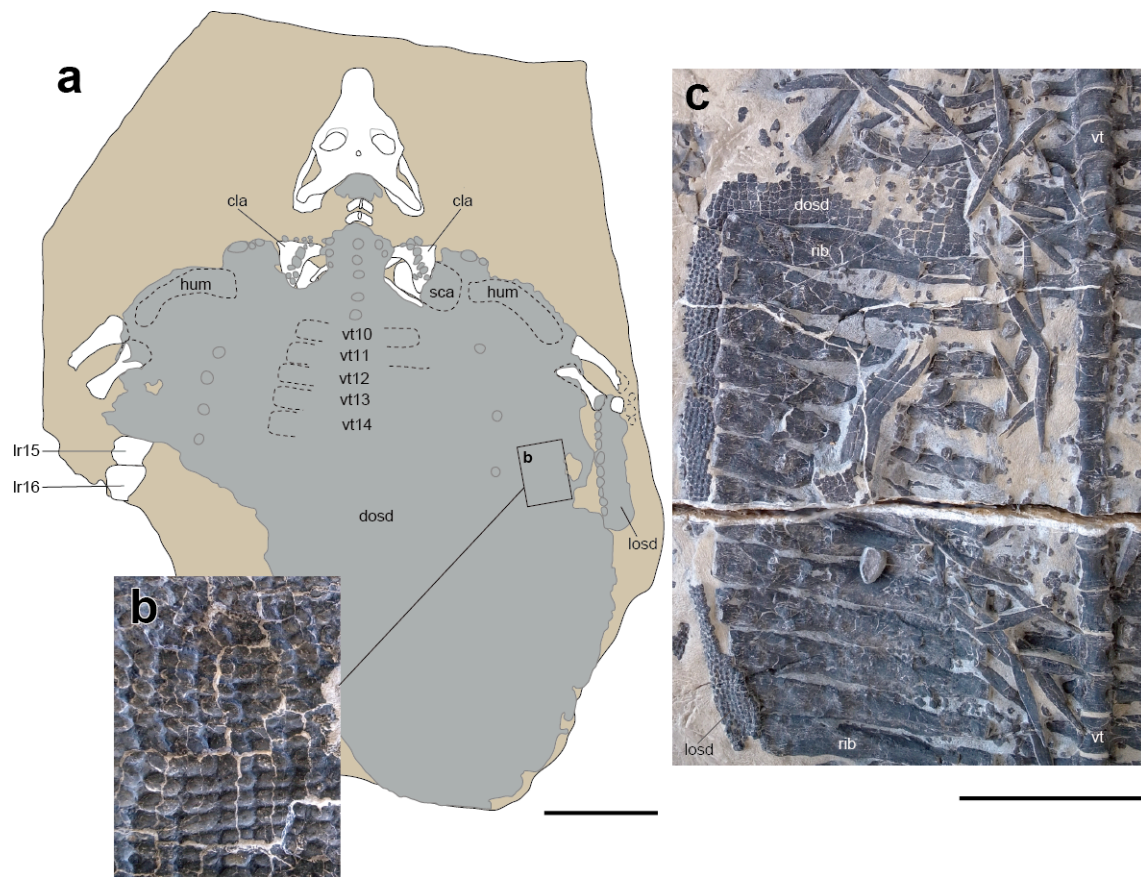


**Supplementary Figure S4. Development of the osteoderm in *A. mississippiensis* embryo.** (a) Transverse section of the anterior thoracic region of a stage 22 embryo. Scale bar, 100  $\mu$ m. Boxes indicate the positions of **b** and **c**. (b) Enlarged image of **a**, showing cell aggregation for the formation of the osteoderm. Scale bar, 100  $\mu$ m. (c) Enlarged image of **a**, showing boundary between the dermis and the subdermal mesenchyme. Scale bar, 100  $\mu$ m. dgl, dorsal gland; drm, dermis; epd, epidermis; mlo, longissimus muscle group; mtsp, transversospinalis muscle group; ns, neural spine; posd, precursor of the osteoderm.



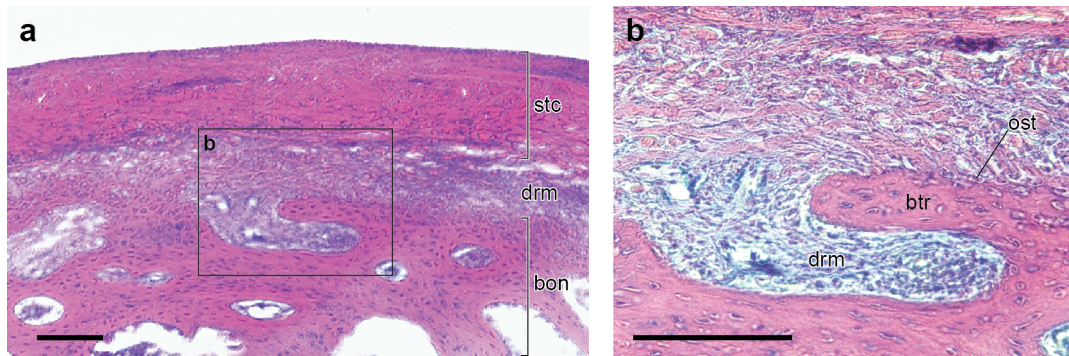


**Supplementary Figure S5. Axial skeleton of the Late Triassic *Odontochelys semitestacea* (IVPP V 15653).** (a) Ventral view of the ribs and vertebrae. Scale bar, 2 cm. Red arrows, articular facets of the rib head; blue arrows, vertebral parapophyses; black arrows, synarthroses between rib and vertebra. (b) Enlarged image of articular surfaces of a rib and vertebra. Scale bar, 2 cm. (c) Enlarged image of a synarthrosis between the rib and vertebra. Scale bar, 2 cm.



**Supplementary Figure S6. Detailed osteology of *Sinosaurosphargis yunguiensis*.** (a) Holotype (IVPP V 17040). Scale bar, 10 cm. (b) Enlarged images of osteoderms. (c) Paratype (IVPP V 16076). Scale bar, 10 cm. cla, clavicle; dosd, dorsal osteoderm; hum, humerus; losd, lateral osteoderm; lr15 and 16, left ribs corresponding to the 15th and 16th presacral vertebrae; sca, scapula; vt, vertebra; vt10–14, positions of 10–14th presacral vertebrae.





**Supplementary Figure S7. Histology of the surface of the distal phalanx underlying the claw in *G. gallus* adult.** (a) Cross section of the dorsal part of the distal phalanx of the third digit. Scale bar, 100  $\mu\text{m}$ . (b) Enlarged image of a bony trabecula incorporating fiber bundles of the dermis in a. Box in a indicates the position of b. Scale bar, 100  $\mu\text{m}$ . drm, dermis; bon, bony tissue of the distal phalanx; btr, bony trabecula; ost, osteoblast; stc, stratum corneum of the claw.

### Supplementary Methods

**Loggerhead turtle samples.** Loggerhead turtle (*Caretta caretta*) eggs were legally collected at Shirahama, Wakayama, Japan in 1984, as described previously<sup>61</sup>. Histological sections of the loggerhead turtles (10  $\mu\text{m}$ ) were stained with hematoxylin and eosin.

**Chicken distal phalanx samples.** Histological sections of the distal phalanx of the chicken (8  $\mu\text{m}$ ) were stained with Alcian blue, hematoxylin, and eosin.

### Supplementary Reference

- 61 Kuratani, S. Development of the chondrocranium of the loggerhead turtle, *Caretta caretta*. *Zool Sci* **16**, 803-818 (1999).