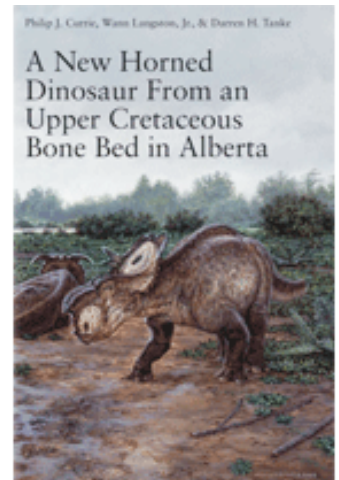


Figures

3. Structure of the brain cavity and inner ear of the centrosaurine ceratopsid dinosaur *Pachyrhinosaurus* based on CT scanning and 3D visualization

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WitmerLab web page with downloads of movies and 3D PDFs:
http://www.oucom.ohiou.edu/dbms-witmer/Pachyrhinosaurus_main.htm

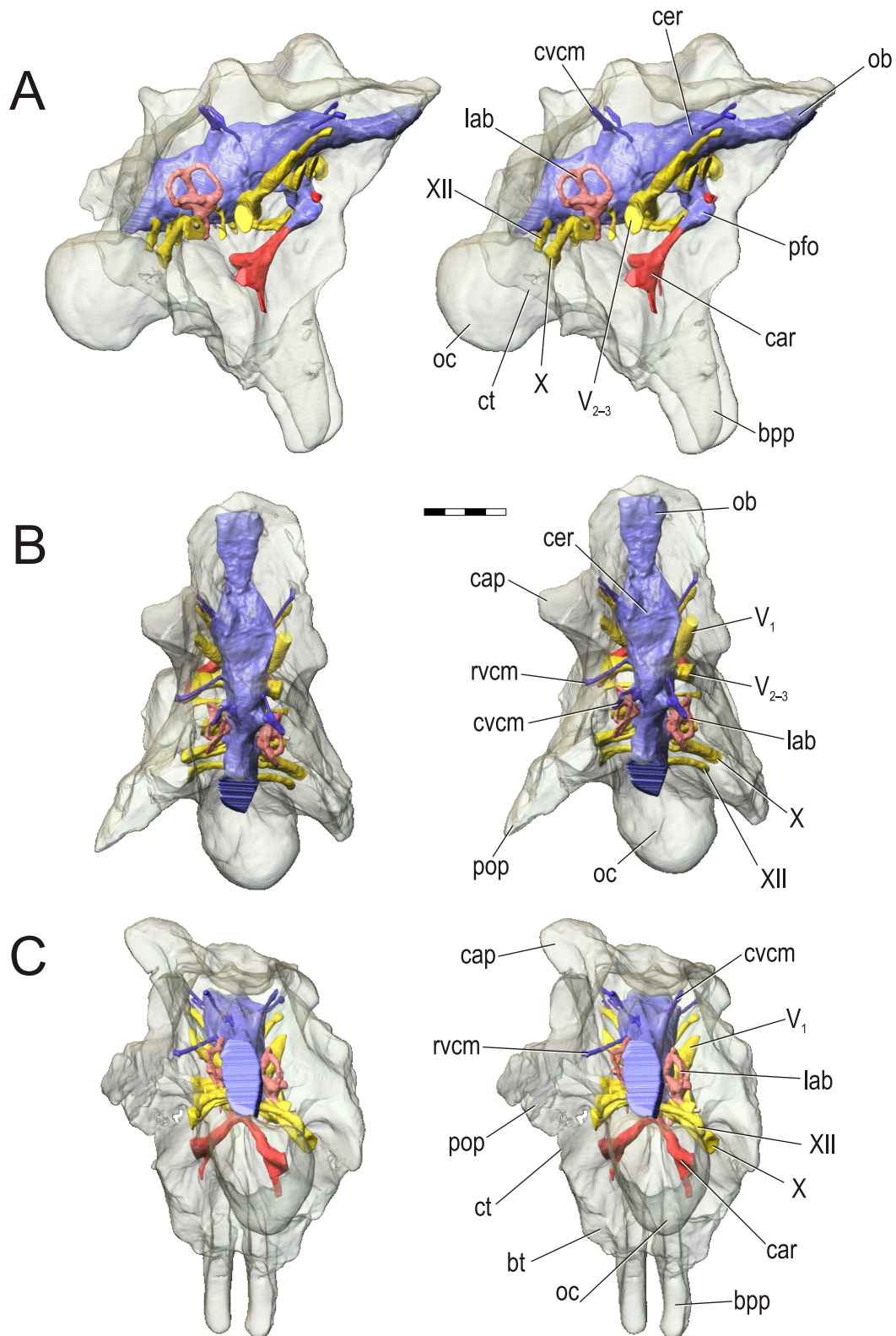
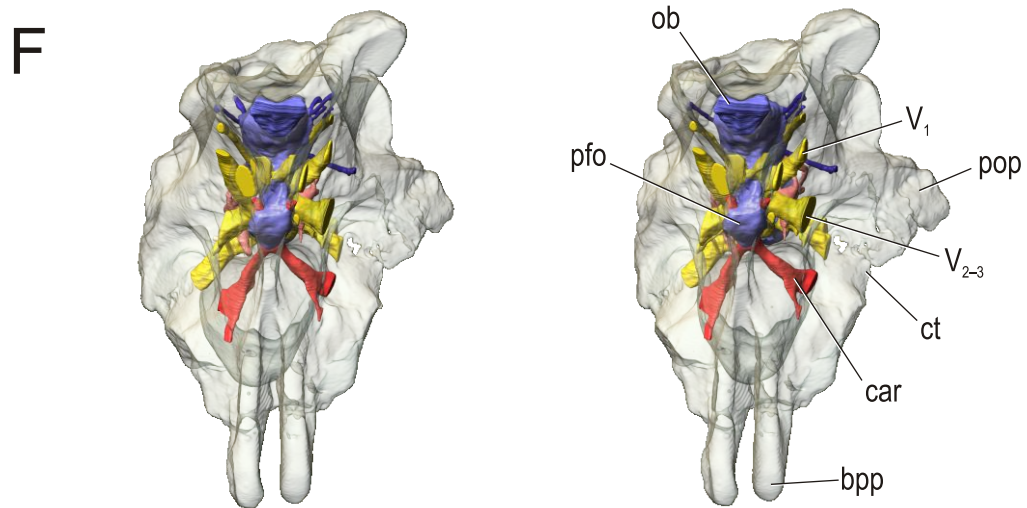
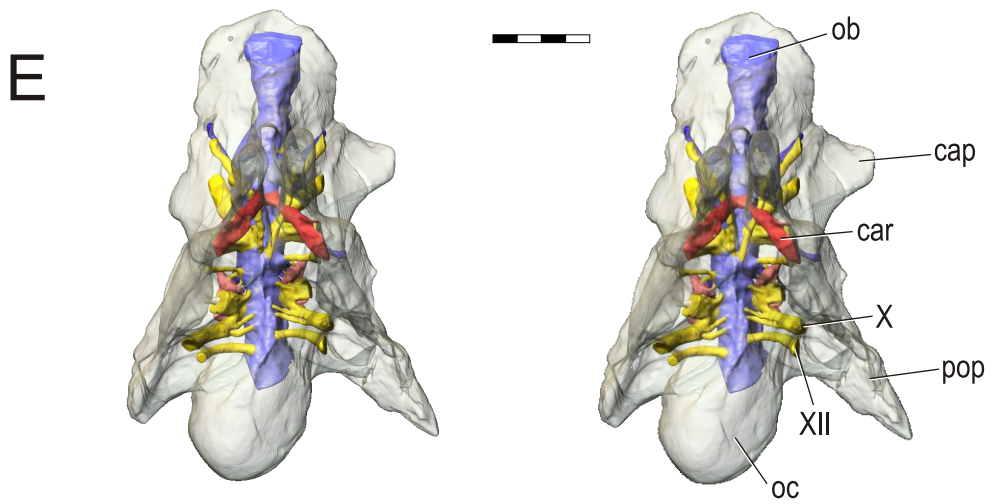
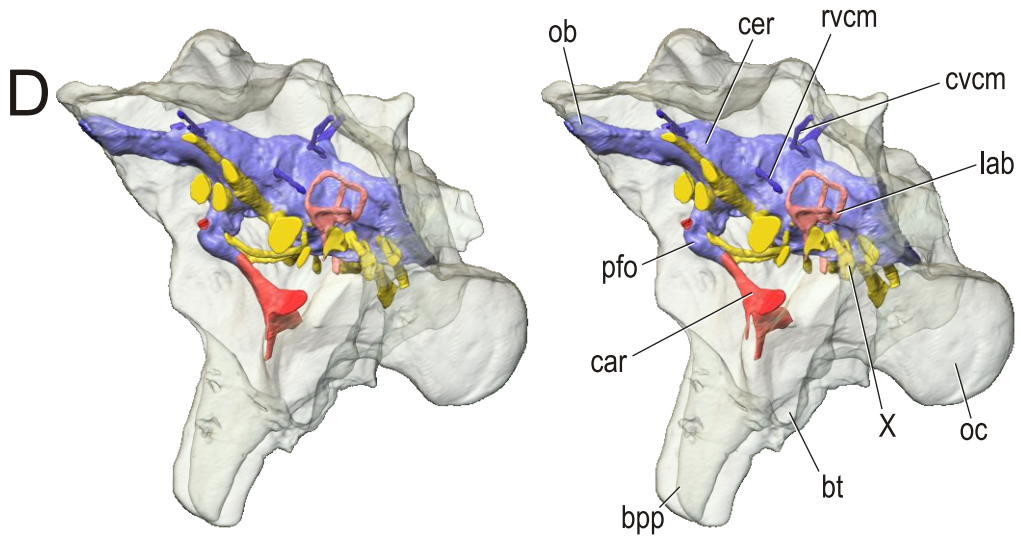


Fig. 1. Stereopairs of articulated braincase of *Pachyrhinosaurus lakustae* (TMP 1989.55.1243) derived from reconstructed computed tomographic (CT) scans and shown in the following views: (A) right lateral, (B) dorsal, (C) caudal, (D) left lateral, (E) ventral, and (F) rostral. Bone is rendered semitransparent, revealing cranial endocast in blue, endosseous labyrinth in pink, nerve canals (most of which also transmit veins) in yellow, smaller venous canals in dark blue, and arterial canals in red. Scale bar = 4 cm. Abbreviations: bpp, basipterygoid process; bt, basal tuber; cap, capitate process of laterosphenoid; car, cerebral carotid artery canal; cer, cerebral hemisphere; ct, crista tuberalis; cvcm, caudal middle cerebral vein; lab, endosseous labyrinth; ob, olfactory bulb; oc, occipital condyle; pfo, pituitary (= hypophyseal) fossa; pop, paroccipital process; rvcm, rostral middle cerebral vein; V₁, ophthalmic nerve canal; V₂₋₃, maxillomandibular nerve canal; X, shared canal for vagus and accessory nerves and accompanying vessels; XII, hypoglossal nerve canal.



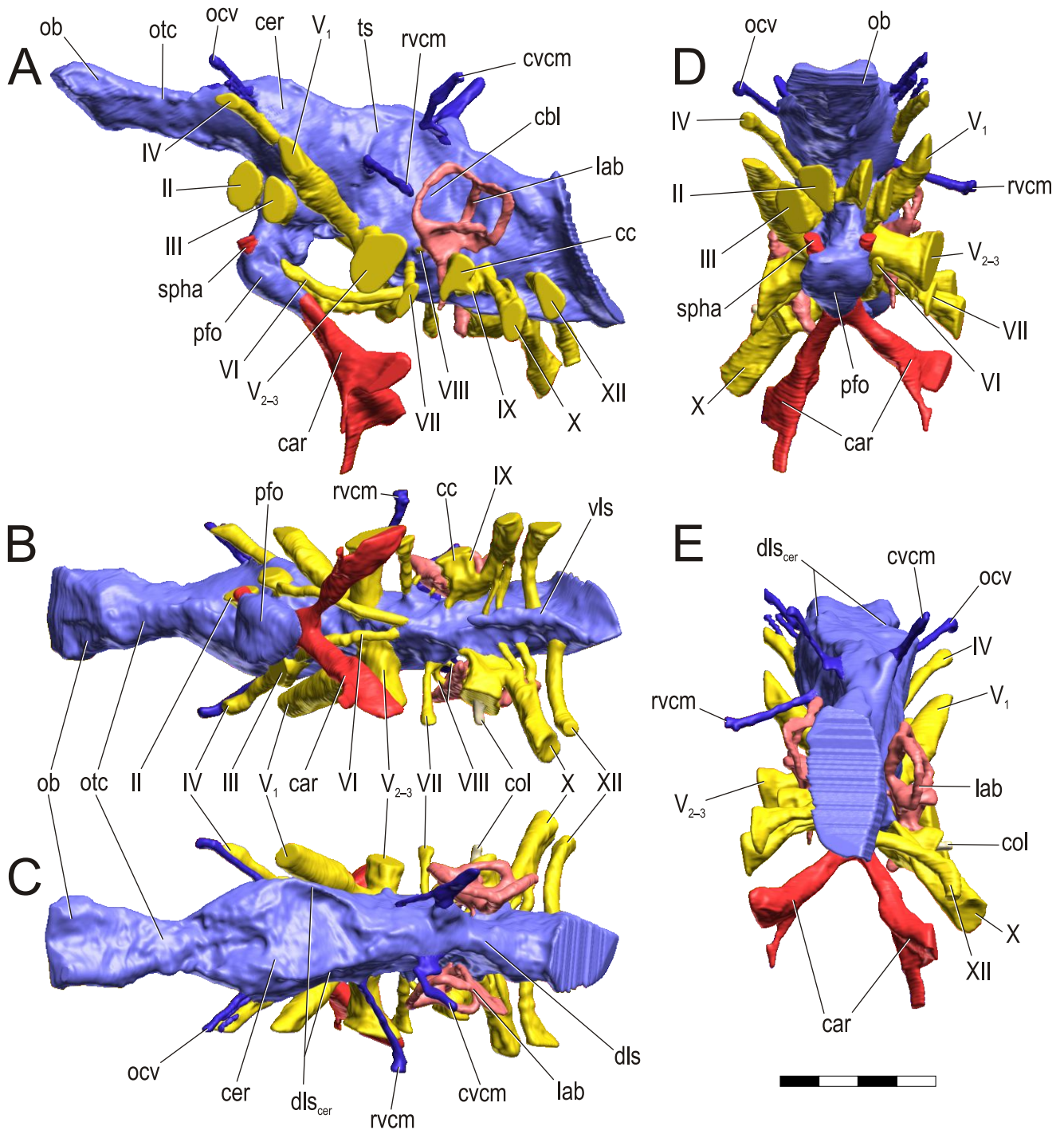
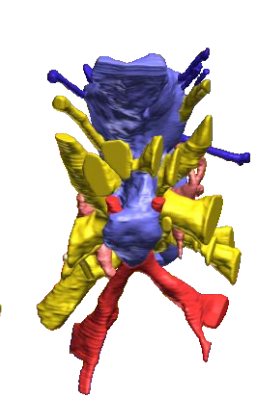
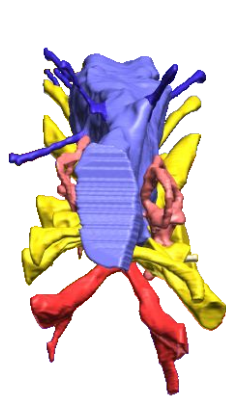
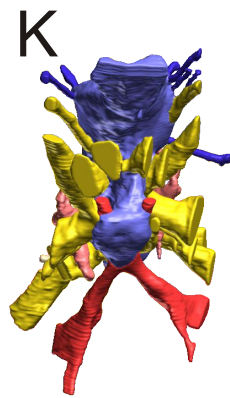
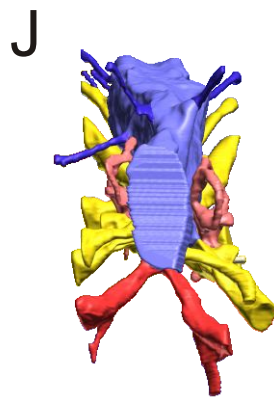
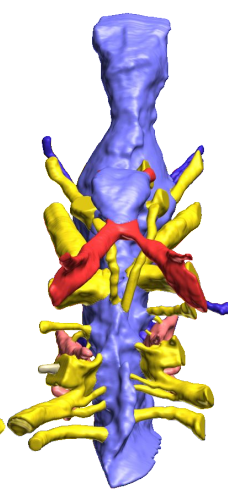
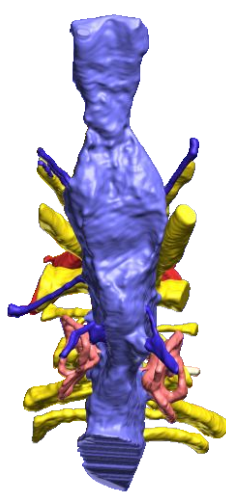
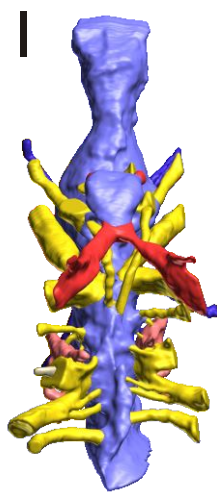
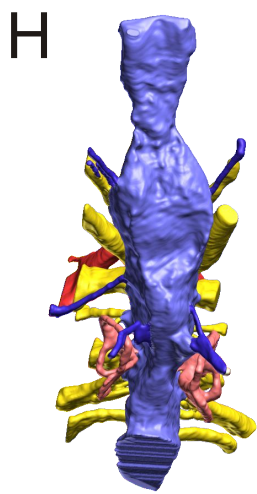
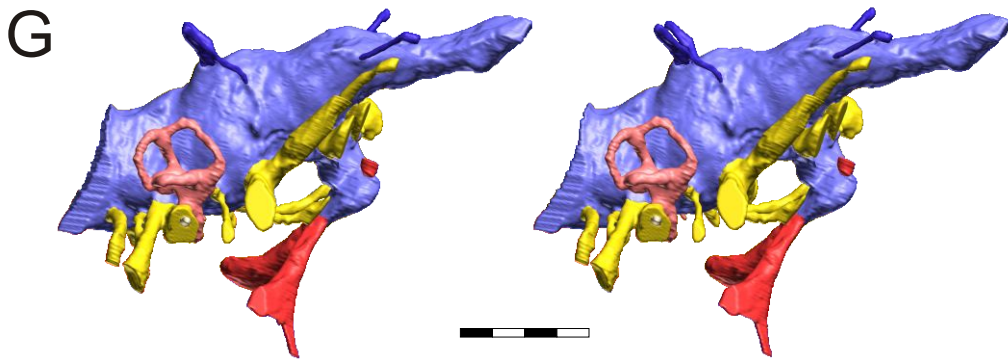
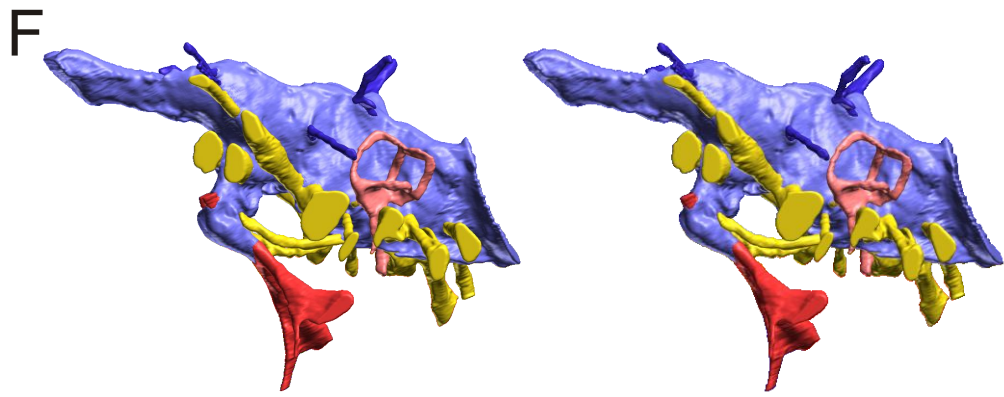


Fig. 2. Cranial endocast of *Pachyrhinosaurus lakustae* (TMP 1989.55.1243) reconstructed from computed tomographic (CT) scans and shown in the following views: (A) left lateral, (B) ventral, (C) dorsal, (D) rostral, and (E) caudal. Stereopairs are in the following views: (F) left lateral, (G) right lateral, (H) dorsal, (I) ventral, (J) caudal, and (K) rostral. Color scheme: cranial endocast, blue; endosseous labyrinth, pink; nerve canals (most of which also transmit veins), yellow; smaller venous canals, dark blue; arterial canals, red. Scale bar = 4 cm. Abbreviations: car, cerebral carotid artery canal; cbl, cerebellum; cc, columellar canal; cer, cerebral hemisphere; cvcm, caudal middle cerebral vein; col, columella (= stapes); dls, dorsal longitudinal sinus (a dural venous sinus); *dls_{cer}*, cerebral branch of dorsal longitudinal sinus; lab, endosseous labyrinth; ob, olfactory bulb; ocv, orbitocerebral vein canal; otc, olfactory tract cavity; pfo, pituitary (= hypophyseal) fossa; rvcm, rostral middle cerebral vein; spha, sphenoid artery canal; ts, transverse sinus; vls, ventral longitudinal sinus (a dural venous sinus); II, optic nerve canal; III, oculomotor nerve canal; IV, trochlear nerve canal; V1, ophthalmic nerve canal; V2-3, maxillomandibular nerve canal; VI, abducens nerve canal; VII, facial nerve canal; VIII, vestibulocochlear nerve canal; IX, glossopharyngeal nerve canal (part of columellar canal); X, shared canal for vagus and accessory nerves and accompanying vessels; XII, hypoglossal nerve canal.



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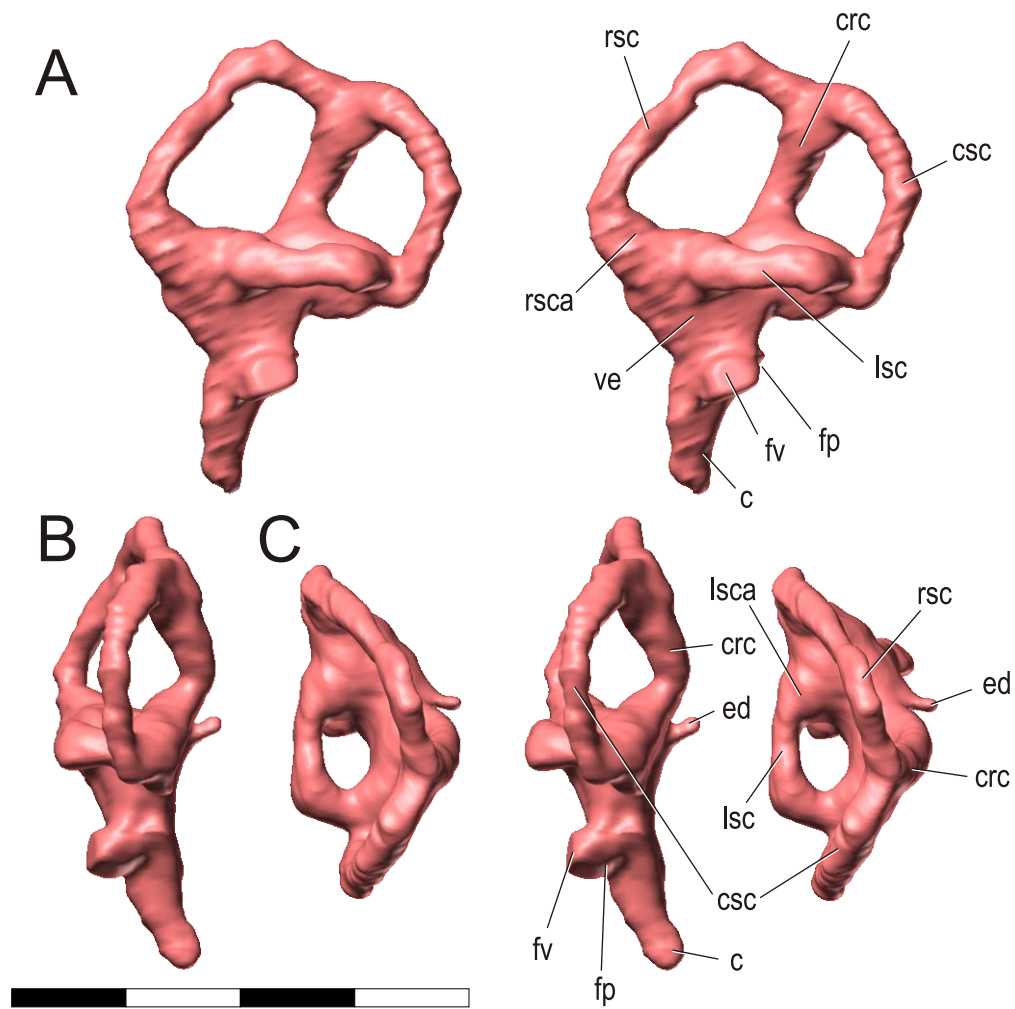


Fig. 3. Endosseous labyrinth of the left inner ear of *Pachyrhinosaurus lakustae* (TMP 1989.55.1243) reconstructed from computed tomographic (CT) scans. Stereopairs are in the following views: (A) lateral, (B) caudal, and (C) dorsal. Orientations were determined based on orientation of the labyrinth within the skull and with the lateral semicircular canal placed horizontally. Scale bar = 4 cm. Abbreviations: c, cochlea (= lagena); crc, crus communis; csc, caudal (posterior vertical) semicircular canal; ed, endolymphatic duct; fp, fenestra perilymphaticum (= round window); fv, fenestra vestibuli (= oval window); lsc, lateral (horizontal) semicircular canal; lsca, ampulla of lateral semicircular canal; rsc, rostral (anterior vertical) semicircular canal; rsca, ampulla of rostral semicircular canal; ve, vestibule of inner ear.

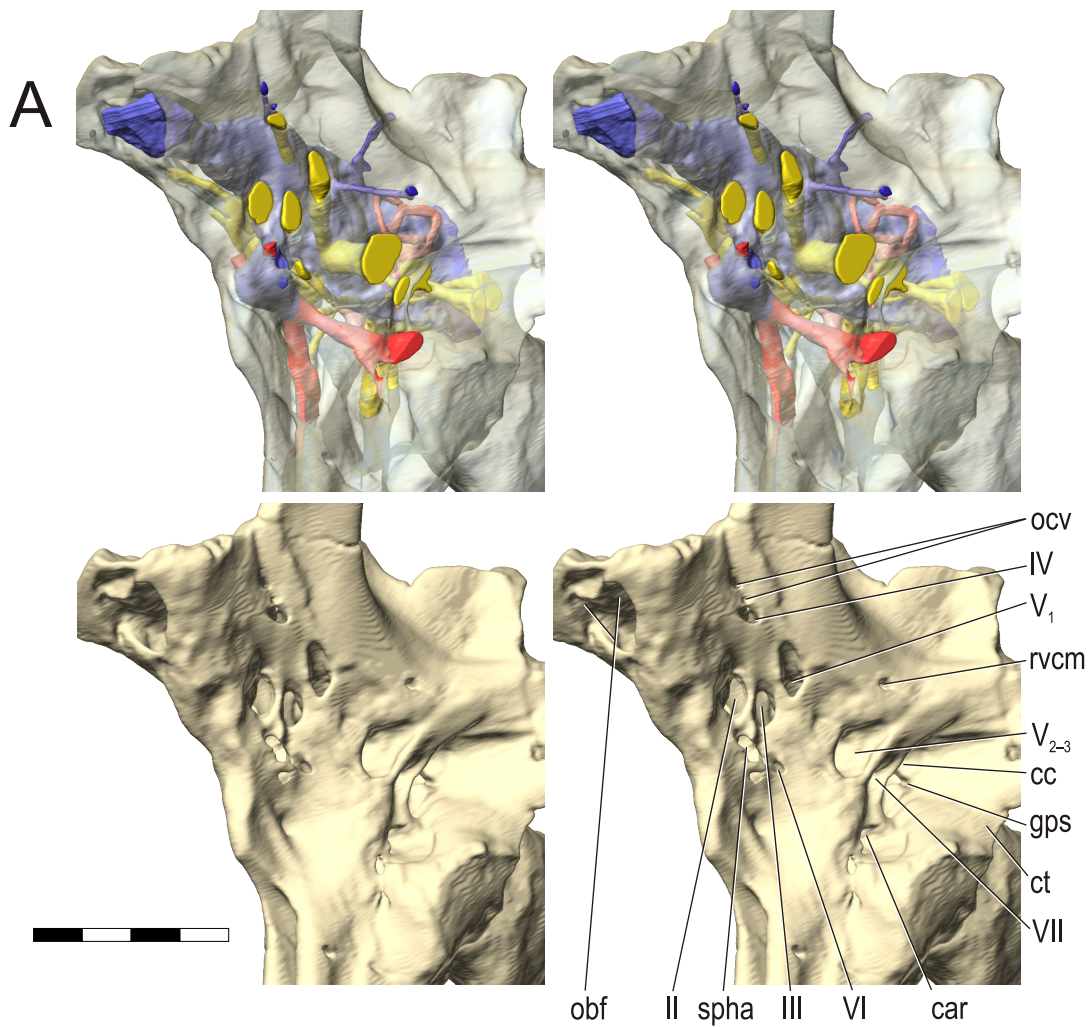
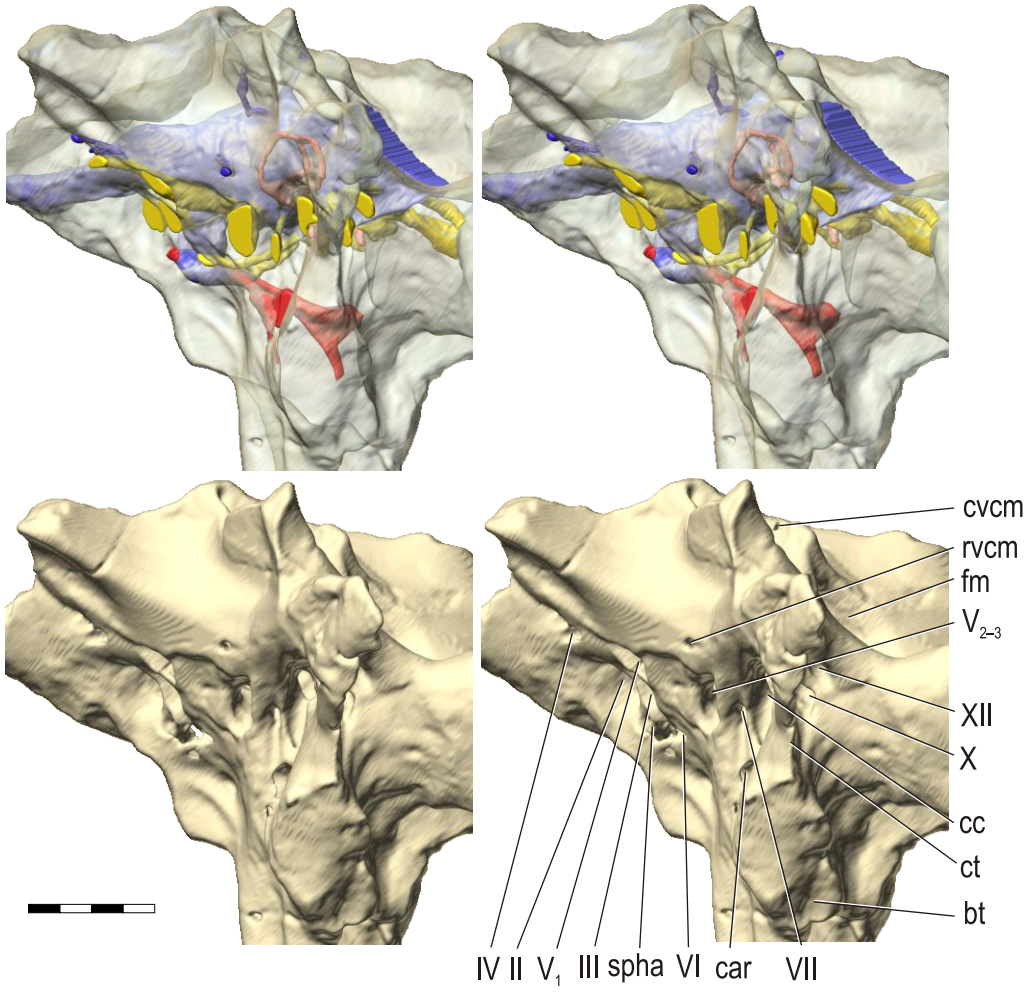


Fig. 4. Stereopairs of a braincase of *Pachyrhinosaurus lakustae* (TMP 1989.55.1243) reconstructed from computed tomographic (CT) scans in the (A) left rostroventrolateral view and (B) left caudolateral view to show the osteological correlates (e.g., foramina, fossae, crests) of many of the soft-tissue structures discussed in the text. Each view consists of a set of stereopairs (above) showing a semitransparent braincase revealing enclosed soft-tissue structures, coupled with a set of stereopairs (below) in the same view showing the bony braincase and labeled structures. Color scheme: cranial endocast, blue; endosseous labyrinth, pink; nerve canals (most of which also transmit veins), yellow; smaller venous canals, dark blue; arterial canals, red. Scale bar = 4 cm. Abbreviations: bt, basal tuber; car, cerebral carotid artery canal; cc, columellar canal; ct, crista tuberalis; cvcm, caudal middle cerebral vein; fm, foramen magnum; gps, glossopharyngeal sulcus; obf, olfactory bulb fossa; ocv, orbitocerebral vein canal; rvcm, rostral middle cerebral vein; spha, sphenoid artery canal; II, optic nerve canal; III, oculomotor nerve canal; IV, trochlear nerve canal; V1, ophthalmic nerve canal; V2-3, maxillomandibular nerve canal; VI, abducens nerve canal; VII, facial nerve canal; X, shared canal for vagus and accessory nerves and accompanying vessels; XII, hypoglossal canal.

B



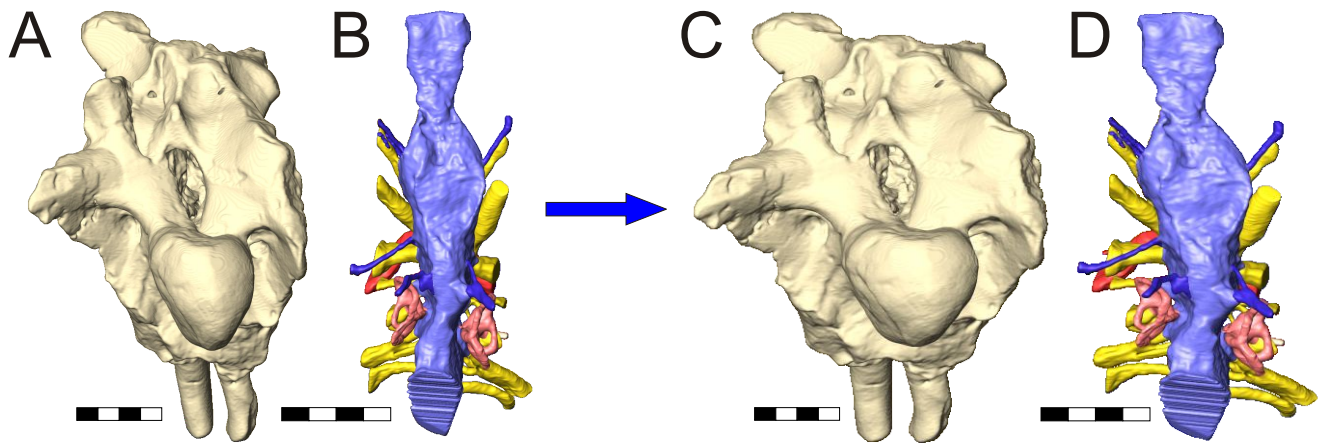


Fig. 5. Simple retrodeformation of a braincase and cranial endocast of *Pachyrhinosaurus lakustae* (TMP 1989.55.1243) reconstructed from computed tomographic (CT) scans. (A, C) Braincase in caudal view. (B, D) Cranial endocast in dorsal view. Scale bar = 4 cm. In A and B, the structures are shown as preserved prior to retrodeformation. In C and D, the structures have been transformed by simply stretching the dataset transversely so that the width of the occipital condyle equals its height (the condition observed in undeformed specimens). Even this simple retrodeformation restores a more natural shape to the braincase and endocast and increases endocast volume by 35%.