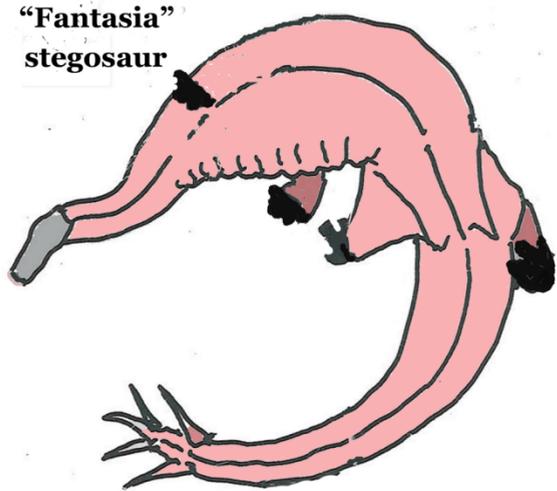


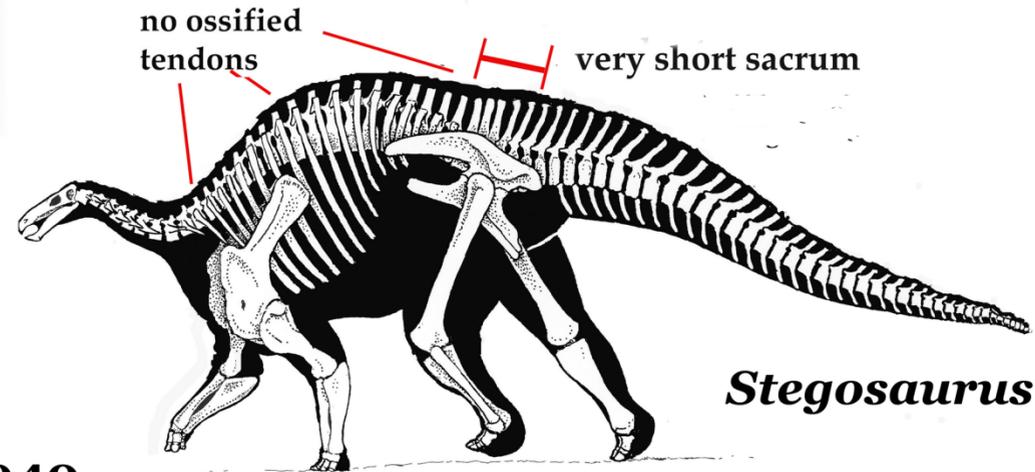
STEGOSAURIAN CHOREOGRAPHY : MASSIVE ENLARGEMENT OF PROTRACTION MUSCLES POWERS BACKING UP AND TURNING DURING SPIKE FIGHTING.

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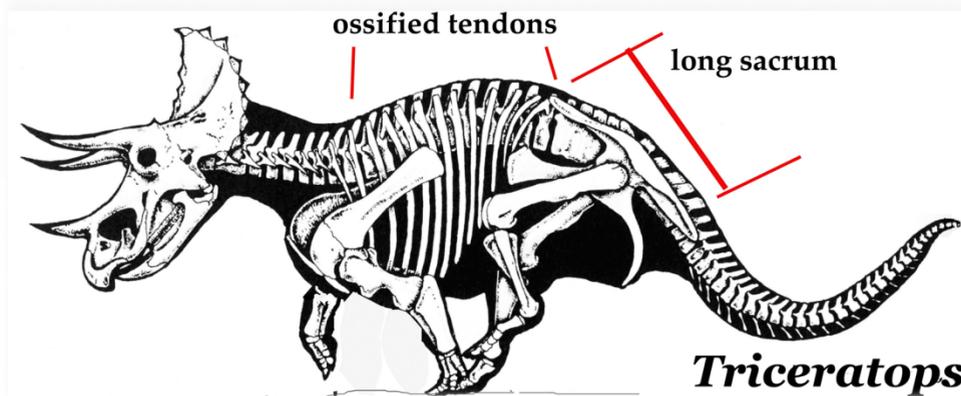


Aerial view of "Fantasia" 1940 stegosaur spike-fighting

Disney's "Fantasia" of 1940 presents a dynamic *Stegosaurus* who curls her torso around and thrusts the deadly tail spikes forward at an enemy's muzzle. But could a real, live stegosaur bend its vertebral column that way? Reconstruction of torso joints and shoulder muscles strongly suggest that stegosaurs did possess unusual power for turning and backing up and so could make dangerously accurate spike thrusts in all directions. Most ornithischian dinosaurs had a lattice work of bone rods -- ossified tendons -- that stiffened the vertebral column from mid torso to the sacrum. Stegosaurs completely lack the lattice. In horned dinosaurs flexibility is further inhibited by exceptionally long sacra composed of many vertebrae fused together, up to 40% of torso column. Stegosaur sacra, in contrast, are far shorter so the vertebral column could flex and curl far more freely.



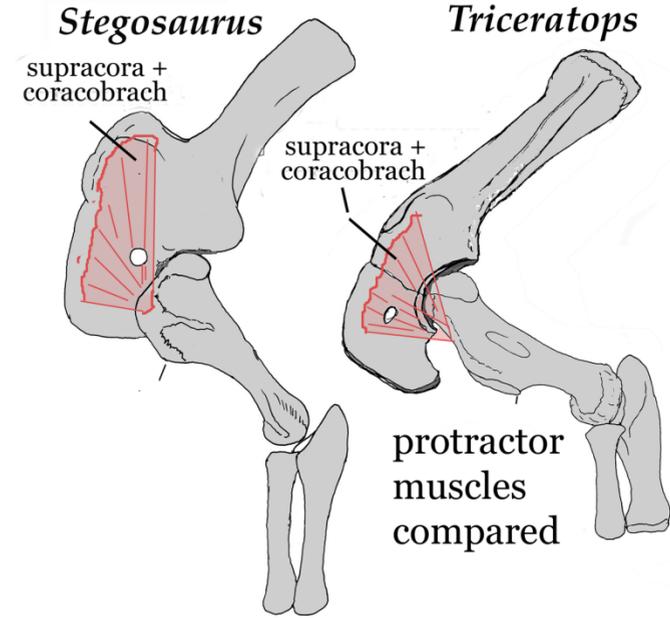
Stegosaurus



Triceratops

Comparison of stiffness in torso

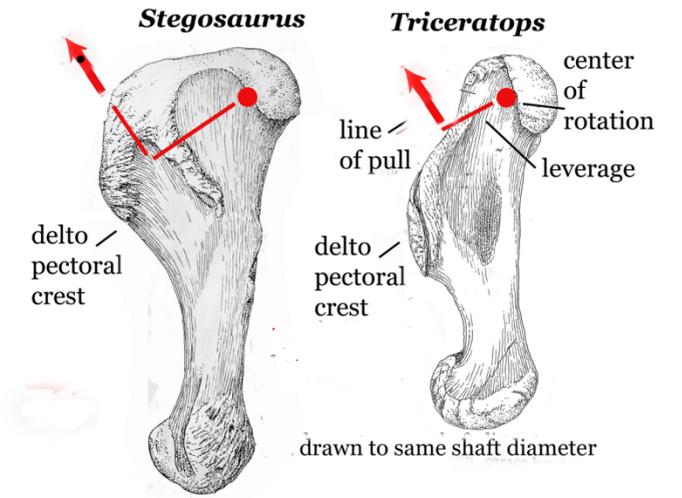
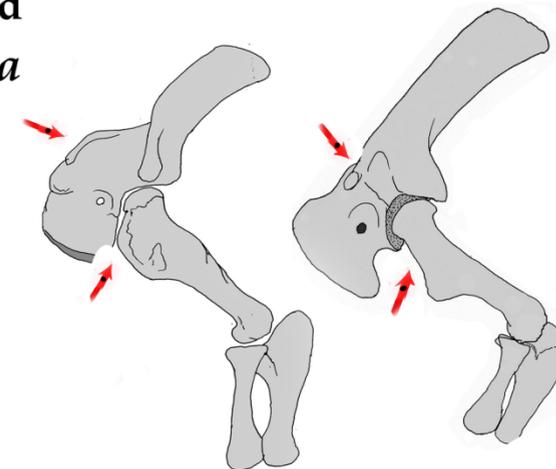
If stegosaurs performed aggressive turning and backing up, they would require unusual strength in forelimb protractor muscles that push the body backward and outward. The strongest humerus protractors are sections of the scapular deltoid and the underlying supra-coracoideus + coraco-brachialis (in part). In most ornithischian families, including the largest horned dinosaurs, the origin of these muscles was unexpanded, so the anterior area of the scapula was narrow. But stegosaurs show



Nodosaurs approach stegosaurs in shoulder muscles

nodosaurid
Sauropelta

ankylosaurid
Euoplocephalus



mechanics of protractor muscle

extraordinary enlargement area for the muscles, producing an immense anterior scapular extension.

Powerful turning and backing require increases in the leverage on the upper delto-pectoral crest of the humerus where the protractor muscles insert. Most ornithischians, including horned dinosaurs, had unexpanded upper delto-pectoral crests. Stegosaurs, in sharp contrast, had an enormous expansion of the upper-anterior delto-pectoral crest; the anterior edge of the crest was thickened as if to resist far greater muscle pull.

For their body size, stegosaurs show greater muscle volume and greater leverage for forelimb protraction than in any other well known dinosaur family. Therefore, stegosaurs did possess unusual power for turning and backing up and so could make dangerously accurate spike thrusts in all directions.

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