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Fossil Focus: Elasmosaurs

by Sven Sachs[*1] and Benjamin P. Kear [*2]

Introduction:

Elasmosaurs were a group of marine reptiles that lived during the Cretaceous period (about 145 million to 66 million years ago). They were fully adapted to an aquatic lifestyle, and had a distinctive body plan comprising a compact, streamlined body, long, paddle-like limbs and an extremely elongated neck with a large number of vertebrae (Fig. 1). The first named elasmosaur was Elasmosaurus platyurus from the Late Cretaceous (Campanian stage, about 83.6 million to 72.1 million years ago). It was found in Kansas and described by the famous US scientist Edward Drinker Cope (1840–97, Fig. 2), who, when he first wrote about it in 1868, believed that the almost complete series of 72 neck vertebrae came from a massively long tail. Today, many articulated skeletons of elasmosaurs provide insight in the anatomy, lifestyle and relationships of these spectacular ancient sea monsters.

FIGURE 1 — MOUNTED SKELETON OF THE ELASMOSAUR *STYXOSAURUS SNOWII*, FROM THE LATE CRETACEOUS OF SOUTH DAKOTA (MUSEUM OF GEOLOGY, SOUTH DAKOTA SCHOOL OF MINES, RAPID CITY). PHOTO COURTESY MIKE EVERHART.

Classification and relationships:

The term elasmosaur refers to the group Elasmosauridae, which belongs to the Plesiosauria, an extinct radiation of aquatic reptiles that flourished during most of the Mesozoic era (252 million to 66 million years ago). Elasmosaurids form part of the Plesiosauroidea, a lineage that includes other long-necked plesiosaurs, but also the Polycotylidae, a group from the Cretaceous period, whose members have much shorter necks and proportionately larger heads. The Elasmosauridae are defined as species that are more closely related to Elasmosaurus platyurus than to other plesiosaurs.

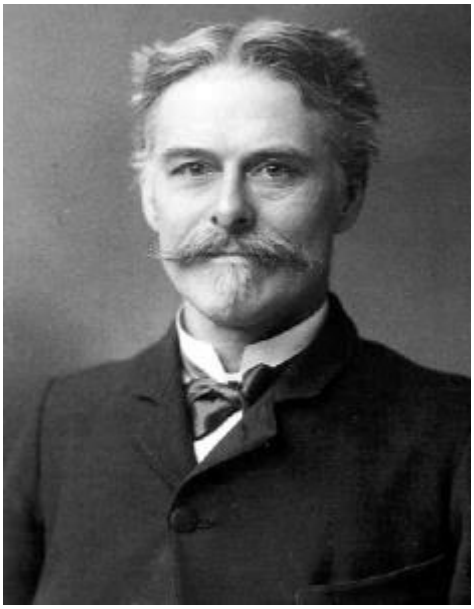

FIGURE 2 — PORTRAIT OF EDWARD DRINKER COPE, WHO COINED THE CONCEPT OF ELASMOSAURS.

Anatomy:

The most striking anatomical feature of elasmosaurs is the immensely long neck. The highest number of neck vertebrae in elasmosaurs, and indeed in any vertebrate, occurs in Albertonectes vanderveldei from the Campanian stage of Canada. Albertonectes has 75 individual neck vertebrae, but most elasmosaurs had only between 50 and 70. However, because long necks were ubiquitous for many plesiosaurs, they cannot be used to define the group. More unique anatomical features include: (1) a convex side edge of the eye socket (see Fig. 3A); and (2), a large opening between the coracoids (bones of the chest) — this is termed the intercoracoid embayment and is roughly 'heart-like' in shape (see Fig. 3B).

Elasmosaurs typically had a slender triangular skull (see Fig. 4A, B). The dentition was irregular (heterodont) with large fang teeth towards the front of the jaws, and progressively smaller ones behind. The teeth interlocked and were perfect for catching fish and squid, although the animals also seem to have eaten shellfish from the sea floor. In most elasmosaurs, the premaxillae (the forward-most tooth-bearing bones in the skull) accommodated about 5 teeth, with the maxillae (second and largest tooth-bearing bones in the skull) about 14. The dentaries (main elements of the lower jaw) contained about 17–19 teeth. All of the tooth crowns are slender and oval to circular in cross-section. The outer enamel layer usually shows fine ridges that run from the crown base to the tip of the tooth. The cylindrical tooth roots frequently also show evidence of resorption, or bone breakdown, linked with the tooth-replacement process.

Although the elasmosaur body plan was largely standardized, one group — the Aristonectinae — took this anatomy to an extreme. Aristonectines are known from the latest Cretaceous (Campanian and Maastrichtian stages, about 83.6 million to 66 million years ago), and had markedly shorter necks, and huge (around 700 mm long), broad skulls (see Fig. 4C, D) that bore a multitude of small (6 cm high) regular (homodont) teeth. The first described aristonectine, Aristonectes parvidens from the Late Cretaceous (Maastrichtian stage, about 72.1 million to 66 million years ago) of Argentina, contained about 10–13 premaxillary teeth, 51–53 maxillary teeth and 60–65 dentary teeth. The neck vertebrae were compact and clearly wider than they were long; in other elasmosaurs, the neck

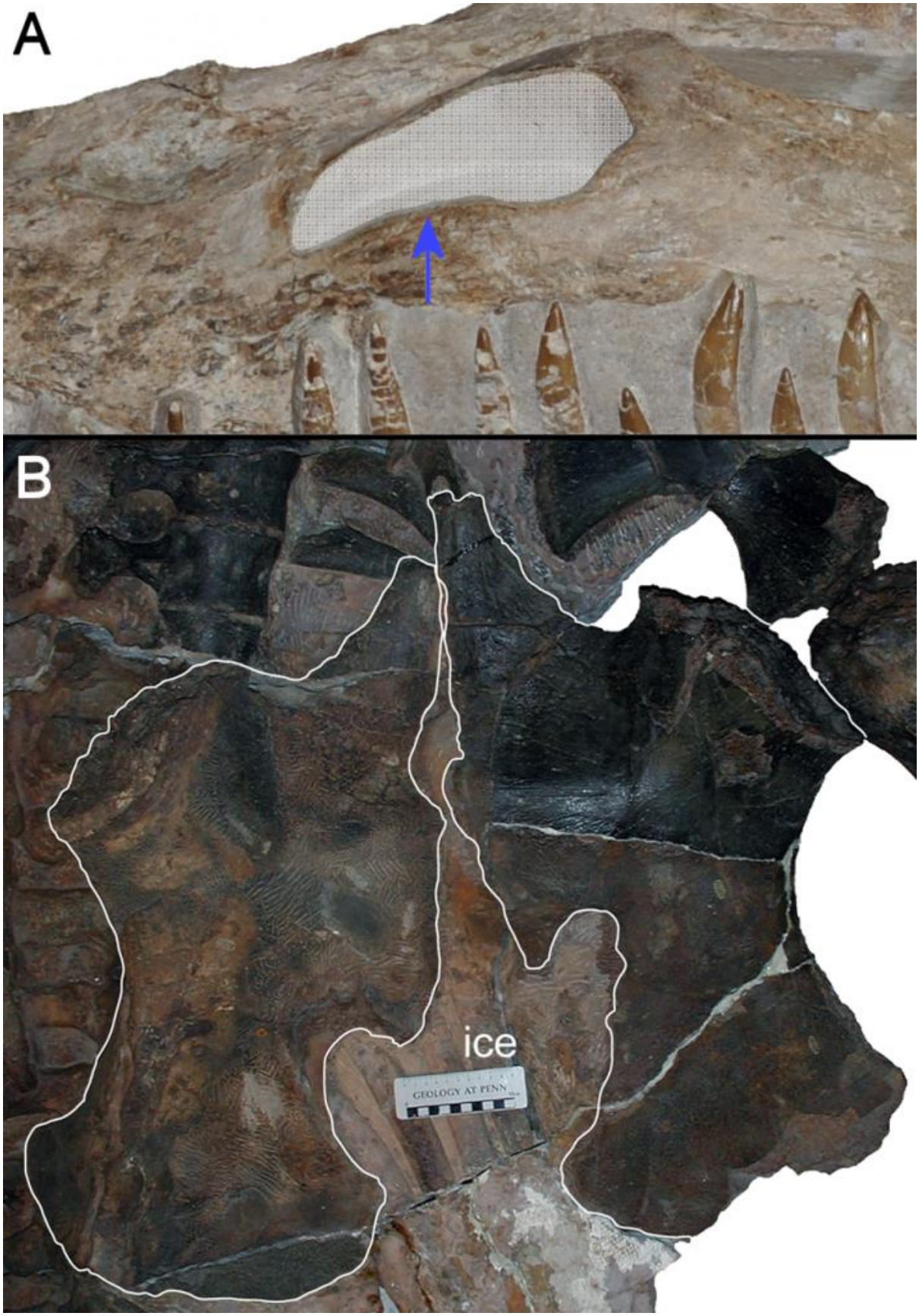

FIGURE 3 — IMPORTANT ANATOMICAL FEATURES OF ELASMOSAURS: (A) CONVEX LOWER EDGE OF THE ORBIT (BLUE ARROW), (B) INTERCORACOID EMBAYMENT (ICE).

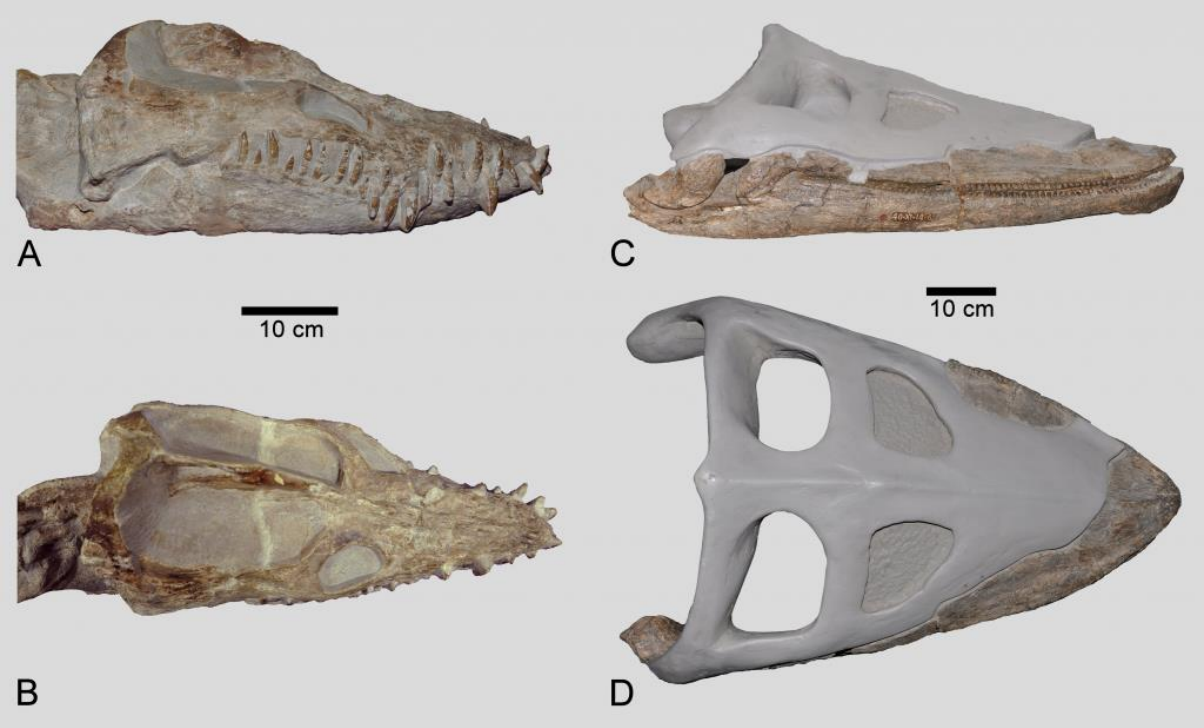

FIGURE 4 — ELASMOSAUR SKULL TYPES. LEFT: SKULL OF THE 'TYPICAL' ELASMOSAUR *LIBONECTES ATLASENSE* (STAATLICHES MUSEUM FÜR NATURKUNDE KARLSRUHE, GERMANY) FROM THE LATE CRETACEOUS OF MOROCCO IN (A) SIDE AND (B) TOP VIEW. RIGHT: SKULL OF THE ARISTONECTINE *ARISTONECTES PARVIDENS* FROM THE LATE CREATCEOUS OF PATAGONIA AND ANTARCTICA (MUSEO DE LA PLATA, LA PLATA, ARGENTINA) IN (C) SIDE AND (D) TOP VIEW.

vertebrae are as long as they are wide, or distinctly longer. Yet despite these differences, aristonectines still displayed classic elasmosaurid features such as an intercoracoid embayment and a prominent notch on the underside of the vertebral articular facets (see Fig. 5A).

The neck vertebrae of the non-aristonectine elasmosaurs have a distinctive longitudinal lateral ridge (a ridge running lengthwise down their sides ; see Fig. 5B), which also occurs in other long-necked plesiosaurs (such as Occitanosaurus from the Lower Jurassic period, 201 million to 174 million years ago, or Spitrasaurus from the Upper Jurassic, 163.5 million to 145 million years ago) and served to anchor the neck musculature.

Like all plesiosaurs, elasmosaurs had large paddle-like limbs with hyperelongated fingers. The front paddles (pectoral paddles) were larger than the hind paddles (pelvic paddles) and would have been used in a manner similar to those of sea lions today.

The tails of elasmosaurs (such as Albertonectes and Morenosaurus from the Late Cretaceous) were short, with the last few tail vertebrae fused into a 'pygostyle-like' structure similar to those of birds. This might have supported some sort of tail fin, but the shape of this structure (if present) is unknown.

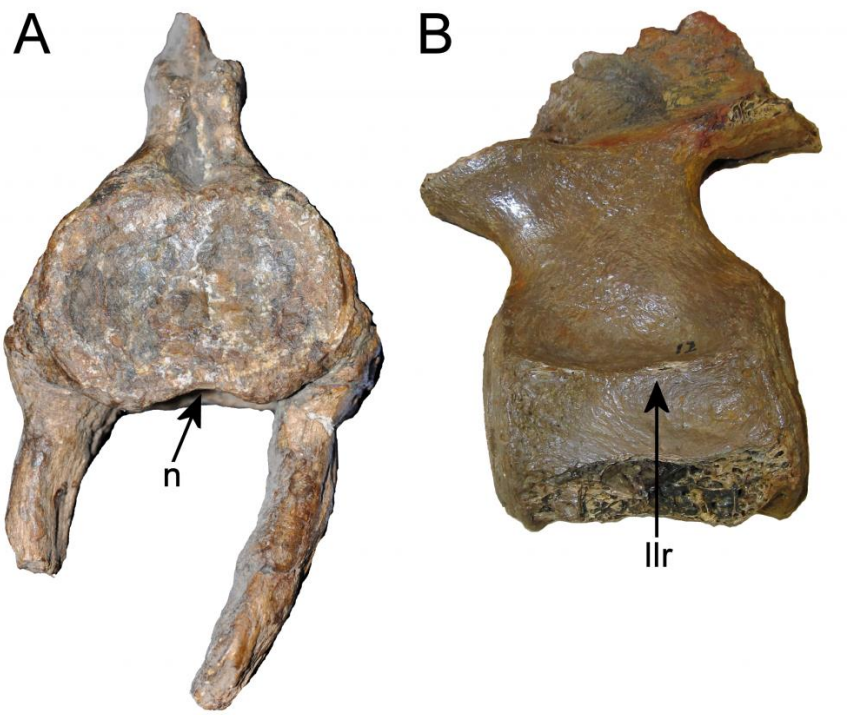

FIGURE 5 — ELASMOSAURID VERTEBRAL FEATURES. (A) THE ARTICULAR FACE OF A CERVICAL (NECK) VERTEBRA OF *ARISTONECTES PARVIDENS* (COLLECTION OF THE MUSEO DE LA PLATA, LA PLATA, ARGENTINA) SHOWING THE VENTRAL NOTCH (N). (B) SIDE VIEW OF A CERVICAL VERTEBRA OF *LIBONECTES MORGANI* (COLLECTION OF THE SHULER MUSEUM OF PALAEONTOLOGY IN DALLAS, TEXAS) INDICATING THE LATERAL LONGITUDINAL RIDGE (LLR).

FIGURE 6 — GASTROLITH MASS FOUND WITH THE ELASMOSAUR *LIBONECTES MORGANI* FROM THE LATE CREATCEOUS OF TEXAS (SHULER MUSEUM OF PALAEONTOLOGY, DALLAS, TEXAS).

Lifestyle:

Elasmosaurs were presumably active predators, with their streamlined bodies and long paddles denoting agile swimmers. The function of the long neck is unknown. A number of elasmosaur skeletons have been found to contain stomach stones (gastroliths, Fig. 6). The function of these is unclear, but they probably aided in digestion. Elasmosaurs lived alongside many large apex predators (such as mosasaurs or pliosaurs) and there is evidence that elasmosaurs were prey for these gigantic hunters. For instance, the skull of the elasmosaur Eromangasaurus australis from the Early Cretaceous (Albian stage, about 113 million to 100.5 million years ago) of Australia shows bite marks (see Fig. 7) that might have been caused by the enormous pliosaur Kronosaurus queenslandicus.

FIGURE 7 — SKULL OF THE ELASMOSAUR *EROMANGASAURUS AUSTRALIS* FROM THE EARLY CRETACEOUS OF QUEENSLAND, WHICH BEARS BITE MARKS (BM) POSSIBLY INFLICTED BY THE GIGANTIC PLIOSAUR *KRONOSAURUS QUEENSLANDICUS* (QUEENSLAND MUSEUM, BRISBANE, AUSTRALIA).

Fossil Record:

The Elasmosauridae is, so far, recorded only from the Cretaceous period. But they were distributed in seas around all continents, and in all palaeoenvironments from the equator to the (sometimes freezing) ancient north and south poles. The earliest possible elasmosaur is the 'Speeton Clay plesiosaur', an incomplete elasmosaurid-like skeleton (lacking a skull) from the Early Cretaceous (Hauterivian stage, about 133.9 million to 130.8 million years ago) of England. A slightly older putative elasmosaur is Gronausaurus wegneri (Valanginian stage of the Early Cretaceous, about 139.4 million to 133.9 million years ago) from Germany. The oldest undisputed elasmosaur skeleton is Callawayasaurus colombiensis from the Early Cretaceous (Aptian stage, about 126.3 million to 113 million years ago) of Colombia. The last representatives of the family are known from the very end of the Cretaceous in places including Morocco and California.

Summary:

Elasmosaurs (Fig. 8) were a diverse plesiosaur radiation. Their members were characterized by extremely elongate necks with up to 75 vertebrae. Elasmosaurs are known from the Early Cretaceous to the end of the Mesozoic era. An elasmosaurid lineage, the Aristonectinae, had shorter

necks, but an increased number of teeth. A common feature of all elasmosaurs is an opening in the coracoid, the intercoracoid embayment.

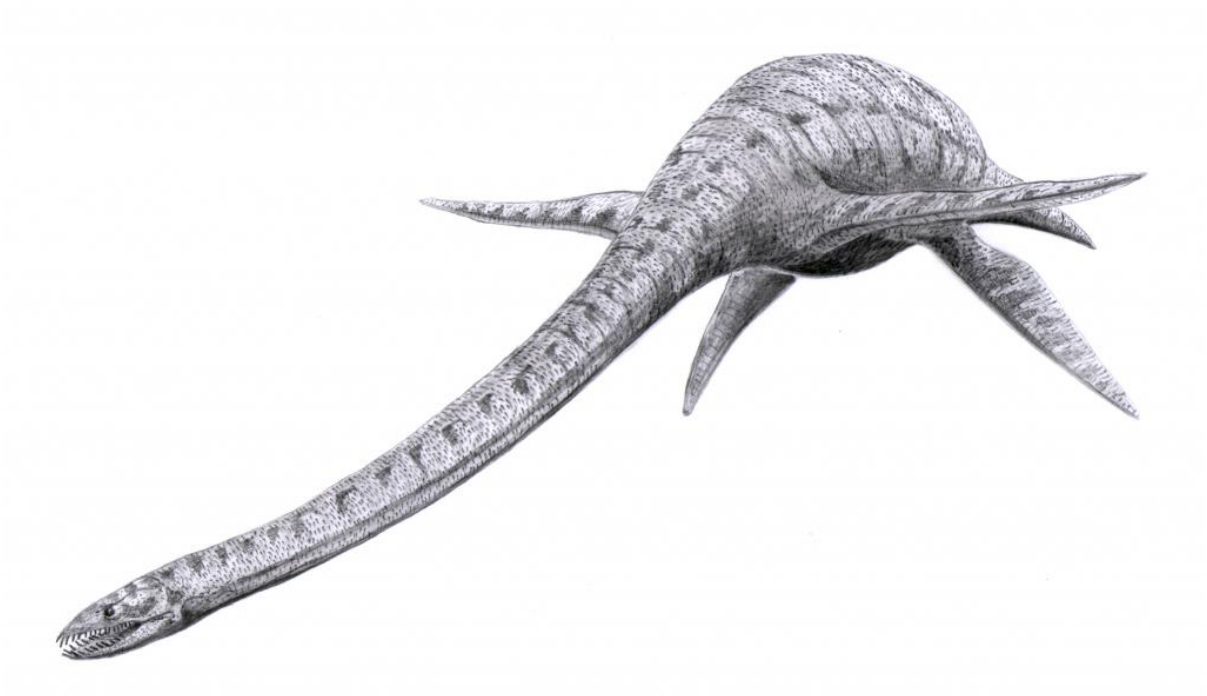

FIGURE 8 — LIFE RECONSTRUCTION OF *ELASMOSAURUS PLATYURUS* FROM THE LATE CRETACEOUS OF KANSAS. DRAWING BY ADAM STUART SMITH.

Suggested Reading:

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