The Paleontograph

A newsletter for those interested in all aspects of Paleontology
Volume 5 Issue 1 March, 2016

From Your Editor

Welcome to our latest issue. I hope you enjoyed the holidays. If you are anything like me, you are looking forward to Spring. We've had a mild winter here in CO. Weather is different than the east coast. While the nights are colder, the days are warmer. It's a nice change for me.

I finally have my fossil lab up and running and I am spending my days, or part thereof, working off my backlog of fossils. It has been a couple of months since our last issue but Bob has kept writing and so we have an interesting issue for you to enjoy.

The Paleontograph was created in 2012 to continue what was originally the newsletter of The New Jersey Paleontological Society. The Paleontograph publishes articles, book reviews, personal accounts, and anything else that relates to Paleontology and fossils. Feel free to submit both technical and non-technical work. We try to appeal to a wide range of people interested in fossils. Articles about localities, specific types of fossils, fossil preparation, shows or events, museum displays, field trips, websites are all welcome.

This newsletter is meant to be one by and for the readers. Issues will come out when there is enough content to fill an issue. I encourage all to submit contributions. It will be interesting, informative and fun to read. It can become whatever the readers and contributors want it to be, so it will be a work in progress. TC, January 2012

Edited by Tom Caggiano and distributed at no charge

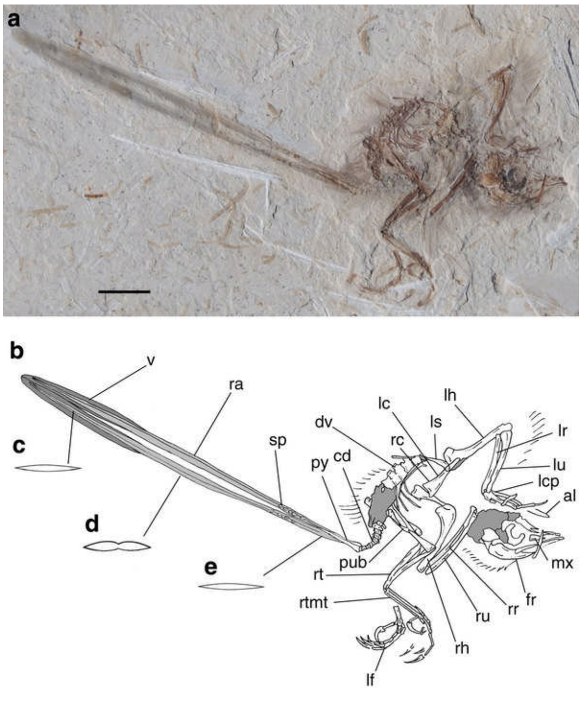
Tomcagg@aol.com

Early Cretaceous Bird from Brazil with Preserved Feathers

Bob Sheridan October 25, 2015

By now we know many dozens of genera of dinosaurs and birds of which at least a few specimens are preserved with feathers. So far these have been from Solnhofen in Germany (Archaeopteryx) or China (everything else). There has not been a case of a specimen preserved with feathers from the southern hemisphere until now.

Carvalho et al. (2015) described a new fossil bird from the Pedra Branca Mine in northeastern Brazil. The specimen is from the Early Cretaceous Crato Formation which has yielded a large number of well preserved fossils of plants and animals. This particular fossil dated at 115 Myr.



The specimen (URFJ-DG 031 Av) is clearly an enantiornithine ("opposite bird"), a type of bird that has been extinct since the end of the Cretaceous. Enantiornithines have an articulation of the scapula and corocoid that is reversed relative to extant birds. Otherwise, the specimen looks very modern: toothless beak, short tail, rounded light skull. While not perfectly preserved, it does appear well articulated. The specimen is probably young as indicated by its very small size (6 cm long--about the size of a hummingbird), large eyes, poorly developed distal ends of long bones, and lack of fusion the ankles. It has not yet been given a genus name, and there is not yet enough reason to assign it to a previously known enantiornithine.

The most interesting thing about this specimen is the preserved feathers. There is a halo of short filaments around the body, and traces of longer feathers around the forearms. The most extraordinary feathers are the ones on the tail. There are two very long ribbons (30% longer than the body), each with a groove in the center. There is some "granularity" at the base of these ribbons, which the authors feel may be the remains of a color pattern. They are reminiscent of the long tail ribbons in other Early Cretaceous birds like Confuciusornis. Also some modern birds have very long tail feathers. This type of fossil feather is referred to as "rachis dominated", meaning that the central shaft is large and the vanes of the feathers are relatively narrow. However, it should be pointed out that it is not clear whether we can relate the specific parts of unusual fossil feathers, which tend to be nothing more than flattened stains on rocks, to parts of modern feathers.

In Confuciusornis it appears that only the "males" have elongated tail feathers, which would imply that the feathers are for sexual display. On the other hand, if this new specimen represents a very young animal, one would not expect it to be sporting such feathers. This might imply that in the past some birds developed adult plumage early in their lives.

Sources:

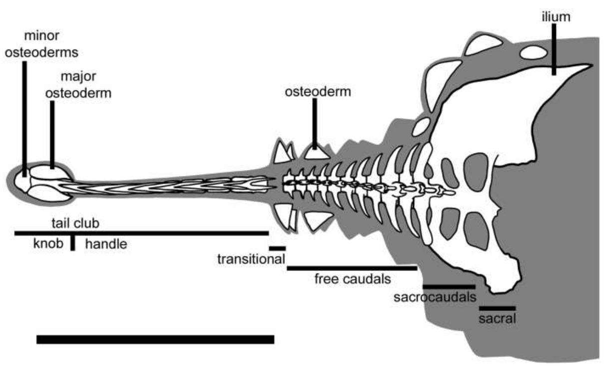
Carvalho, I. dS.; Novas, F. E.; Agnolin, F.L.; Isasi, M.P.; Freitas, F.I.; Andrade, J.A.
"A mesozoic bird from Gondwana preserving feathers."
Nature Communications 2015, 6:7141

How the Ankylosaur Got Its Tail Club

Bob Sheridan November 5, 2015

Ankylosaurs and nodosaurs are herbivorous tetrapodal dinosaurs from the Late Cretaceous. They are very wide in the body and low to the ground. The most striking thing about them is that they are heavily armored, with most of the back and head covered with bony places and thick spikes sticking out to the side of the body and skull. There are two characteristics that distinguish between these groups. First, nodosaurs have longer, more pointed snouts, indicating that they were browsers rather than grazers. Second, ankylosaurs have tail clubs.

The tail club is the subject of today's story. The club consists of two parts: the "handle" and the "knob." The handle: The last dozen or so tail vertebrae (about half of the entire tail) form a rigid unit because processes from the vertebrae extend forward and backward along the axis of the tail and touch the processes from neighboring vertebrae. A specific type of process, the prezygapophyses, are at least 50% as long as the centrum of the vertebrae in ankylosaurs with tail clubs. The entire handle may be ossified into a single unit. The knob consists of bones formed in the skin of the tail. In mature ankylosaurs the handle and the knob may be fused.



A paper by Arbour and Currie (2015) asks the question: Which came first, the handle or the knob? The approach taken here is to construct a phylogenetic tree of nodosaur and ankylosaur species and examine the tail characteristics of each, in particular whether the prezygapophyses are longer than 50% of the centrum length and whether there is a knob present. This should give an idea about when in the evolution of ankylosaurs, these characteristics arose. As with most dinosaurs, most species of ankylosaur are not completely known, so the value of the tail characteristics is usually "unknown." However, there is evidence for some of the more primitive ankylosaurs having no knobs, but having elongated prezygapophyses. Interestingly, most of the specimens where this is true are from China (e.g. Liaongosaurus, Gobisaurus) and were recently discovered. They are also tens of millions of years older than most previously known ankylosaurs.

A fossil tail

The authors feel that the fossil evidence can eliminate the possibility that the knob evolved before the handle. On the other hand, it is harder to completely eliminate the possibility of the handle and knob appearing together, since it is possible that in some cases for the knob not to be preserved in the fossil. "Knob without a handle" would make no physiological sense, since a heavy knob would probably dislocate unreinforced tail vertebrae if the tail were swung violently. In contrast, one can imagine a "handle without a knob" ankylosaur as having a "tail bat" instead of a "tail club," which would still be a good weapon.

Sources:

Arbour, V.M.; Currie, P.J.
"Ankylosaurid dinosaur tail clubs evolved through stepwise acquisition of key features."
J. Anat. 2015, 227, 514-523.

Jurassic World--A Review

Bob Sheridan November 26, 2015

This piece is about the new movie in the "Jurassic Park" series, "Jurassic World" (JW). The last Jurassic Park (JP) movie was JP III from 2001, so JW revives a fairly old (but very lucrative) movie franchise, although JP has existed all along as a video game theme. I did review JP III for the Paleontograph at the time it was released, and noted that it followed the usual downward spiral for sequels: First movie great, second movie not as good, third movie an abomination. Computer animated dinosaurs are no longer a novelty, so having them in a movie is no longer sufficient reason for me to to see it in theaters. Thus, I saw JW last week as a DVD from Netflix.

The overall premise of the 1990 novel by Michael Crichton, as well as the first JP movie (1993), is the following. Genetic engineers at a company called InGen find a way to extract dinosaur DNA from blood-sucking insects in amber. On two isolated islands off the coast of Costa Rica, InGen builds a large facility to reconstruct dinosaur genomes and grow dinosaur embryos in ostrich eggs. Several dozen dinosaur species are created this way and raised to adulthood. (It has been noted many times that most of the dinosaurs are from the Cretaceous rather than the Jurassic.) The business plan is to create a large theme park on one island (Isla Nublar) where the public can see living dinosaurs in a "natural habitat." The park has the features you would expect where you would have to have people get close to large animals but keep them both safe: moat, electric fences, etc.. As might be expected, through a combination of human hubris and malfeasance, the dinosaurs escape and action ensues, consisting mostly of dinosaurs attacking people. Since the action takes place before the would-be park has opened, there is only the park staff and maybe a dozen visitors. The star of the first JP movie would be the Tyrannosaurus and "raptors" (more on them later). At the end of the novel and movie, the implication is that the dinosaurs on Isla Nublar will be destroyed.

The premise of JP II novel and 1995 movie (also called "The Lost World") is that dinosaurs continue to exist on the other island (Isla Sorna) and representatives from InGen come to recover them, not realizing a few naturalists are on the island studying the dinosaurs. Not surprisingly, things do not go according to plan for either group. The movie JP III (movie released 2001, but there is no novel) also takes place on Isla Sorna. Again, most of the action consists of various dinosaurs attacking people. The star of JP III is the Spinosaurus, but Pteranodon features prominently.

The premise of JW, which takes place 20 years after the previous movies, is that a large, very popular theme park has been open on Isla Nublar for many years. To keep the crowds coming, InGen engineers create new type of animal every three years. Since the engineers understand genetics very well at this point, they can create pretty much whatever they want, so these new animals do not necessarily correspond to real dinosaurs, and can be made larger and fiercer. The latest of these new animals is Indominus rex, a theropod somewhat bigger than Tyrannosaurus with long arms. I don't think I'm giving anything away when I tell you the dinosaurs, including the Indominus, escape and attack people, but now there are thousands of people to attack.

In JW, the movie makers neutralize any complaints about the dinosaurs not being accurately depicted. The reason was brought out as early as the original novel, and it does make sense. The dinosaur DNA extracted from amber is always incomplete, so InGen engineers substitute DNA from other animals. At best, the JP dinosaurs are approximations of the real dinosaurs from the Mesozoic and can depart in any number of ways. Since we are paleontology enthusiasts, though, we get pleasure out of pointing out scientific inaccuracies in popular culture, so I will now do so.

JP "raptors" are identified as Velociraptors in the novel, which should be the size of a large dog, but they are shown as man-sized or bigger in the movies, somewhere between Deinonychus and Utahraptor. They are depicted as incredibly fast (cheetah-speed) and unrealistically intelligent (chimp-like).

Cont'd

Jurassic World Cont'd

Several years after the first movie, it was realized that all dromaeosaurs should be feathered, and I seem to remember in JP III the raptors were shown with short quills on their heads, as a kind of compromise. The raptor characters in JW are shown in their original featherless form, though.

JP III and JW both show Pteranodon (long-crested in JP III and short-crested in JW). These are accurately depicted as large, with a 20ft wingspan. JW has another large-headed, long-tailed, long-toothed pterosaur that looks something like Rhamphorhynchus, except that it has about eight times the expected wingspan. In JP III and JW we see pterosaurs swooping down and picking up adult humans. This is very unlikely; no matter how pterosaurs are engineered they would not be able to fly carrying 5 times their own weight.

JW introduces a mosasaur, which is used in a Sea World killer whale type of attraction. This animal is 2-3 times as long as any realistic mosasaur reconstruction. One wonders where mosasaur DNA would come from. Not from amber certainly.

Finally, when the JP novel was written, it was marginally plausible that ancient DNA could be cloned from amber. In the first movie we are erroneously shown that Dominican amber (which is only about 20 Myr. old) can being used. There were some reports in the late 1990's that insect DNA could be isolated from amber as old as 110 Myr. However, these reports were later retracted because the DNA turned out to be modern contaminants (human and bacteria). No ancient DNA has ever been isolated from amber, even very recent amber.

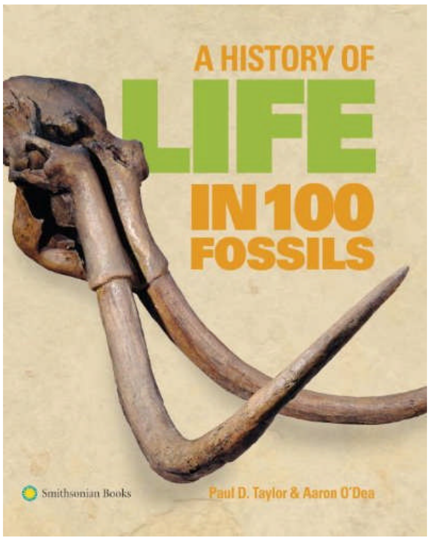
Ultimately, the beef I have with JW has nothing to do with how accurately dinosaurs are depicted, or whether the plot gimmicks make any sense (and most don't). The best movie sequels take the themes and characters in new directions. The worst movie sequels just repeat elements from the original movie. We've seen most of the scenes in JW before in at least one other JP movie: Corporate greed and hubris creates its own downfall, dinosaurs escape through a series of accidents, dinosaurs attack children in a vehicle, children escape unprotected through the park, two large theropods fight, one character forms a rapport with the raptors, pterosaurs swoop down and lift people, etc.. The worst thing, I think, is that through the JP series the dinosaurs went from being interesting, but dangerous, animals with plausible behaviors to being movie monsters whose only purpose is to attack the protagonists. Very disrespectful toward real dinosaurs, in my opinion. So I feel the JP franchise has gone on long enough.

History/Story of Life in 100/25 Fossils

Bob Sheridan December 20, 2015

I recently came across two recent paleontology books with very similar titles:
"A History of Life in 100 Fossils" by Paul Taylor and Aaron O'Dea
"The Story of Life in 25 Fossils" by Donald Prothero.
Both are aimed at adults and the writing strikes a good balance between too technical and too oversimplified.

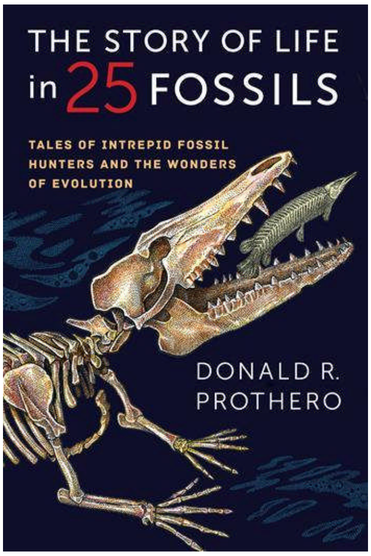
I would classify "History" (from 2014) as a coffee table book, in that it is fairly large (9 X 11 inches) and each of the 100 fossils is treated with a full-page color photograph and a page of text. The fossils are roughly in chronological order, from the Apex Chert (presumably the earliest fossils of cyanobacteria 3.5 billion years ago), to the moa (extinct only a few hundred years). Each fossil represents not only a particular specimen, but a genus, or even a concept like "directional evolution." At the end of the book there is a tabulation of each specimen with its current location (usually a museum) and catalog number, plus its size.



Cont'd

100/25 Cont'd

After following this hobby for 30 years, you would think I would have already seen the photographs of the most important fossils. However, at least a dozen of these are new to me. I will mention two. The first has to do with Ophiocortyceps, a parasitic fungus that infects worker ants in rain forests. Once into the ant's brain, the fungus turns an ant into a "zombie" and induces an unusual behavior: the ant crawls upward from the forest floor until it settles on the underside of the leaf. There it grasps the leaf tightly with its jaws, in what is called a death-grip, punching characteristic dumbbell shaped holes in the leaf. The fungus eventually kills the ant, sprouts out of its exoskeleton and spreads its spores. There is a specimen of a laurel leaf from the Messel Shale (48 Myr) that has 29 death-grip holes. The second example has to do with nummulites. These are coin-shaped, and coin-sized (0.5-2 inch), shells of marine amebas that lived from the Eocene to the Miocene. Nummulites are good index fossils because they vary with geological time. Interestingly, the limestone used to build the Great Pyramids is full of nummulites, and there is a improbable ancient story that these are the remains of "lentils" eaten by the builders of the pyramids.



"Story" is by Donald Prothero, a long-time writer of popular books on paleontology. I have reviewed at least three of his books for the Paleontograph: "Evolution: What the Fossils Say and Why It Matters", "Rhinoceros Giants", and "Abominable Science." The approach of "Story" is similar to that of "History," in the sense that the jumping-off point is a series of key fossil discoveries presented in roughly chronological order. However, the style is very different. "Story" is more text-oriented, with many black and white photographs and diagrams. There are many more stories about individual paleontologists and their discoveries. "Story" is also more on the technical side, and has specific references for each chapter. Also for each chapter there is a "See it for yourself" section that points the reader to museums where the specific fossils are on display. You can imagine that, since we are examining at only 25 fossils, each chapter is broader than an individual genus: the transition between fish and tetrapods, fossil horses, the origin of whales, etc. It is pretty much up to date. For example, the fact that Spinosaurus has short legs and probably could not walk as a normal theropod was published only six months ago. Unfortunately, there are a few jarring typos. For instance it is mentioned in the section on ichthyosaurs that their top speed is estimated 1.2 miles per hour. This is probably an order of magnitude too small, seeing how dolphins, the modern analog of ichthyosaurs, can swim 20 miles per hour. One should be prepared, also, for some swipes at popular culture, with in the author's opinion tends to distort or exaggerate paleontological "facts." This is not surprising because Prothero has played role of debunker in previous books.

Again, since following the field of paleontology has been my hobby for a long time, and I have read many of the popular books, the topics presented in "Story" were somewhat familiar to me, at least in broad outline. One notable exception is the origin of manatees, of which I knew nothing. Another is the discussion about estimating the size of Megalodon, the giant shark. Apparently, there is a broad range of estimates, anywhere between 40 and 60 feet. We normally hear about the upper estimate, just because it is more exciting.

I recommend both these books: "History" for those who are picture-oriented, and "Story" for those who like getting into the details.

Sources:
Prothero, D.R.
"The Story of Life in 25 Fossils. Tales of Intrepid Fossil Hunters and the Wonders of Evolution."
Columbia University Press, New York, 2015. 389 pages. $35 (hardcover)

Taylor, P.D.; O'Dea, A.
"A History of Life in 100 Fossils."
Smithsonian Books, Washington DC, 2014. 224 pages. $40 (hardcover)

Open or Covered Nests for Dinosaur Eggs?

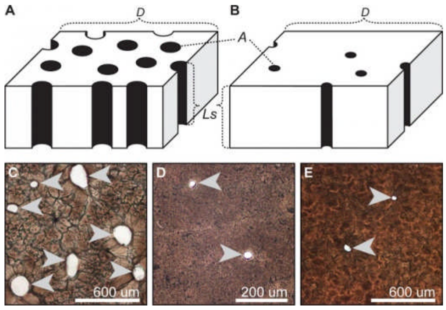
Bob Sheridan December 23, 2015

Most archosaurs, including dinosaurs, lay hard shelled eggs. In this story we will consider how crocodylians and birds, the only surviving archosaurs, treat their eggs once laid. Crocodylians bury their eggs in vegetation or sand and rely on external heat sources to keep the eggs warm. Most birds, on the other hand, keep their eggs in open nests, and use their body heat to keep the eggs warm. Can we say something about how dinosaurs handled their eggs? While we do have the remains of many dinosaur nests, it is not easy to tell whether the nests were open or covered during incubation.

A paper by Tanaka et al. (2015) links the treatment of dinosaur eggs with the porosity of eggshells. All land-based eggs need to have pores so oxygen and carbon dioxide can exchange with the outside world. Too few pores and the animal suffocates, too many and the egg dries out. Buried eggs have less exchange with the atmosphere, so the optimum porosity of the egg might change.

Pores in hard shelled eggs are basically a cylindrical passage from the inside surface to the outside. Porosity can be increased by having more pores or by making the diameter of the pores larger, or by making the pore shorter, i.e. making the shell thinner. Fortunately, it is easy to measure both number and diameter of pores for eggs from living and extinct animals (with the assumption that fossilization does not change these measurements). An overall measure of porosity used by the authors is the total area of pore opening per square millimeter of egg surface divided by the pore length. The authors calculated this number from published data for 127 species of extant birds and crocodylians and for a few dozen extinct dinosaurs and birds.

A work of this type involves some uncertainties. The assignment of which egg shell goes with which dinosaur is based on association of fossil egg shell with embryo skeletons. However, this cannot always be done with certainty, so this paper sometimes refers to the “ootaxa”, i.e. the type of egg, instead the “taxa”, i.e. genus of dinosaur. The area and mass of a dinosaur egg can be estimated by the curvature of the shell when no intact specimen is available.



Among the extant archosaurs, there were 20 examples of covered nests (almost all crocodylians, but a few birds), and 107 with open nests (almost all birds). Given the uncertainties, the results seem clear. A graph of the log of eggshell porosity vs. the log of the egg mass shows two distinct lines, one for covered nests and one for open nests, although the cloud of individual points overlap somewhat. On the average, the covered nest eggs have several-fold higher porosity than open nest eggs. This makes physical sense. If the eggs are covered, they can be made more porous with less risk of drying out.

One can superimpose the porosity and egg mass of extinct animals on the same graph and get an estimate of whether their eggs would have been in open or covered nests depending on which line the eggs is closest to. It should be noted that some extrapolation will be involved since some dinosaur eggs are much bigger than the largest extant eggs. There are some clear separations among the extinct taxa. Some titanosaurs eggs like Megaloolithus are more likely to fall into the covered nest category. Similarly the egg from a Jurassic theropod called Lourinhanosaurus is likely to have had a covered nest. On the other hand, some advanced “bird-like” theropods like troodonts and oviraptors clearly had open nests. Extinct birds like moas had open nests. Some of this is consistent with previous thought on parental behavior in dinosaurs. As sauropods weighing tens of tons, titanosaurs would not be expected to sit on their eggs, so it is likely they followed a “cover and forget” strategy. On the other hand, we have several fossils of oviraptors sitting on nests, so we know that “brooding,” if not direct incubation, was a common behavior for these dinosaurs. From the small number of examples, it seems plausible that open nests evolved fairly late (say the Early Cretaceous) and was specific for dinosaurs most closely related to birds.

Con'td

Eggs Cont'd

One caveat with this study, not mentioned by the authors, is that since almost all the extant open nest eggs belong to birds, it is not easy to decide whether lower porosity is more correlated with having an open nest (a parental behavior), with being warm-blooded (physiology), or merely with being a bird or a near-bird theropod (ancestry). It would be interesting to include more extant birds with covered nests in a subsequent study, or some crocodylians with open nests, if there is such an animal. Also, pterosaurs are archosaurs and it would be interesting to include them as well. Unfortunately, this is not so easy presently because there are only a few known pterosaur eggs, and they probably had a soft shell.

Sources:

Tanaka, K.; Zelenitsky, D.K.; Therrien, F.
"Eggshell porosity provides insight on evolution of nesting in dinosaurs."
PLoS ONE, 2015,
DOI:10.1371/journal.pone.0142829

Why Only Sauropods Have Long (in Absolute Size) Necks

Bob Sheridan January 1, 2016

A minority of animals have necks that are long relative to the size of the body. Among extant mammals, the giraffe is the only example, but there are many birds with fairly long necks. Currently there are no long-necked reptiles. There are many extreme examples among extinct animals, however: plesiosaurs, some pterosaurs, some dinosaurs, etc. The long-neck champions among dinosaurs are the sauropods.

A recent paper by Taylor and Wedel (2015) discuss possible reasons why, among all animals living or extinct, sauropods can have the largest necks in absolute size: 5-15 meters. This study does not address the idea of why evolution would have favored a long neck (able to eat from treetops, more attractive to females, etc.), only what makes the long neck physically attainable. If we are talking absolute length of neck, the number of non-sauropod animals we have for comparison limited. Here is the list used by the authors, with the total length of all the cervical vertebrae indicated:

1. Alberonectes (giant plesiosaur 7 meters)
2. Arambourgiana (giant pterosaur 3 meters)
3. Tanystropheus (Triassic marine reptile 2.7 meters)
4. Giraffe (living mammal 2.4 meters)
5. Therizinosaurus (herbivorous theropod 2.2 meters)
6. Gigantoraptor (giant oviraptor theropod 2.2 meters)
7. Paraceratherium (giant rhinoceros-like mammal 2 meters)
8. Ostrich (living bird 1 meter)

For comparison the human neck is ~0.15 meters.

For certain purposes, for example if we were concerned with supporting the weight of the neck, we would eliminate the marine reptiles (1 and 3) in the comparison. The longest neck of a sauropod for which we can estimate the total length is Supersaurus at 15 meters. The smallest sauropod mentioned in this paper is Diplodocus with a neck at 6.5 meters. (It should be pointed out that it is controversial whether Supersaurus is different than Diplodocus except in size.)

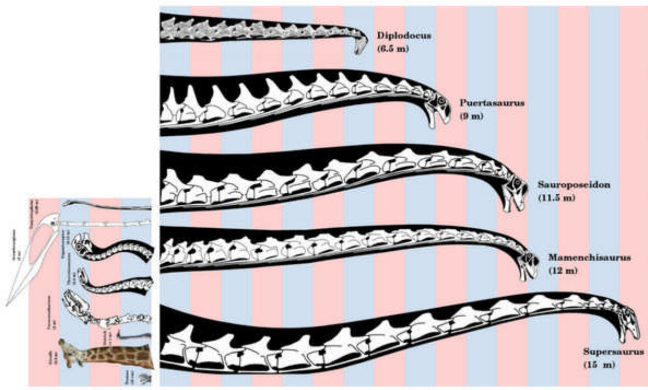


Figure 3: Necks of long-necked sauropods, to scale. *Diplodocus*, modified from elements in Hatcher (1901, plate 3), represents a "typical" long-necked sauropod, familiar from many mounted skeletons in museums. *Puertasaurus*, *Sauroposeidon*, *Mamenchisaurus* and *Supersaurus* modified from Scott Hartman's reconstructions of *Futalognkosaurus*, *Cedarosaurus*, *Mamenchisaurus* and *Supersaurus* respectively. Alternating pink and blue bars are one meter in width. Inset shows Fig. 1 to the same scale.

Cont"d

Necks Con'td

These are the reasons the authors cite as being a factor in sauropods having very long necks:

1. Large body mass. If the neck weighs more than the torso and tail, the animal would face-plant.
2. Quadrupedal stance. This eliminates (bipedal) theropod dinosaurs from having extreme necks. In order to maintain balance at the hips, they would also need very long tails.
3. Tiny heads, i.e. smaller in diameter than the neck. The sauropod head has very minimal musculature and teeth; it is used to rake food in without chewing. It should be noted that the theropods with long necks have small heads and are herbivores or omnivores, unlike most theropods, which are carnivores and have to maintain a large head with many sharp teeth.
4. Many cervical vertebrae. Being reptiles, sauropods do not have a limit to the number of cervical vertebrae. In contrast, mammals are limited to seven.
5. Elongated cervical vertebrae (e.g. longer than wide). The longer the individual vertebra, the longer the neck. Most other animals elongate the neck by elongating the vertebrae. The exception is plesiosaurs which have short cervical vertebrae but very many of them.
6. Air sacs. Saurischian dinosaurs (theropods, prosauropods, and sauropods) have air sacs in their flesh and bones. In particular sauropod cervical vertebrae are highly sculpted and contain many hollows (~60% of their apparent volume would be air). This makes the neck much lighter. Mammals do not have this feature, but birds (which are, after all saurischian dinosaurs) and pterosaurs do.
7. Neural spines, cervical ribs, etc. These are processes that extend from the centrum of each vertebra, below and above, and well as in front and in back. These give a large surface for tendons and neck muscles to attach to individual vertebrae, give longer lever for a muscle to work, and allow the vertebrae to support each other. This makes the neck a “truss bridge” that resists drooping under gravity. Of course, there is a compromise between being droop-resistant and being too stiff. Different types of sauropods differ in the anatomy of their vertebral processes, meaning there is more than one way to achieve the result. Theropod dinosaurs are similar to sauropods in that they also have elaborate vertebral processes. In contrast, most other animals with long necks, including mammals, birds, and pterosaurs, have vertebrae with elongated centra, but without extending processes, so the vertebrae are attached to each other only at the ends of the centra, and the neck must be supported mostly by muscle.

The authors point out sauropods have all of these favorable characteristics, and the other animals lack at least two. Therefore, only sauropods can have absolutely large necks. The authors argue, some other animals like the theropods (plus the ostrich) have at least some of the characteristics and might potentially have very long necks if they reached a high enough body size.

I am not very comfortable with this analysis, which is very qualitative. Sauropods are different from other animals in many ways, and there are only a handful of other animals to compare against, almost all of which are much smaller than a sauropod. Effectively, the study is “drawing a line through two points.” Thus, there are many high correlations between the characteristics and neck length, and it is hard to tell which of these characteristics, or combinations of characteristics, are sufficient to predict a long neck. A more proper study would include more primitive, smaller sauropods and prosauropods. Also a proper study would be quantitative, i.e. we would have numbers to express how elongated a vertebra centra was, a number for body mass, etc., and determine which of these measures was sufficient to predict a long neck.

Sources:

Taylor, M.P.; Wedel, M.J.
“Why sauropods had long necks; and why giraffes have short necks.”
2015PeerJ 1:e36; DOI 10.7717/peerj.36