The Magical, Mystery Pterosaur

Nyctosaurus gracilis

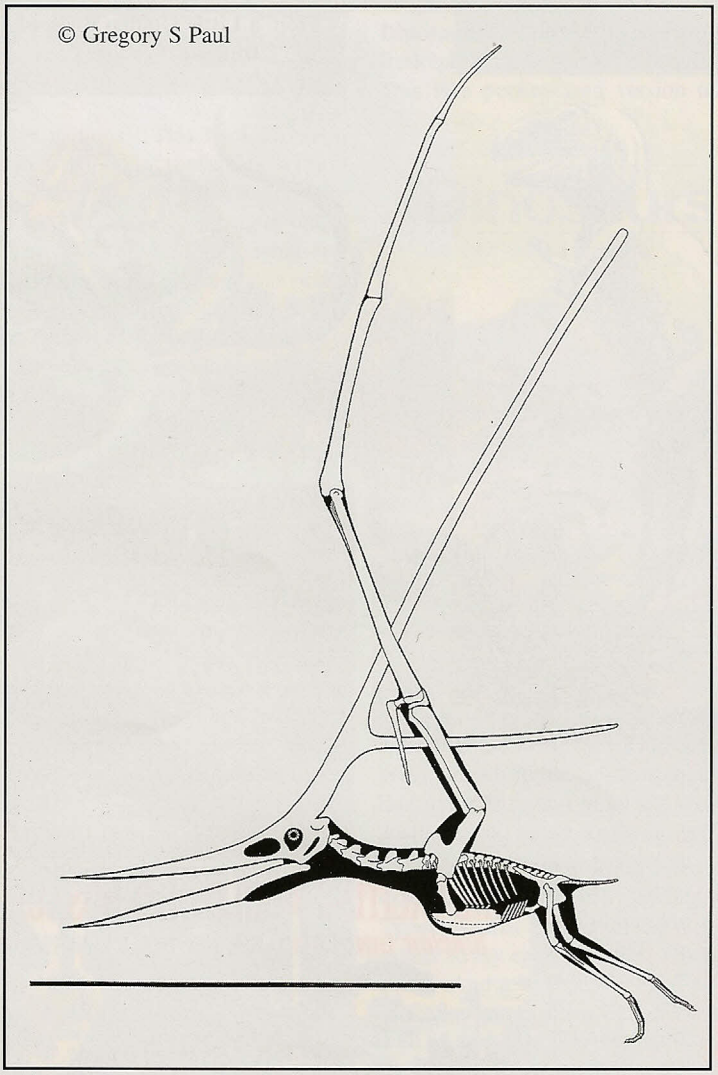
Written & illustrated by Gregory S. Paul

Just when one thinks that fossil creatures cannot get any wilder or wackier, along comes another beast of ancient days that blows our neural networks. And in this case it is not even a new species.

The Late Cretaceous pterosaur *Nyctosaurus gracilis* was discovered in the late 1800s, at pretty much the same time and place as its larger and similar relation, *Pteranodon*. Long known from nearly complete skulls and skeletons, *Nyctosaurus* appeared to lack much in the way of a head crest. Although its 6-9 ft wingspan is impressive by modern standards, by late Mesozoic criteria it was dwarfed by other pterosaurs, so unadorned *Nyctosaurus* was pretty much neglected by paleoartists.

The situation has changed dramatically with the description by Christopher Bennett in Palaontologische Zeitschrift of new specimens which, unfortunately, reside in private hands. Both fossils include skull and skeletal material. The main body of the skull is not remarkable, being quite similar in outline to *Pteranodon* except that the very slender upper and lower beak tips matched one another in length, unlike the other pterosaur whose upper beak strongly overbit the lower. One of the new *Nyctosaurus* skulls is pretty much completely preserved, including happily the entire crest. In the other specimen the crest is shattered and fragmentary but what is present shows similar form. The crest consists of a swept back, transversely flattened, very narrow strap that is about two and a half times longer than the skull proper. There is a slight taper progressing up the crest. Shortly up the crest is a branch directed backwards, about the same length as the skull, and similar in width and breadth to the main branch with a slight distal taper.

The crest is a psychedelic structure that gives new meaning to the neocreationist concept of "intelligent" design -- it looks like someone designed it while on LSD. A cross between a reindeer and a flying archosaur is suggested. Only bioevolution could come up with something like this and not be embarrassed by the results. The crest is so extreme in size and form that it is difficult to believe real, live creatures could have lived with such a structure, especially fliers.



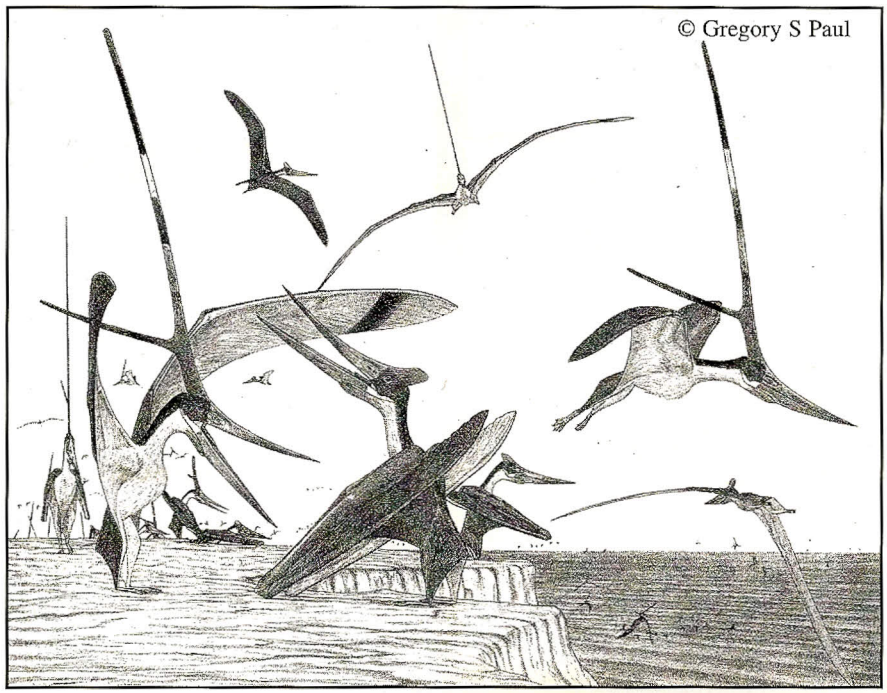
Known from the sediments laid down in the famed Niobrara interior seaway that covered what are now the great plains, *Nyctosaurus* and *Pteranodon* were entirely marine in habits so restorations showing either soaring over the heads of tyrannosaurs are wrong, wrong, wrong. It is as absurd as showing an albatross over an elephant. Showing these pterosaurs associated with *Tyrannosaurus rex* is doubly inappropriate because both appear to have been extinct by the Maastrichtian. So it is equivalent to showing a Miocene pseudodontorn over a living elephant. The classic remains of these pterosaurs come from the sediments lain down by the famed Niobrara seaway when it cut the continent in two from Texas to the Yukon. They may have soared over the oceans of the world, back when most of the deep sea consisted of the superPacific. They probably spent much of their lives in the air, bobbing about on the surface to rest or perhaps feed, and returning to land only to breed.

It is generally thought that the *Nyctosaurus* and *Pteranodon* were sea wave soarers in a manner similar to albatross and other long winged marine birds. As I explain in **Dinosaurs of the Air** and elsewhere, past estimates of the mass of giant pterosaurs have tended to be way understated, but even when hefted up to correct values these pterosaurs were somewhat more lightly loaded than marine birds. A nyctosaur weighed just a couple of pounds. Despite their very long span, albatross wings are actually rather heavily loaded in terms of mass/wing area because the wings are so narrow and the body quite large. The flight of the lighter pterosaurs must have been somewhat different from that of albatross, and may have been more like that of similarly lightly loaded frigate birds. But adding to the perplexity of *Nyctosaurus* and *Pteranodon* flight are the very large pectoralis crests on the humeri, suggesting they had larger, higher leverage flight muscles than soaring birds in which the crest is very reduced. Perhaps the pterosaurs flapped more often than their modern counterparts. Even better adapted for flapping were the, in some cases even more titanic, nonmarine azhdarchids including *Quetzalcoatlus*, in which the wings were relatively shorter and much more robustly constructed even in smaller examples.

Bennett notes critical points about nyctosaur crests in regards to their possible impact on flight. First, their crisp edges differ from the amorphous rims of the crests of pterosaurs in which keratin sheaths greatly expand the area of the crest. So in life the crest probably looked pretty much like what we see in the fossils, being reminiscent of flattened deer antlers. If so, then the crest would have had minimal rudder effect for something of its great dimensions. Second, there are specimens about as big as the crested skeletons that lack large crests. That the crestless specimens are consistently immature in their bone structure indicates that the crests did not appear until final maturity. It is less likely that the crestless specimens were the girls and the crested ones the boys, although this cannot be ruled out until more specimens are sampled. If remains quite possible that, as in Pteranodon, the crests of females were much smaller than

those of the males.

The combination of low surface area and failure to appear until all grown up suggest that the crests were not airfoils such as rudders, but were instead display features. In this case a primary objective of the crests would be to have minimal impact upon the aerodynamics of their owners, achieved by being extremely thin from side to side. They probably barely disturbed the air as they cut through it like a hot razor through creamy butter. Suggestions that the crests were broad surfaced thrust generating sails (as when a wind vessel sails into the wind using the sail to generate lateral lift as the wind blows along its surface) are not viable because, aside from the lack of anatomical evidence, sails only work when the mainbody of the vessel has a substrate that it can work against. Water in the case of sail boats and ships, the ground or ice in case of sail????? [what are terms for sail driven ice runners and land racers?]. Also, when sailing against the wind the sail is set at an angle to the direction of travel, so a pterosaur that tried to do this with its crest would also have to swivel its large beak to the side, creating a rudder effect that would prevent the creature from moving in a straight line.



One known pterosaur exhibits the knife like lower beak needed to surface skim for food like skimmers, but the Niobrara pterosaurs lacked this hydrodynamic feature. Because *Pteranodon's* upper beak was longer than the other, Bennett suggests it could not feed on the wing, and instead did so while floating as do some marine birds such as albatross. Surface feeders would seem vulnerable to swimming predators, perhaps the later prefer to focus on fat and oil laden fish and cephalopods rather than skin and bones fliers during joint feeding frenzies. *Nyctosaurus* may have surface fed, or dipped into the water while flying like gulls, or both. Preserved soft tissues show a small pouch slung under the incut portion of the lower jaw in some small pterosaurs; presumably this was also true of the giants. The pouch could be used to store fish quickly gathered up during feeding frenzies.

Marine pterosaurs had to return to land to reproduce. Being very vulnerable to land predators, marine pterosaurs probably did so on islands, or at least up in trees or on cliffs inaccessible to predators. There is evidence for islands in the Niobrara seaway. The concentration of animals from large areas of ocean into a few breeding spots leads to dense populations, and pterosaur rookeries may have been polluted with massive whitish guano deposits.

The legs of big marine pterosaurs tend to be reduced both relative to the wings and body, suggested they were not very well adapted for ground locomotion in the manner also typical of big marine birds. The continental azhdarchids had much longer legs. *Nyctosaurus* has exceptionally reduced legs. It also lacked the separate clawed fingers that other pterosaurs probably used for quadrupedal locomotion, and the folded arms were too long to be easily used in cooperation with the legs. *Nyctosaurus* may have clumsily walked on two legs, its short tailed body awkwardly erect, like a pterosaurian cross between a "gooney bird" albatross and a penguin. When standing, the arms may have been used as props. Landings after months at sea could have been belly flopping affairs. Takeoffs may have required a running start unless the wind was up.

Presumably Niobrara pterosaur crests were used as a prominent visual display to intimidate rivals, and/or impress potential female mates, rather like the tails of peacocks. The bigger and better formed the crest the better, being evidence of the health and fitness of the male. The crests could have been a solid colored or banded, dark, light or both. Brilliant colors are a real possibility. What motions the crest may have been put through are uncertain, vertical and/or broadside presentations are possible. The prominent beaks may also have been part of the display, both visually and as a means to an auditory component via clattering.

The *Nyctosaurus* scene shows a crowded, guano contaminated rookery, atop a cliff on a Niobrara island. It is the beginning of the breeding season, and in the forefront a full crested male and female are displaying to one another in a selection and bonding ritual that another male is approaching to try his luck. Other *Nyctosaurus* rest as still others soar on the cliff induced updraft, and more fly to and from sea amidst small marine birds. Large marine birds are often mate loyal over long periods of time; we have no idea if this was true of their pterosaurian counterparts. Big marine birds tend to have long lifespans so they breed slowly. The same may have been true of oceanic pterosaurs. Marine fliers are not well suited for gathering much in the way of nesting materials, which may not be available on barren islands anyway.

After pterosaur eggs were deposited they could not be left exposed to the elements, so the eggs were probably incubated. Adult pterosaurs probably had the high metabolic rates needed to warm eggs. Heat transfer could have been via a naked brooding patch on the chest, as sometimes practiced by birds. Presumably the chicks were fed for a period by one or more parents. The variable size of specimens found far out into marine sediments suggest that the pterosaurs left the nest and became active fliers before completing growth, a major difference from most, but not all, birds.