

# Who Discovered the World's Largest Flying Creature?

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In early 2007 Chatterjee et al [1] reported on their findings of what they considered to be the World's largest flying bird, the *Argentavis* of the Miocene period, ~6 million years ago (wingspan = 7 m). However their computer calculations showed that those birds were too big to have flown or even have glided.

One and three decades earlier Wellnhofer [2] and Lawson and Langston Jr. [3] reported on finding remains of an even larger and bigger flyer, the *Quetzalcoatlus*, (wingspan = 15.5 m), which Levenspiel [4], with Fitzgerald and Pettit [5, 6] showed how it could have flown.

*This paper discusses these findings.*

For flying animals the minimum power needed to counter gravity and stay aloft in level flight was given by Renard [7] over a century ago as

$$P_{needed} \propto \frac{M^{\frac{3}{2}}}{A^{\frac{1}{2}} \rho^{\frac{1}{2}}} \quad (1)$$

where M is the weight of the creature, A its wing area, and  $\rho$  is the density or pressure of the atmosphere.

It was pointed out by von Karman [8] that this expression is what is essentially used today by aerodynamicists and aircraft designers to represent the power needed to keep an aircraft aloft, from Piper Cub to Boeing 747. *Figure 1* shows a graph of a version of this expression developed by Tennekes [9] for airplanes, birds and insects.

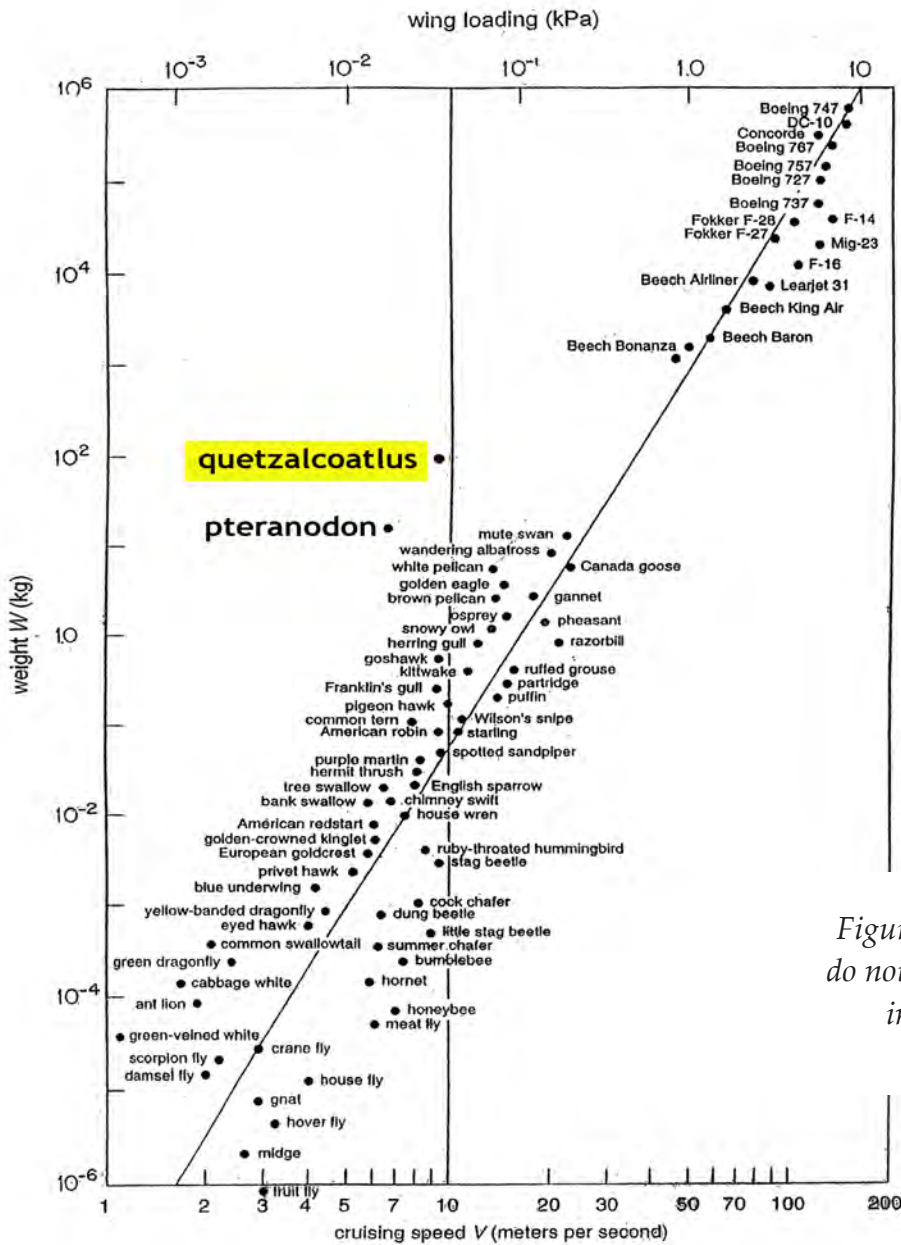
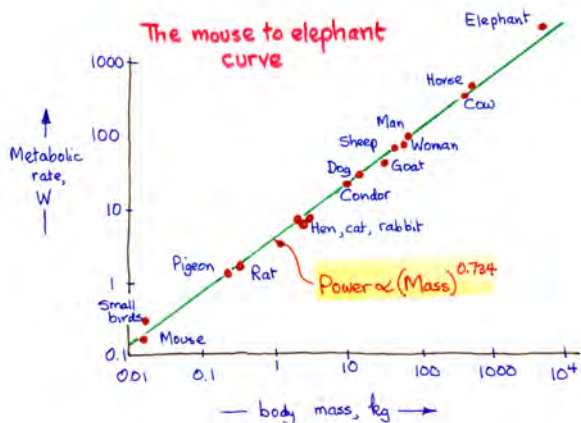


Figure 1. Prehistoric flyers do not fit with today's birds, insects and aircraft



The available power of resting warm-blooded creatures, in effect their metabolic rate, is represented by the mouse-to-elephant curve [10], shown in Figure 2. This resting power is related to their weights

$$P_{available} \propto M^{0.754} \quad (2)$$

Figure 2. The power of warm-blooded creatures is related to their masses.

If the power available to a bird exceeds the power needed to fly, or

$$P_{available} > P_{needed} \quad (3)$$

then the bird can fly. From eqs 1 and 2 this equation represents smaller birds. On the other hand if it does not have the power needed, or if

$$P_{available} < P_{needed} \quad (4)$$

then it cannot fly. This represents larger birds.

Today the largest flying birds are the Australian bustard, the European swan and the South American condor, and they all have a weight of about 14.5 kg and a wingspan of no more than about 4 m.

Chatterjee et al [1] and Levenspiel et al [4, 5, 6] have reported that in ancient times the Argentavis and Quetzalcoatlus violated these observed limits, as shown in the table below, or in Figure 3:

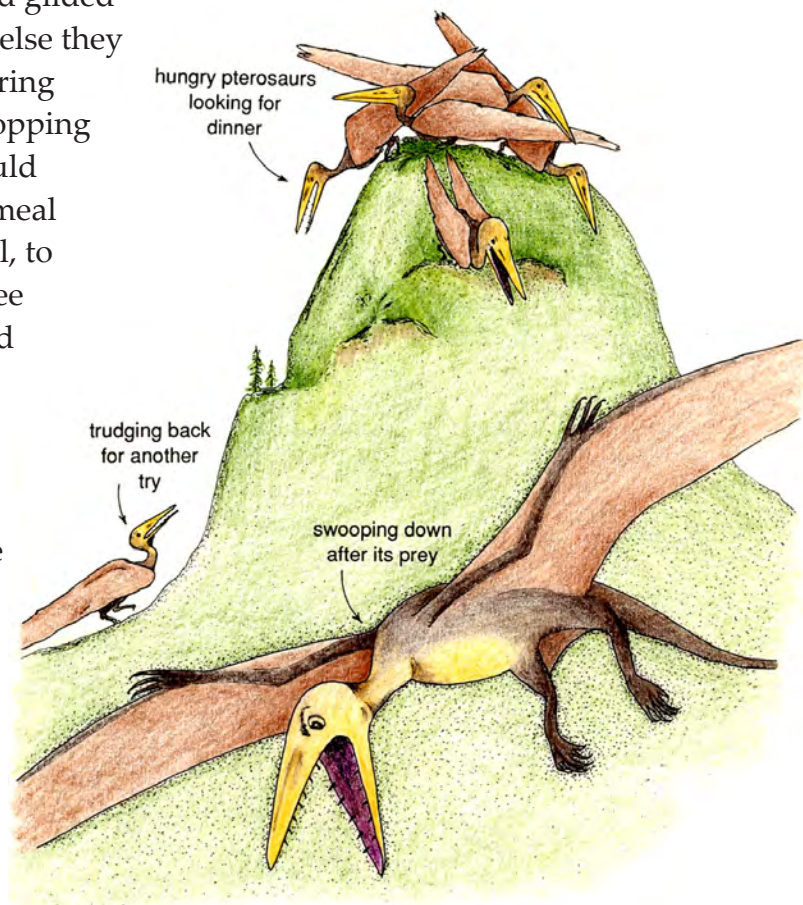
	Today's Birds	Argentavis, Chatterjee [1]	Quetzalcoatlus, Levenspiel [4,5,6]
<b>Max Mass</b>	14.5 kg	70 kg	86-100 kg
<b>Max Wingspan</b>	4 m	7 m	15 m
<b>when existed</b>	today	~6 Mya	~100 Mya



Figure 3. Wingspan of the three ancient flyers is compared with today's largest bird and to the Boeing-737

**Throughout the years many scholars have tried to explain these anomalies. Here are some of these:**

1. The anatomical adaptation needed for these ancient flyers to fly are:
  - They had to have light porous bones,
  - They had to live at a much higher metabolic rate with a much more efficient use of oxygen than all other creatures of their size. From biological considerations, see *Figure 2*, such adaptations are quite unlikely.
2. Again from *Figure 2*, calculations by Chatterjee's group found that *Argentavis* could only generate 170 watts of power, while that needed for sustained flight was in the order of 600 watts. So they concluded that such creatures could not make takeoffs or landings on level ground, or maintain sustained flight.
3. These giant creatures may not have been true flyers. They may have stayed on the ground and waited for strong winds. With a wind speed of over 5 m/s they could have spread their wings and glided about or used updrafts. Or else they could sit on top of hills peering down. On spying dinner hopping about down below they could swoop down, snatch their meal and then trudge back uphill, to rejoin their cousins there, see *Figure 4*. However Bramford and Whitfield [11] raised all sorts of difficulties with the above explanations, Most importantly these creatures appear to lack the physical power to perform hovering,



*Figures 4. Pterosaurs may have only glided.*

4. To counter these difficulties other researchers proposed that the southern half of the Andes mountain range of South America somehow did not exist 100 Million years ago so the strong westerly winds (the “roaring 40’s”) could sweep practically continuously across the low lying continent unopposed thus allowing those ancient birds to fly, see *Figure 5*.

All these difficulties lead to improbable scenarios. To have survived for millions of years these flyers had to be fast, efficient and well adapted to their environment.

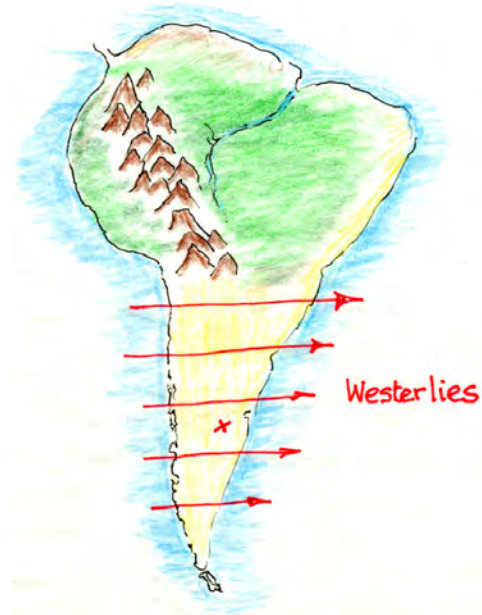
For a completely different type of explanation, Levenspiel et al. [4, 5, 6] proposed that the atmosphere in those ancient times may have been at a higher pressure, about 3.2 ~ 4.8 bar. This would lower the power needed to fly, see eqs.1 to 4. But what evidence have we of a higher atmospheric pressure? Let’s see.

In its early days the Earth and its sister planet, Venus, had dense atmospheres which contained much CO<sub>2</sub>. Today Venus’ atmosphere is still at about 100 bar consisting of over 92% CO<sub>2</sub>. Earth’s surface has water, Venus has none, so in the beginning about half of Earth’s atmospheric CO<sub>2</sub> dissolved in the oceans, where it combined with the dissolved Ca(OH)<sub>2</sub> to produce enormous deposits of CaCO<sub>3</sub>, or limestone. In some places these deposits are hundreds of meters thick. As a result of this action Earth’s atmospheric CO<sub>2</sub> progressively decreased from maybe about 50 - 70 bar to today’s very low value.

A detailed analysis by Hay [12] of the extensive measurements taken around the world by Ronov and Yareshevsky [13] show that the remains of the limestone deposited on the Earth’s crust in the last 570 million years translates into an atmosphere consisting of 38 bar of CO<sub>2</sub> to form the chalk cliffs of Dover, the vast limestone regions of Guai-Yang in South China, the plains of Central Siberia and Central U.S. from West Virginia through Kansas, and elsewhere; see Levenspiel et al [4,5,6].

Independently, Holland [14] estimated that the total CO<sub>2</sub> in the atmosphere to have been about 50 - 70 bar.

To sum up these conflicting views, on one hand we have the unresolved puzzle about how the ancient flyers could have flown [1], and then the explanation about how they actually could have flown [4].



*Figure 5. Southern South America minus their Andes mountain range will allow strong prevailing winds to blow constantly across the continent.*

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