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In a recent letter to *Nature*, Heptonstall[1] states that he used the same formula as Whitfield and I used to calculate the stalling speed of *Pteranodon*. I should like to point out that the formula, used with a high lift coefficient, gives the stalling speed, or minimum possible flying speed, not the maximum velocity as he states.

The body weight of *Archaeopteryx* has recently been recalculated[3] as 200 g, a value far below the 500 g obtained by Jerison[4] and used by Heptonstall. This new calculation seems to me to be far more reasonable and its use alters the wing loading, the stress on the bones and the flying characteristics of the animal. The wing area given of 373 cm^2 is too low; the true figure is 479 cm^2. This includes a piece of body between the wings, in accordance with standard aeronautical convention; this is done by Pennycuick[5] and others[6] working on bird flight.

But the most serious false assumption in this article is the statement that the lift generated by the large tail of *Archaeopteryx* can be ignored because it is too far back to matter in normal flight. This tail had an area of 140 cm^2 and so approached the dimension of one of the wings. Although the tail is behind the centre of gravity of the animal, the lift produced is still significant, particularly when the centre of lift of the wings moves forwards during the downstroke of the wing beat. Incidentally, in the Concorde, much of the lifting surface is at the rear and in conventional planes the horizontal tail flaps provide an additional lifting surface placed well to the back of the aircraft. The tail of *Archaeopteryx* was also important in a variety of other ways; in providing stability, for example.

I have recently been trying to determine the aerodynamic characteristics of *Archaeopteryx* so as to test the animal's gliding performance, using a computer program designed to do this; this has already been done for *Pteranodon*[7]. One of the most difficult problems has been finding the lift and drag coefficients for the tail. Already it can be estimated that the lift from the tail reduces the stalling speed by approximately 20%. This is a useful adaptation for low speed landing and makes it a less violent business than that envisaged by Heptonstall. It certainly would make things easier if the tail of *Archaeopteryx* could be ignored, but it is a large integral part of the animal and must be considered in any sensible aerodynamic analysis.

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Dr Heptonstall writes: Both Yalden[1] and Bramwell[2] question the weight of *Archaeopteryx* which I estimated to have been 500 g (ref. 3). My figure was based on a detailed anatomical comparison with the pigeon, *Columba livia*, the average weight of which is nearly 400 g (ref. 4). Although the lengths of many of the bones are similar (for example, femur, radius, ulna and metacarpals) some are larger (for example, fibula and humerus). The comparison showed that certain parts of the body were significantly heavier, particularly the head, neck and tail. The weight of the organs in the thorax of *Archaeopteryx* can only be inferred from an estimate of the volume. Using Heilmann's reconstruction[5], I found that the volume for *Archaeopteryx* was very similar to that of the pigeon. From this I deduced that *Archaeopteryx* could not have weighed less than 400 g (that is, at least twice that suggested by Yalden), and after allowing for the additional weight of the head, neck, tail and skeleton (the bones are not pneumatic) I arrived at a figure close to 500 g. In merely comparing the wing span with various living species, Yalden misses the point that this primitive bird had a high wing loading (probably higher than that of the pheasant[6]).

The omission of the body strip in my calculations is implied in my sentence which begins "If the body . . . provided negligible lift". This strip was only 40 cm^2 (not 91 cm^2 as implied by Yalden's data) and its inclusion leads to a figure for lift which is too high. It is often more convenient to use it but it is a convention which is not strictly valid since the body strip does not behave like an aerofoil in generating high lift. I considered that in view of the possible errors already incurred by selecting typical values for C_L and k, the effect of the body strip could be ignored. Although some authors incorporate this strip, others do not[4,7].

I agree with Yalden's comment concerning flight paths from tree to tree. I was making the point that the bird seems to have been poorly adapted for landing on the ground.

Bramwell's first statement concerning the use of the classical equation in aerodynamics relating lift force to velocity and the like is incorrect. Keeping the values of C_L, ρ and A constant, the general relationship then follows that the lift force is proportional to the square of the velocity and after defining the maximum permitted value of L the equation obviously provides maximum v. In her criticism of the omission of the tail from the calculations, Bramwell claims that because the tail is big it must generate appreciable lift. This is clearly not true because any flat (or nearly flat) surface must be inclined several degrees to the flow before lift can be generated[8]. I consider that while *Archaeopteryx* glided, just sufficient lift was induced to balance the weight of the tail. This elaborate tail undoubtedly had its uses, particularly for stabilizing or inducing pitching movements, and may well have been used to a limited extent in flapping flight as Bramwell envisages. The main function of the tail plane of an aircraft is to provide stability like the feathers on an arrow, not for giving it lift.

In conclusion, I should like to point out that Yalden's opening sentence is misleading in that the formula which I used relating bone strength to bending moment is that which is widely quoted in textbooks on strength of materials and was not used by Pennycuik in his work on pigeon flight[4].

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