mean mass of six male specimens as 307 g and a female as 278 g, while Spector[7] gives the mean of four specimens as 270 g. There is therefore no particular justification in using a mean mass of 400 g for *Columba livia*, and it may well be that Pennycuick's animals were very large specimens. Equally, it is not known whether the skeletons of *Columba* which match in size that of *Archaeopteryx* come from large or small *Columba*.

Second, it is questionable whether *Columba* is a very good choice for comparison with *Archaeopteryx*. Pigeons have a higher proportion of their mass as flight muscle than other birds. On average, flight muscles contribute 17% of the mass in other birds, but about 25% of the mass in pigeons[6,8]. Further, the bones of *Archaeopteryx* and of jackdaws, *Corvus monedula*, can be matched for size as well as with *Columba livia*. The jackdaw is an insectivorous species, and is arboreal, so might be a reasonable comparison with *Archaeopteryx*. Greenewalt[8] suggests that this species weighs about 220 g, though to be fair one can be no more sure that this was the weight of the particular specimens whose skeletons are available than one could in the case of the pigeons.

A third point of disagreement concerns the reconstruction of *Archaeopteryx* by Heilmann[4]. Heptonstall has sent me the measurements he used and comparing these with a cast of the Berlin specimen of *Archaeopteryx* suggests that the body form shown in the reconstruction is much too deep dorso-ventrally, by perhaps 30%, and is also too long by 20%. I therefore remain convinced that a mass of about 200 g is a reasonable guess for *Archaeopteryx*[3].

Furthermore, Heptonstall's[1] reply to the comments by Bramwell[9] on the use of the formula

$$v = \sqrt{\frac{2L}{C_L \rho A}}$$

is seriously misleading. He says that if C_L and A are fixed, and L is set at its maximum value, then v is given its maximal value. This would be true of a fixed wing aircraft, but birds are not in this category. Pennycuick[10] has calculated for gliding pigeons a range of C_L from around 0.3 at high speeds to 1.3 at low speeds (and, indeed, as high as 2.8 when the pigeon is hovering); these changes in C_L are brought about by extending or partially folding the wings, thus altering A. Very similar results have been obtained with falcons[11]. (These values of C_L obtained by Pennycuick were calculated with the areas of the body strip and tail included in the figure for the wing area[1].) The velocity which Heptonstall originally calculated[12] is, then, the maximum diving speed with the wings fully extended, a rather improbable configuration. Out of interest, I recalculated the flying speeds using the same formula. For the "minimum" flying speed, V_{min}, in level flight, I assumed that the wing was fully extended, and used a figure of 1.3 for C_L (based on Pennycuick's data[10]), while for the "maximum" flying speed V_{max}, I assumed the lower figure of 0.3 for C_L and a wing area reduced by 30%, both of these figures also based on the performances of Pennycuick's pigeons[10]. The estimate of the mass of 200 g was used; the "wing area" included the body strip and the tail. These suggest a speed of 6.3 m/s for V_{min} and 15.3 m/s for V_{max}. However, it must be emphasized that, quite apart from their highly speculative nature, these are not likely to have been the real minimum or maximum flying speeds. Stalling speed is likely to have been rather lower than the estimated V_{min}, while a few wing beats might have slowed the bird even further, if it was trying to land rather than keep flying. Equally, a diving *Archaeopteryx* might well have achieved higher speeds than the estimated V_{max}, if it had folded its wings more than I have suggested.

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DR HEPTONSTALL writes: I agree with Yalden that before comparing specimens of a living species with *Archaeopteryx* with a view to estimating the live weight of the latter, one must know both the weight and the skeletal dimensions of the living specimens. This relationship in Pennycuik's specimens of *Columba livia* is available from his paper[5] as he supplies the dimensions of the wing bones. As a result of recent correspondence on this subject[2,9] I have made a biometrical analysis of a specimen of the crow *Corvus corone corone* which weighed 553 g. Swinton[13] states that *Archaeopteryx* was similar in size to the larger common species, namely the raven, but this does not seem to be correct. In general my measurements indicate that the carrion crow was a little larger than *Archaeopteryx* and suggest a weight of 450–500 g for the latter.

My use[12] of the equation relating velocity to lift and wing area appears to require further clarification. I used this equation to determine the minimum radii of horizontal and vertical flight paths, these being determined by the maximum lift which the wings were permitted to generate. If we consider a horizontal circular path radius r with angle of bank θ, it follows from resolving the forces that

$$L \cos \theta = mg \tag{i}$$

$$\text{and } L \sin \theta = \frac{mv^2}{r} \tag{ii}$$

On fixing L at 2 mg the banking angle is found from (i) to be 60°. Combining (ii) with the equation quoted by Yalden and eliminating v gives

$$r = \frac{2m}{2 C_L \rho A \sin \theta}$$

As θ is fixed at 60° and m and ρ are constants, r is inversely proportional to the lift coefficient times the wing area. It follows therefore that for paths of minimum radius both C_L and A must have maximum values. My use of the term "maximum velocity"[1,12] was intended to apply only to these conditions. It is, of course, obvious that a higher velocity could have been reached on flight paths of greater radii if the wings were reduced in area and/or the lift coefficient was lowered. On this point I should like to correct a statement made by Yalden in which he says that "changes in C_L are brought about by extending or partially folding the wings, thus altering A". The lift coefficient is not determined by wing area but depends on the geometry of the wing and to some extent on the Reynolds number. The most convenient method of changing C_L is to vary the inclination of the wing relative to the airflow.

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Alteration of Sites on the Mammalian Sperm Surface following Capacitation

THE ovum cannot be penetrated by a spermatozoon until the latter undergoes a change termed capacitation[1] which, in the golden hamster, can be produced *in vitro* by incubation in various body fluids[2-4] including serum[5] and β-glucuronidase[6].