

The Primaries of *Archaeopteryx*.—All who are interested in the origin of the birds or in bird flight will welcome de Beer's (1954) critical and finely illustrated study of *Archaeopteryx lithographica*. It is, of course, more than a study of the British Museum specimen, giving, to those who have had no chance to see them, valuable information on the Berlin specimen and on the beautifully preserved single feather described by von Meyer.

One point that de Beer does not clear up is the marked difference in appearance between the primaries of the British Museum and Berlin specimens. The two specimens are preserved in strikingly similar attitudes, with wings partly spread, the body turned slightly on the left side, and the head thrown back as if in an effort to avoid asphyxiation in the thixotropic mud on which it had landed and from which, lacking any appreciable degree of powered flight, it could not take off. The primaries of the Berlin specimen form a graded series, the medial being longest and the proximal and distal progressively shorter; and the proximal shafts curve forward and the distal ones backward; the whole combining to produce a surprisingly modern-looking wing tip that approaches the elliptical form seen in the passerines. In the British Museum specimen not only is the series more irregular, but the distal primaries are long and nearly straight.

Many apparent distinctions between the two specimens are shown by de Beer to be based on misconceptions. He finds the British Museum specimen to be about 10 per cent larger than the Berlin one in length of femur, tibia, humerus, radius, and ulna, but about 25 per cent larger in length of toes. Differences in age, sex, or degree of ossification might account for any of the observed discrepancies; and, in view of the numerous points of close agreement, de Beer is hesitant to accept the claims of generic or even specific distinction. In view of the many remarkable resemblances, the apparent discrepancy between the primaries demands attention.

The tail and left foot of the British Museum specimen are excellently preserved, and the specimen is of great value in several other characters that complement the Berlin one. Yet the more one studies the illustrations of it, the more impressed one must be with the amount of disintegration that took place before it was completely covered. It is possible that the tail and left foot were covered substantially before the rest of the animal. As de Beer indicates, the small displacement of several detached elements argues strongly against the animal having been preyed upon; but the right leg is detached and its foot missing, parts of the skull and most of the cervical vertebrae are missing, all the metacarpals are detached and some missing, and only four scattered phalanges remain of the fingers. This condition indicates a degree of disintegration that makes some displacement of the remiges probable if not inevitable.

The longer primaries of the Berlin specimen seem to be about 140 to 145 mm. long, if they are inserted about as we would expect. The lengths of the primaries and longer secondaries of the British Museum specimen are stated by de Beer to be about 130 mm., which would be disproportionately short for the longest primaries; but although, with the metacarpals displaced, exact measurement is impossible, I estimate that the longest primaries are over 150 mm. in length. The tips of three primaries of the right wing seem to be missing from the slab, which gives an illusion of a short, truncate wing tip. De Beer carefully studied the impression of the right wing of the British Museum specimen under critical illumination and concluded that it bore six primaries. He points out that some shaft impressions are double-struck, giving an appearance of a higher number. He suggests that the first primary, which is very short, had been recently replaced. Numbers 2 to 6 all appear to extend about the same distance, but this curious effect, as noted above, seems to be due to

appreciable amounts of the tips of numbers 3, 4, and 5 having been lost from the edge of the slab. Numbers 2 and 6 are of nearly equal extent, although the more distally attached number 6 is presumably substantially shorter than number 2. The impression of the left wing is fully within the limits of the slab, but the primaries are conspicuously disarranged. It is difficult to distinguish the demarcation between primaries and secondaries; but, on the basis of relative length, the most distal primary seems to correspond with number 5 of the right wing. Counting back from this point we find that what appears to be number 1 projects beyond number 2. This effect might be due to the loosening of number 1 from the elastic ligament; but, from the angles of the shafts, I suspect that these two feathers have crossed. Primaries 4 and 5 extend substantially beyond number 3; even allowing for some displacement it seems likely that they are the longest feathers.

In the Berlin specimen Heilmann (1926) counted 11 or 12 primaries, being uncertain whether a small feather that projects just beyond the claw of the second digit was a primary or a displaced covert. This feather shows very clearly in his excellent photograph (Figure 20) of the left wing. It is not obvious in available photographs of the right wing, but Heilmann indicates it in his drawing (Figure 2) of the complete specimen, and it is almost certainly a primary. As de Beer has suggested, Heilmann's high count seems to have been due to some shafts being double-struck. Examination of Heilmann's photograph of the left wing, in which the detail is exquisite, shows that the shafts that he labels 2, 4, 6 and 8 are quite precise duplicates of 1, 3, 5 and 7, and that they show no corresponding feather-tip impressions. They are quite clearly double-struck. After these first impressions were made the wing seems to have moved backward some 5 or 6 mm. into its final position. Water washing over the wing then obscured the original outline and penetrated under the margins of the wing enough to destroy the peripheral parts of the first impressions of the shafts. (This movement leads one to believe that Heilmann's count of secondaries may also have been high.) The wing accordingly bears 8 primaries, numbers 1 to 4 increasing smoothly in extent, number 5 being slightly shorter than 4, and 6 to 8 successively shorter in a regular sequence. The shafts of numbers 4 and 5 are nearly straight, whereas the three proximal primaries curve forward and the three distal ones curve markedly backward. The perfect symmetry of this wing tip and the agreement in general outline of the somewhat less sharply delineated right wing make it difficult to believe that any of these left primaries could be seriously displaced or that any could be missing.

The length and straight shafts of the primaries designated 4 and 5 by de Beer strongly suggest that they are fully homologous with the feathers to which I have designated these numbers for the Berlin specimen. It thus appears that primaries 6 to 8 of the British Museum specimen's left wing and 7 and 8 of the right wing were detached and washed or blown away before the bird was covered.

Heilmann, on the presumption that the Berlin specimen had 12 primaries, tentatively assigned numbers 1 to 7 to the second metacarpal (the third digit crossed distally below the second, and its metacarpal is assumed to have run beneath the primary shafts); number 8 was assigned to the 1st phalanx of the third digit; and 9 and 10 to the first phalanx and 11 and 12 to the second phalanx of the second digit. On the basis of 8 primaries we may tentatively assign numbers 1 to 5 to the second metacarpal, and 6, 7 and 8 to the first phalanx of the third digit and first and second phalanges of the second digit, respectively. If the distal portion of the elastic ligament rotted away as fast as the skin and tendons of the digits, it is not surprising that these outer primaries should have been detached. They are more likely to have been washed or blown far from the carcass than the digits; and when we con-

sider that all the digits of the right hand have been lost and only four scattered phalanges, two of them claws, remain of the left hand, we cannot wonder that the primaries borne on them have disappeared.

Acceptance of such a reconstruction of the wing of the British Museum specimen would support the correlations listed by de Beer and justify the inclusion of the Berlin specimen in *Archaeopteryx*. If, however, it be maintained that the impressions in the British Museum specimen represent the entire wing, not only must the Berlin specimen be left in *Archaeornis*, but the two genera must be regarded as rather distantly related despite their close skeletal resemblances. I find it hard to believe, however, that an arboreal, climbing bird, such as *Archaeopteryx* must have been, could have had long, straight distal primaries that would have seriously interfered with the use of its fingers.

It may be noted in closing that, from its narrow front web and the backward sweep of its shaft, von Meyer's isolated feather is seen to be a distal or subdistal primary. If it belonged to *Archaeopteryx* it must, from its size, have been number 7, according to my interpretation.

LITERATURE CITED

- DE BEER, G. 1954. *Archaeopteryx lithographica*. A study based on the British Museum specimen. (London, British Museum), xi + 67 pp.
- HEILMANN, G. 1926. The origin of birds. (London, H. F. & G. Witherby), 208 pp.
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Merlin Attacks Brown-eared Bulbuls.—We were crossing a broad gravel-filled stream bed near Toyama, Japan, on the west-central coast of Honshu when a flock of Brown-eared Bulbuls (*Ixos amaurotis*) numbering about 70 birds approached upstream and crossed the river bed ahead of us. As they approached the bank a half a mile away a Merlin (*Falco columbarius*) appeared, flying parallel to our route, and headed toward the bulbuls. It reached them just as they left the river bed and were above a farm home surrounded by dense trees, mainly *Cryptomeria japonica*. The Merlin immediately attacked and the flock wheeled and circled about the trees attempting to avoid it. It stayed on the periphery of the flock attempting to isolate an individual or break up the flock. Oddly enough the bulbuls made no effort to alight in the trees but flew around and over them as though to confuse the falcon. The flock had been over a hundred feet high when attacked and in its frantic maneuvering gradually descended to nearly ground level. After a full three minutes of this an individual swung too far out of the flock and the Merlin stooped, taking it to the ground. The Merlin was only slightly larger than the bulbul which lay on its back pecking valiantly at the raptor. Undaunted by its ultimate fate it continued to fight until the Merlin flipped it over and quickly bit it at the base of the skull. Meanwhile the flock had regrouped and disappeared southward. The raptor, disturbed by us, flew heavily with its victim to a spot far out on the river bed. We decided from its small size and strong barring that it was an immature male.

Two days previously we had seen a Kestrel (*Falco tinnunculus*) work a flock of Gray Starlings (*Sturnus cineraceus*) in the same way, but it made no stoop. On previous years we had seen Kestrels and accipiters attack flocks of bulbuls in Kyushu. —H. ELLIOTT McCLURE, *406th Medical General Laboratory, APO 500, San Francisco, California.*