

# Discussion Contribution

## *Separated Primary Feathers*

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All separated primary feathers show emargination and move in response to aerodynamic forces. In particular a first primary of an emarginate series will bend and twist in an air stream as the shaft is rotated. The effect is to produce a curve of lift against shaft angle which rises for some 10–15 degrees and then remains constant for a further 15–20 degrees. A group of such feathers behaves similarly provided the series is complete, starting at the first primary; only the first is stable on its own. Such an array is able to produce high values of lift coefficient, though with high drag (measured), so that the overall ‘angle of presentation’ to the air stream is uncritical; this arrangement has obvious advantages. The maximum development of emargination is seen in two very different types of bird. Firstly, those like pheasants or partridges which live in thick low vegetation: short wings are inevitable, and a steep climbing take-off necessary. The very short wing (aspect ratio 2–3) can be flapped along a horizontal plane while the tip feathers assume an optimum (?) lift configuration. Secondly, the large birds of prey: they are primarily soaring birds and much discussion has taken place on the functions of the emarginated tip in soaring. Why does such emargination not occur in marine soarers? The large land soarers have to take-off from flat ground in conditions of little or no wind by flapping a large gliding wing, most of which cannot, due to its low air speed, develop useful lift. The tip can develop high values of lift, under overload conditions, until the forward speed has risen to a value where the rest of the wing can develop useful lift. Whether emargination has a function in the reduction of induced drag in gliding flight, as has been suggested, remains to be demonstrated. If it has such an effect then it must be of use only in the lightly loaded wings of low aspect ratio, otherwise how can one explain its almost complete absence in marine soarers?