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As one who has long watched the birds I feel that we have only scratched the surface of soaring possibilities.

The purpose of this paper is to outline a program for the systematic study of soaring birdflight with view to practical application of the results to soaring. A brief discussion of some of the more promising areas is presented in hope of stimulating technical interest in this sadly neglected field. The results of such a program will enable us to set our goals accurately and will provide valuable technical data. They will furnish an answer to the all important question of dynamic soaring, and if it is a reality, its mechanism. If the results prove that the birds are no better equipped in their struggle to remain aloft than are our sailplanes, then that information will also be extremely valuable. However, preliminary results in a number of recent studies and general observations promise that there is much to be learned from the birds.

In order to perform a detailed quantitative investigation of natural soaring flight, we must accurately measure all the important areodynamic forces which act during flight. We must map the air flows about the wings, body and tail. We must discern the separate and integral effects of the various parts of the bird on its flight characteristics. Such detailed measurements cannot be made easily or accurately on a live bird. Of course, the overall static performance of the live bird can be measured as has already been done by Dr. Raspet[1]. However, dynamic effects and overall aerodynamics must come from wind tunnel tests on mounted wings, where forces can be measured accurately under the conditions and configurations desired.

In using lifeless wings of a soaring bird for our tests we are making two assumptions: (1) The dead wing if mounted in an accurate flight configuration will possess the same aerodynamic characteristics as the living wing and (2) In natural soaring flight, the wing of the bird is essentially a rigid structure (allowing for elasticity effects). Any voluntary wing motion is for control purposes only; constant wing or feather adjustments are not a requisite for soaring flight. This supposes that the reactions of the wings to air currents are almost automatic and not under constant regulation by the bird's muscles. These assumptions are supported by both field observations and close-up motion pictures of the birds in flight. It is true that the flapping motion of bird wings is extremely complex and involved. However, the relatively static conditions of the motionless soaring wings make investigation in this range quite feasible.

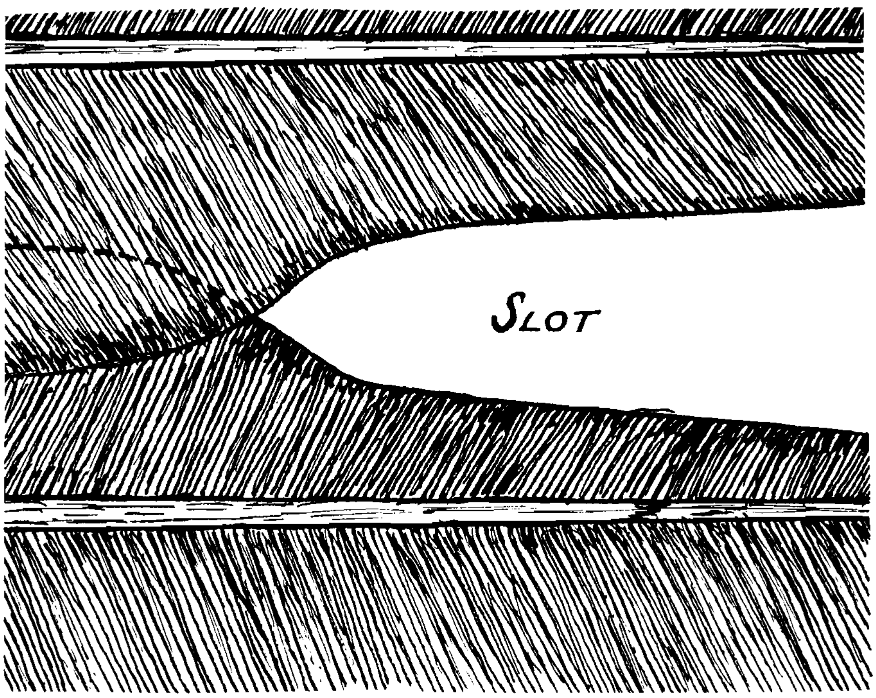

Fig. 2a — Pinion slot detail of Black Vulture.

We thus consider the bird wings as any other mechanical wing possessed of certain aerodynamic qualities and proceed to measure these qualities by conventional methods. A most important factor in the testing will be the attainment of accurate flight configurations. Successful mounting methods have already been devised (Fig. 1). It is true that there may be some slight inaccuracies due to the use of a mounted specimen, but the general aerodynamic characteristics of the bird will certainly be determined.

The choice of a subject bird for the tests is not difficult as there are a number of common birds which possess remarkable soaring powers. Such are the eagle, hawk, condor and vulture. These land soarers all possess the slotted pinion wing-tip which occurs in the most efficient soarers, excepting the albatross which is a sea bird. Due to its abundance and exceptional flight powers, either the Turkey or Black Vulture offers an excellent specimen.

The wind tunnel data must be supplemented by performance data taken on live birds. The test results should then be integrated into a plausible theory which accurately explains and predicts natural soaring flight. The entire study should be conducted from the bird-flight point of view; we should try to gain a rather complete picture of the bird's potentialities and mechanisms.

The tests should include such items as (1) determination of the wing polar (2) mapping of air flow patterns (3) determination of the purpose and effects of the slotted pinions (4) determination of the induced and parasite drag properties of the wings (5) effects of varying wing geometry (6) body and tail characteristics (7) dynamic soaring possibilities and (8) stability aspects.

The overall program may be briefly summarized in three steps: (1) Wind tunnel and free-flight investigations to determine the aerodynamic properties of soaring birds (2) Integration of test results into a theory which satisfactorily explains the bird's exceptional flight qualities, and (3) Use of the principles learned for the improvement of sailplanes and soaring techniques.

In short, we have before us the actual everyday accomplishment of ideal soaring flight. Our task is to find out how the bird does it and to apply the principles to our own craft. We are indeed fortunate in having as our guide a creature which is the