

NOTES AND COMMENTS

LOONS AND THEIR WINGS

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In his interesting article on adaptive evolution in birds' wings, Savile (1957) makes several statements about the loons and their evolution which I feel require further discussion.

The idea that loons were relatives of the Upper Cretaceous Hesperornithes and are therefore primitive has persisted in the literature for many years, although in my opinion it is quite unjustified. As I have recently pointed out (1956) the best known of the early fossil loons (*Colymboides minutus*) was a small species which, compared with modern loons, had legs only moderately adapted for propulsion under water and relatively large wings, enabling it to fly strongly. Loons as we know them evolved between the time of *Colymboides minutus* (late Oligocene or early Miocene) and the Upper Middle Miocene (Calvert formation), the age of occurrence of the earliest recorded fossil of the Recent genus *Gavia* (Wetmore, 1941). Loons probably evolved from gull-like ancestors; certainly they evolved from strong-flying ones.

As has been pointed out by Stolpe (1935) and others, the similarities shared by the Hesperornithes, the grebes, and the loons result from convergent evolution. I see no valid reason for believing that they had a common swimming ancestor. The Hesperornithes were highly specialized end products of a very early adaptive radiation of birds. There is no conclusive proof that any other known Cretaceous birds possessed teeth. The retention of these structures in the Hesperornithes was of undoubted selective advantage—witness the evolution of analagous structures in the bills of mergansers. Neither the adaptive "disadvantage" of weight nor the "substitution" of a muscular gizzard discussed by Dilger (1957) as reasons for the loss of teeth in birds applied to these flightless birds which presumably used their teeth to hold their prey.

Thus loons were derived from birds which flew well, and they were not related to the Hesperornithes, which died out long before loons became their ecological counterparts. The wings of loons must therefore be thought of as either in the process of "degeneration," or as being adapted to a particular set of conditions. I would like to present evidence for the latter view.

Like the Hesperornithes and the grebes, the loons are foot-propelled diving birds. While they may swim by alternate strokes of the feet when on the surface, they move the feet simultaneously when they are below the surface. Ordinarily the wings are kept folded and under the flank feathers while the birds are under water; however, in turning sharply or when wounded or pressed, loons use their wings under water (Townsend, 1924). The speed with which loons normally move under water is indicative of the size and power of their hind limb musculature, which, compared with other birds, forms a relatively high proportion of the total body weight. Yet loons can and do perform long migrations. Thus loons appear to be adapted for sustained flight with a minimum weight of wings and pectoral muscles. An important evolutionary factor is the conservatism of wing proportions within the loons (and many other groups of birds). I have shown the remarkable similarity in the proportional lengths of the wing elements between *Colymboides minutus* and the Recent loons (1956: 415), and it is evident through what is known of their evolution that loons' wings have changed little if any in their proportions. There has, however, been a reduction in relative size of the fore limb as the hind limb has become increasingly heavy. What we have in modern loons is an adaptive balance; the selective advantages of an increasingly strong (and heavy) hind limb being opposed by the disadvantage of the accompanying increase in wing-loading.

Speed in flight is a compensation for a high wing-loading, and I suggest that the form of loons' wings is an adaptation for speed in flight "necessitated" by an increase in wing-loading, in turn brought about by the strong development of the legs for propulsion under water.

In using data on weights and wing areas it should be emphasized that the weights of migratory birds, and hence the corresponding figures for wing-loading, are extremely variable. I have been collecting data on the grebes and have found more than 100 per cent variation in wing-loading in the Pied-billed Grebe. Two males of this species, each having a wing area of 52 square inches, weighed 282 grams and 576 grams. The figures for wing loading are 1.75 and 3.55 pounds per square foot, respectively.

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THE LOON WING

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I regret that, in following Heilmann (The origin of birds. Witherby, London. 1926), I unwittingly perpetuated an error concerning the relationship of *Hesperornis*. I wish to thank Dr. Storer for drawing attention to this error, and I trust that his correction will be widely noted.

Dr. Storer's interpretation invalidates the chronology of my speculative interpretation of the origin of the loon wing. Whether it upsets it in other respects is a moot point. I still feel that it is quite possible that the loons arose

from a line that, although capable of flight, failed to develop a really efficient wing. In particular, I find it difficult to believe that the poorly developed loon alula is anything but primitively inefficient; for, as long as a bird of substantial size flies at all, a functional alula is very valuable, and it is hard to believe that it is detrimental in swimming or diving.

I am grateful to the many correspondents who have written to me about this problem, but it must be admitted that none has yet presented a convincing alternative solution.

CROSSING RELATIONSHIPS IN THE GENUS *CARICA*

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The cultivated papaya (*Carica papaya*) is native to Central America (1) and in the post-Columbus period it spread to other tropical parts of the world. Papaya cultivation is subject to serious depredations primarily from many fungus, bacteria and virus diseases. In subtropical countries, on the fringes of tropics, the papaya cannot be grown because it is very susceptible to temperatures below 40° F. Efforts are being made therefore to develop varieties resistant to diseases prevalent in the particular area, and to develop varieties for subtropical climates.

The papaya belongs to the genus *Carica*, which has some 40 species native to Central America and Northern part of South America. *C. monoica* shows some tolerance to one of the virulent papaya diseases called virus Bunchy Top, which is common in Puerto Rico and the adjoining Caribbean area. *C. candamarcensis*, on the other hand, grows only at an altitude of 4,000 feet or more, which has much cooler climate for papayas. The fruit of *C. candamarcensis* is edible. The present exploratory

work was undertaken, therefore, to study the crossing compatibility relations of wild species of *Carica* with cultivated papaya, a prerequisite to the transfer of any desirable characters from wild species to cultivated papaya.

Many successful, as well as unsuccessful, interspecific crosses have been reported. Warmke and others (2) reported a new interspecific cross, *C. goudotiana* × *C. monoica*, the latter being used as a male parent. Addison (3) had succeeded in making the interspecific cross, *C. papaya* × *C. monoica*. Still earlier successful crosses were made between *C. candamarcensis* × *C. papaya*, *C. cauliflora* × *C. papaya*, *C. erythrocarpa* × *C. candamarcensis*, *C. papaya* × *C. gracilis* (4). Seany and Wieland have been successful to cross *C. candamarcensis* × *C. monoica* and to study F₁ and F₂ (personal correspondence). In the present work crosses between four species, namely *C. papaya*, *C. monoica*, *C. goudotiana* and *C. cauliflora* were attempted.

C. papaya is a tree growing 10 to 25 feet or more. Usually unbranched, it bears large melon-