A FOUR-WINGED COCK-PHEASANT*

BY THOMAS HUME BISSONNETTE

INTRODUCTION

THE development and appearance in nature of supernumerary limbs in vertebrates, particularly birds, is of interest from various aspects. Among these are the following:—

(1) They show that experimental operative interference is not necessary; they occur without it. (2) That a few birds bearing them succeed in surviving the difficulties of embryonic life and grow to maturity draws attention to the much larger number that begin development but fail to survive pre-natal and early post-natal competition. (3) They may have significance in regard to the "Fin-fold Theory" of the origin and evolution of the vertebrate tetrapod limb, as indications of linear fields in the regions of these limbs from which only one limb normally develops on each side of the body-axis to reach maturity anatomically and functionally. (4) They exemplify the occasional development of subsidiary, uncontrolled, or partially controlled survivals from accidental mechanical transplants of parts of the limb-fields or of physiologically isolated parts of such fields. (5) They may also give evidence of the results in such isolates of a lack of proper nerve-supply and of consequent lack of functional activity during that period of development during which normal development is dependent upon such activity for completion. (6) They are also interesting from the standpoint of anomalies or vagaries of Nature. (7) They may also be instances of the abnormalities associated with the high degree of hybridization sometimes occurring in some groups of birds, such as the pheasants among game birds, and the doves in laboratory-controlled hybridization. (Bissonnette, 1941; Riddle and Johnson, 1939, and cases cited there).

A four-legged pheasant chick about four days old has been described and figured by Bissonnette (1943). In it the supernumerary legs were attached to a second pelvic girdle formed to the left of the vertebral column which showed signs of having developed in association with spina bifida in the sacral and anterior caudal region. The ilia of this supernumerary pelvic girdle were not separated by any vertebrae, as the primary ilia were, and this lack was associated with a tapering off and union posteriorly of the ilia of the two dorsal halves of the girdle. It gave evidence for the transplantation of self-differentiating parts of the pelvic girdle with enough of the limb-field to give the skeletons of two almost complete legs, with joints, but little or no musculature and without the usual fusions of digits which often follow operative trans-

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plantations of limb-fields. (Hamburger and Waugh, 1940).

A case of supernumerary wings has also come to light in a four-winged cock Ring-neck Pheasant almost a year old and in complete winter plumage. It was dead about two days when received in frozen condition from Bushy Hill Game Farm, Simsbury, Connecticut, in February, 1941, through the interest of Wm. N. Craig, of West Hartford. Its anomalous second pair of wings made it of significance for the reasons above stated. The spring change to breeding plumage and head furnishings had not become evident (figs. 1, 2).

DESCRIPTION

The usual complement of wings and legs was present, apparently normally situated, formed and feathered. In addition to the normal pair of wings, however, there were two conspicuous bunches of feathers borne upon two appendages attached to the dorsal surface of the neck about an inch or more anterior to the normal wings. The left bunch consisted principally of feathers resembling flight feathers; the right of coverts or lower dorsal wing feathers. The left resembled a feather duster; the right a rounded tuft or pompom (figs. 1, 2).

Each accessory wing was supported by a bony frame loosely connected by tendons or ligaments to the third from last neck vertebra where there was a slight dorsal hump or detour, involving two or three vertebrae. Each "wing" had for skeleton a single rod-like bone; the left about half an inch longer than the right, flattened, grooved, and forked distally, as though to support two phalanges or digits; the right more nearly cylindrical, almost to its distal end, where it tapered off sharply, conically, dorso-posteriorly, as though to support one digit only (figs. 3, 4, 5).

These accessory wings were not articulated with the neck vertebrae nor with any bony elements that might represent rudiments of pectoral girdles, differing in this from the accessory legs described by Bissonnette (1943). Each was fastened to the twelfth neck vertebra by a tendon or ligament not longer than a quarter of an inch. Large feather follicles in the skin made skinning and dissection difficult. Skeletal parts could not be distinguished by palpation from quills. The neck and attached accessory wing skeletons were, therefore, cleared and stained by the potassium-hydroxide-alizarin-red-glycerine technique and photographed to show the relations of the parts (figs. 3, 4, 5).

DISCUSSION AND CONCLUSIONS

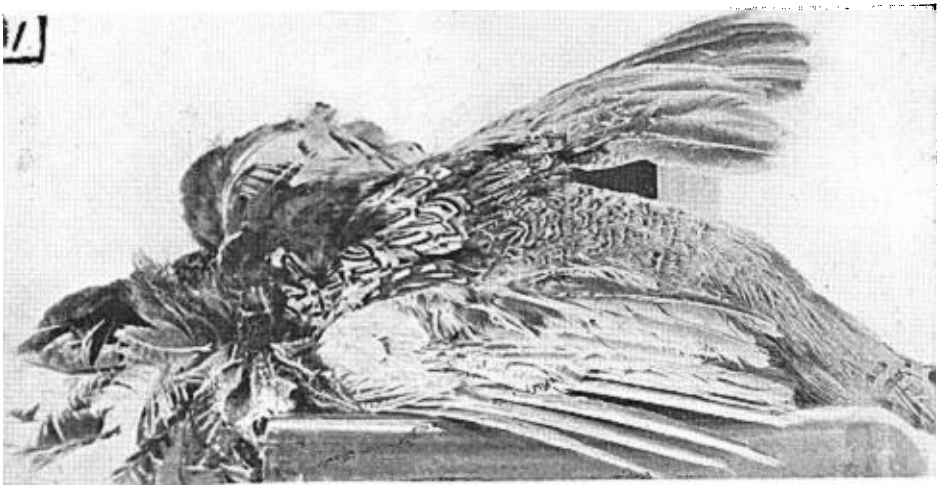
This accessory pair of wings developed either outside the gradient fields of the normal wings, from accidental mechanical transplants of fragments of wing-field, or near the anterior margins of these fields because of physiological isolation of those regions which then became

self-differentiating (Huxley and De Beer, 1934) and developed in parallel with the more normal remainder of the field on each side. The difference in type of feather predominating in the two suggests either that the accessory fields were derived from slightly different parts of the original fields, in one leading to its development with skin like the shoulder or preaxial border of the wing, in the other to development with skin like that on the postaxial border of the wing; or that subsequent reactivation of the normal wing-fields led them to take over different epidermal regions for skin. The latter reaction, if operating, induced or permitted growth of different types of feather; in the right, wing coverts, and in the left, flight feathers or primaries, principally.

The positions of these supernumerary wings and their skeletal structures suggest that a series of wing-fields or an elongated field parallel with the vertebral axis arises in pheasant embryos in accord with the "fin-fold theory" of the origin and evolution of the tetrapod limbs of vertebrates. Whether the highly hybrid genetic condition of the Ring-neck Pheasant may have led to reversion toward ancestral conditions with a series of wing-rudiments or a fold on each side in this region is a question, perhaps, of more academic than practical interest, and need only be mentioned and not stressed here.

But the relation of this condition to the field theory of limb development in birds is significant. Normally a strong activity or metabolic- or growth-rate of one pair in the bilateral series or of one section of the field, a posterior or central pair or section, inhibits the development of those anterior or posterior to it. In this case, reduced activity of this usually dominating pair or section, for some unknown reason, may have permitted an anterior pair of wing primordia near the anterior periphery of the field to develop sufficiently to insure their persistence as weakly self-differentiating rudiments which reached the stages of development or completeness found in this bird. Their rudimentary nature indicates considerable effects of the partial dominance of the normal wing primordia, which attained normal structure and feathering and took over the basal portions of the accessory fields and prevented the development of accessory pectoral girdles. This presumably followed return of vitality and activity to the principal wing-centers (Huxley and De Beer, 1934, sec. V, p. 321, and sec. VII, p. 325.)

The usual twisting of the chick embryo in the neck region during early development makes it less difficult to understand how the skin and feathers upon the accessory wings came to differ. One was farther from the normal wing-centers than the other. Competition between supernumerary and normal wing-centers for materials and slight difference in distances from the main centers could lead to such differences as are found here. One was more affected by the dominant normal wing and, therefore, more rudimentary, as indicated by its shorter bony component with less sign of division for support of digits and its lack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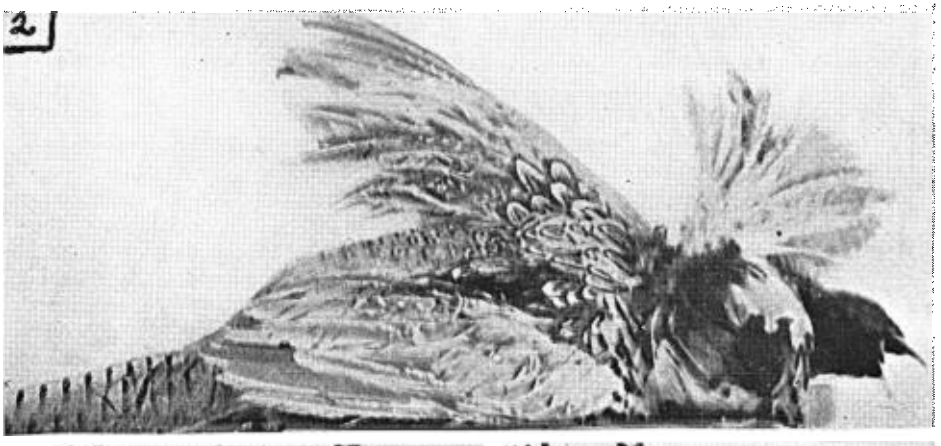
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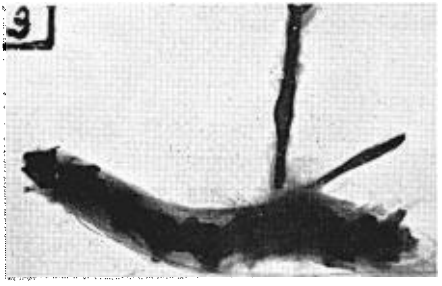
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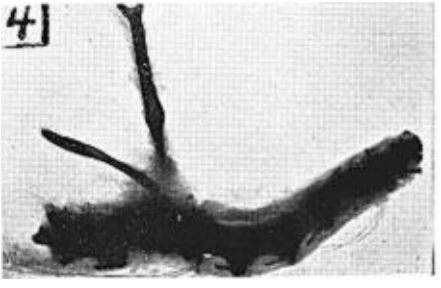
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of flight or quill feathers, which make up a large part of the plumage of the more remote and better developed accessory wing.

While the power to produce a series of wing-fields or an elongated field is hereditary in the bird, it is unlikely that this particular anomaly is inherited as such. Rather it is a result of developmental arrest or accident at an early stage of development. The exact anomaly found here is the resultant from the interaction between (1) the hereditary wing-producing potency and (2) a given set of internal or physiological processes either in reduced activity of the main or normal centers which physiologically frees the anterior regions of the fields from control, or an accidental mechanical transfer of a self-differentiating part of each such field beyond this control, in these regions. Physiological conditions have modified the expression of an hereditary potency. The reduction of activity seems more probable than the mechanical transfer or transplantation.

Lack of adequate nerve supply will account in part for the fusions of limb bones and digits indicated in these accessory wings and for lack or atrophy of muscles (Hamburger and Waugh, 1940; Eastlick, 1943). It may also be a partial cause for the fusions of segments of the wing skeletons and absence of joints. But the tendency of distal segments of the wings of birds to undergo fusions and to lose elements of the skeleton usually found in vertebrate tetrapod limbs is also a factor that may be enough to account for such fusions and absences of digits as are found in this bird. This tendency in birds may itself be due to reduced nerve supply to the distal segments of the wings. The bones found appear to be more nearly homologous with those of the wrist and hand than with those of the more proximal parts, which, however, may be represented in the basal parts of these bones in the absence of the usual joints. This absence of joints is also met with in inadequately innervated limbs, possibly in relation to lack of movement during development. A phycomelic hereditary tendency need not be invoked as a probable factor in this lack of arm bones. (Phycomelic, with hand elements but lacking arm elements). The condition found is perhaps another result of encroachment by the dominating, more normal limb-centers, which took over the proximal parts of the accessory limb fields otherwise destined to produce girdles and proximal wing-segments.

The condition is therefore believed to be the result of physiological

FIG. 1. Four-winged Cock-pheasant from left side.

FIG. 2. Four-winged Cock-pheasant from right side.

FIG. 3. Neck and supernumerary wing skeletons from left side. Note the forked end of left wing skeleton and conical point of the right one. (KOH-alizarin red-glycerine clearing and staining.)

FIGS. 4 & 5. Neck and supernumerary wing skeletons from right side. (KOH-alizarin red-glycerine clearing and staining.)

or mechanical isolation of the anterior portions of the wing-fields of the early pheasant embryo, persisting long enough to let the isolates reach a self-differentiating stage. It is also indicated that the normal dominant wing-fields resumed control of some of the proximal parts of the weaker accessory fields and so eliminated girdles and some proximal wing-segments from the rudimentary or atrophic supernumerary wings. Difference in results of this dominance, because of torsion of the embryo, led to difference in the bony elements and in type of feather predominating on the skin covering the right and left accessory wings.

This is another, previously unreported, of the many anomalies and reduplications found in the complexly hybrid offspring of Ring-neck Pheasants *(Phasianus colchicus torquatus)*. Others are partly double wings (Bissonnette, 1941b), four legs (Bissonnette, 1943), and numerous degrees of intersexuality as shown in the "mule" pheasant (Bissonnette, 1940, 1941a).

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Trinity College, Hartford, Connecticut.