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An Instance of Polymely in the Frog

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AN INSTANCE OF POLYMELY IN THE FROG

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In November, 1922, a polymelous specimen of *Rana clamata* was brought into the laboratory by one of my students [1] who informed me that it was found on the grounds of his home in the city in a pool which had been stocked with frogs' eggs which were collected in the environs of St. Louis in the spring of 1921.

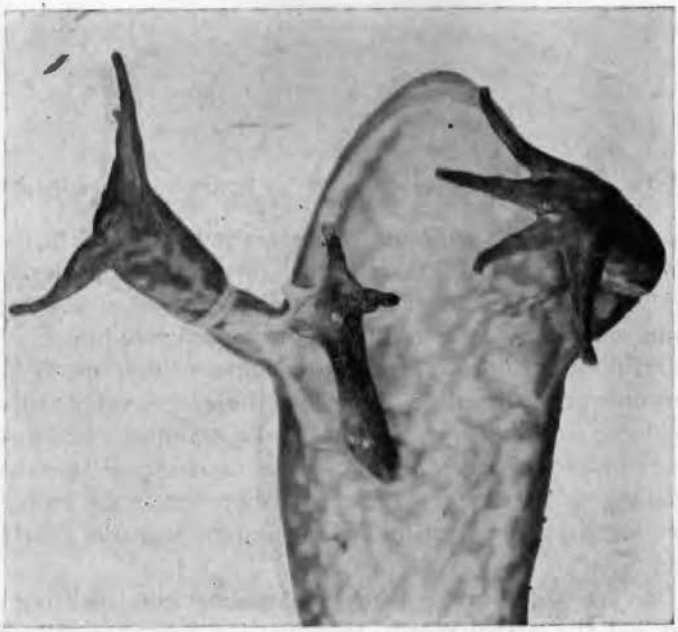

Fig. 1. Photograph of living frog showing supernumerary fore limb.

The frog, a well developed female 9 cm. in length, was kept alive for several weeks in an aquarium where it could be observed at pleasure. The supernumerary fore limb was located in the right sternal region posterior to the sterno-coracoid articulation. While the frog was at rest the limb extended obliquely across the chest in such a manner that the manus projected in front of the right gleno-humeral articulation, as illustrated in figure 1. When the frog was handled the supernumerary limb projected ventrally

1 Henry Doerr.

Fig. 2. Radiogram of living frog showing supernumerary fore limb.

and anteriorly, as shown in the radiogram in figure 2. The manus was clearly double and exhibited eight imperfectly developed digits. The skin on this limb was well pigmented and showed a pattern somewhat similar to that of the normal fore limbs.

Careful observations revealed no spontaneous movements of the supernumerary limb, although the humerus was movably articulated with the supernumerary pectoral girdle. Neither could any responses be elicited either by mechanical or electrical stimulation. Obviously, no sensory nerve fibers were present in the limb. No musculature was apparent in the limb and the skin was closely adherent.

After we had secured photo—and radiographs the frog was killed and the sternal region, including the supernumerary limb, was dissected. The pectoral musculature was normal in all respects except that the right pectoralis major muscle took origin from the lateral border of the supernumerary pectoral girdle as well as from the sternum and xiphisternum. No muscles were present in the limb. Neither did any muscles insert on the supernumerary pectoral girdle nor on the proximal portion of the supernumerary humerus.

The supernumerary pectoral girdle consists of three components two of which are ossified, the other cartilaginous. These components are immovably articulated with the sternum and the

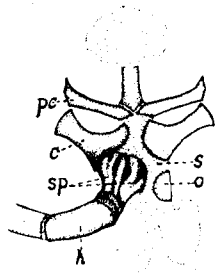

Fig. 3. Drawing, natural size, to illustrate relation of the supernumerary pectoral girdle and fore limb to the sternum and right coracoid. c, right coracoid; h, supernumerary humerus; o, ossified area of sternum, pc, procoracoid; s, sternum; sp, supernumerary pectoral girdle.

right coracoid, as illustrated in figure 3. This articulation involves a marked deflexion of the sternum to the left and ventrally and a modification in the form of the proximal end of the right coracoid. The medial, intermediate, and lateral components of the supernumerary pectoral girdle probably represent coracoid, procoracoid and scapula respectively. These three components, two of which appear in the radiogram in figure 2, are distinctly separated near the proximal end but are in intimate contact with each other at the distal end at which there is a well defined glenoid cavity with a cartilaginous wall. The gleno-humeral articulation is provided with a complete capsule, including a fibrous and a synovial layer, and is freely movable.

The brachium is relatively short. The humerus is thick and slightly curved. The radioulna is immovably articulated with the humerus. The carpal bones, as shown by the radiograms, are not completely ossified. The manus is distinctly double, showing eight imperfectly developed digits. Beneath the skin and associated with the bones of the brachium and antebrachium are a few ligamentous strands and a small amount of loose connective tissue. As stated above, the supernumerary limb contains no muscles. Neither could any nerves be traced into it.

The reduplication of the manus and the distinct separation of the distal portions of the bones of the antebrachium suggest reduplication of all the bones of the limb. In order to test this hypothesis the bones of the supernumerary limb were carefully compared with the bones of a normal fore limb, the disarticulated limb, with skin removed, was radiographed in various positions in order to discover possible lines of fusion, and transverse sections were made, after decalcification, both of the radioulna and the humerus.

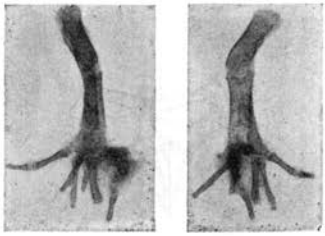

Fig. 4. Radiograms of supernumerary limb with skin removed.

The bones, both of the brachium and antebrachium, are thicker than the corresponding bones in a normal fore limb. As indicated above and as illustrated by the radiograms in figure 4, the distal portion of the bony structure in the antebrachium is divided into two distinct heads which are separated by a deep cleft. Each head supports the skeletal structure of a manus. The greatest diameter of each head lies parallel with the plane which bisects the angle between them and sustains the same relation to the manus as the greatest diameter of the head of a normal radioulna ,which passes through both fused bones. Therefore, comparison with the normal radioulna suggests that both of these heads involve the condyles of a radius and an ulna. This is suggested also by a longitudinal depression in the surface of both heads proximal to the condyles and by somewhat indefinite lines of fusion seen in the radiograms. A study of transverse sections affords evidence of reduplication of the distal but not of the proximal portion of the radioulna. Careful study of the radiograms and transverse sections revealed no conclusive evidence of reduplication or fusion in the humerus.

The experimental work of Howell ('17) on the growth of the bones in the brachium and antebrachium in the dog shows clearly that, while these bones attain almost normal length, their growth in diameter is appreciably retarded in the absence of the mechanical stress and strain due to the normal musculature. Therefore, he concludes that growth in the diameter of these bones is, in a large degree, dependent on the stress and strain of muscles. As stated above, both the humerus and radioulna in the supernumerary limb described above, though free from muscles, exceed in diameter the corresponding bones in the normal fore limbs. In the light of Howell's experimental work this fact seems to warrant the conclusion that the humerus as well as the radioulna in this supernumerary limb is either reduplicated or fundamentally paired.

The literature bearing on polymely of the fore limbs in the frog

was reviewed recently by Colton ('22) who tabulated the recorded cases and also described an interesting case of his own. Therefore, a review of this literature will not be included in this paper. There is little in this literature which affords a basis for the explanation of the causes of this anomaly in any given instance. However, experimental embryology sheds some light on this problem.

The experimental work of Harrison('21) shows clearly that in *Amblystoma punctatum,* a related Amphibian species, an apparently complete limb, including a reduced pectoral girdle, may arise from a transplant which does not include all the tissue in the limb bud area. Indeed, he maintains that "provided the combination is harmonic," a complete limb may develop following the "inoculation of mesoderm cells from the limb bud under the skin in some other region of the embryo." In certain experiments a whole limb developed out of a single half bud. In some instances limbs derived from an incomplete limb bud also exhibited reduplication of parts.

The theory that a supernumerary limb may represent an embryonic inclusion can not be wholly disregarded. However, in the light of the experimental work cited above, the writer believes that the facts observed in the present case are not incompatible with the theory that the supernumerary limb arose from a portion of the right anterior limb bud which became separated and displaced from the remaining tissue in the limb bud area.

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