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Actinopterygian postcranial skeleton with special reference to the diversity of fin ray elements, and the problem of identifying homologies

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Abstract

The actinopterygian postcranial skeleton is not as well known as its cranial counterpart, and consequently it is less represented in phylogenetic analyses. Due to this incomplete knowledge, it is often difficult to postulate hypotheses about homologous structures. Fin rays, scutes, fulcra, and spines have been traditionally interpreted as modified scales, but their diversity has been almost ignored. The present study reveals differences in the structure and role of procurrent rays, principal rays, rudimentary rays, and spines of unpaired fins in teleosteomorphs (including †'pholidophoriforms') versus "true" teleosts and other actinopterygians. Based on results presented here, revised definitions of these elements are provided.

Presence of long, segmented-but-unbranched first and last principal rays forming the leading margins of the caudal fin is interpreted as a new synapomorphy of Teleostei. In contrast, leading margins of the caudal fin formed by more than one principal ray (mainly segmented-and-branched rays) are consistently present in teleosteomorphs, e.g., †pachycormiforms, †aspidorhynchiforms, and diverse †'pholidophoriforms'. Similar patterns are found in both dorsal and anal fins where the main leading marginal ray is a segmented-and-branched principal ray in teleosteomorphs. This is in contrast to true teleosts, where the long, first (segmented but unbranched) principal ray has this role. A new structure, named complex ray, is described here for a lepidotrichium that fuses to elements like basal fulcra (e.g., †'pholidophoriforms') or bony splints (e.g., †*Tharsis*, elopiforms, albuliforms). The absence of a complex first pectoral ray is a synapomorphy of osteoglossomorphs plus more advanced teleosts and its presence is a symplesiomorphy shared by teleosteomorphs and basal teleosts including elopiforms and albuliforms. In contrast to a complex ray, a spine is the result of early fusion of two hemilepidotrichia into a strong, massive ray. Spines are found in phylogenetically unrelated actinopterygians (e.g., acipenserids, probably †pachycormiforms, and some teleosts) and are interpreted as independently acquired in those groups. Spines and complex rays are non-homologous structures. Basal fulcra are paired or unpaired elements, which can be present simultaneously in an individual; often the most anterior basal fulcra are unpaired whereas the most posterior fulcra are consistently paired. They are commonly present in unpaired fins of non-teleostean fishes. Among extant fishes they are absent in polypteriforms, *Amia*, and most teleosts. Because of their placement, structure, and phylogenetic occurrence, basal fulcra and procurrent rays are interpreted as homologous elements. Whereas "true" teleosts lack any fulcra on paired fins (a synapomorphy of the group), basal fulcra as well as fringing fulcra are described for 'pholidophoriforms' paired fins. Fringing fulcra are always paired. Three types of fringing fulcra series are described. Beyond the following, their distribution among actinopterygians remains unknown. The series of fringing fulcra in basal actinopterygians is formed by expanded terminal segments of marginal lepidotrichia. The series formed by a combination of expanded terminal segments of rays and independent spiny, small elements (more traditionally named as fringing fulcra) in teleosteomorphs. Only a series of spiny elements along the leading marginal fin ray(s) are found in some halecostomes. The origin and early structure of the spiny, independent fringing fulcra remain unknown.

Beyond the descriptions of new structures and reinterpretations of others, this survey has revealed new characters that support different actinopterygian groups.

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