

Early diversification of actinopterygians

Richard CLOUTIER & Gloria ARRATIA

Abstract

During the past decade, new Devonian (e.g., *Cheirolepis* n. sp., *Dialipina salgueiroensis*, *Limnomis*) and Carboniferous actinopterygians (e.g., *Aesopichthys*, *Cyranorhis*, *Discoserra*, *Guildayichthys*, *Kalops*, *Melanecta*, *Mesopoma*, *Proceramala*, *Wendychthys*, *Woodichthys*) have been discovered around the world. In addition, new basal osteichthyan taxa, such as *Psarolepis*, have been found showing puzzling combinations of actinopterygian and sarcopterygian characters. Although the monophyly of the Actinopterygii has never been questioned, the synapomorphies corroborating the monophyly as well as the interrelationships among basal actinopterygians vary among the studies. The Late Silurian *Lophosteus*, the Early Devonian *Dialipina*, the Middle-Late Devonian *Cheirolepis*, the Frasnian *Howqualepis*, and the recent *Polypterus* have each been identified as the basal taxon of the actinopterygians. A combined data matrix is compiled in order to include 142 cranial and 43 postcranial characters (new and previously published characters) of 33 basal Paleozoic actinopterygians, five advanced actinopterygians (including the Jurassic *Leptolepis*, and the living *Polypterus*, *Acipenser*, *Amia*, and *Lepisosteus*) and four basal osteichthyans. Phylogenetic characters are redefined. Owing to the morphological diversity of fossil and living taxa and the morphological incompleteness of certain species, the large proportion of missing data generates conflictual phylogenetic information. We evaluated the influence of outgroup selection, the inclusion/exclusion of Jurassic and living taxa, and the inclusion/deletion of poorly known characters on the resolution of lower actinopterygians. Although some interrelationships among Devonian and Carboniferous taxa are well corroborated, phylogenetic uncertainties remain for the position of certain taxa.

Introduction

In order to investigate the origin and early diversification of the actinopterygians, it is enlightening to provide a brief parallel between actinopterygians and sarcopterygians. First, both groups represent the most diversified taxa of living vertebrates. The diversity of living actinopterygians is estimated to some 29 000 species, whereas the sarcopterygian count is approximated to 25 000 living species (CLOUTIER 2000a,b). Second, the oldest representatives of both groups go as far back as the Late Silurian. Four Late Silurian actinopterygians have been described: *Andreolepis hedei* (uppermost Lower or Middle Ludlow to Pridoli) is known from Sweden, Poland, the Baltic regions, Russia, Siberia, and South Wales (TURNER 2000); *Lophosteus superbus* is known from Saaremaa, Estonia; and Ludlowian *Ligulalepis yunnanensis* and Late Wenlockian *Naxilepis gracilis* have been identified in eastern Yunnan in southern China (ZHU & WANG 2000); undetermined Ludlowian palaeoniscoid scales have been mentioned from Australia (BURROW & TURNER 2000). On the other hand, the basal sarcopterygian *Psarolepis* sp. is reported from the Pridoli of China and Vietnam (ZHU & SCHULTZE 1997, ZHU et al. 1999, ZHU & WANG 2000). Thus, the common origin of these sister taxa dates at least from the Lower Silurian approximately 425 million years ago. Although actinopterygians are most diversified today, their early diversification during the Devonian was slower than that of sarcopterygians. While fewer than 20 species of Devonian actinopterygians have been discovered, more than 180 sarcopterygian species have been described (CLOUTIER & AHLBERG 1996). This fact might explain in part the major discrepancy between the numbers of phylogenetic studies dealing with the early diversification of both groups. A dozen studies focus on interrelationships among lower actinopterygians, whereas a few dozen concern lower sarcopterygian taxa. However, one paleoichthyologist, Hans-Peter SCHULTZE, has contributed significantly to our understanding of the basal interrelationships of both groups.

The whole contribution can be purchased as PDF file.

Availability

Generally all our publications are available as PDF files; full publications as a general rule after the printed version is out of print. If you have questions concerning particular contributions please contact us by e-mail:

pdf@pfeil-verlag.de.

The PDF files are protected by copyright.

The PDF file may be printed for personal use.

The reproduction and dissemination of the content or part of it is permitted.

It is not allowed to transfer the digital personal certificate or the password to other persons.

Prices

Books: Prices are to be found in the catalog.

Articles in journals and single contributions or chapters in books:

10 EURO basic price per order (including the first 10 pages),
and

0.50 EURO per page, beginning with the 11th page.

Page numbers are found in the contents of the publications.

Orders

Use our order form for PDF files or send your order informal per e-mail (pdf@pfeil-verlag.de). The only accepted payment is by credit card. While using the order form for PDF files, your data will be transmitted by secure link (ssl). You also may send the informations informally by e-mail, fax, phone or mail.

Handling

As soon as possible, depending on our business hours and your order, you will receive your PDF file together with the certificate and password by e-mail.

Larger PDF files can be downloaded from our webpage, if necessary.

Your invoice will be sent out by e-mail after we charged your credit card.

To open the encrypted PDF files you have to install your personal certificate after your first order. All PDF files with the same certificate can be opened from that time on.

Dieser Beitrag kann als PDF-Datei erworben werden.

Verfügbarkeit von PDF-Dateien

Prinzipiell sind von allen unseren Publikationen PDF-Dateien erhältlich. Komplette Publikationen in der Regel erst nachdem die gedruckte Version vergriffen ist. Anfragen bezüglich bestimmter Beiträge richten Sie bitte per E-Mail an pdf@pfeil-verlag.de.

Die PDF-Dateien sind urheberrechtlich geschützt.

Ein Ausdruck der PDF-Dateien ist nur für den persönlichen Gebrauch erlaubt.

Die Vervielfältigung von Ausdrucken, erneutes Digitalisieren sowie die Weitergabe von Texten und Abbildungen sind nicht gestattet.

Das persönliche Zertifikat und das Passwort dürfen nicht an Dritte weitergegeben werden.

Preise

Bücher: Die Preise sind dem Katalog zu entnehmen. Zeitschriftenbeiträge und einzelne Kapitel aus Sammelbänden bzw. Büchern:

10 EURO Grundbetrag pro Bestellung (einschließlich der ersten 10 Seiten),
und

0,50 EURO pro Seite ab der 11. Seite.

Den Umfang der Beiträge entnehmen Sie bitte den Inhaltsverzeichnissen.

Bestellungen

Bestellungen sind mit dem PDF-Bestellformular oder formlos per E-Mail (pdf@pfeil-verlag.de) an uns zu richten. Die Bezahlung ist ausschließlich per Kreditkarte möglich. Bei Verwendung unseres Bestellformulars werden die Kreditkartendaten über eine gesicherte Verbindung (ssl) übermittelt. Sie können die Daten aber auch formlos per E-Mail, Fax, Post oder telefonisch übermitteln.

Abwicklung

So bald wie möglich, aber abhängig von unseren Bürozeiten und der gewünschten Bestellung, schicken wir Ihnen die PDF-Datei(en) zusammen mit Ihrem persönlichen Zertifikat und dem zugehörigem Passwort per E-Mail. Größere Dateien bieten wir Ihnen gegebenenfalls zum Herunterladen an.

Der fällige Betrag wird von Ihrer Kreditkarte abgebucht und Sie erhalten die Rechnung ebenfalls per E-Mail.

Um die verschlüsselten PDF-Dateien öffnen zu können, muss bei der ersten Bestellung das passwortgeschützte persönliches Zertifikat installiert werden, welches anschließend auf dem Rechner verbleibt. Alle mit diesem Zertifikat verschlüsselten Dateien können anschließend auf diesem Rechner geöffnet werden.