

A review of the interrelationships of the order Ellimmichthyiformes (Teleostei: Clupeomorpha)

Jesús ALVARADO-ORTEGA, Ernesto OVALLES-DAMIÁN & Gloria ARRATIA

Abstract

A review of the interrelationships within the extinct order Ellimmichthyiformes is performed including data used by previous authors and species belonging to the genera *Diplomystus*, *Ellimmichthys*, *Ellimma*, *Ezcutuberezi*, *Paraclupea*, *Sorbinichthys*, *Triplomystus*, and *Scutatuspinosus*. Two new forms from El Espinal Quarry, Chiapas, Mexico, are included; one belongs to a new species of *Triplomystus* and the other has been named as *Paraclupea*-like. The phylogenetic hypothesis obtained involves two kinds of characters: discrete and continuous. The use of discrete characters is not sufficient to generate a completely resolved phylogenetic hypothesis. The present results support the monophyly of the order Ellimmichthyiformes with two families, the Paraclupeidae and Sorbinichthyidae fam. nov. The family Paraclupeidae includes *Scutatuspinosus*, *Ellimma*, *Ezcutuberezi*, *Ellimmichthys*, *Diplomystus solignaci*, *Paraclupea*, *Paraclupea*-like and *Triplomystus*, whereas the family Sorbinichthyidae includes *Sorbinichthys* and the nominal species of the genus *Diplomystus*, with the exception of *D. solignaci*. Based on this hypothesis and the paleogeographic and temporal distribution of the ellimmichthyiforms, it is suggested that the paraclupeids were an Early Cretaceous group distributed along the Megathethys, including the southeastern border of Asia, whereas the sorbinichthyids had a more eastern distribution, from Europe and the Middle East to Asia and North America, and reached their greatest diversity in the Late Cretaceous.

Introduction

The interrelationships of the Ellimmichthyiformes, a group of fossil fishes commonly named “double armored herrings”, has been studied since GRANDE (1985) erected this order. As Figure 1 illustrates, previous phylogenetic studies of this Early Cretaceous-Eocene primitive clupeomorph group have not included all nominal species of this group and, in some ways, they contradict each other. This prevents the recognition of any pattern in their paleogeographic distribution, which has been considered to be a paleontological puzzle (CHANG & CHEN 2000) that was already beginning to be solved by CHANG & MAISEY (2003). In this work, we analyze all published data as well as our new evidence and interpretations to the greatest possible extent. We also include a brief review of the rare Brazilian species, *Scutatupinosus itapagipensis* SILVA-SANTOS & CORREA, 1985 (Fig. 2), originally considered to be a clupeiform incertae sedis, and whose re-description is under preparation by F. J. de FIGUEREIDO (pers. comm. 2006). Additionally, two Mexican species from the El Espinal Quarry, Chiapas, southeastern Mexico (Figs. 3, 4), are included; one has been recognized as a new species belonging to *Triplomystus* (ALVARADO-ORTEGA & OVALLES-DAMIÁN 2008) and the other has been named as *Paraclupea*-like (OVALLES-DAMIÁN 2004, OVALLES-DAMIÁN & ALVARADO-ORTEGA 2002, ALVARADO-ORTEGA et al. 2006).

This review is based on ZARAGÜETA-BAGILS (2002, 2004), who performed the most extensive phylogenetic studies of the Ellimmichthyiformes as they are currently understood, in which he rejected the monophyly of this order as it was defined by previous authors (Fig. 1). Additionally, characters from other authors such as GRANDE (1982, 1985), CHANG & GRANDE (1997), POYATO-ARIZA et al. (2000), CHANG & MAISEY (2003), and FOREY (2004) are included. The goal of this paper is to integrate all available data by providing a comparison of such previous hypotheses and to review previously used characters. This paper will also demonstrate the effect of including new taxa in previous phylogenetic analyses.

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.