

# A three-dimensional skull of a primitive clupeomorph from the Cenomanian English Chalk, and implications for the evolution of the clupeomorph acusticolateralis system

Peter L. FOREY

## Abstract

A three-dimensional skull of a †paraclupeid is described and referred to the genus †*Diplomystus* based on the shape of the dorsal scutes. All other †paraclupeids are known only from flattened or nearly flattened specimens. Therefore, this skull provides hitherto unavailable data on delicate braincase structures. This study allows a more complete assessment of primitive clupeomorph conditions and contributes to our understanding of how the complex specialisations of the acusticolateralis system in Recent clupeiform fishes developed. All are absent from †paraclupeids. A phylogeny is proposed (†Paraclupeidae (†*Spratticeps* (†*Santanaclupea*, †*Denticeps*, clupeids))) which acknowledges a sequential acquisition of acusticolateralis specialisations. Additionally, some derived characters are identified within the †paraclupeids such as excavated parietals and enlarged entopterygoid teeth occluding with enlarged teeth upon a consolidated basibranchial toothplate.

## Introduction

The family †Paraclupeidae CHANG & CHOU 1977 (= †Ellimmichthyidae GRANDE, 1982 after CHANG & GRANDE 1997) is a group of Lower Cretaceous to Middle Eocene clupeomorph fishes consisting of at least six genera (†*Ellimmichthys*, †*Paraclupea*, †*Triplomystus*, †*Sorbinichthys*, †*Ezkutubrezei* and †*Diplomystus*) and at least ten species (see below). They are characterised by laterally expanded and subrectangular dorsal scutes each of which bears a median keel. Our current view on the phylogenetic placement of these fishes GRANDE (1982) suggests that †paraclupeids, the only family within the order †Ellimmichthyiformes, with the genus †*Armigatus*, form an unresolved trichotomy with the crown group clupeiforms. †*Spratticeps gaultinus* PATTERSON, 1970, currently known only by isolated partial braincases, may be a stem species to Recent clupeiforms. A phylogenetic framework current in the literature is shown in Figure 1 together with some of the characters listed in the legend. †Paraclupeids and †*Armigatus* are regarded as plesiomorphic clupeomorphs because they lack a recessus lateralis (a convergence of sensory canals in the temporal region separated from the perilymphatic cavity of the inner ear by a membrane). Some of these characters mentioned in Figure 1, such as the presence of pre-epiotic fossae, prootic and pterotic bullae, are difficult to see in material that has been flattened during fossilisation. Most currently described †paraclupeids are preserved flattened and therefore the systematic distribution of some of these features is unknown. The importance of the specimen described in this paper is that it is preserved in perfect three-dimensions and therefore many cranial details can be seen undistorted. Furthermore, it can be identified as belonging to the genus †*Diplomystus* by virtue of the fact that the dorsal scutes are pectinated along their posterior borders (GRANDE 1982) and the supraoccipital crest is enlarged. It is therefore possible to answer some uncertainties concerning the more delicate structures. Additionally this specimen shows a very well-preserved palate and copula and this adds considerable information to our knowledge of the visceral skeleton which is currently very scanty in other †paraclupeids. In nearly all areas of the skull which can be directly compared, this †*Diplomystus* specimen is similar to other †paraclupeids. Therefore, it may be legitimate to extrapolate

## 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 11<sup>th</sup> 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.